BHARAT COKING COAL LTD.
A Mini Ratna Company
(A Subsidiary of Coal India Ltd.)
REGD.Office: KoylaBhawan, Koyla Nagar, Dhanbad-826005
CIN No.U10101JH1972GO1000918
OFFICE OF THE GENERAL MANAGER
BARORA AREA

Ref No.GM/AR-1/ENV./2025/ 1510 Dated: - 29/11/25

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

Sub: Six monthly reports on implementation of Environmental measures for the period from April 2025 to September 2025 in respect of Cluster –XV group of mines

Ref.: -EC Order No. J-11015/100/2011-IA. II (M)

Dear Sir,
Kindly find enclosed herewith the six-monthly report on implementation of Environmental measures for the period from April 2025 to September 2025 in respect of Cluster –XV group of mines. Kharkharee colliery having leasehold area 584.00 Ha is under mining operation. Remaining three mines have been closed for production.
This is for your kind information and doing needful, please.

Yours faithfully

29.11.25
General Manager
Barora Area

Encl: as above
Cc to:
1. HoD (Envt.), BCCL, Koyla Bhawan, Dhanbad (Through Email)
2. Nodal Officer (Envt.), Govindpur Area (Through Email)

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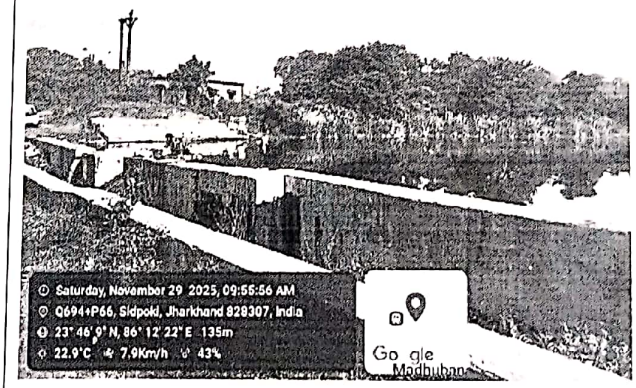
ENVIRONMENTAL CLEARANCE COMPLIANCE OF CLUSTER-XV

(GRANTED VIDE J-11015/100/2011-IA.II (M) Dated 16.12.2013)

April 2025 to September 2025

<table>
<tr><th>S. No.</th><th>A. Specific Conditions by MoEF&CC:</th><th>Compliance</th></tr>
<tr><td>i</td><td>The maximum production in the cluster shall not exceed beyond that for which environmental clearance has been granted for Cluster –XV as per given below:
<table>
<tr><th rowspan="2">Sl. No.</th><th rowspan="2">Name of Mines</th><th colspan="2">Production capacity (MTPY)</th><th rowspan="2">Leasehold area (Ha.)</th></tr>
<tr><th>Normative</th><th>Peak</th></tr>
<tr><td>1</td><td>Kharkharee Coll.</td><td>0.092</td><td>0.12</td><td>584.00</td></tr>
<tr><td>2</td><td>Madhuband coll.</td><td>0.113</td><td>0.147</td><td>393.77</td></tr>
<tr><td>3</td><td>Phularitand coll.</td><td>0.120</td><td>0.156</td><td>340.88</td></tr>
<tr><td>4</td><td>Dharmabandhcoll(Closed for production)</td><td>0</td><td>0</td><td>377.90</td></tr>
<tr><td></td><td>Total</td><td>0.325</td><td>0.423</td><td>1696.55</td></tr>
</table></td><td>The production from the cluster is within the limit for which Environmental clearance has been granted.
Kharkharee colliery having leasehold area 584.00 Ha is under mining operation. Details of production from Kharkharee Colliery is given below:
<table>
<tr><th>FY</th><th>Production (Te)</th></tr>
<tr><td>2023-24</td><td>5283.94</td></tr>
<tr><td>2024-25</td><td>768.38</td></tr>
<tr><td>2025-26 (till 30th Sept.' 2025)</td><td>0</td></tr>
</table>
Remaining three mines have been closed for production.</td></tr>
<tr><td>Ii</td><td>The proponent shall prepare a contingency plan for subsidence.</td><td>It is being complied as per the guidelines of DGMS.</td></tr>
<tr><td>Iii</td><td>Keeping in view the pattern of the subsidence in the area, no depillaring should be carried out until the rehabilitation of the affected families and shifting of infrastructure.</td><td>It shall be complied. No depillaring is being carried out at present.</td></tr>
<tr><td>Iv</td><td>The channels adjoining the ML area leading to Jamunia river should not be disturbed and be regularly desilted.</td><td>It is being complied.</td></tr>
<tr><td>V</td><td>The quality of the Jamunia river water should be continuously monitored and in order to prevent silting, a series of check dams should be constructed using boulders. This will help in recharging the ground water.</td><td>It is being complied. Check dams have been constructed at nullahs.
 

(Pictures of Check dams is attached as Annexure XV)</td></tr>
<tr><td>vi</td><td>The coal from the mines will be transported by mechanically covered trucks within two months.</td><td>Presently, coal transportation on public roads is being done by covering vehicle with tarpaulin.</td></tr>
<tr><td>Vii</td><td>In underground mining there is presence of organic gases. These gases are volatile in nature. Due to transmission of air, fire takes place. The routine mining engineering will not serve the purpose. Therefore, proper studies are carried out to understand underground seams and how these fire areas could be sealed from further spreading.</td><td>All the statutory provisions under Mines Act, 1952 and CMR, 1957 along with statutes constituted under Mines Act are fully complied to prevent any occurrence of fire. Regular monitoring and inspection are done by DGMS.</td></tr>
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Viii	**Cumulative impact of fire and gases for all the clusters of coal mines in Jharia Coal field is carried out.**	It is being complied. Presently, Revised Master Plan approved by GoI is under implementation for this purpose. Fire control in Jharia and its periphery is being done according to revised Jharia Master Plan approved by Cabinet committee on Economic Affairs (CCEA).
Ix	**National Remote Sensing Agency (NRSA) should be contacted for thermal imaging techniques which are being utilized for assessing the extent of impact of underground of fire. BCCL should consider for an MOU with NRSA for short and long term studies so as to obtain detailed information on Satellite imagery, thermal imagery, subsidence prediction and surface features of the mining area.**	The latest NRSA map is being submitted to RO, Ranchi and enclosed herewith. Action is being taken as specified in EC and as per Revised Jharia Master Plan approved by Cabinet committee on Economic Affairs (CCEA). **(NRSA Report attached as Annexure I)** Project Report On Delineation of Surface Coal Fire and associated Land Subsidence in Jharia Coalfield (2022-2024), Jharkhand using satellite based remote-sensing techniques A collaborative project between National Remote Sensing Centre (NRSC) Indian Space Research Organisation (ISRO) Hyderabad - 500 037 Bharat Coking Coal Limited Koyla Bhawan, Koyla Nagar Dhanbad, Jharkhand May, 2025
x	**The Project proponent should monitor the water quality of the Jamunia river as per the standards prescribed by the JSPCB/CPCB to maintain the required BOD in the river water.**	Work of monitoring ambient environment including water quality of the Jamunia river is being done by CMPDIL, Ranchi. **(Monitoring report of Jamunia River is enclosed as Annexure II)**
xi	**The nullah as adjacent to the river should not be disturbed.**	It is being complied. The nullah adjacent to the river will not be disturbed.
Xii	**The open cast quarries of the abandoned mines should be backfilled to the ground level and restored with native species.**	It is being complied.
Xiii	**All coal from the smaller U/G mines should be transported by high capacity and mechanically covered trucks/tippers.**	Coal is being transported on public road in tarpaulin covered trucks.
Xiv	**Green belts shall be developed on both sides of the roads.**	Plantations have been carried out in consultation of DFO, Dhanbad. **(Plantation is enclosed as Annexure VI)**
XV	**Action plan for quenching of fires and rehabilitation along with the details of master plan be submitted to MOEF for monitoring purpose.**	It is being complied. The Revised Jharia Master Plan approved by Cabinet committee on Economic Affairs (CCEA) is uploaded on BCCL website **(Master Plan for Fire, Subsidence and Rehabilitation is enclosed as Annexure III).**

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		BHARAT COKING COAL LIMITED MASTER PLAN FOR DEALING WITH FIRE, SUBSIDENCE AND REHABILITATION IN THE LEASEHOLD OF BCCL UPDATED MARCH' 2008. CENTRAL MINE PLANNING & DESIGN INSTITUTE LTD REGIONAL INSTITUTE - 2 DHANBAD
XVI	**Presently coal of Munidih washery from other mines of the cluster is taking place through NH. An alternate route for coal transportation may be explored.**	Munidih washery doesn't exist in Cluster XV. Coal transportation is being done by tarpaulin covered truck on public roads.
XVII	**For understanding the composition of emissions from coal mine fires, BCCL may initiate action as proposed in the visit report of the EAC to Dhanbad.**	**Source Apportionment Study**: 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/Envt./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 dated January'2023 **(NEERI Report is attached as Annexure VII)**

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		"Source apportionment of ambient air particulate matter in Jharia coalfield: region, Jharkhand" Sponsor Bharat Coking Coal Limited (BCCL) CSIR-National Environmental Engineering Research Institute, Nagpur April 2022
XVIII	**The approved mining plan is submitted to the MOEF.**	Most of the BCCL mines are taken over mines from the erstwhile private owners who were operating mines without mine plans at the time of nationalization and now are being operated as per project reports/feasibility reports/Mine Closure Plans prepared by CMPDIL and the guide lines of DGMS.
XIX	**The measure to identify in the Environmental Plan for Cluster- XV groups of mine and the conditions given in this environmental clearance letter shall be dovetailed to the implementation of the Jharia Action Plan.**	Dhanbad Action Plan is being implemented. The salient actions of this area: 1. Covered transportation of Coal. 2. Water sprinkling. 3. Plantation. 4. Utilization of surplus mine water 5. Installation of PM10 online analyzers at mines.
XX	**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 XV 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 prevent ingress of air (Ventilation) in such areas, which may restart fresh fires.**	The latest NRSA map is being submitted to RO, Ranchi and enclosed herewith. **(NRSA Report attached as Annexure I)** Action is being taken as specified in EC and as per revised Jharia Master Plan approved by Cabinet committee on Economic Affairs (CCEA).

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XXI	**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.**	It is being complied.
XXII	**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.**	It is being complied. Mining is being carried out as per the guidelines of DGMS. All mines are UG in cluster-XV
XXIII	**Mining shall be carried out as per statuette 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.**	It is being complied. Mining is being carried out as per the guidelines of DGMS.
XXIV	**Total afforestation plan shall be implemented covering an area of 621.28 Ha. (Additional) at the end of mining which will include, Green belt over an area of 229.12 Ha., density of tree plantation 2500/ Ha. Of plants.**	Being complied. Details are attached as **Annexure-VI**
XXV	**Details of transportation, CSR, R&R and implementation of environmental action plan for the clusters XV should be brought out in a booklet from within a year and regularly updated.**	It is being followed. CSR dept. has been established at area level. **(CSR Activities enclosed as Annexure VIII)** CSR Booklet Barora Area Bharat Coking Coal Limited
XXVI	**Specific mitigative measures identified for the Jharia Coalfields in the Environmental Action Plan prepared for Dhanbad as a critically polluted are and relevant for Cluster- XV shall be implemented**	Dhanbad Action Plan is being implemented. The salient actions of this area: 1. Covered transportation of Coal. 2. Water sprinkling. 3. Plantation. 4. Utilization of surplus mine water 5. Installation of PM10 online analyzers at mines.
XXVII	**The locations of monitoring stations in the Jharia coalfield should be finalized in consultation with Jharkhand State Pollution Control Board. Committee stated that**	Establishment of ambient environment quality monitoring stations has been finalized with the consultation of

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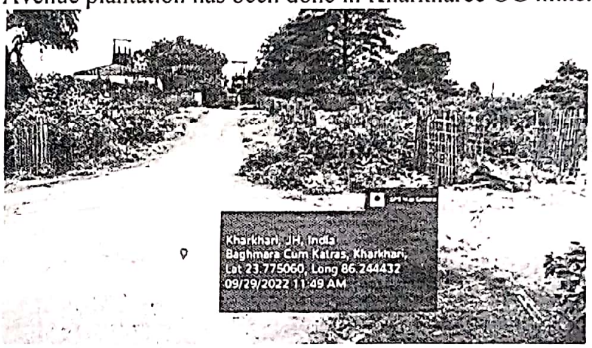
	wood, coal, fly ash from TPPs, silica from natural dust, etc.) and a source Apportionment Study should be got carried out for the entire Jharia Coalfields. Mineralogical composition study should be undertaken on the composition of the suspended particulate matter (PM_{10} and $PM_{2.5}$) in Jharia Coalfields and also quantified. These studies would help ascertain source and extent of the air pollution, based on which appropriate mitigative measures could be taken.	done by Central Institute of Mining & Fuel Research (CIMFR), Dhanbad, which is a CSIR laboratory recognized under the EP Rules. Now the monitoring work has been taken up by CMPDIL, Ranchi. **Source Apportionment Study**: 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/Envt./SOURCEAPPORTIONMENT(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 dated January 2023 **(NEERI Report is attached as Annexure VII).**
XVIII	**The proponent will continue the existing Road-Rail transport network system in view of the implementation of the Master Plan (For 10 years) and another 5 Years gestation period after the completion of Master Plan for consolidation of the backfilled dug out fire areas and unstable areas is required. All mitigation measures (like covered trucks, green belting on either side of the roads, enhanced water sprinkling, strengthening and maintaining the roads etc.) shall be adopted up to 15 years (phase-I) with the existing Road- Rail transport system. In phase – II, BCCL shall implement conveyor-cum-rail transport to avoid movement of trucks within the cluster for coal transportation in phase-II which shall start after 15 years. Transportation of coal shall be by Rail and Conveyor belt, minimizing the existing road transport system in all the mines of the cluster and shall continue after 15 years. Loading of coal by pay loaders shall be discontinued. Adequate number suitably designed off-take points shall be provided.**	Coal transportation is being done by tarpaulin covered trucks on public roads. Water Sprinkling is being done through water tanker. Approach road is black topped and well maintained. Avenue plantation has been done in Kharkharee UG mine. 
XXIX	**1537 nos. of PAFs should be rehabilitated at cost of Rs.140.03 crores as per the approved Jharia Action Plan.**	It is being complied as per Revised Jharia Action Plan approved by Cabinet committee on Economic Affairs (CCEA).
XXX	**Regular monitoring of subsidence movement on the surface over and around 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.**	It shall be complied. No depillaring is being carried out at present.
XXXI	**Coal Extraction shall also be optimized in areas where agricultural production is continuing. Some pillars shall be left below the agricultural land. No depillaring & coal extraction should be carried out below habitation, H.T Lines & beneath road, water bodies.**	It is being complied. No depillaring & coal extraction will be carried out below habitation, H.T Lines & beneath road, water bodies.
XXXII	**Subsidence shall be monitored closely and if subsidence is found exceeding the permitted limits, then the land owners shall be adequately compensated with mutual agreement with the land owners.**	No depillaring is being carried out at present.
XXXIII	**3-tiers plantation should be developed 2KM stretch of road from the mine using native species.**	It is being complied. Plantation with native species has been done in the mine lease. **(Plantation details are attached as Annexure VI)**
XXXIV	**Water sprinkling system shall be provided to check fugitive emission from loading operations, conveyor**	It is being complied. Water Sprinkling is being done through water tanker. Approach road is black topped and

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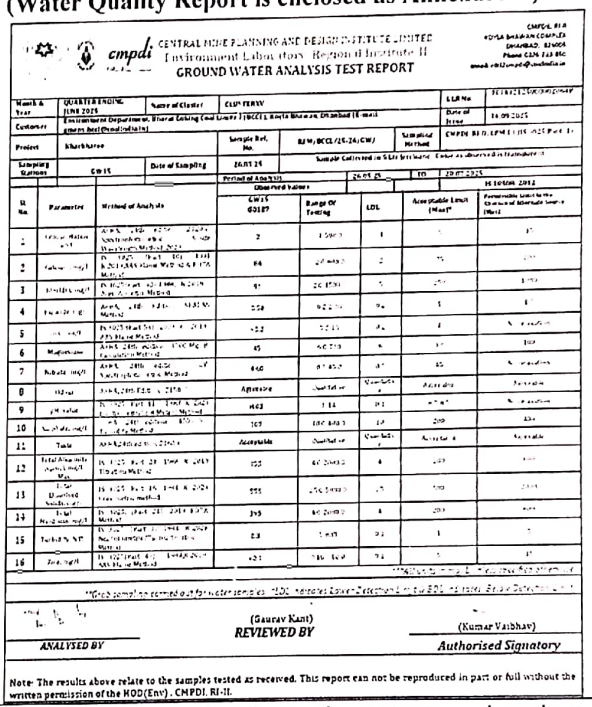
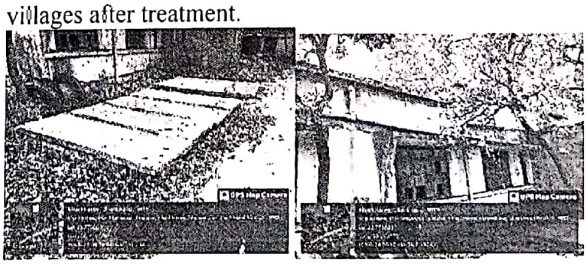
	system, haulage roads, transfer points, etc. Major approach roads shall be black topped and properly maintained.	well maintained.
XXXV	A progressive afforestation plan shall be prepared and implemented over the mine lease area acquired and shall include areas under green belt development, areas along roads infrastructure, along ML boundary and township etc, by planting native species in consultation with the local DFO/Agricultural Department.	It is being complied. Plantation has been done in consultation with the DFO, Dhanbad. **(Plantation Details are attached as Annexure VI)**
XXXVI	Acid water Treatment Plant, volume of water to be treated and disposal of brine should be provided.	There is no issue of Acid mine water in Cluster-XV.
XXXVII	Mine discharge water outside the ML shall be monitored, particularly for TDS and treated to confirm prescribed levels before discharge into the natural environment.	Mine discharge water is being allowed to settle down in the mine sumps before disposal into storage reservoirs. The monitoring of water quality parameters is being done through CMPDIL RI-II, Dhanbad and parameters are well within the prescribed limit provided by CPCB. **(Water Quality Report is enclosed as Annexure V)** 
XXXVIII	The Company shall put up artificial groundwater recharge measures for augmentation of ground water resource, incase water table shows a declining trend. The project authorities shall meet water requirement of nearby village(s) in case the village wells go dry due to dewatering of mines.	Roof top rain water harvesting structure has been constructed at Office of Project Officer, Kharkharee Colliery. Excess mine water is being supplied to nearby villages after treatment. 
XXXIX	Besides carrying out regular periodic health check up of their workers, 10% of the workers identified from workforce engaged in active mining operations shall be subjected to health check up for occupational disease and hearing impairment, if any, through an agency such as NIOH, Ahemdabad within a period of one year and the results reported to this Ministry and to DGMS.	**NIOH study**: -Final report has been submitted by NIOH which has already been scrutinized by medical department, BCCL. **(NIOH Report is enclosed as Annexure IX)**

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		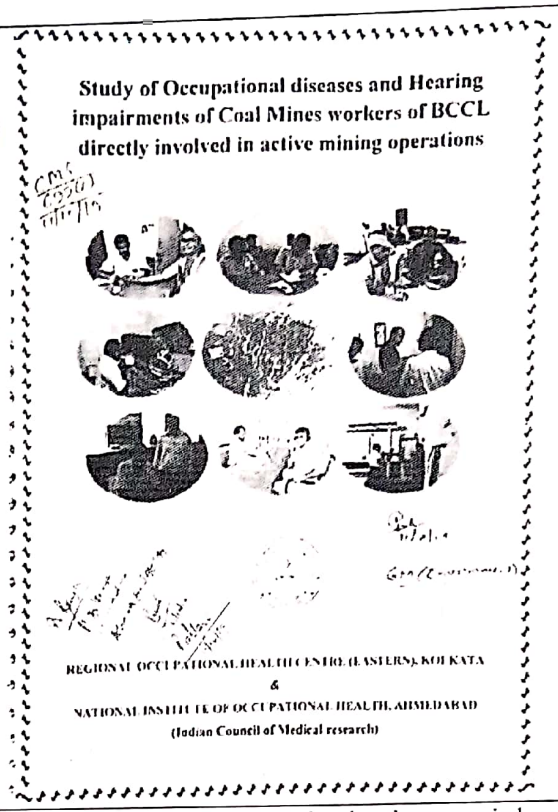
xL	**The mining in the existing mines would be phased out after expiry of the current mining lease and after reclamation of mined over area. The operating mines may be analyzed and monitored for compliance of conditions, having bearing with movement of wild life until such time they are closed/phased out.**	It shall be complied. Reclamation has been carried out in phased manner.
xLi	**Sufficient coal pillars shall be left unextracted around the air shaft (within the subsidence influence area) to protect from any damage from subsidence, if any.**	It is being complied. Coal pillars will be left unextracted around the air shaft to avoid subsidence.
xLii	**High root density tree species shall be selected and planted over likely areas to be affected by subsidence.**	It is being complied. Plantation has been carried out in consultation with DFO, Dhanbad. Native species has been planted. **(Plantation Details are attached As Annexure VI)**
xLiii	**Depression due to subsidence resulting in water accumulating within the low lying areas shall be filled up or drained out by cutting drains.**	It is being complied. Depression due to subsidence will be filled. Presently, no depillaring has been carried out.
xLiv	**Solid barriers shall be left below the roads falling within the blocks to avoid any damage to the roads.**	It is being complied. Solid barriers are constructed at critical points.
xLv	**The CSR Action Plan shall consist of need-based CSR Action Plan, CSR Auditing and monitoring mechanism etc. The proponent will spend 5% of the retained earnings of the previous year subject to a minimum of Rs.5/- per tonne of coal production which should be adjusted as per the annual inflation. The progress made there on shall be uploaded on the company website. Monitoring of the impact of the activities under CSR shall be carried out periodically**	It is being complied. CSR expenditure is being dealt at M/s BCCL HQ level and Cluster-XV is a contributor for the same.
xLvi	**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**	BCCL is implementing CSR activities. A separate CSR committee has been formed at area level, who 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

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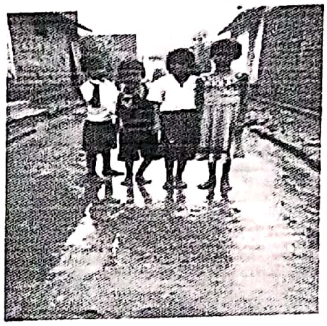
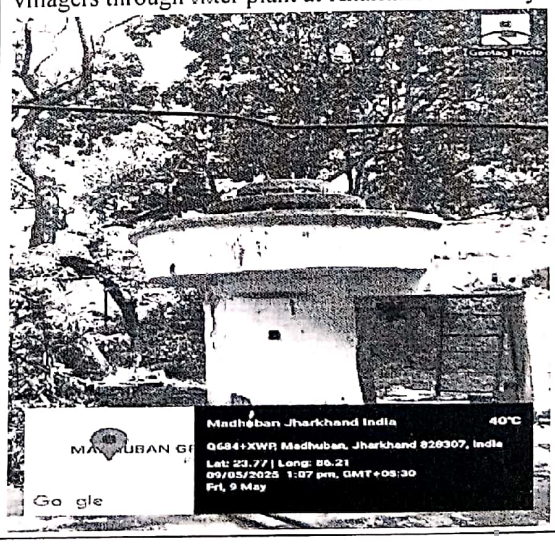
	company website every year. The company must give priority to capacity building both within the company and to the local youth, who are motivated to carry out the work in future. The gap/space available between the entire mine area should be suitably planted with native species. Plantation should also be made in vacant area and along the road side so as to reduce dust pollution.	web site. **(CSR expenditure done at BCCL level is attached as Annexure VIII)** TISS has conducted survey to frame CSR policy for better implementation and monitoring of the CSR activities. **(TISS Report attached as Annexure X)**  **Impact Assessment of CSR projects undertaken by Bharat Coking Coal Limited, Dhanbad FY (2015-16)** By National CSR Hub Tata Institute of Social Sciences, Mumbai
xLvii	**Central recreation park with herbal garden should be developed for use of all inhabitants.**	Herbal garden is being developed at Kharkharee Pit Office.
xLviii	**The mine water should be treated properly before supply to the villager.**	It is being complied. Water is being supplied to nearby villagers through filter plant at Kharkharee Colliery. 

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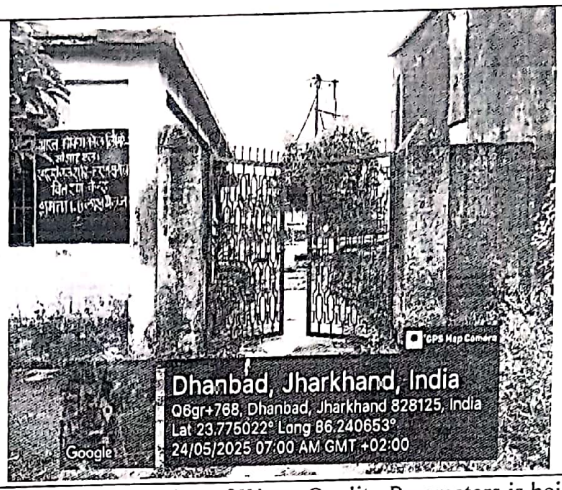
<tr><td></td><td></td><td> 
</td></tr>
<tr><td>xLix</td><td>Mine discharge water shall be treated to meet standards prescribed standards before discharge into natural water courses/agriculture. The quality of water discharge shall be monitored at the outlet and proper records maintained thereof and uploaded regularly on the company website.</td><td>Regular monitoring of Water Quality Parameters is being carried out by CMPDIL.

(Water Quality Report is enclosed as Annexure V)</td></tr>
<tr><td>L</td><td>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 abandoned pits and voids should be backfilled with OB and reclaimed with plantation and or may be used for pisciculture.</td><td>It shall be complied. Includes post mining condition.</td></tr>
<tr><td>Li</td><td>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 peizometers. The monitoring for quantity shall be dome 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.</td><td>Groundwater level and quality is being monitored by CMPDIL. The Location and design of Piezometers to be installed have been finalized by CMPDIL.
3 hydrograph 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'24, Aug'24, Nov'24 & Jan'25 the Ground water level data is enclosed in the table below:
<table>
<tr><th rowspan="2">Sl No.</th><th rowspan="2">Well No.</th><th rowspan="2">Location</th><th colspan="4">Water level (bgl in meters)</th></tr>
<tr><th>May'24</th><th>Aug'24</th><th>Nov'24</th><th>Jan'25</th></tr>
<tr><td>1</td><td>A-24</td><td>Pipratanr</td><td>5.43</td><td>3.71</td><td>3.96</td><td>4.12</td></tr>
<tr><td>2</td><td>B-32A</td><td>Madhuband</td><td>6.60</td><td>2.10</td><td>3.60</td><td>4.82</td></tr>
<tr><td>3</td><td>B62A</td><td>Saiyardih</td><td>4.97</td><td>3.01</td><td>3.19</td><td>4.80</td></tr>
<tr><td colspan="3">Avg. GW (bgl)</td><td>5.67</td><td>2.94</td><td>3.58</td><td>5.18</td></tr>
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Peizometer installation: Construction of 2 nos. Piezometric well is complete. 2 nos. DWLRs have also been installed.</td></tr>
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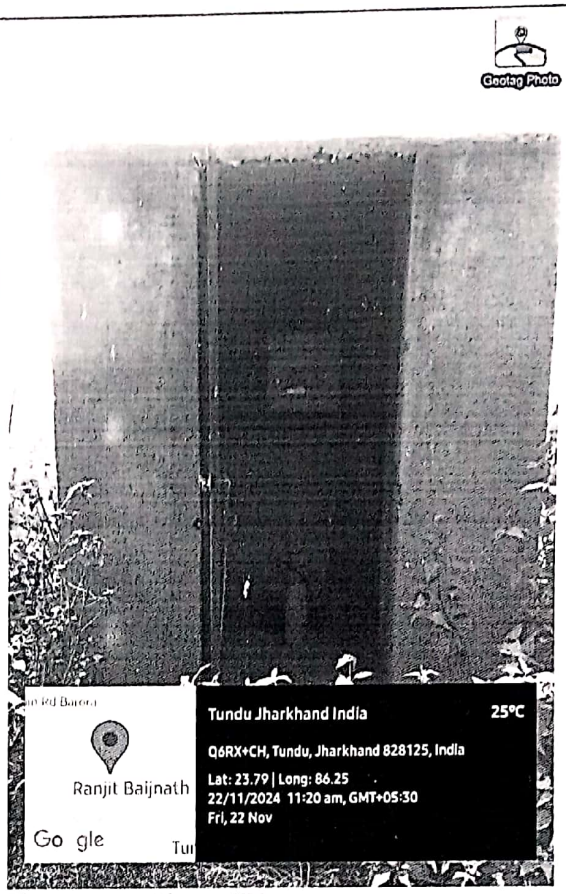
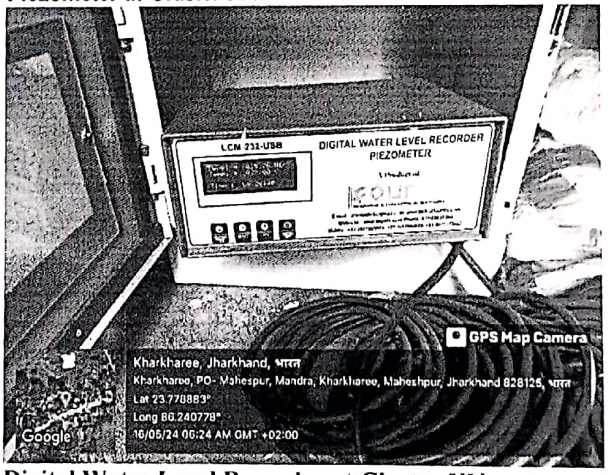


Piezometer at Cluster XV



Digital Water Level Recorder at Cluster XV

(Latest Ground Water Report Attached as Annexure XI)

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		cmpdi RESTRICTED **GROUNDWATER LEVEL & QUALITY REPORT** **FOR CLUSTERS OF MINES, BCCL** (Assessment year - 2024-25) [CLUSTER – I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XIII, XIV, XV, XVI & XVII 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 Geology Department Regional Institute-II CMPDI, Dhanbad MARCH – 2025 Job no - 200424005
Lii	**ETP shall also be provided for workshop, and CHP, if any. Effluents shall be treated to confirm to prescribe standards in case discharge into the natural water course.**	All mines are UG in nature.
Liii	**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: 50000) 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.**	Presently a time series map of vegetation cover in the Jharia Coal Field is being carried out through CMPDI, Ranchi using satellite imagery for every 3 years & it has been uploaded on the official website of company. Further CMPDI has been requested to prepare "Time series of land use maps based on satellite imagery of the core zone and buffer zone in the scale 1:50000 **(Land use Pattern Attached as Annexure XII)**

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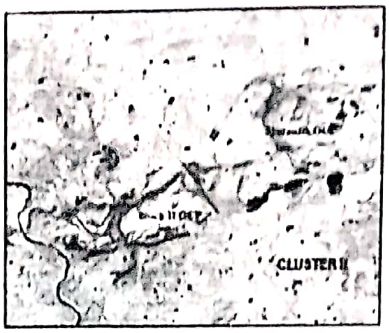
		Land Reclamation/ Restoration Monitoring of Five Clusters of (Opencast + Underground) Coal Mines of Bharat Coking Coal Limited based on Satellite Data of the Year 2022  Submitted to Bharat Coking Coal Limited cmpdi
Liv	**A Final Mine Closure Plan along with details of Corpus Fund shall be submitted to 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. The mining plan and post – mining plan, closure plan should be prepared and submitted to the Ministry.**	CMPDI has prepare the "Final Mine Closure Plan along with a Plan for Habitat Restoration and with details of Corpus Fund". BCCL has deposited the amount in a separate Escrow Account for corpus fund as per Mine Closure Guidelines as specified in the mine closure Plan. **(Escrow account details attached as Annexure XIII)**
Lv	**A separate management structure for implementing environment policy and socio-economic issues and the capacity building required in this regard.**	Complied. An Environment cell consisting of GM (Environment) at head quarter level, co-ordinates with all the Areas and reports to the Director (Technical) and in turn he reports to the CMD of the company. Socio economic issues and capacity building are being evaluated by Tata Institute of Social Science. **(TISS Report attached as Annexure X)**

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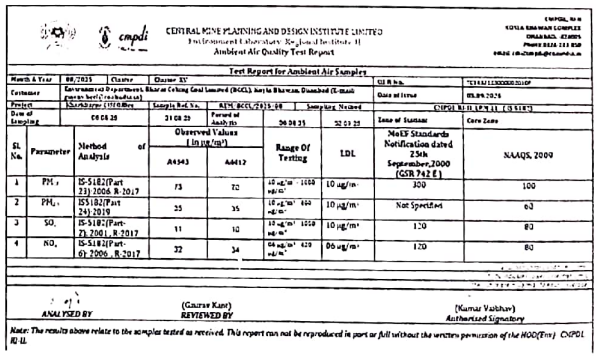
Lvi	**Corporate Environment Responsibility:** **a) The Company shall have a well laid down Environment Policy approved by the Board of Directors.**	A well-defined Corporate Environment Policy has already been laid down and approved by Board of Directors. This is also posted on BCCL website. **(Corporate Environment Policy is attached as Annexure XIV)** **URL-** **https://www.bcclweb.in/environment/CEP_280220.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 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.	Being complied. Being complied.
B	**General Conditions by MoEFCC:**	
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. There is no change in mine technology and scope of working.
ii	**No change in the calendar plan of production for quantum of mineral coal shall be made.**	Being complied. The production from the cluster is within the limit for which Environmental clearance has been granted.
iii	**Four ambient air quality monitoring stations shall be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2 and NOx 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 location of monitoring stations in Jharia Coal Field has been finalized in consultation with the Jharkhand State Pollution Control Board. Ambient air quality along with heavy metals such as Hg, As, Ni, Cd, Cr etc. is regularly monitored by CMPDIL. **(Environment Monitoring Report is attached as Annexure IV)** AMBIENT AIR QUALITY DATA 

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

Test Report for Ambient Air Samples

Month & Year	08/2025	Cluster	Cluster XV		QR R No.	
Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Jharia Dhanbad (E-mail: param.hse@cmpdi.co.in)				Date of Issue	05.09.2025
Project	Jharkhand State Office	Sample Ref. No.	RIPL/BCCL/25/15-08	Sampling Method	CMPDI, RI-II, LPA-11, (IS 5182)	
Date of Sampling	06.08.25	21.08.25	Period of Analysis	26.08.25	02.09.25	Zone of Station	Core Zone

Sl. No.	Parameter	Method of Analysis	Observed Values (in µg/m³)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September,2000 (GSR 742 E)	NAAQS, 2009
			A4543	A4612				
1	PM_{10}	IS-5182(Part 23):2006 R-2017	73	72	10 µg/m³ - 1000 µg/m³	10 µg/m³	100	100
2	$PM_{2.5}$	IS5182(Part 24):2019	35	35	10 µg/m³ - 800 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2):2001, R-2017	11	10	10 µg/m³ - 1000 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182(Part-6):2006, R-2017	32	34	06 µg/m³ - 400 µg/m³	06 µg/m³	120	80

ANALYSED BY (Gaurav Kant) REVIEWED BY (Kumar Vaibhav) Authorized Signatory

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

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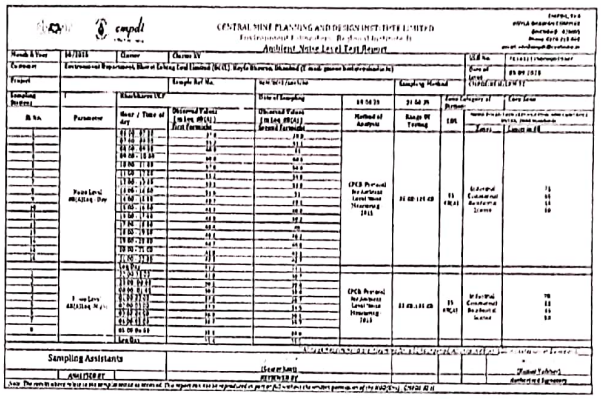
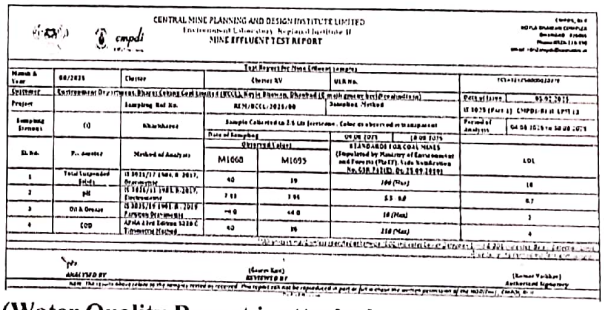
iv	**Data on ambient air quality (PM_{10}, $PM_{2.5}$, SO_2 and NO_xHg,As,Ni,Cd,Cr and other monitoring data shall be regularly submitted to the Ministry including its Regional Office at Bhubaneswar and to the State Pollution Control Board and the Central Pollution Control Board once in six months. Random verification of samples through analysis from independent laboratories recognized under the EPA rules,1986 shall be furnished as part of compliance report.**	Data on ambient air and other monitoring data is being regularly submitted to the Ministry along with compliance report. **(Environment Monitoring Report is attached as Annexure IV)**
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.**	It is being Complied in mines and also the Noise levels are below the Ambient Noise Standard (Day time 75 dB & Night Time (70 dB for Industrial Area).Regular maintenance of machineries are being practiced for control of noise level.  **(Environment Monitoring Report is attached as Annexure IV)**
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 19th May 1993 and 31st December 1993 or as amended from time to time before discharge. Oil and grease trap shall be installed before discharge of workshop effluents.**	The work of monitoring of ambient environment is being done by CMPDIL, Ranchi. Physico-Chemical characteristics of effluents are well within the prescribed limit.  **(Water Quality Report is attached as Annexure V)**
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 vehicle is being practiced to kept vehicular emission under control. Coal is being transported in tarpaulin covered trucks.
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.**	Monitoring of Environmental quality parameters have been regularly done by CMPDIL, Ranchi with proper analysis equipment. **(Environment Monitoring Report is attached as Annexure IV)**
ix	**Personnel working in dusty areas shall wear protective respiratory devices and they shall also be provided with adequate training and information on safety and health aspects.**	It is being complied. A separate full-fledged Human Resource Development Department is conducting regular training programme on these issues. Apart from this Vocational Training Centers are existing in all the areas of BCCL, which provides periodical training on the safety

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		and occupational health issue to each of the workers working in the mines.
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.**	Initial Medical Examination (IME) and Periodical Medical Examination (PME) of all the personnel is carried out as per the Statutes and Director General of Mines Safety (DGMS) guideline. **NIOH study**: Final report has been submitted by NIOH which has already been scrutinized by Medical department, BCCL. **(Soft copy of NIOH Report is attached as Annexure IX)**
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.**	A full-fledged Environment cell, with a suitable qualified multidisciplinary team of executives has been established. GM (Environment) at head quarter level, co-ordinates with all the Areas and reports to the Director (Technical) and in turn he reports to the CMD of the company. Socio economic issues and capacity building are being evaluated by Tata Institute of Social Science
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.**	It is being complied. Separate head "plantation" &" Environment" is there for recurring expenditure and used for eco-restoration, environmental protection measures, statutory payments, etc.
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.**	Complied. Advertisement in local newspaper has been given.
xiv	**A copy of the environmental clearance letter shall be marked to concern Panchayat/ZilaParishad, 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. Clearance letter has been displayed on Company web site.
xv	**A copy of the environmental clearance letter 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. URL- https://www.bcclweb.in/?page_id=4731&lang=en
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. The clearance letter and its six monthly environmental clearance conditions is uploaded on company's websites for the public. The monitoring data is also displayed at mine office and uploaded on website. URL- https://www.bcclweb.in/?page_id=4731&lang=en
xvii	**The project proponent shall submit six monthly**	Complied/Being complied.

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	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.	
xviii	**The Regional Office of this Ministry located at Bhubaneswar shall monitor compliance of the stipulated conditions. The project authorities shall extend fill cooperation to the office(s) of the Regional Office by furnishing the requisite data/information/monitoring reports.**	Noted. Project authority is ready to extend its full cooperation for any kind of visit and inspection conducted by Regional Office in connection with EC Conditions Compliance.
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 company's website along with the status of compliance of Environment condition and shall be sent to the respective Regional Offices of the MOEF by e-mail.**	Environmental Statement (Form-V) has been regularly submitted for mines which are under operation for each financial year to Jharkhand State Pollution Control Board. Environment Statement is enclosed as Annexure XVI.

General Manager
Govindpur Area

General Manager
Barora Area

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Project Report

On

Delineation of Surface Coal Fire and associated Land Subsidence in Jharia Coalfield (2022-2024), Jharkhand using satellite based remote-sensing techniques

A collaborative project between

National Remote Sensing Centre (NRSC)
Indian Space Research Organisation (ISRO)
Hyderabad - 500 037

Bharat Coking Coal Limited

Bharat Coking Coal Limited
Koyla Bhawan, Koyla Nagar
Dhandbad, Jharkhand

May, 2025

NATIONAL REMOTE SENSING CENTRE

REPORT / DOCUMENT CONTROL SHEET

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7	**Particulars of collation**	**Pages** 43	**Figures** 19	**Tables** 6	**References** 18
8	**Author(s)**	Shri Punit R Jalan, S/E 'SC', Shri Priyom Roy, S/E 'SE', Smt Nirmala Jain, S/E 'SE', Dr. Tapas Ranjan Martha, Head GMED			
9	**Affiliation of authors**	Geosciences Group, RSA-A, NRSC/ISRO			
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11	**Originating unit**	NRSC			
12	**Sponsor(s)/ Name and Address**	BCCL			
13	**Date of Initiation**	18/05/2022			
14	**Date of Publication**	16/05/2025			
15	**Abstract (with Keywords):** Surface coal fires cause not only economic damage to the countries but also create harsh working conditions for the mine workers due to prolonged exposure to toxic fumes. Along with this, the sub-surface fire and underground mining create a void beneath the ground, causing subsidence and affecting local communities by damaging infrastructures. The present study addresses the delineation of surface coal fires for 2022-2024 and mining-related subsidence. Thermal and SWIR bands with high and medium spatial resolutions of winter season Landsat-8/9 images were used to identify the anomalous pixels (high temperature) compared to the surrounding area and demarcated as coal mine fire area. Further, ALOS-PALSAR 2, L band microwave data, was used to identify the zone of probable land subsidence (using differential interferometry) due to mining. The identified areas were field verified in 2023 and 2024, where the fire areas were classified in terms of mine fires and overburden dump fires, and the subsidence was verified through ground evidence. The study presents a comparative analysis of the dynamics of coal fire area between the previous studies and the maps generated for 2022 to 2024 and a block-wise distribution of coal fire zones for both classes (mine fire and overburden fire). The fire area increased from ~1.85 sq.km in 2020 to ~4.54 sq.km in 2022 and then again increased in 2023 to ~5.00 sq.km, which subsequently decreased to ~3.91 sq.km in 2024. The cardinal direction-wise comparative analysis for individual years is investigated to understand the major contributors to the total fire areas and changes from the previous year. Apart from this, subsidence in the old overburden dumping area of Nudkhurkee OCP was identified and verified during the fieldwork, where the cause of subsidence can be due to the settling of the dumped materials. The final coal mine fire and subsidence maps of the Jharia coal field are prepared.				

Acknowledgements

The project team is grateful to Dr. Prakash Chauhan, Director, NRSC for his support at various stages of project execution. We are extremely grateful to Dr. K. Sreenivas, Deputy Director (RSAA), NRSC for his overall guidance and encouragement. We also thank Dr. I C Das, Group Director (GSG), NRSC for providing us with his critical feedback. We also thank Smt B Santhisree, Group Head (SDPEG) and Shri N Raghavender, Scientist-SF (SDPEG), NRSC for providing us the instrument and necessary instructions for smooth operation during the field. We thank BCCL for providing us the opportunity to collaborate for this work. We thank Shri Full Jha, General Manager (JMP), BCCL and Shri Mithilesh Kumar, General Manager (Mining), BCCL in aiding us by providing necessary resources for ease of access to the locations lying within the mines of BCCL. We thank BCCL team Shri Srijan Thakur, Deputy Manager (JMP), Shri Shashi Prakash, Assistant Manager (JMP) and Mushtaq Ahmed, Assistant Manager (Central Survey) for assisting us in navigation during the field visit for coal fire areas and subsidence sites.

Executive Summary

Surface coal fires cause not only economic damage to the countries but also create harsh working conditions for the mine workers due to prolonged exposure to toxic fumes. Along with this, the sub-surface fire and underground mining create a void beneath the ground, causing subsidence and affecting local communities by damaging infrastructures. The present study addresses the delineation of surface coal fires for 2022-2024 and mining-related subsidence. Thermal and SWIR bands with high and medium spatial resolutions of winter season Landsat-8/9 images were used to identify the anomalous pixels (high temperature) compared to the surrounding area and demarcated as coal mine fire area. Further, ALOS-PALSAR 2, L band microwave data, was used to identify the zone of probable land subsidence (using differential interferometry) due to mining. The identified areas were field verified in 2023 and 2024, where the fire areas were classified in terms of mine fires and overburden dump fires, and the subsidence was verified through ground evidence. The study presents a comparative analysis of the dynamics of coal fire area between the previous studies and the maps generated for 2022 to 2024 and a block-wise distribution of coal fire zones for both classes (mine fire and overburden fire). The fire area increased from ~1.85 sq.km in 2020 to ~4.54 sq.km in 2022 and then again increased in 2023 to ~5.00 sq.km, which subsequently decreased to ~3.91 sq.km in 2024. The cardinal direction-wise comparative analysis for individual years is investigated to understand the major contributors to the total fire areas and changes from the previous year. Apart from this, subsidence in the old overburden dumping area of Nudkhurkee OCP was identified and verified during the fieldwork, where the cause of subsidence can be due to the settling of the dumped materials. The final coal mine fire and subsidence maps of the Jharia coal field is prepared.

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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. 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 dioxide, which are the result of coal burning process, 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 80^0 to 120^0C, 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 dates 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

Bharat Coking Coal Ltd. (BCCL), a Public Sector Undertaking is engaged in coal mining activities in the area. As a part of its operational activity, BCCL is monitoring the existing fire locations in the area and also their relative movement with time. Additionally, BCCL funds several activities to monitor and map the dynamic nature of the coal fires. In this regard, several satellite-based research works were taken up for mapping the coal fire in last two decades in the area (Chatterjee, 2006; Chatterjee et al., 1996; Martha et al., 2010; Reddy et al., 1993). These projects were funded and supported by BCCL. 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 data for 2001 over Raniganj coalfield, West Bengal. Further another project was executed in 2006, in which coal fire of the Jharia Coalfield was mapped for 2003 and 2006, using ETM+ and ASTER data, respectively. In the last decade, three similar projects were executed by NRSC in 2012, 2017 and 2020 to map the coal fire and land subsidence.

The current project is based on the letter (Ref. no. BCCL/GM(JMP)/File-2022/283) from General Manager (JMP), BCCL addressed to Director, NRSC on the 30 of September 2022 with a request to take up Coal fire and Land Subsidence study of the Jharia Coal Field using space-borne remote sensing techniques and to report the status of the same for the year 2022, 2023 and 2024 (three years). The project was initiated on 18-05-2023.

1.2 Objectives

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

- To map the coal fire in the study area based on pixel integrated relative radiant temperature derived Landsat-8/9 Thermal data as on 2022, 2023 and 2024.
- To compare the change in the coal fire distribution in the Jharia coalfield within the period of 2020, 2022, 2023 and 2024.
- To identify the land subsidence zones in Jharia coalfield, Jharkhand using microwave data.

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 approximately within latitudes 23º 42’ N and 23º 50’N and longitudes 86º 09’E and 86º 30’E.

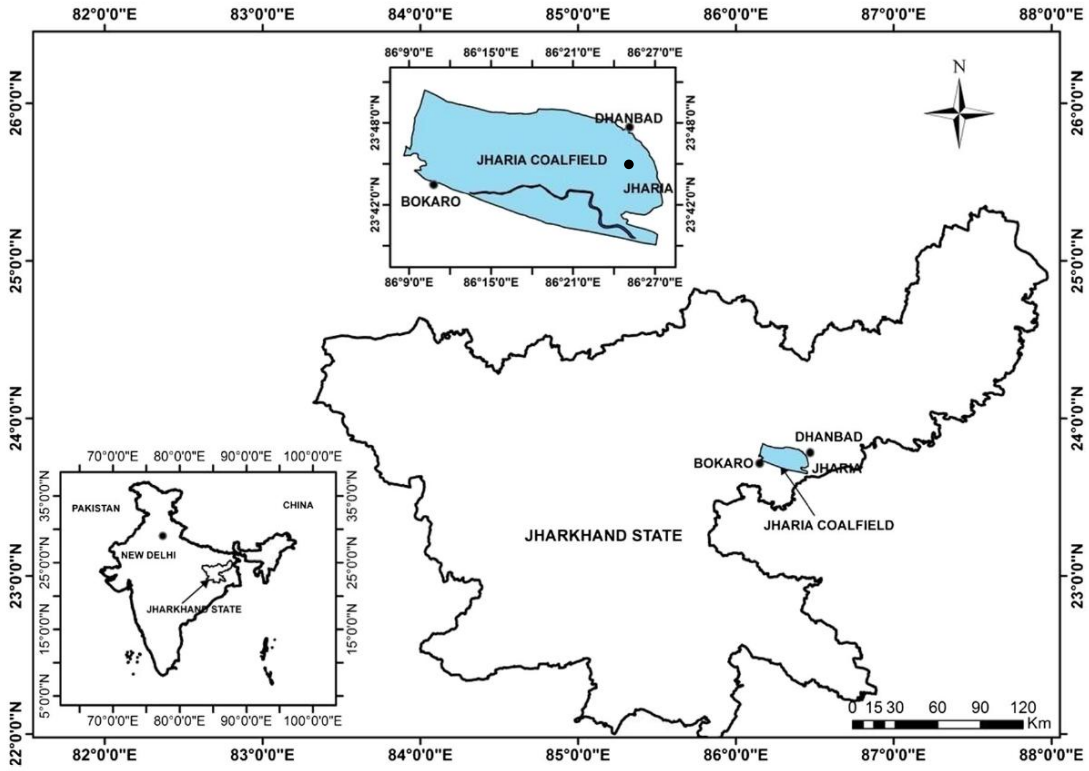

Figure 1: Study area map of Jharia Coalfield, Jharkhand.

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 ~10º C in the month of December – January and maximum temperature is ~50º C in the month of May – June.

2.3 General Geology

Gondwana Super Group 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 in and around the northern part of Jharia coalfield. 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.

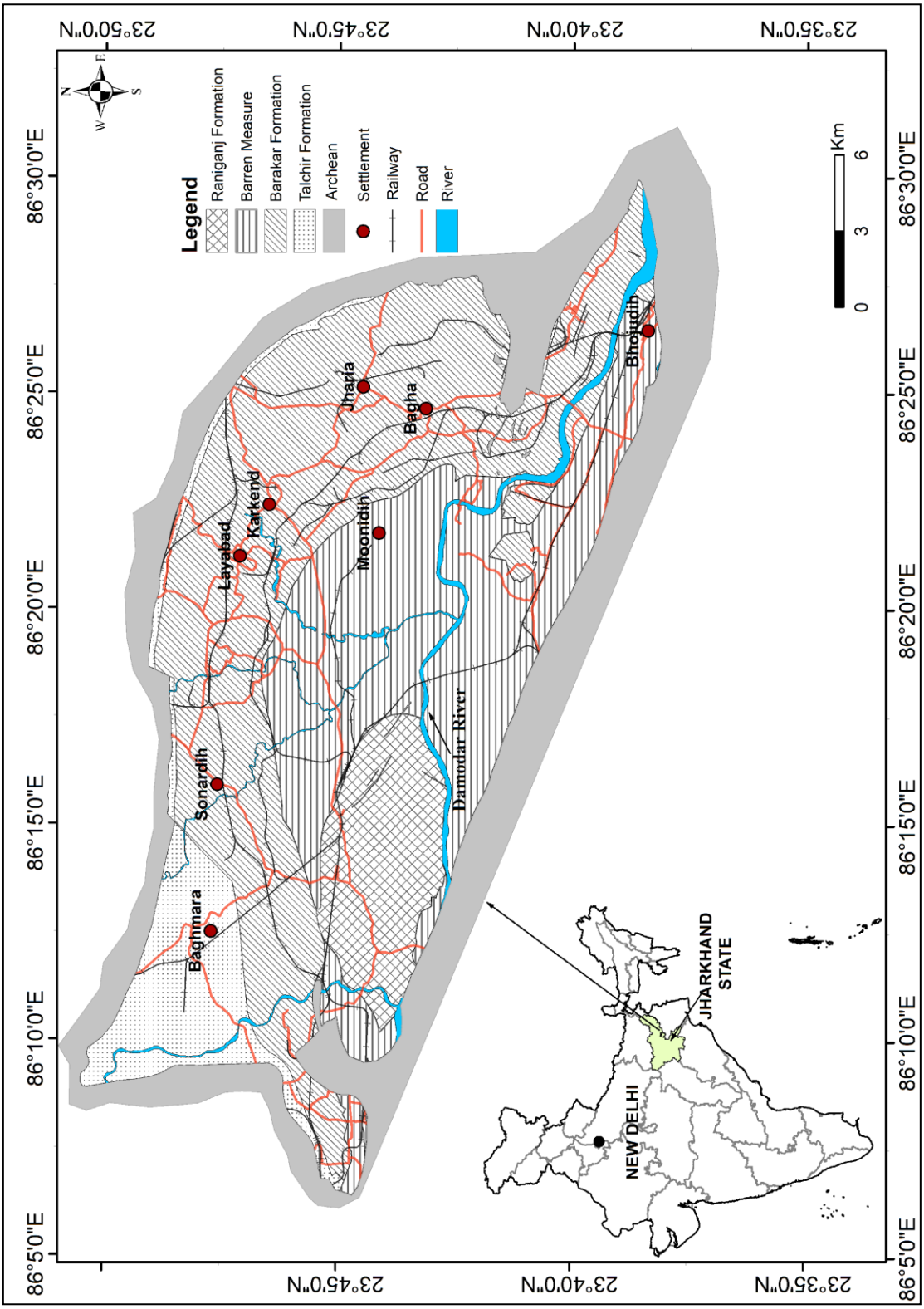

Figure 2 : Geological map of Jharia coal field, Dhanbad, Jharkhand (Source: NGDR).

CHAPTER III

DATA REQUIREMENTS

3.1 Remote Sensing Data

Coal fire map was created from three years period from 2022 to 2024 using Landsat bands details of which are provided in the table 2. A comparative analysis was carried out for each year based on the previous year and 2020 coal fire map prepared by NRSC from the Landsat 8 TIRS bands.

For the land subsidence study, L-band microwave data from ALOS-PALSAR satellite (JAXA) were used. Seven scenes of "Fine Beam mode" SLC data were taken from PALSAR-2 archives over a period from February, 2021 to February, 2024. 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.

Satellite	**Sensor**	**Resolution**	**Time**	**Date**	**Data source**
Landsat-8	TIRS 1/2	100m	Daytime	28 November 2022	USGS, USA
Landsat-9	TIRS 1/2	100m		12 December 2023 and 03 December 2024	
	NIR	30m			
	SWIR 1/2	30m			
ALOS	PALSAR-2 (Fine Beam mode)	10 m	NA	27 February 2021	JAXA, Japan
				11 November 2021	
				26 February 2022	
				10 November 2022	
				25 February 2023	
				07 December 2023	
				24 February 2024	
Landsat Satellite Bands			Wavelength (um)		
NIR			0.85 – 0.88		
SWIR 1			1.57 - 1.65		

SWIR 2	2.11 – 2.29
TIRS 1	10.6 – 11.19
TIRS 2	11.5 – 12.51
PALSAR-2 Frequency/ Wavelength: 1.27 Ghz / 23.62cm	

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 for fire zones identification and field verification

4.1.1 Processing of Landsat TIRS band Data

Since the launch of Landsat 4/5 satellite and subsequent launch of other Landsat 7/8/9 has made space borne thermal data available through its thermal infrared sensor (TIRS) bands. 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-8/9 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 (Gangopadhyay et al. 2012). In present study, band 10 of TIRS sensor with the details of acquisition provided in table 2 has been used for coal fire mapping. 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-8/9 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.

$$L_\lambda = M_L Q_{cal} + A_L \text{ …….. (1)}$$

Where:

L_λ = Spectral radiance (Watts/ (m^2 * srad * μm)).

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 Landsat-8/9 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 literature (Gupta, 2003).

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

T_R = Radiant (brightness) temperature,

K_1 = Calibration constant (1260.56 K),

K_2 = Calibration constant (666.09 watts/ (m^2 *srad*μm)),

L_λ = Spectral radiance

4.1.2 Thresholding of radiant temperature image

Once the Landsat-8/9 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-8/9, 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-8/9 data used in this study, the cut-off temperature was determined for individual years from its respective Landsat images which came around 30.5°C for 2023 and 28°C for 2024 as shown in figure 4.

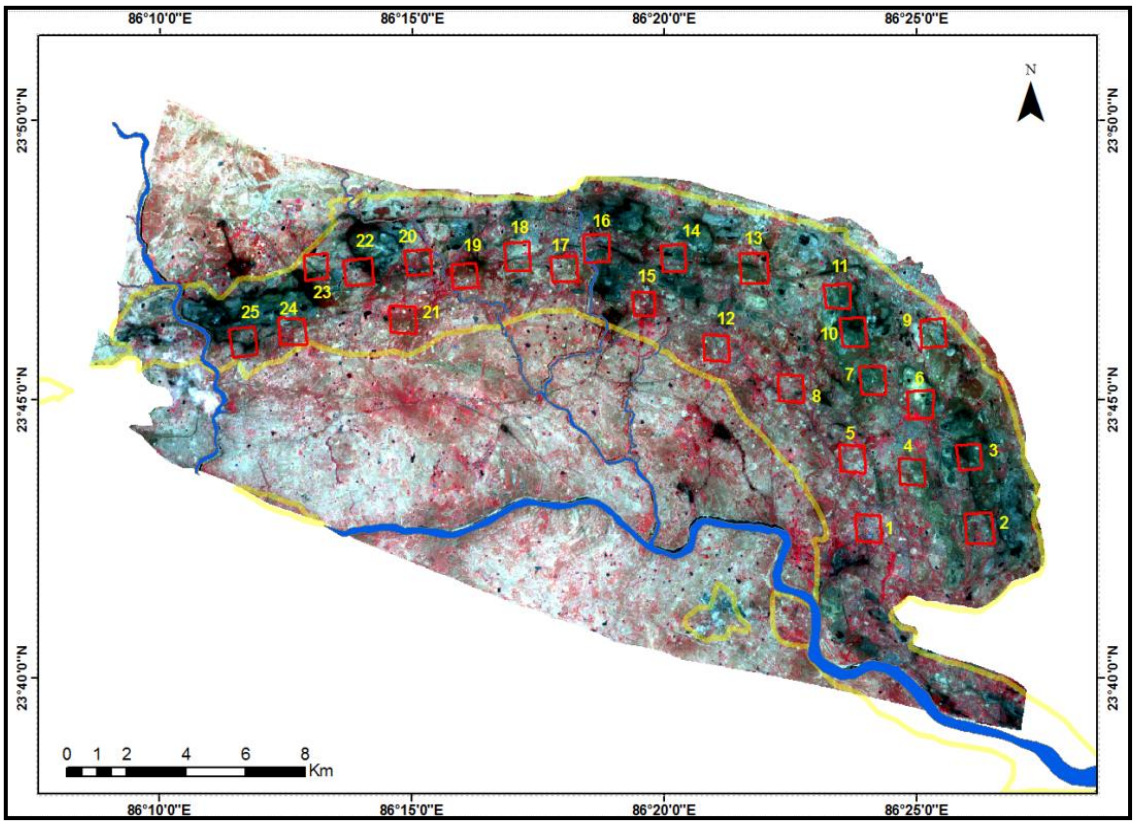

Figure 3. False colour composite image of Jharia Coalfield, with subset blocks (in red boxes) to obtain temperature values (from radiant temperature image) within the Barakar formation across the Jharia coalfield.

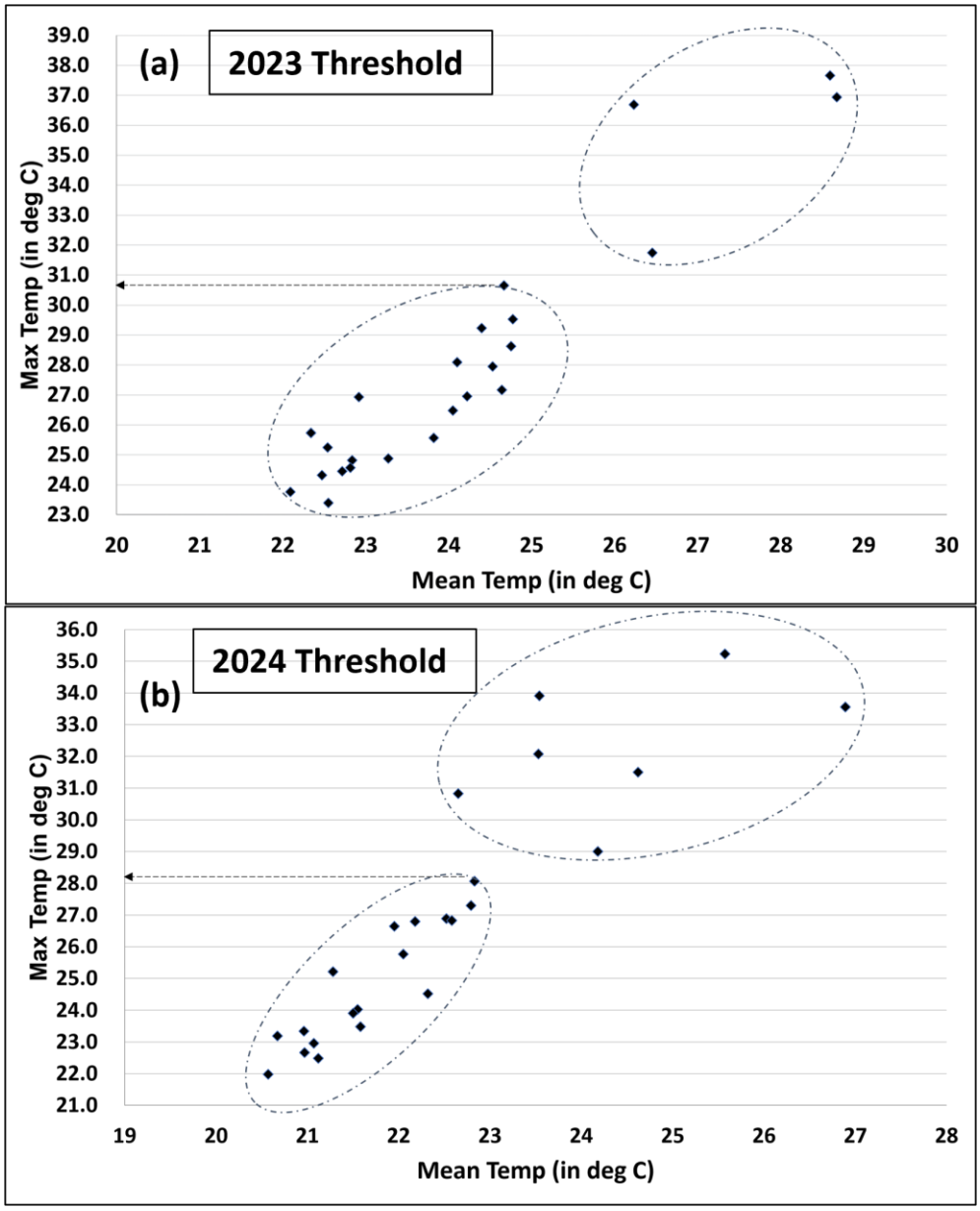

Figure 4. Maximum temperature plotted against mean temperature for various locations for 2023 and 2024; cluster separation observed around (a) 30.5°C for 2023 and (b) 28°C for 2024 (marked with arrow).

4.1.3 Medium-Resolution SWIR/NIR-based fire area identification.

The SWIR 1, 2 and NIR bands of Landsat-9 data for the year 2023 and 2024 were considered to detect small size coal fires that weren't identified through the Radiant Temperature as the TIRS band resolution is 100m. Based on Wein's displacement law distribution of energy, particle with higher energy emits radiation with peak at higher wavelengths hence the DN values for SWIR and NIR bands for fire pixels will look darker compared to the surrounding areas and when set to fire colour composite with

SWIR-2, SWIR-1 and NIR combination can be identified as red or orange pixels from the image. The cluster of pixels was then digitized manually.

4.1.4 Surface Fire Temperature estimation using Thermal Sensor

The validation of the surface fire temperature estimated from the satellite platforms was carried out using handheld thermal infrared imager which captured heat map of an area and provided approximate surface temperature and temperature difference using inverse square law. Important details of the instrument are given in the table 3.

Table 3: Details of the handheld thermal infrared imager.

Description	Value
Make	Fluke
Model	Ti 300
Detection type	Infrared / emitted radiation
Operating wavelength	8-14 µm
Field of View (H * V)	24 * 17 deg
Temperature measuring range	-20 to +650 deg C
Accuracy	±1 deg C

The images are captured by aiming the instrument (Figure 5) at the specific spot and taking a snap of the area. The captured thermal images during the field work were taken by reaching the closest proximity of the pre-field identified areas. The captured image gives details of the fire temperature at that spot. The optical image is also captured by the instrument along with the thermal image of a focused area.

Figure 5: Left image shows the front portion and right image shows the rear portion of the Fluke Ti300 hand held thermal imager.

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).

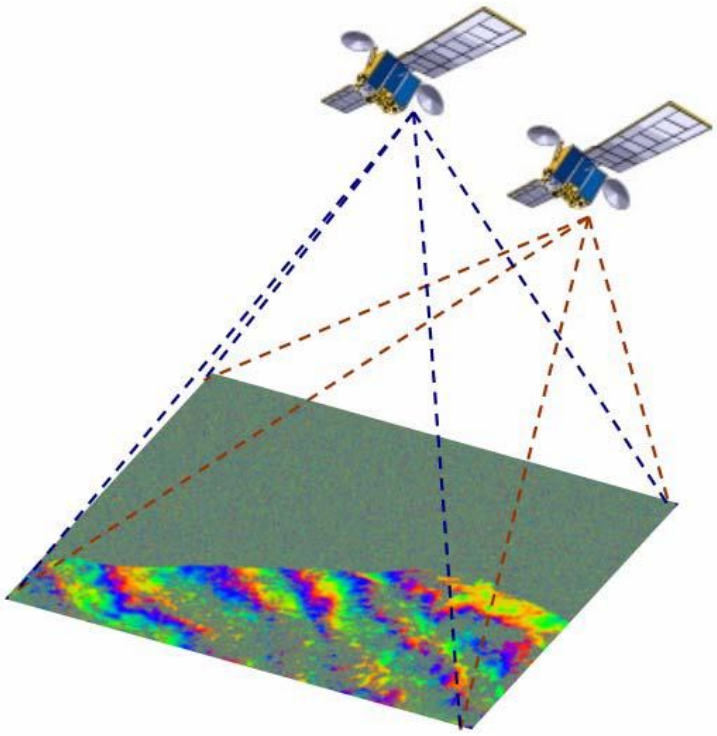

Figure 6. DInSAR acquisition scheme.

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, ΦTopo denotes the topographic component, ΦMov denotes the terrain deformation/ displacement component, ΦAtm is the noise component and ΦNoise 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 and external Digital Elevation Model (DEM) and the orbital ephemeris from the SAR acquisitions, considering no height errors on the DEM.

$$\Delta\Phi dif = \Phi ErrorTopo + \Phi Mov + \Phi Atm + \Phi Noise \quad (4)$$

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 improvement 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 (Carnec et al., 1996; Bürgmann et al., 2000).

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

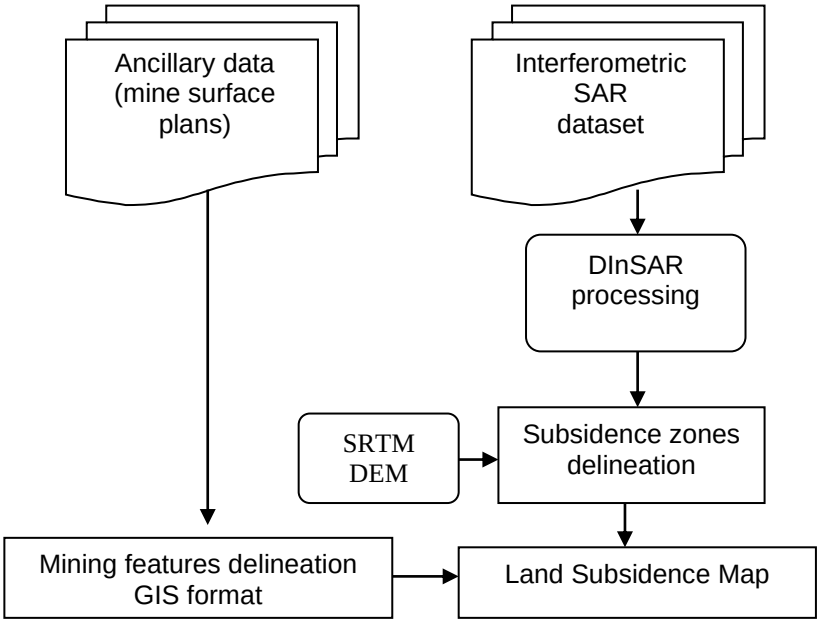

Figure 7. Work flow diagram for generating land subsidence map using DInSAR technique.

4.2.2 Identification of subsidence zones through processed Interferograms

In the present study, 7 sets of ALOS-PALSAR L-band microwave data (as mentioned in table 1) were procured. The datasets were paired into master-slave pairs. The interferograms for the long temporal baselines include data pairs of time difference of ~ one year were produced. The short temporal baselines could not be carried out due to satellite offset. The figure 8 shows the interferograms pairs produced.

		SLAVE IMAGE				
		27 February 2021	11 November 2021	26 February 2022	10 November 2022	25 February 2023
MASTER IMAGE	27 February 2021					
	11 November 2021					
	26 February 2022					
	10 November 2022					
	25 February 2023					
	07 December 2023					
	24 February 2024					
		Satellite Offset				
		Interferogram produced				

Figure 8. ALOS-PALSAR - 2 Master-Slave pairs long temporal base line processing

The master-slave pairs of long temporal baseline (approximately one year as shown in figure 8) will incorporate terrain changes due to mining activities as well, as long-term ground subsidence from underground mining, settling of old Overburden dump and subsidence due to mining. The figure 9 shows an example of the identifiable subsidence area through the interferogram.

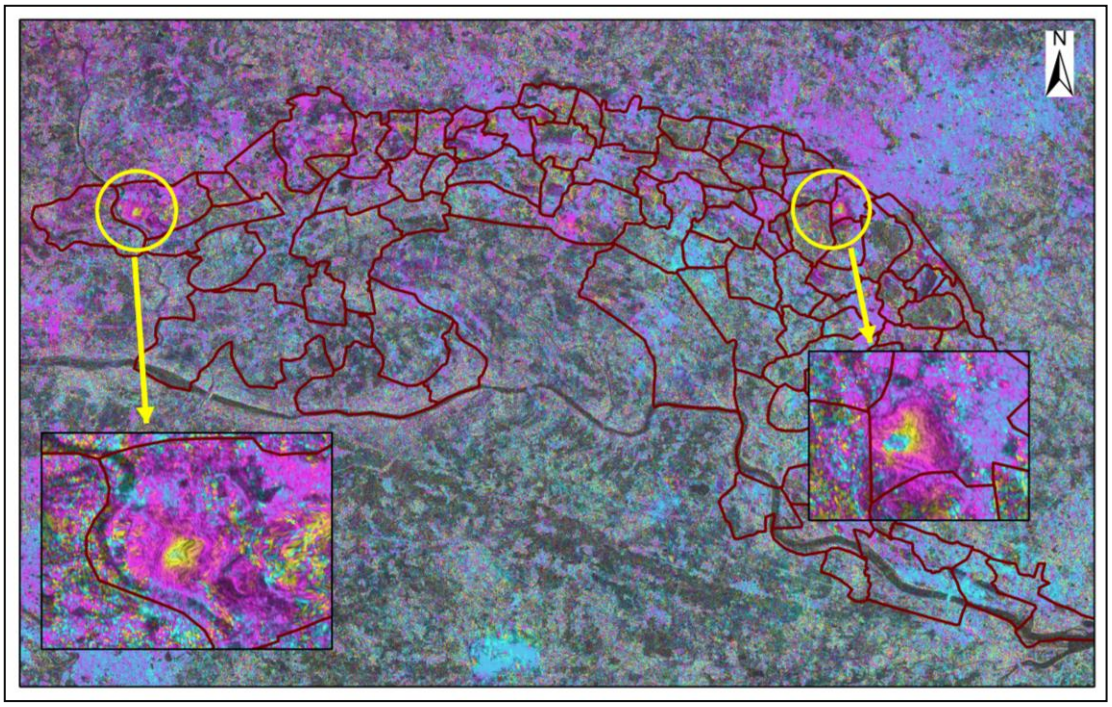

Figure 9. Fringe patterns generated from long baseline processing (e.g. Master: 26 February 2022 Slave: 27 February 2021).

The results from the long 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. Using this, a subsidence map of the Jharia Coalfield was generated.

CHAPTER V

FIELD WORK

Field work for verification of the coal fire locations for 2023 and 2024 and the subsidence points generated from 2022 to 2024 as identified by the satellite data was carried out from 15 to 18 December 2023 and 22 to 25 February 2025, respectively. NRSC further independently and physically verified both the coal fire and the subsidence locations. A total of 53 coal fire points for 2023, 54 coal fire points and 30 subsidence locations for 2024 were identified from the satellite data analysis (figure 10-11). The surface temperature for the coal fire areas was captured using the handheld sensor. Specific evidence of subsidence around the active mine areas and old Overburden dumps was identified to verify the subsidence map, which is shown in the result section.

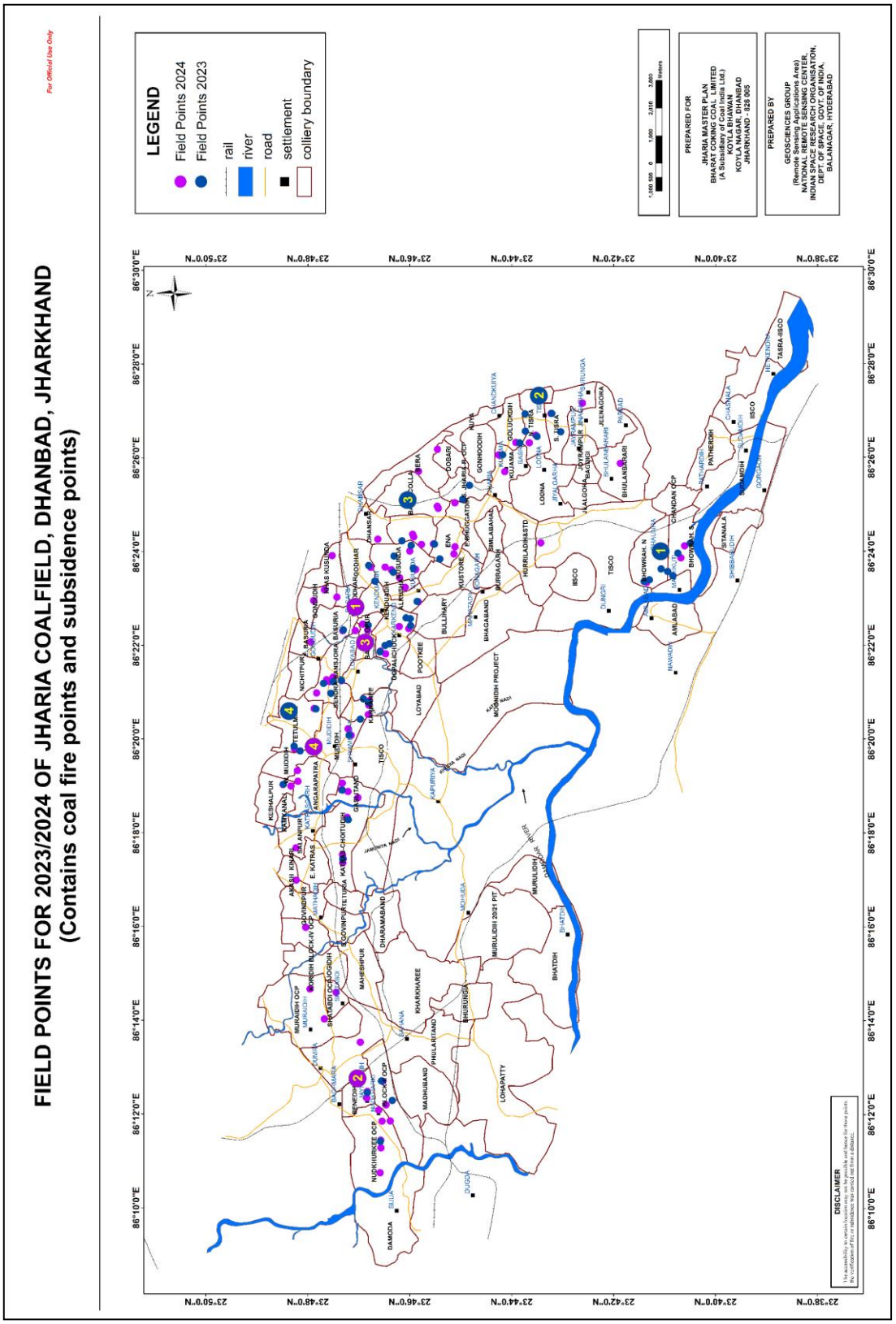

Figure 10. Field data points for coal fire and subsidence (only for 2024) verification for 2023 and 2024.

Fire location observations:

1. The 100+ fire locations were visited during the field for 2023 and 2024; all the points were verified and classified as Overburden dump Fire and Active Mine Fire. Accordingly, the polygon associated with the field point was assigned its particular class.
2. Upon physically reaching the fire location, the fire area could easily be identified due to large fissures, cracks, carbonated rocks or through CMB, CO, CO2 gases smell, and by visible blazing fire (burning fire) in the active mining areas. For locations at a distance, the fire could be identified from the change in the refraction due to the emitting gasses or through the handheld thermal sensor.
3. Largely the extent of fire in and around large Overburden dump areas such as Kusunda, Bhowrah, Block-II, Gopalichuck, etc., identified in 2023 and 2024, have remained approximately the same as seen during the field. The blazing fire inside the active mining areas of ENA, Basjuria, Bhowrah, etc, was found only in 2024. The blazing fire locations, such as Benedih/Block-II OCP, Mudidih, etc, identified during the 2023 field visit were still persisting.
4. As shown in the results section, the fire area decreased as compared to 2023 in 2024, while based on the field observation.

Subsidence location observations:

1. Subsidence locations identified from the satellite data are difficult to verify in the field unless there are tell-tale signatures like large cracks or fissures on the ground, bending of the trees, or damage to anthropogenic constructions like vertical cracks on building cracks, etc.
2. Out of the 30 identified subsidence locations from the interferograms produced through the ALOS-PALSAR-2 SLC pairs of microwave data. The identified location can be categories into three categories as; old Overburden dump regions, new Overburden dump regions and active mining area or edge of the active mining area.
3. The two main areas of subsidence, as seen from Figure 9, where subsidence is occurring on a pervasive scale, were identified in the old Overburden dump area of Nudkhurkee OCP and the old Overburden dump area of Dhansar,

where the bending / slanting trees due to the slow settling of the dumped material could be observed. Similar features to Nudkhurkee OCP old Overburden dump could be identified in the other regions of old or new Overburden dump areas; a few field photographs are shown in section 6.2.

4. The slanting trees and cracks on the ground could be identified at the edge of the active mine regions, where at one of the identified points in the Kankanee block.
5. Three other locations where subsidence is seen from microwave data fall within the mining lease of TISCO and IISCO and, hence, are not under the purview of BCCL mining authorities.

CHAPTER VI

RESULTS

6.1 Coal Fire Maps and Mine-Wise fire area statistics

The Landsat images of 2022 to 2024 used to prepare the coal mine fire area maps to indicate thermal anomalies as identified through a 100m spatial resolution TIRS band and 30m spatial resolution SWIR 1/2 and NIR band. The anomalies are identified based on the surrounding areas; hence, any small fires through fissures with minor differences in temperature as compared to the surroundings go undetected, or any fire with a size lower than the detectable limit also goes undetected. A few other limitations of the methodology are mentioned in Chapter 8. The Coal fire maps, as shown in Figure 11-13 for 2022 to 2024 in comparison to previous similar studies, show the trend in shift of coal fire zones.

To understand the dynamic spatial extent of the fire pockets, a total fire area comparison between the 2020 block-wise fire area distribution and distribution for the subsequent years is shown in Table 4. The table highlights the year-on-year increment and decrement by assigning a red or green color to the cell. The red indicates an increase in the total fire area for a block as compared to the previous year, and the green indicates a decrease in the total fire area for a block as compared to the previous year. The total fire area was 1.85 sq.km, 4.54 sq.km, 5.00 sq.km, and 3.91 sq.km for 2020,2022, 2023, and 2024 respectively.

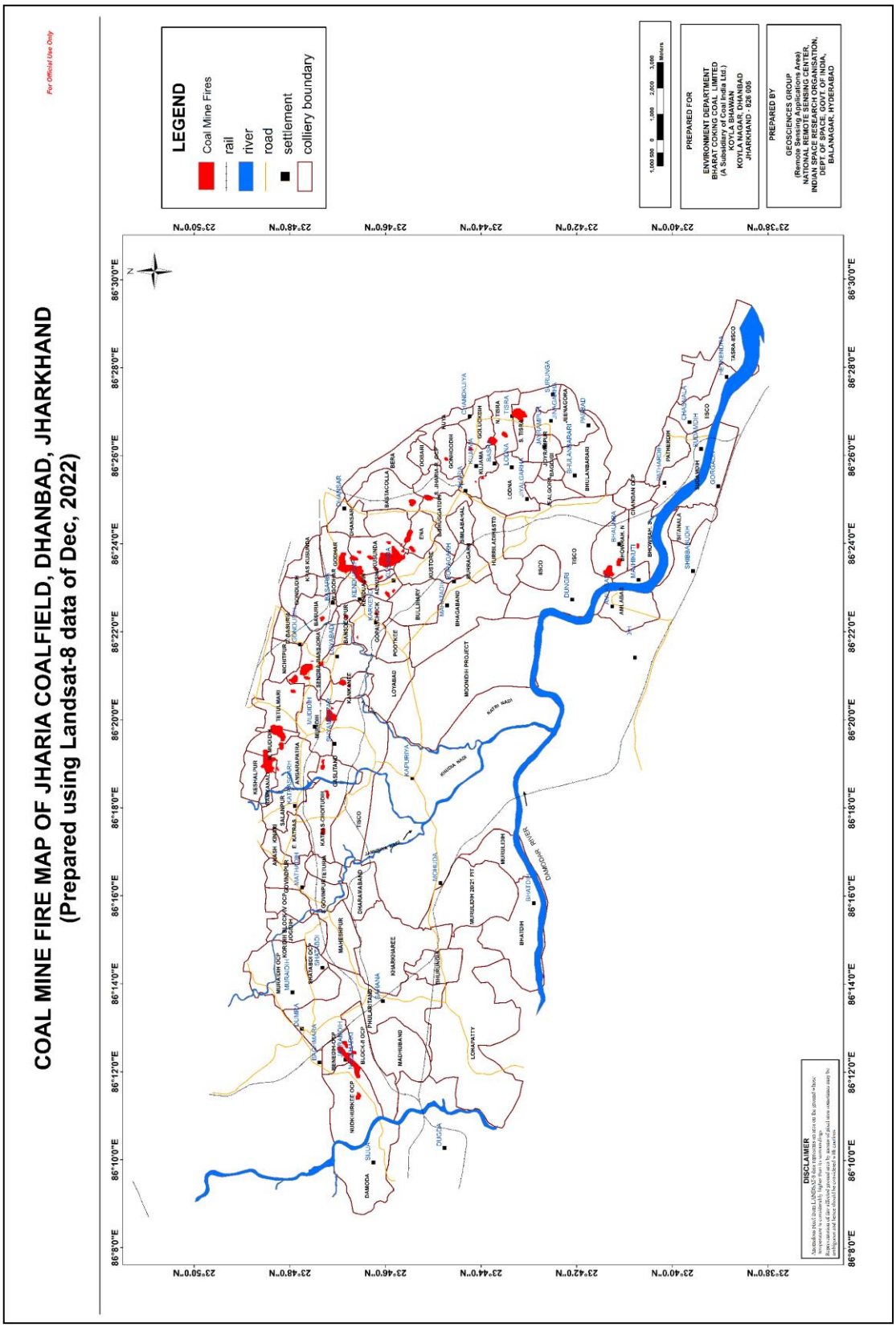

Figure 11. Coal fire map of the Jharia Coalfield (from Landsat-8 Data of Dec 2022)

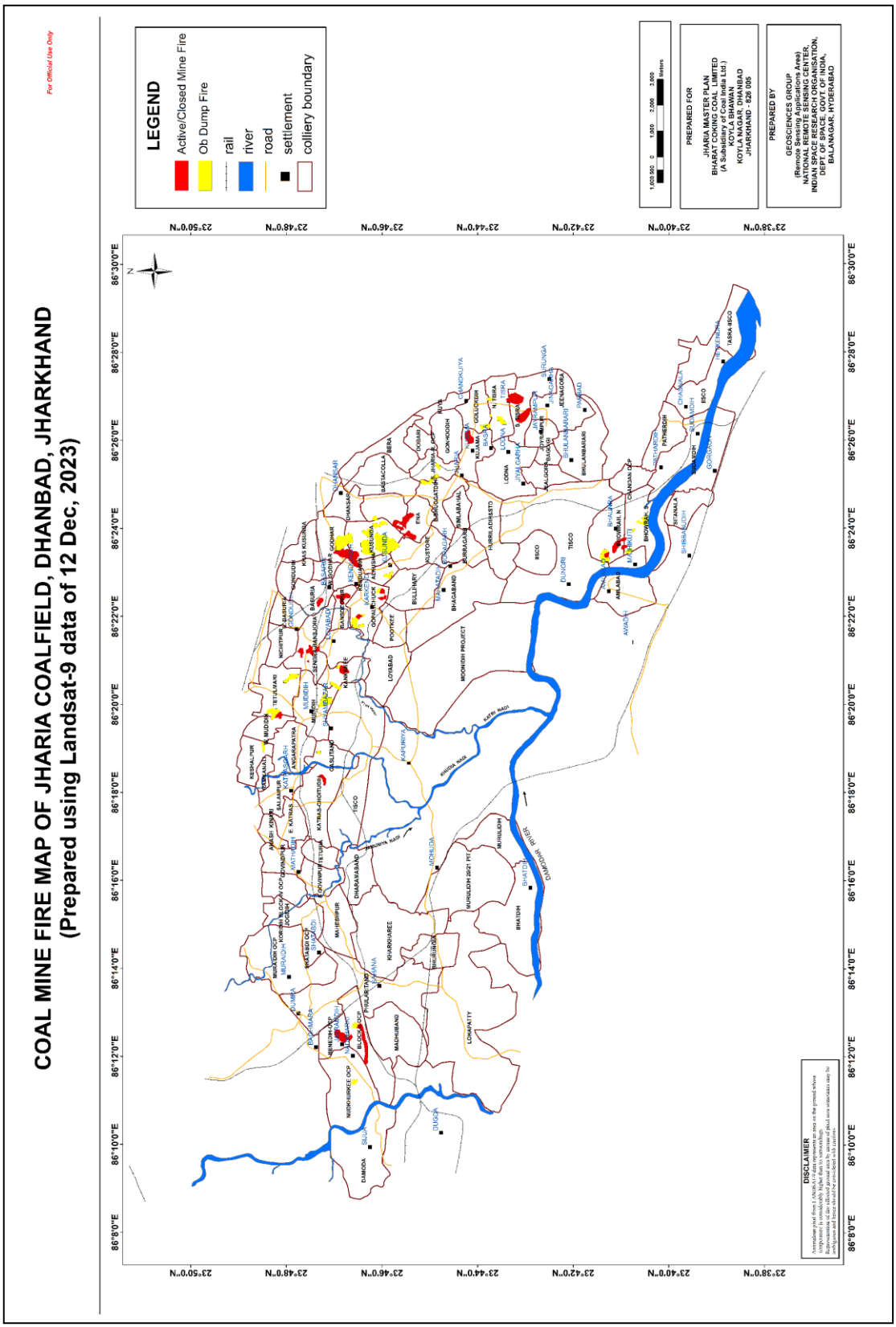

Figure 12. Coal fire map of the Jharia Coalfield (from Landsat-9 Data of Dec 2023)

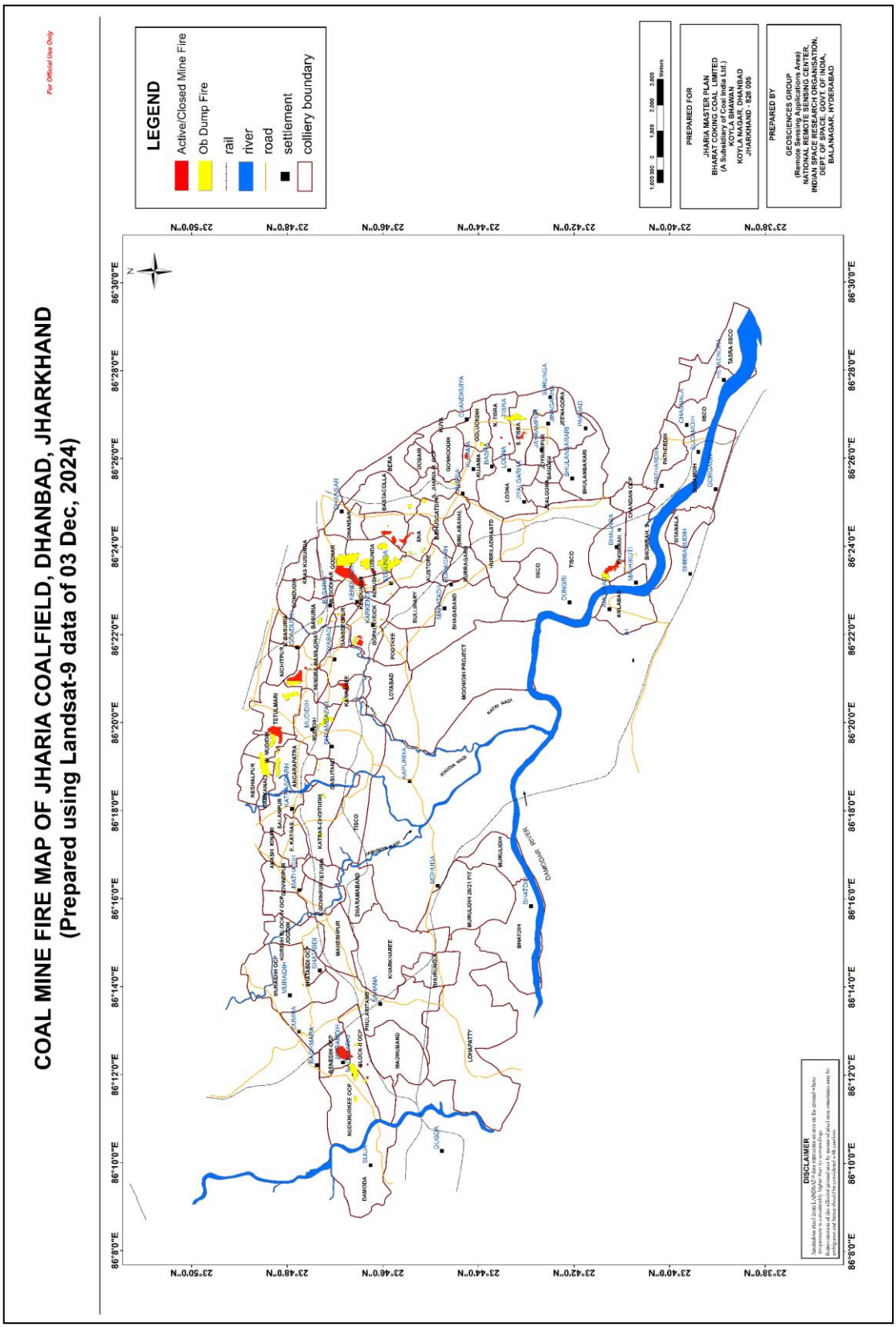

Figure 13. Coal fire map of the Jharia Coalfield (from Landsat-9 Data of Dec 2024)

Based on the figure 11 and 12, cardinal direction-wise fire zones distribution is as follows:

- For the coal fire map of 2023, the eastern side of the covering regions such as Jharia OCP, Kujama, Tisra (North and South), and Bhowrah (North and South) contains large patches of coal fire areas and regions with high increase in fire area in comparison to 2020 and 2022.
- The western side of Nudkhurkee OCP, Block-II OCP, and Benedih OCP, with fire patches covering both the active mine and Overburden dump areas, shows a shift from the northern region to the south region, which may be indicative of a shift in the mining zone. The fire patch area for the western side has remained approximately similar in comparison to 2022 but has primarily increased as compared to 2020.
- The North-Eastern side from Kusunda, Ena, covering Godhar, Alkusa till Basuria and Bansdeopur, etc., is the most significant contributor to the total coal fire area for the Jharia coal mines, with most portions seeing a significant increase in fire patches in comparison with 2022 and a very high increase in regions of Gopalichuck and Kusunda. The portion has remained the largest contributor for the years 2020 and 2022 as well.
- The Northern side from Loyabad to Katras, consisting of areas such as Sendra-Bansjora, Mudidh, Keshalipur, and Katras, sees scattered small to large fire patches of the coal fire area. The total coal fire area has slightly decreased, specifically for West Mudidh and Keshalipur, but the small patches have scattered even further in comparison to 2022.

Table 4: The tables show Year on Year mine wise comparison for total fire area for 2022-2024, where red indicates increase in fire area and green indicates decrease in fire area compared to previous year. Zero indicates no fire or fire is below the detection resolution of Landsat images.

S.I.	COLLIERY AREA NAME	FIRE AREA 2020 (SQ. KM.)	FIRE AREA 2022 (SQ. KM.)	FIRE AREA 2023 (SQ. KM.)	FIRE AREA 2024(SQ. KM.)
1	AKASH KINARI	**0.000**	**0.000**	**0.000**	**0.000**
2	ALKUSHA	**0.046**	**0.073**	**0.022**	**0.066**
3	AMLABAD	**0.000**	**0.000**	**0.003**	**0.000**

4	ANGARAPATRA	**0.036**	**0.083**	**0.000**	**0.116**
5	BAGDIGI	**0.000**	**0.000**	**0.000**	**0.000**
6	BANSDEOPUR	**0.000**	**0.052**	**0.123**	**0.044**
7	BARAREE	**0.040**	**0.000**	**0.000**	**0.000**
8	BASTACOLLA	**0.000**	**0.080**	**0.000**	**0.023**
9	BASURIA	**0.012**	**0.000**	**0.058**	**0.032**
10	BENEDIH OCP	**0.020**	**0.256**	**0.168**	**0.208**
11	BERA	**0.000**	**0.000**	**0.000**	**0.000**
12	BHAGABAND	**0.000**	**0.000**	**0.000**	**0.000**
13	BHATDIH	**0.000**	**0.000**	**0.000**	**0.000**
14	BHOWRAH. N	**0.006**	**0.203**	**0.275**	**0.196**
15	BHOWRAH. S	**0.023**	**0.027**	**0.156**	**0.013**
16	BHURUNGIA	**0.000**	**0.000**	**0.000**	**0.000**
17	BLOCK-II OCP	**0.034**	**0.065**	**0.285**	**0.086**
18	BULLIHARY	**0.000**	**0.003**	**0.000**	**0.000**
19	BURRAGARH	**0.000**	**0.000**	**0.000**	**0.000**
20	CHANDAN OCP	**0.000**	**0.000**	**0.000**	**0.000**
21	DAMODA	**0.000**	**0.000**	**0.000**	**0.000**
22	DHANSAR	**0.000**	**0.000**	**0.000**	**0.000**
23	DHARAMABAND	**0.000**	**0.000**	**0.000**	**0.000**
24	DOBARI	**0.000**	**0.000**	**0.000**	**0.000**
25	E. BASURIA	**0.000**	**0.000**	**0.000**	**0.000**
25	E. KATRAS	**0.000**	**0.000**	**0.000**	**0.000**
26	E.BHUGGATDIH	**0.020**	**0.054**	**0.053**	**0.024**
27	ENA	**0.004**	**0.115**	**0.335**	**0.203**
28	GASLITAND	**0.156**	**0.079**	**0.018**	**0.009**
29	GODHAR	**0.132**	**0.299**	**0.353**	**0.374**
30	GOLUCKDIH	**0.000**	**0.051**	**0.062**	**0.022**
31	GONDUDIH	**0.000**	**0.000**	**0.000**	**0.013**
32	GONHOODIH	**0.001**	**0.029**	**0.000**	**0.000**
33	GOPALICHUCK	**0.000**	**0.082**	**0.255**	**0.107**
34	GOVINDPUR	**0.000**	**0.000**	**0.000**	**0.000**
35	HURRILADIH&STD	**0.000**	**0.000**	**0.000**	**0.000**
36	IISCO	**0.000**	**0.000**	**0.000**	**0.000**
37	INDUSTRY	**0.000**	**0.000**	**0.000**	**0.000**
38	JEALGORA	**0.000**	**0.000**	**0.000**	**0.000**
39	JEENAGORA	**0.000**	**0.000**	**0.000**	**0.000**
40	JOGIDIH	**0.000**	**0.000**	**0.000**	**0.000**
41	JOYRAMPUR	**0.011**	**0.000**	**0.000**	**0.000**
42	KANKANEE	**0.057**	**0.084**	**0.140**	**0.090**
43	KATRAS-CHOITUDIH	**0.214**	**0.090**	**0.067**	**0.038**
44	KENDUADIH	**0.001**	**0.133**	**0.158**	**0.110**
45	KESHALPUR	**0.134**	**0.232**	**0.040**	**0.177**
46	KHARKHAREE	**0.000**	**0.000**	**0.000**	**0.000**
47	KHAS KUSUNDA	**0.000**	**0.000**	**0.000**	**0.000**
48	KORIDIH BLOCK-	**0.000**	**0.000**	**0.000**	**0.000**

	IV OCP				
49	KUJAMA	**0.000**	**0.026**	**0.123**	**0.029**
50	KUSTORE	**0.014**	**0.033**	**0.039**	**0.021**
51	KUSUNDA	**0.399**	**0.858**	**1.030**	**0.711**
52	KUYA	**0.000**	**0.000**	**0.000**	**0.000**
53	LODNA	**0.000**	**0.000**	**0.000**	**0.000**
54	LOHAPATTY	**0.000**	**0.000**	**0.000**	**0.000**
55	LOYABAD	**0.000**	**0.006**	**0.003**	**0.000**
56	MADHUBAND	**0.000**	**0.000**	**0.000**	**0.000**
57	MAHESHPUR	**0.000**	**0.000**	**0.000**	**0.000**
58	MOONIDIH PROJECT	**0.000**	**0.000**	**0.000**	**0.000**
59	MUDIDIH	**0.220**	**0.197**	**0.194**	**0.109**
60	MURAIDIH OCP	**0.006**	**0.000**	**0.000**	**0.009**
61	MURULIDIH	**0.000**	**0.000**	**0.000**	**0.000**
62	MURULIDIH 20/21 PIT	**0.000**	**0.000**	**0.000**	**0.000**
63	N. TISRA	**0.031**	**0.097**	**0.123**	**0.041**
64	NICHITPUR	**0.000**	**0.000**	**0.000**	**0.000**
65	NUDKHURKEE OCP	**0.000**	**0.400**	**0.039**	**0.154**
66	PATHERDIH	**0.000**	**0.000**	**0.000**	**0.000**
67	PHULARITAND	**0.000**	**0.000**	**0.000**	**0.000**
68	POOTKEE	**0.000**	**0.000**	**0.000**	**0.000**
69	RAMKANALI	**0.000**	**0.011**	**0.000**	**0.016**
70	S. JHARIA-R. OCP	**0.010**	**0.005**	**0.085**	**0.020**
71	S. TISRA	**0.021**	**0.210**	**0.367**	**0.157**
72	S.GOVINDPUR	**0.000**	**0.000**	**0.000**	**0.000**
73	SALANPUR	**0.000**	**0.000**	**0.000**	**0.000**
74	SENDRA-BANSJORA	**0.110**	**0.350**	**0.152**	**0.248**
75	SHATABDI OCP	**0.005**	**0.000**	**0.000**	**0.000**
76	SIMLABAHAL	**0.000**	**0.000**	**0.000**	**0.000**
77	SITANALA	**0.000**	**0.000**	**0.000**	**0.000**
78	SUDAMDIH	**0.000**	**0.000**	**0.000**	**0.000**
79	TASRA-IISCO	**0.000**	**0.000**	**0.000**	**0.000**
80	TETULMARI	**0.011**	**0.000**	**0.232**	**0.253**
81	TETURIA	**0.000**	**0.000**	**0.000**	**0.000**
82	TISCO	**0.000**	**0.000**	**0.000**	**0.004**
83	W. GODHAR	**0.000**	**0.000**	**0.000**	**0.002**
84	W. MUDIDIH	**0.085**	**0.265**	**0.050**	**0.192**
	Total	**1.85**	**4.54**	**5.00**	**3.91**

The classification of the coal fire area was based on field observation of whether the fire existed in the open cast mining areas/ old mining areas or the overburden dump of the active mine area. The larger patches of anomalies identified

by the Landsat images were meticulously separated from mine fires or Overburden dump fires after the field. The classified maps of 2023 and 2024 are shown in Figures 12 and 13. The spatial extent statistics and block-wise fire distribution for the separate classes of mine fire and Overburden dump fire for 2023 and 2024 are also shown in Tables 5 and 6, respectively. The bar graph-based statistical figure for block-wise increment and decrement of the fire area of the two classes is shown in Figures 14 and 15.

Table 5: Mine-wise area under coal fire classified in two classes of mine fire and Overburden dump fire for 2023 (grey cells in the table indicate the area has no fire or the fire is below detection resolution of satellite).

S.I.	Mine Area Name	Mine Fire (sq. km)	Overburden Fire (sq. km)
1	ALKUSHA	0.020	0.002
2	AMLABAD		0.003
3	BANSDEOPUR	0.123	
4	BASURIA	0.058	
5	BENEDIH	0.168	
6	BHOWRAH. N	0.161	0.115
7	BHOWRAH. S	0.023	0.133
8	BLOCK-II	0.242	0.043
9	E.BHUGGATDIH		0.053
10	ENA	0.307	0.028
11	GASLITAND		0.018
12	GODHAR	0.139	0.214
13	GOLUCKDIH		0.062
14	GOPALICHUCK	0.105	0.150
15	KANKANEE	0.089	0.051
16	KATRAS	0.056	0.012
17	KENDUADIH	0.096	0.062
18	KESHALPUR		0.040
19	KUJAMA	0.123	
20	KUSTORE		0.039
21	KUSUNDA	0.109	0.922
22	LOYABAD	0.002	0.000
23	MUDIDIH		0.194
24	N. TISRA	0.015	0.107
25	NUDKHURKEE	0.002	0.037
26	S. JHARIA		0.085
27	S. TISRA	0.367	
28	BANSJORA	0.152	
29	TETULMARI	0.013	0.219
30	W. MUDIDIH	0.036	0.014
	Total	**2.41**	**2.60**

Table 6: Mine-wise area under coal fire classified into two classes of mine fire and Overburden dump fire for 2024 (grey cells in the table indicate the area has no fire or the fire is below detection resolution of satellite).

S.I.	Mine Area Name	Mine Fire (sq. Km)	Overburden Fire (sq. Km)
1	ALKUSHA	0.060	0.006
2	ANGARAPATRA		0.116
3	BANSDEOPUR	0.021	0.023
4	BASTACOLLA		0.023
5	BASURIA		0.032
6	BENEDIH-OCP	0.203	0.005
7	BHOWRAH. N	0.127	0.069
8	BHOWRAH. S		0.013
9	BLOCK-II OCP	0.040	0.046
10	E.BHUGGATDIH		0.024
11	ENA	0.169	0.034
12	GASLITAND		0.009
13	GODHAR	0.185	0.189
14	GOLUCKDIH		0.022
15	GONDUDIH		0.013
16	GOPALICHUCK	0.058	0.049
17	JEENAGORA		0.001
18	KANKANEE	0.074	0.016
19	KATRAS-CHOITUDIH		0.038
20	KENDUADIH	0.105	0.005
21	KESHALPUR		0.177
22	KUJAMA	0.029	
23	KUSTORE		0.021
24	KUSUNDA	0.056	0.655
25	MUDIDIH		0.109
26	MURAIDIH OCP		0.009
27	N. TISRA	0.012	0.028
28	NUDKHURKEE OCP		0.154
29	RAMKANALI		0.016
30	S. JHARIA-R. OCP	0.006	0.014
31	S. TISRA	0.033	0.124
32	SENDRA-BANSJORA	0.157	0.091
33	TETULMARI	0.130	0.123
34	TISCO		0.004
35	W. GODHAR		0.002
36	W. MUDIDIH	0.066	0.127
	Total	**1.53**	**2.38**

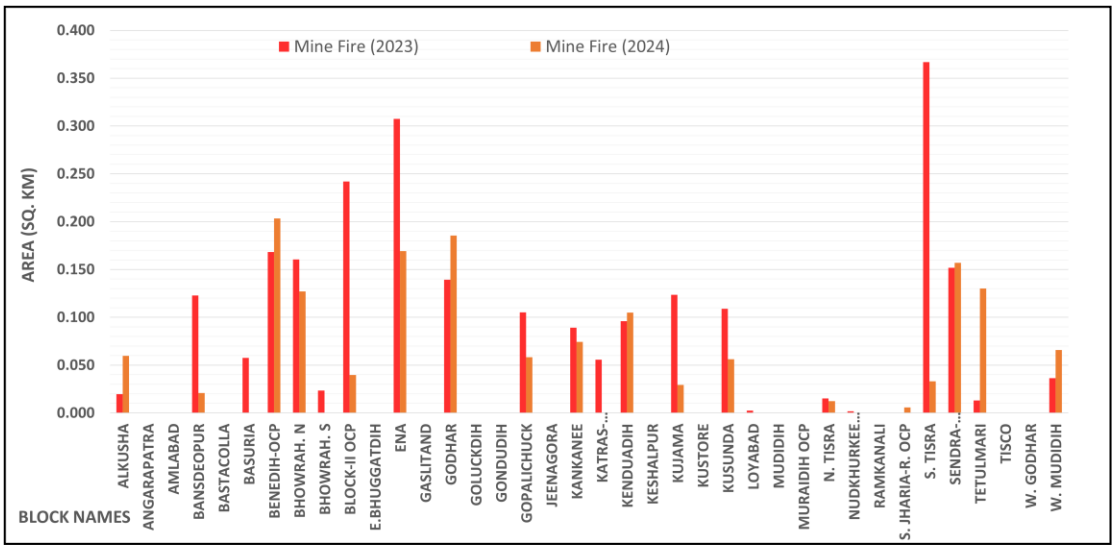

Figure 14. Block-wise comparison between 2023 and 2024 of Mine fire area.

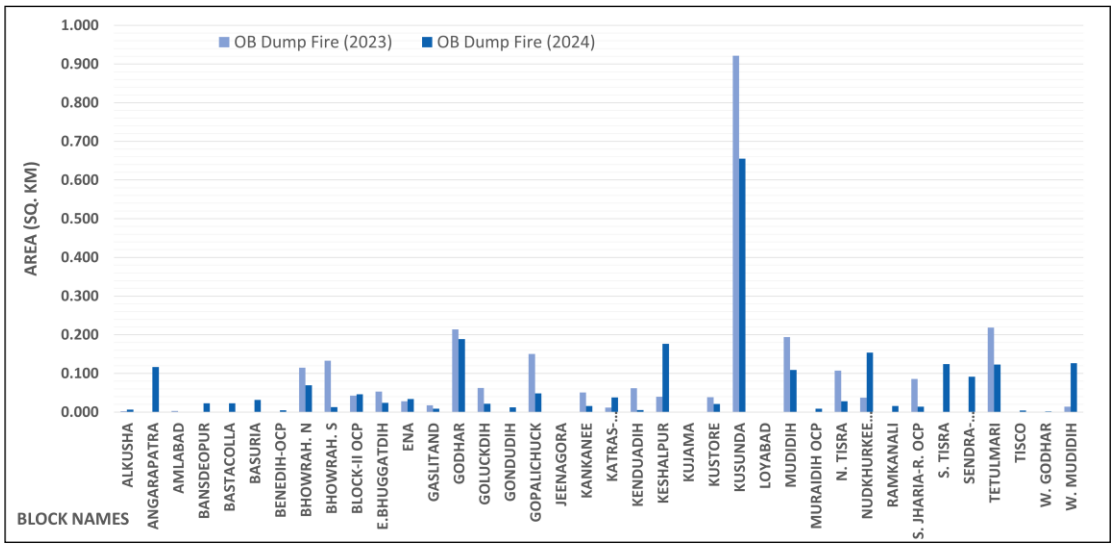

Figure 15. Block-wise comparison between 2023 and 2024 of Overburden dump fire area.

A similar cardinal direction-wise analysis of 2024 in comparison to 2023 provides a larger picture while at the same time allowing for focused analysis of the portions, with further distribution of fire area to two classes enabling us to provide further details on the regions of increasing and decreasing fire which helps the user in area-wise objective specific mitigation strategy.

- The eastern side of the mining extent has seen a significant decrease in overall fire area, number of fire patches, and specifically active mine fire from 2023 to 2024, with a significant decrease in active mine fire area for South Tisra Block, the Bhowrah active mining fire area regions and extent is approximately unchanged from 2023 to 2024.

- The western side has also seen a decrease in total fire area and active mine fire portions but an increase in the Overburden dump fire for the Nudkhurkee OCP block, which is part of a single mining area covering the Benedih OCP and Block-II OCP as well.
- The north-eastern side, while still being the highest contributor to the total fire area, has seen a slight decrease in the extent, specifically in the active mine fire areas due to Basuria and Bansdeopur blocks. At the same time, the Kusunda, Ena, and Gopalichuck portions have remained mainly similar for both classes.
- The northern portion has seen a significant increase in approximately all the parameters about coal mine fires, including the number of blazing fires in active mines, total mining area, and the extent to the two separate classes of mine fire. Although the northern portion was always the second largest contributor to the total mine fire area for the Jharia coalfield, the increase has made its contribution comparable to that of the north-eastern side, which was not observed in previous years—a large portion of Overburden dumps fire in the regions of Keshalpur, West. Mudidh and Angartapatra and the newly identified active mine fire regions of Sendra-Bansjora are the few key changes from 2023. The Overburden dump fire area of Mudidh and the active mine fire area of Kankanee have primarily remained as they were in 2023.

The ground temperature measurements for the fire area were taken for both years using the handheld thermal sensor, and the sensed temperature for a few of the Overburden dump fire and mine fire areas are shown in figures 16 and 17 for 2023 and 2024, respectively with the respective field location shown in figure 10. The surface temperature reading was taken for most of the fire locations using the handheld thermal sensor, where the Overburden dump fire temperature ranged from 100° to 500° C degrees. In comparison, the mine fire either contained only fissures/ cracks where the temperature ranged from 300° to 500°C or fissures/cracks along with blazing fire where the temperature was very high, surpassing the detectable limit of 650° C of the temperature for few locations.

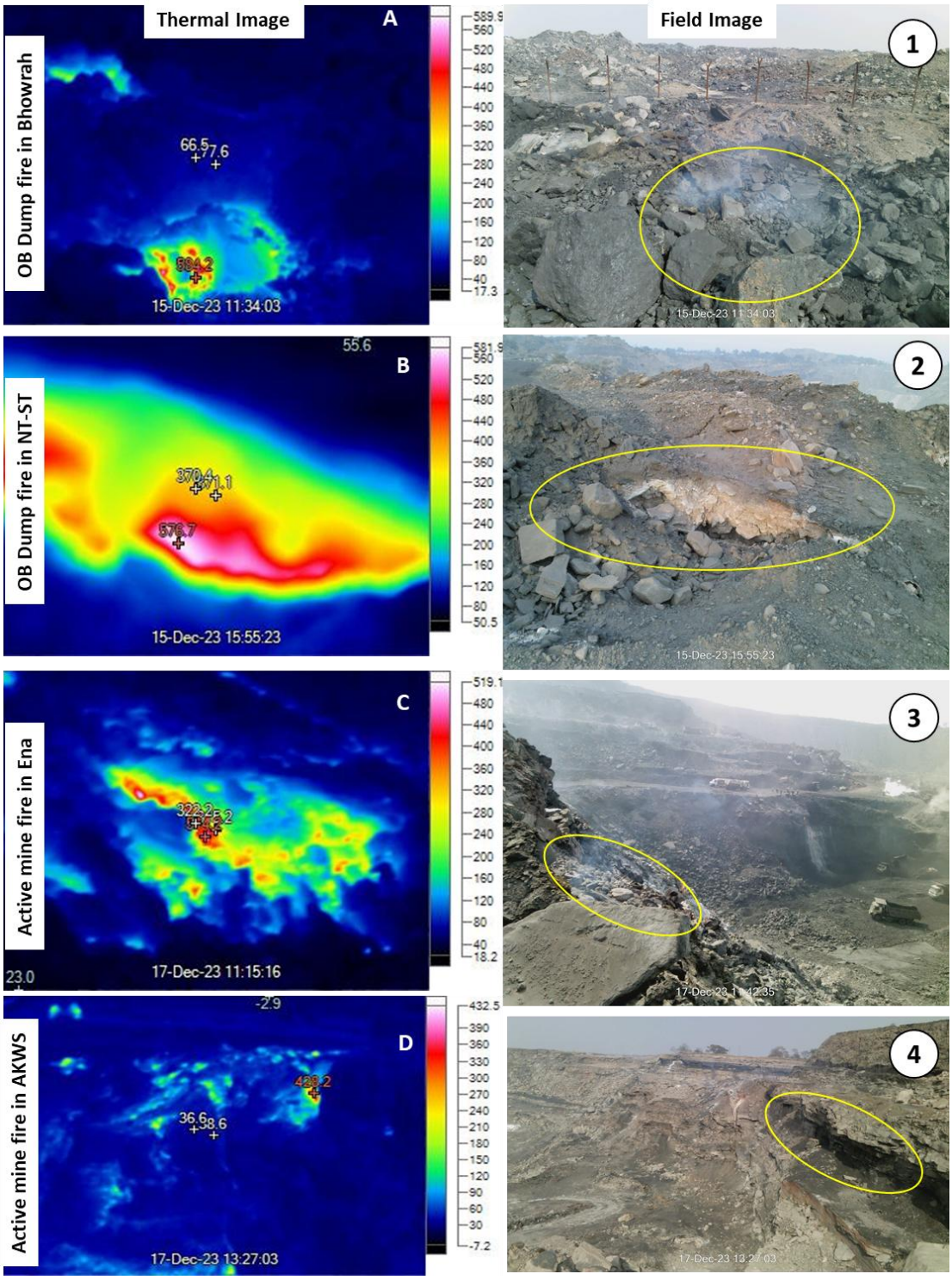

Figure 16. Thermal images and ground photographs from field survey for 2023 (yellow polygon shows the location from where thermal measurements are taken).

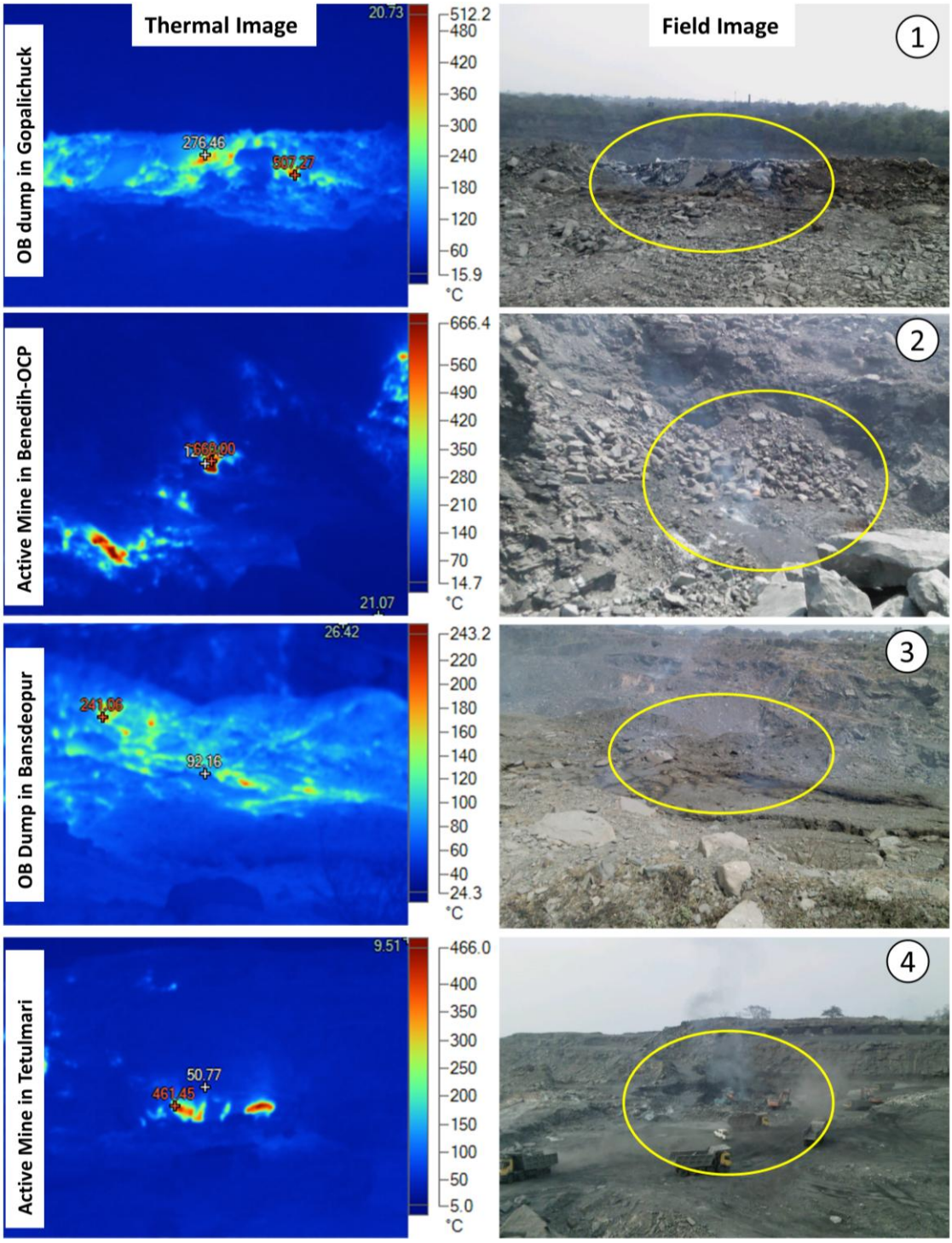

Figure 17. Thermal images and ground photographs from field survey for 2024 (yellow polygon shows the location from where thermal measurements are taken).

6.2 Subsidence Maps and Field images

The interferogram pair-by-pair processing for the seven acquired ALOS-PALSAR-2 L Band SLCs was carried out, and through the visual interpretation of the interferograms, the possible subsidence area was identified. The ground-based signature could be identified for the areas of Basuria, ENA, Dobari, and Nudkhurkee OCP as the bending of the treeing at the edge of the mine or settling of old Overburden dump or fall of loose material from Overburden dump areas. A few field photographs are shown in Figure 18, and the Jharia subsidence map is in Figure 19.

Figure 18. Field photographs for identified ground evidence for the subsidence areas for four different locations with (a) showing slanting trees, (b) showing falling of loose material, (c) edge of the mine slanting trees and (d) showing large crack due to mining activities.

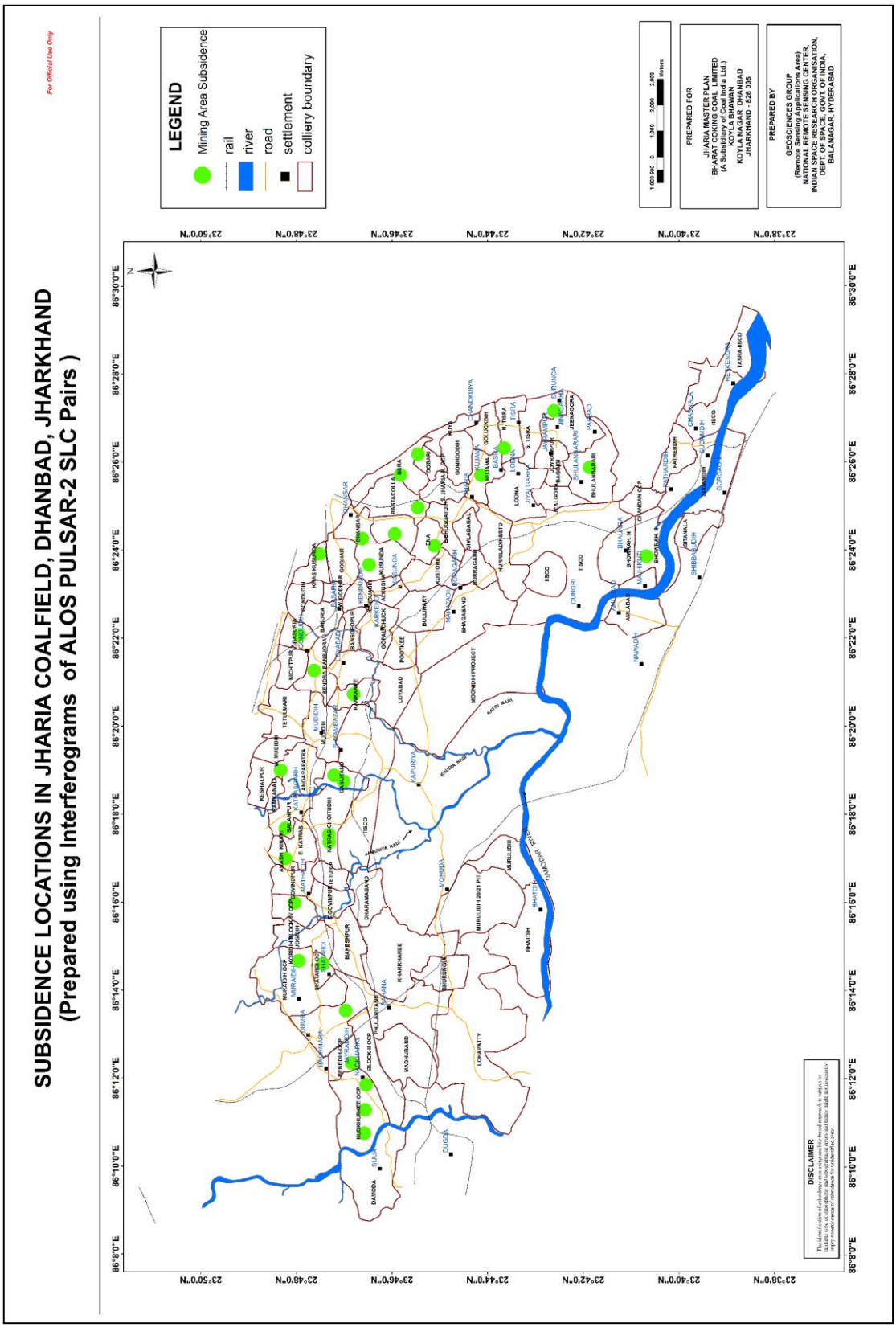

Figure 19. Subsidence map of the Jharia Coalfield (from ALOS PALSAR-2 data)

CHAPTER VII

DISCUSSION AND CONCLUSIONS

7.1 Discussion

7.1.1 Coal fire analysis

The present status of the fire in the Jharia Coal Fields for the period of 2022 to 2024 shows an increase in fire area for 2022 in comparison to 2020 (although field verification was not carried out in 2022) and an increase for 2023 in comparison to 2022 in approximately 0.5 sq. km where the cardinal direction-wise fire zones distributions were analysed in section 6.1. The identification of two classes in mine fire areas and overburden dump fire areas allowed for a deeper look into the areas of increment and decrement, which were analysed for the years 2023 and 2024, as shown in Figures 14 and 16. There is a decrease in total fire area of approximately 1.0 sq. km for 2023 and 2024 and a decrease in fire area in the two subclasses as well.

The identification of anomalous pixels from the Landsat images has changed from the previous analysis, where the coarse resolution of 100m x 100m of TIRS bands was solely used by converting it into radiant temperature through Planck's radiation function to using the fire color composite of medium resolutions of 30m x 30m bands of SWIR and NIR bands to identify the bright pixels indicative of fire along with the previous methodology. The change in the strategy has allowed for the identification of areas with fire patches covering smaller spatial extent while validating the identified areas through both methodologies for each other. As the identifiable overall resolution decreased, the total identified areas of coal fires increased, contributing to the increase in overall fire from previous years.

All the fire areas identified were field verified, and the accuracy of identification through satellite imagery is still consistently very high, strengthening the outcomes of the methodology for the identification of fire areas. The Fluke Ti300 thermal sensor provides a temperature estimate of the identified fire zones and a causative relationship between the satellite-measured temperature and the actual surface temperature.

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 a differential interferometric technique. Seven scenes of PALSAR-2 data spanning 2021 to 2024 were used to identify the subsidence in the region and separately identify them from the terrain changes due to mining. Verifying 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 identifying a few subsidence areas within the BCCL mine boundary. The two main areas of subsidence lie in the old Overburden dump area of Nudkhurkee OCP and the old Overburden dump area of Dhansar, while the other subsidence point lies in the active mine areas or Overburden dump areas; no subsidence was identified in the human habitation zones. No quantitative estimates of the subsidence have been carried out in the study.

7.2 Conclusions

The change in the areal extent of fire as identified by the Landsat images and block-wise distribution calculated for 2023 and 2024 and compared with old data of 2020 and non-verified maps of 2022, where an increase in the fire area for 2023 was majorly contributed by the north-eastern and easter sides and decrease for 2024 was due to eastern side while the central area of focus being the northern side due to substantial increase in the fire area from 2023 to 2024. The persistent coal fire zones from 2022 to 2024 in the North-eastern sides were also identified and verified during the field.

The accuracy of the generated maps, as verified from the field, was very high, and the causative relationship between the temperature measurement from the handheld thermal sensor and the identified higher fire pixel anomalies was satisfactory, with a higher degree of anomalies relating to the higher measured temperatures on the surface. The results section also discussed the temperature range for Overburden dump areas and active mine fire areas.

No subsidence was observed in the human habitation zones, and the main areas of subsidence do not seem to have consequences of the near settlements, while

the active mining area subsidence and new Overburden dump subsidence can be of concern for the mining area personnel due to constant failure of the loose material

Note: *The minimum mapable unit from satellite image it 30m by 30m or 0.0009 km^2.* *Estimations of fire extent (in terms of sq.km.) for the present study carried out for 2023-2024. They may differ from the actual ground area under fire. These estimations are made for comparative purpose only, to indicate the increase or decrease of areal extent of fire. Hence, they should not be quoted as fire area on the ground.*

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 is 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 for the fire area composite and 100m x 100m for TIRS bands based radiant temperature (resampled to 30m x 30m spatial resolution) 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. 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 4.1.2, 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 are 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.

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) Considering the precision of DInSAR data for different wavelengths, topographic and atmospheric errors, slow subsidence rates may not be detected. Further, the displacement measured is along the line of sight of the sensor and not vertical displacement.

8) Temporal decorrelation and noise due to adverse land use and land cover may affect DInSAR based detection and monitoring of land subsidence. Changes vegetation pattern over time can cause significant decorrelation between the master and slave image, thus producing a very low coherent output. Under such conditions, subsidence information may not be retrieved

9) 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 need 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.

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WATER QUALITY REPORT
OF
BHARAT COKING COAL LIMITED, CLUSTER – I

(FOR THE Q.E. JUNE, 2025)

E. C. no. J-11015/93/2009-IA.II (M) dated 06.02.2013.

CMPDI

ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CLUSTER - I

(FOR THE. Q.E. JUNE, 2025)

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3.	CHAPTER-II	WATER SAMPLING & ANALYSIS
4.	**PLATES:** PLATE NO. - I	SURFACE PLAN SHOWING WATER MONITORING LOCATIONS

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 $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Water sampling stations

The Water sampling stations were selected for mine sump water, Ground water supply, wells / 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 analyzed 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.

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 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 I is in the westernmost part of the Jharia coalfield. It includes Damoda OCP, Damoda UG. The Cluster – I is situated at a distance of about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster 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 Jamunia River.

1.2 The Cluster I is designed to produce 0.9 Mtpa (normative) and 1.17 Mtpa peak capacity of coal. The average grade of coal W-II to W-IV.

The Project is being worked by deploying shovel dumper combination.

The Project has been granted Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 0.9 MTPA (normative) and 1.17 MTPA peak capacity of coal production vide letter no **E. C. no. J-11015/93/2009-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

2.1 Location of sampling sites

(Refer **Plate No. - I**)

i) Ground Water Quality at **Ghutway Village (GW1)**

ii) Surface Water Quality at **U/S of Jamunia River (SW1)**

iii) Surface Water Quality at **D/S of Jamunia River (SW2)**

iv) Mine Water Quality at Damoda Colliery **(MW1)**

v) Mine Water Quality at Madhuband Colliery **(MW22)**

2.2 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.

2.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results show that most of the parameters are within the permissible limits.

TC-14321

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

CMPDIL, RI-II
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Month & Year	**QUARTER ENDING JUNE 2025**	**Cluster**	**I**	**ULR No.**	**TC1432125000002050 P**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.09.2025**
Project	**Ghutway Village**	**Sample Ref. No.**	**REM/BCCL/25-26/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ghutway Village**	**Date of Sampling**	**05.05.25**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**05.05.2025 TO 20.07.2025**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW-1	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
	Colour, Hazen unit	APHA, 24th Edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	60	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	55	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method,2023	0.63	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th Edition, 3500-Mg B: Calculation Method,2023	50	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th Edition, UV-Spectrophotometric Method,2023	7.22	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 24th Edition, , 2150-C,2023	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.55	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th Edition, 4500 S , Turbidity Method,2023	164	10.0-400.0	10	200	400
11	Taste	APHA,24th Edition, 2160-C , 2023	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	150	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	712	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	355	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**QUARTER ENDING JUNE 2025**	**Cluster**	**I**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.09.2025**
Project	**Ghutway Village**	**Sample Ref. No.**	**REM/BCCL/25-26/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ghutway Village**	**Date of Sampling**	**05.05.2025**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**05.05.2025** **TO**	**20.07.2025**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW-1	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th d Edition ,Carmine,2023	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 24th Edition, , 4500-Cl-B. (Iodometric Method-I),2023	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 22nd Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th Edition IS-3025,part 56:2003, R-2019/, AAS-VGA,2023	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th Edition, AAS-GTA,2023	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th Edition, AAS-GTA,2023	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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

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Month & Year	Quarter Ending JUNE 2025	Cluster	I	ULR No.	TC1432125170000 2067P TC1432125180000 2068P
Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)			Date of Issue	16.09.2025

Project		REM/SW/BCCL/25-26/	Sampling Method	(IS 3025 , Part-1) CMPDI/RI-II/LPM 13	
Sampling Stations	(i) Upstream in Jamunia River(SW1)	Date of Sampling	04.06.2025	Period of Analysis	
	(ii) Downstream in Jamunia River(SW2)	Date of Sampling	04.06.2025	04.06.2025 to 20.08.2025	

Sl. No.	Parameter	Method of Analysis	Observed Values		IS : 2296 INLAND SURFACE WATER [1982] Class 'C	Range of Testing	LDL
1	BOD (3 days 27°C), mg/l	IS 3025 (Part 44) : 1993, R-2019 , 3 day incubation at 27°C	<2.0	<2.0	3	2.00-100.00	2
2	Colour,Hazen Units	APHA 24th Edition , 2120-B-:2023	1	1	10	1-500.0	1
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 Argentometric Method	38	38	600	2.0-1500.0	5
4	Copper, mg/l	IS 3025 (Part 42) : 1992 R : 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, R:2003 Winkler Azide Method	6.5	6.2	4	1.0-10.0	0.1
6	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method,2023	0.73	0.62	1.5	0.2-2.00	0.2
7	Hexavalent Chromium, mg/l	APHA 24th Edition, 1,5-Diphenylcarbohydrazide Method IS 3025 (Part 52) : 2003,R-2023	<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	<0.2	<0.2	50	0.2-10	0.2
9	Nitrate , mg/l	APHA, 24th Edition, UV-Spectrophotometric Method,2023	4.92	4.31	50	0.5-45.0	0.5
10	pH value	IS 3025, (Part 11) : 1983 R-2023 Electrometric (Ph Meter) method	7.84	7.68	6.5-8.5	1.0-14.0	2
11	Sulphate, mg/l	APHA –24th Edition,4500- S, Turbidity Method,2023	37	46	400	10.0-400.0	10
12	Total Dissolved Solids, mg/l	IS 3025, (Part 16): 1984 R-2023 Gravimetric method	426	436	1500	25.0-10000.0	25
13	Zinc, mg/l	IS 3025(Part 49) : 1994, R : 2019, AAS-Flame Method	<0.1	<0.1	15	0.10 – 10.0	0.1

***Grab 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 Jerricane , Colour as observed is transparent***

Analysed by

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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

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Month & Year	**QUARTE ENDI NG JUNE 2025**	**Cluster**	**I**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.09.2025**
Project	**Sample Ref. No.**		REM/BCCL/25-26/SW /	**Sampling Method**	**(IS 3025 , Part-1) CMPDI/RI-II/LPM 13**
Sampling Stations	**(i)**	**Upstream in Jamunia River(SW1)**	**Date of Sampling**	04.06.2025	**Period of Analysis**
	(ii)	**Downstream in Jamunia River(SW2)**	**Date of Sampling**	04.06.2025	04.06.2025 to 20.08.2025

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**		**IS : 2296 INLAND SURFACE WATER [1982] Class 'C**	**Range of Testing**	**LDL**
			(i)	**(ii)**			
1	Arsenic (as As), mg/l, Max	IS-3025,Part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	<0.006	0.2	0.006-10	0.006
2	Lead (as Pb), mg/l, Max	APHA, 24th 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 24th edition, AAS-VGA	<0.007	<0.007	0.05	0.007-10	0.007

***Grab 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 Jerricane , Colour as observed is transparent***

	(Gaurav Kant)	(Kumar Vaibhav)
Analysed by	***REVIEWED BY***	***Authorised Signatory***

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Environment Laboratory, Regional Institute-II
MINE EFFLUENT ANALYSIS TEST REPORT

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Month & Year	**QUARTER ENDING JUNE 2025**	**Name of Cluster**	**CLUSTER I**	**ULR No.**	**TC143212559000002109P**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.09.2025**
Project	**Damoda Colliery**	**Sample Ref. No.**	**REM/BCCL/25-26/MW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**MW1**	**Date of Sampling**	**23.06.2025**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	

Period of Analysis **23.06.2025** **to** **10.09.2025**

Sl. No.	Parameter	Method of Analysis	MW1	Range Of Testing	LDL	MOEF -SCH-VI STANDARDS Class 'A'
1	B.O.D (3 days 27°C), mg/l, Max	IS 3025 /44:1993,R:20033 day incubation at 27°C	<2.0	2-10000.0	2	30
2	Colour	APHA,24th Edition ,2120-B-:2023	<1	1.0-500.0	1	-
3	COD, mg/l, Max	APHA 24th Edition 5220 C Titrimetric Method,2023	44	4.0-800.0	4	250
4	Copper (as Cu), mg/l, *Max*	IS 3025(Part42): 1992 R : 2019, AAS-Flame	<0.2	0.2-10.0	0.2	3
5	Dissolved Phosphate (as P), mg/l, Max	IS 3025/ 31, 1988 R 2019	0.083	0.1-5.0	0.1	5
6	Fluoride (as F) mg/l, *Max*	APHA, 24th Edition, Page 4-90 to , 4500 – F- D (SPADNS Method),2023	0.62	0.2-2.0	0.2	2
7	Hexavalent Chromium, mg/l, Max	IS 3025 (Part 52) : 2003,Reaffirmed 2019	<0.01	0.01-1.40	0.01	0.1
8	Iron (as Fe), mg/l, *Max*	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame	<0.2	0.2-10	0.2	3
9	Manganese(as Mn), mg/l, Max	APHA, 24th Edition, AAS-Flame	<0.1	0.1-10	0.1	0.1
10	Nickel (as Ni), mg/l, *Max*	IS-3025(Part 54):2003, R:2019 AAS-Flame	<0.1	0.1-10.0	0.1	3
11	Nitrate Nitrogen, mg/l, *Max*	APHA, 24th Edition,UV-Spectrophotometric	1.06	0.5-45	0.5	10
12	Oil & Grease, mg/l, Max	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	2.0-1000	2	10
13	pH value	IS-3025/11:1983, R-2023, Electrometric	7.79	1 -14	0.1	5.5 to 9.0
14	Temperature (°C)	IS-3025/09:1984, Thermometeric	29.8	1-100	.	Shall not exceed 5° C above the receiving temp.
15	Total Chromium (as Cr), mg/l, *Max*	IS-3025(Part 52):2003, R:2019 AAS-Flame	<0.1	0.1-10.0	0.1	2
16	Total Suspended Solids, mg/l, Max	IS 3025/17:1984, R :2023, Gravimetric	46	10-5000	10	100
17	Zinc (as Zn), mg/l, *Max*	IS 3025 /49 : 1994, R : 2019, AAS-Flame	<0.1	0.1-10.0	0.1	5
18	Odour	APHA, 24th Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Qualitative

****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,*

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

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

MINE EFFLUENT ANALYSIS TEST REPORT

CMPDIL, RI-II
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Month & Year	**QUARTER ENDING JUNE 2025**	**Name of Cluster**	**CLUSTER I**			
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**				**Date of Issue**	**16.09.2025**
Project	**Damoda Colliery**	**Sample Ref. No.**	**REM/BCCL/25-26/MW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**MW1**	**Date of Sampling**	**23.06.2025**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**		

Period of Analysis 23.06.2025 to 10.09.2025

Sl. No.	Parameter	Method of Analysis	MW1	Range Of Testing	LDL	MOEF -SCH-VI STANDARDS Class 'A'
1	Ammonical Nitrogen, mg/l, Max	IS 3025/34:1988,R : 2009, Nessler's	<0.02	0.02-100	0.02	50
2	Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA,2023	<0.006	0.006-5	0.006	0.2
3	Free Ammonia, mg/l, Max	IS:3025/34:1988, Nesseler's	<0.01	0.01-10	0.01	5
4	Lead (as Pb), mg/l, *Max*	IS-3025(Part 59):2006, R 2023 AAS-GTA/APHA, 24th Edition, 3111B, AAS-GTA	<0.005	0.005-10	0.005	2
5	Phenolic compounds	APHA, 24th Edition4-Amino Antipyrine,2023	<0.002	0.002-5	0.002	1
6	Selenium, mg/l, Max	IS-3025,part 56:2003, R-2019/ APHA 24th Edition, AAS-VGA,2023	<0.007	0.007-5	0.007	0.05
7	Sulphide (as S^{2-}) mg/l Max.	APHA 24th Edition Methylene Blue Method,2023	<0.005	0.005-5	0.005	2
8	Total Kjeldahl Nitrogen, mg/l, Max	IS:3025/34:1988, Nesseler's	<1	1-200	1	100
9	Total Residual Chlorine, mg/l, Max	APHA, 24th Edition, , 4500-Cl B. (Iodometric Method-I),2023	<0.04	0.04-5.00	0.04	1

****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,*

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

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TC-14321

MINE EFFLUENT ANALYSIS TEST REPORT

Month & Year	**QUARTER ENDING JUNE 2025**	**Name of Cluster**	**CLUSTER I**	**ULR No.**	**TC143272500000213 0P**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.09.2025**
Project	**Madhuband Colliery**	**Sample Ref. No.**	**REM/BCCL/25-26/MW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**MW22**	**Date of Sampling**	**16.06.2025**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	

Period of Analysis **16.06.2025** **to** **10.09.2025**

Sl. No.	Parameter	Method of Analysis	MW22 M1280	Range Of Testing	LDL	MOEF -SCH-VI STANDARDS Class 'A'
1	B.O.D (3 days 27°C), mg/l, Max	IS 3025 /44:1993,R:20033 day incubation at 27°C	<2.0	2-10000.0	2	30
2	Colour	APHA,24th edition ,2120-B-:2023	2	1.0-500.0	1	-
3	COD, mg/l, Max	APHA 24th edition 5220 C Titrimetric Method	40	4.0-800.0	4	250
4	Copper (as Cu), mg/l, *Max*	IS 3025(Part42): 1992 R : 2019, AAS-Flame	<0.2	0.2-10.0	0.2	3
5	Dissolved Phosphate (as P), mg/l, Max	IS 3025/ 31, 1988 R 2019	0.1	0.1-5.0	0.1	5
6	Fluoride (as F) mg/l, *Max*	APHA, 23RD Edition, Page 4-90 to , 4500 –F- D (SPADNS Method)	0.78	0.2-2.0	0.2	2
7	Hexavalent Chromium, mg/l, Max	IS 3025 (Part 52) : 2003,Reaffirmed 2019	<0.01	0.01-1.40	0.01	0.1
8	Iron (as Fe), mg/l, *Max*	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame	<0.2	0.2-10	0.2	3
9	Manganese(as Mn), mg/l, Max	APHA, 24th edition, AAS-GTA	<0.1	0.1-10	0.005	0.1
10	Nickel (as Ni), mg/l, *Max*	IS-3025(Part 54):2003, R:2019 AAS-Flame	<0.1	0.1-10.0	0.1	3
11	Nitrate Nitrogen, mg/l, *Max*	APHA, 23 rd Edition,UV-Spectrphotometric	0.87	0.5-45	0.5	10
12	Oil & Grease, mg/l, Max	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	2.0-1000	2	10
13	pH value	IS-3025/11:1983, R-2023, Electrometric	7.85	1 -14	0.1	5.5 to 9.0
14	Temperature (°C)	IS-3025/09:1984, Thermometeric	31.1	1-100	.	Shall not exceed 5° C above the receiving temp.
15	Total Chromium (as Cr), mg/l, *Max*	IS-3025(Part 52):2003, R:2019 AAS-Flame	<0.1	0.1-10.0	0.1	2
16	Total Suspended Solids, mg/l, Max	IS 3025/17:1984, R :2023, Gravimetric	41	10-5000	10	100
17	Zinc (as Zn), mg/l, *Max*	IS 3025 /49 : 1994, R : 2019, AAS-Flame	<0.1	0.1-10.0	0.1	5
18	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Qualitative

****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,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

MINE EFFLUENT ANALYSIS TEST REPORT

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

Month & Year	**QUARTER ENDING JUNE 2025**	**Name of Cluster**	**CLUSTER I**				
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.09.2025**
Project	**Madhuband Colliery**	**Sample Ref. No.**	**REM/BCCL/25-26/MW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**		
Sampling Stations	**MW22**	**Date of Sampling**	**16.06.2025**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
				Period of Analysis	**16.06.2025**	**to**	**10.09.2025**

Sl. No.	**Parameter**	**Method of Analysis**	**MW22**	**Range Of Testing**	**LDL**	**MOEF -SCH-VI STANDARDS Class 'A'**
1	Ammonical Nitrogen, mg/l, Max	IS 3025/34:1988,R : 2009, Nessler's	<0.02	0.02-100	0.02	50
2	Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-5	0.006	0.2
3	Free Ammonia, mg/l, Max	IS:3025/34:1988, Nesseler's	<0.01	0.01-10	0.01	5
4	Lead (as Pb), mg/l, *Max*	IS-3025(Part 59):2006, R 2023 AAS-GTA/APHA, 24th Edition, 3111B, AAS-GTA	<0.005	0.005-10	0.005	2
5	Phenolic compounds	APHA, 24th edition4-Amino Antipyrine	<0.002	0.002-5	0.002	1
6	Selenium, mg/l, Max	IS-3025,part 56:2003, R-2019/ APHA 24th edition, AAS-VGA	<0.007	0.007-5	0.007	0.05
7	Sulphide (as S^{2-}) mg/l Max.	APHA 24th edition Methylene Blue Method	<0.005	0.005-5	0.005	2
8	Total Kjeldahl Nitrogen, mg/l, Max	IS:3025/34:1988, Nesseler's	<1	1-200	1	100
9	Total Residual Chlorine, mg/l, Max	APHA, 23rd Edition, , 4500-Cl B. (Iodometric Method-I)	<0.04	0.04-5.00	0.04	1

****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,*

ANALYSED BY

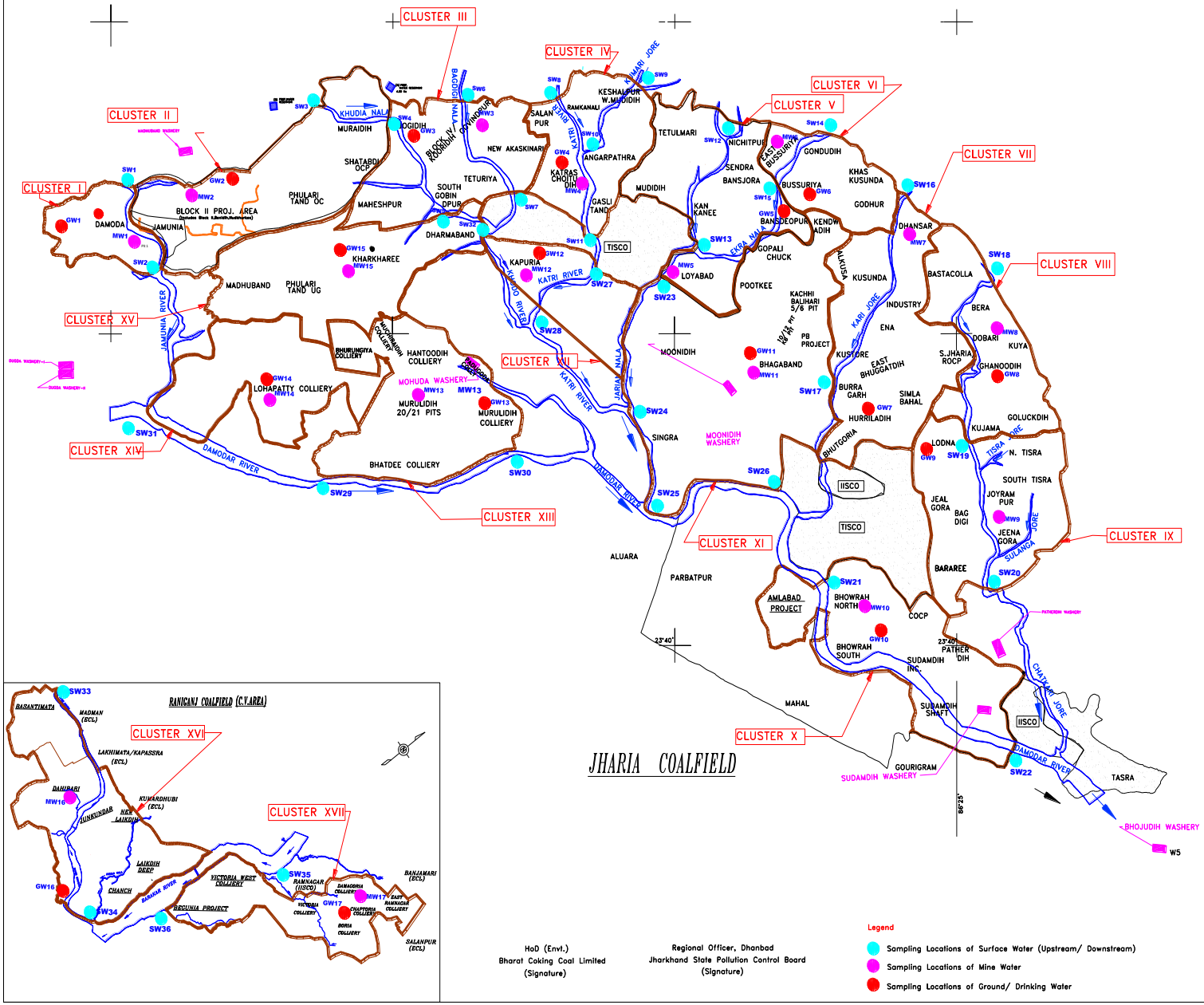
(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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

---- End of Report ----

Water Sampling Locations in BCCL



INDEX

Cluster	Suface Water (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Bagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	Katri River, Kumari Jore	MW4	Chotudih	GW4	Kankanee Village
V	SW12, SW13, SW15	Jarian Nala, Ekra Nala	MW5	Mudidih	GW5	Nichitpur
VI	SW14, SW15	Ekra Nala	MW6	East Bassuria UGP	GW6	Bansjora Borewell
VII	SW16, SW17	Kari Jore	MW7	Dhansar UGP	GW7	Hurriladih
VIII	SW18, SW19	Kashi Jore	MW8	Dobari UGP	GW8	Ghanudih
IX	SW19, SW20	Kashi Jore	MW9	Jeenagora	GW9	Lodna
X	SW21, SW22	Damodar River	MW10	Bhowrah North	GW10	Bhowrah South
XI	SW23, SW24, SW25, SW26	Jarian Nala, Damodar River	MW11	Bhagaband h UGP	GW11	Bhagabandh
XII	SW27, SW28	Katri River	MW12	Kapuria	GW12	Kapuria
XIII	SW29, SW30	Damodar River	MW13	Murulidih (20/21)	GW13	Murilidih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Khudia Nala	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34	Khudia River	MW16	Dahibari OCP	GW16	Patlabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria

HoD (Envt.)
Bharat Coking Coal Limited
(Signature)

Regional Officer, Dhanbad
Jharkhand State Pollution Control Board
(Signature)

Legend
- Sampling Locations of Surface Water (Upstream/ Downstream)
- Sampling Locations of Mine Water
- Sampling Locations of Ground/ Drinking Water

Customer	BHARAT COKING COAL LIMITED
Title	WATER SAMPLING LOCATIONS
Subject	MONITORING STATIONS
CMPDI (ISO 9001 Company)	Scale: Not to Scale

F. No- 22020/02/2016-CRC-II(Part-III) [E-327780]
भारत सरकार /Government of India
कोयला मंत्रालय /Ministry of Coal
एम.पी.एस अनुभाग /MPS Section
*****

कमरा नंबर 622-ए, शास्त्री भवन,
नई दिल्ली, दिनांक 9th July, 2025

To,

1. **The Chief Secretary, Govt. of Jharkhand**
2. **The CMD, Coal India Ltd.**

Subject: Implementation of the Revised Jharia Master Plan for Dealing with Fire, Subsidence & Rehabilitation of affected families in Jharia Coalfield- Reg.

The term of Jharia Master Plan, 2009 was completed in August 2021. A Committee, under the chairmanship of the Secretary (Coal), was constituted on 25th August 2021, to review the Jharia Master Plan. Subsequently, another Committee, under the chairmanship of the Additional Secretary (Coal), was constituted on 12th December 2024, for implementation of Jharia Master Plan.

2. Based on the recommendations of both the Committees, the revised Jharia Master Plan has been formulated. The Cabinet Committee on Economic Affairs has approved the Revised Jharia Master Plan for dealing with Fire, Subsidence & Rehabilitation of affected families of Jharia Coalfield on 25th June 2025. CCEA has approved the following proposals:

(a) Implementation of Revised Jharia Master Plan by Coal India Ltd. with an outlay of ₹ 5940.47 Crores for initial phase from balance amount of ₹ 6663.02 Crore from Jharia & Raniganj Master Plan of 2009 available with Coal India Ltd. In addition to above fund, Coal India Ltd. will provide ₹ 500 Crore per year and interest earned thereon. Additional activities will also be undertaken from the available amount for completion of remaining activities as per Revised Jharia Master Plan.

(b) Restructuring of JRDA to ensure effective implementation of the Revised Jharia Master Plan with (a) Monitoring Committee under co-chairmanship of Secretary (Coal) and Chief Secretary, Government of Jharkhand. The said Committee shall monitor progress of milestones every quarter. (b) Implementing Committee under a CEO of Joint Secretary rank (Serving/Retired) from the Government of Jharkhand. JRDA to be restructured by the State Govt. of Jharkhand as per the organisation structure given at **Annexure-I.**

(c) Authorizing Coal India Ltd. to make changes in the Revised Master Plan, if required, including re-appropriation of funds from one head to another and norms for assistance for different components in consultation with Ministry of Coal for successful implementation of Revised Jharia Master Plan as per delegated financial authority for a Maharatna Company.

3. The initial phase of Revised JMP will be applicable for 81 most vulnerable sites (7 Mineable & 74 Non-Mineable) & 27 NRSC Fire sites of Jharia Coalfield, Dhanbad, Jharkhand. The total of 649 BCCL families, 1130 LTH families (subject to verification) &

13301 Non-LTH families (total 15080 families) living in the danger area of Jharia Coal Field will be directly benefited. The initial phase of the revised JMP is to be completed by December 2028. The summary of the revised Jharia Master Plan is given at **Annexure-II**.

4. The funding arrangement for the implementation of the initial phase of the Revised Jharia Master Plan is as follows:

(a) Funding arrangement -

Balance amount (as on 31.03.2025) from Jharia & Raniganj Master Plan of 2009.	₹ 6663.02 Crore
Additional funding by CIL @ ₹ 500 Crore/ Year (for 3 Years)	₹ 1500.00 Crore
Interest earned thereon	-
Revenues from proposed mineable areas	-
Total	₹ 8163.02 Crore

(b) All the surplus revenues from the seven mineable sites in Jharia coal field would be deposited in an escrow account. The moneys in this account will only be used with permission of CIL Board and primarily for the purpose of rehabilitation under JMP. Suitable sums from this account can also be used for the operations and functioning of BCCL with the approval of CIL Board.

(c) Funding of ₹ 500 Crore/ year from CIL will continue, and a corpus will be created for future phases, if required. Further, funding from the District Mineral Foundation (DMF) will be utilised by DC, Dhanbad, whenever required.

5. Satellite imagery and AI technology to be leveraged for scientific monitoring of implementation.

6. Additional components of the Revised Jharia Master Plan, along with the responsibilities and timelines, are given in **Annexure-III.**

7. It is requested to take necessary action to implement the above decisions in the prescribed time-frame.

This issues with the approval of Hon'ble Minister of Coal and Mines.

Digitally signed by
HITLAR SINGH
Date: 09-07-2025
09:47:33

(Hitlar Singh)
Under Secretary to the Govt. of India

Copy to-

1. The Cabinet Secretariat (Shri S.G.P. Verghese, Joint Secretary, Rashtrapati Bhawan, New Delhi-w.r.t. ref. no. CCEA/12/2025(i))
2. CEO, Niti Aayog
3. Secretary, Department of Expenditure, Ministry of Finance
4. Secretary, Department of Public Enterprises
5. Secretary, Department of Land Resources, Ministry of Rural Development
6. Secretary, Ministry of Road, Transport & Highways
7. Secretary, Ministry of Railways
8. CMD, Bharat Coking Coal Ltd.
9. DC, Dhanbad cum MD, JRDA

Copy for information to:

1. PS to Minister of Coal
2. PSO to Secretary (Coal)
3. PPS to Additional Secretary & Nominated Authority
4. PPS to OSD, O/o Advisor (P)
5. IFD, MoC

Annexure-I

Approved organisation structure of JRDA

Immediate steps shall be taken to strengthen JRDA by establishing a robust administrative structure with suitable manpower. The structure would ensure efficient and effective implementation of the Revised Jharia Master Plan.

1. **Monitoring Committee:**
   i. Secretary (Coal), Co-Chairman
   ii. Chief Secretary, Govt. of Jharkhand, Co-Chairman
   iii. Secretary, Mines, Govt. of Jharkhand, Member
   iv. Secretary, Department of Home, Jail & Disaster Management, Govt. of Jharkhand, Member
   v. Chairman, Coal India Ltd., Member
   vi. CMD, BCCL, Member
   vii. Director General, DGMS, Member
2. **Implementing Committee**

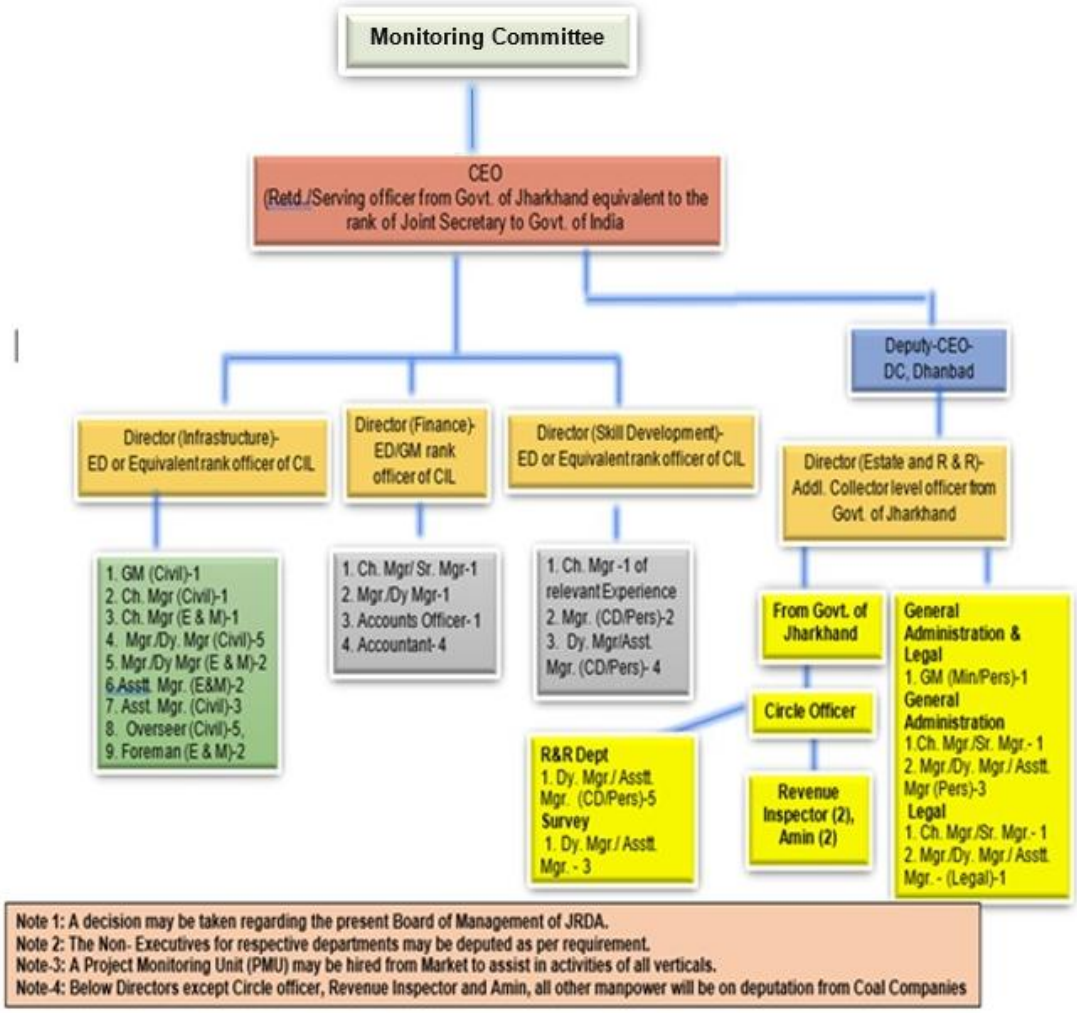
   (a) Leadership: CEO, JRDA would be a retired/serving Joint Secretary-ranked officer from Govt. of Jharkhand, for the term of Revised Jharia Master Plan. This will ensure strong and effective leadership for the duration of the plan.

   (b) Deputy CEO: The Deputy Commissioner (DC) of Dhanbad would serve as the Deputy CEO of JRDA, playing a key role in the local administration and decision-making processes.

   (c) Directors: JRDA to have four directors, each overseeing key verticals:
   i. Director (Infrastructure)-ED or Equivalent rank officer of CIL
   ii. Director (Finance) – ED/GM rank officer of CIL, JRDA
   iii. Director (Skill Development) – ED or Equivalent rank officer of CIL or Recruitment from market
   iv. Director (Estate and R &R) – Additional Collector Level officer from Govt. of Jharkhand

This structure is designed to ensure a coordinated, efficient, and transparent approach to the execution of the Revised Jharia Master Plan, with clear lines of authority and accountability. The involvement of key stakeholders at both the central

and state levels will facilitate smoother implementation and ensure that the plan meets its objectives in a timely and effective manner.



Annexure-II

Summary of Revised Jharia Master Plan

The Revised Jharia Master Plan (JMP) intends to effectively rehabilitate the affected people in Jharia Coalfield and deal with fire to prevent human loss & empower Coal India Ltd. to make changes in the Revised Master Plan within the approved outlay, if required, including re-appropriation of funds from one head to another in consultation with Ministry of Coal for successful implementation as per delegated financial authority. The report of experts will be the guiding the Revised Jharia Master Plan implementation.

1. Salient Features

1.1. The Revised JMP will be applicable for 81 most vulnerable sites in the initial phase & 27 NRSC Fire sites of Jharia Coalfield, Dhanbad, Jharkhand and 649 BCCL families, 1130 LTH families (subject to verification) & 13301 Non-LTH families (total 15080 families) living in the danger area of Jharia Coal Field will be directly benefited. It will be implemented by December 2028.

1.2. The objectives is to deal with fire in 27 fire-affected sites, rehabilitate people from 81 Most vulnerable sites, safeguard the people who will be moved from endangered areas to safer places with better amenities, save large amounts of coal from burning which provides scope for projectizing the available reserves eventually & protect environmental pollution and make the location environment friendly.

1.3. BCCL will implement fire dealing measures in a time-bound manner in 27 fire-affected sites or any other future outbreak.

1.4. Fire and unstable sites will be grouped into Mining Projects, which are considered suitable for mining by CIL, and Non-Mining Projects, which are not considered suitable for mining. Sites falling under Mining Projects will be rehabilitated using the CIL's R&R policy under the responsibility of BCCL and for non-Mining Projects, Jharia Master Plan will be implemented by JRDA. To maintain uniformity, affected non-LTH falling under Mining Projects will be given compensation as recommended for Jharia Master Plan, and top-up funding

above the CIL R&R package for encroachers will be provided from JMP fund. Therefore, Mineable sites will be dealt accordingly by BCCL.

1.5. A new option of cash compensation will be given in place of houses for both LTH & Non-LTH families will be provided. However, houses constructed will be allotted on first priority and after the exhaustion of existing houses, cash compensation will be paid. Ownership rights of houses will be given as per the long-term lease.

1.6. Committee for way ahead of Jharia Master Plan recommended that regarding compensation for the land to the LTH families, it should be determined under CBA Act or the Land Acquisition, Rehabilitation and Resettlement (LARR) Act, 2013. Sections 25 to 30 of the Act lay down the provisions for the determination of compensation for land acquired. Therefore, applying the provisions of the LARR Act, 2013 would be most practical, as it provides a legal framework for determining the price of land. JRDA will ensure that LTH families have proper documents in support of their legal possession of the land.

1.7. Once the house constructions are completed and houses are handed over to affected families, the services to be provided by either JRDA or State govt. Therefore, all Operations & Maintenance (O&M) of the assets will be carried out by JRDA & State Govt. A corpus will be created to support the effective management of the township created for the people to provide civic amenities.

1.8. After shifting of families, BCCL and JRDA will ensure that no new encroachment takes place in the Jharia Master Plan area and all acquired houses are demolished.

1.9. In earlier JMP, there was no legal provision for shifting of families residing in affected areas and no legal powers to JRDA. The Government of Jharkhand will empower JRDA with legal mandate to enforce rehabilitation and resettlement.

1.10. JRDA to be restructured with (a) Monitoring Committee under co-chairmanship of Secretary (Coal) and Chief Secretary, Government of Jharkhand. The Ministry of Coal will set and update weekly milestones along with the authority responsible for the implementation of the same. The said milestones will be monitored by the aforesaid Committee every quarter. (b) Implementing Committee under a CEO of Joint Secretary rank (Serving/Retired) from the Government of Jharkhand.

1.11. All the required amenities at rehabilitation sites, such as schools, hospitals, community centres, street lighting, tap water connections, permanent electricity connection to households, waste collection services, sewerage treatment plants etc. will be provided. Existing housing units will be maintained to make them in a liveable condition.

1.12. Skills will be provided to rehabilitated families and microenterprises will be developed to provide employment.

1.13. Belgaria Township to be notified as municipal body in long run. Resident Welfare Association (RWA) to be formed with seed funding for the corpus and support for 3 years.

1.14. Vacated sites will be taken into possession & ecologically restored through plantation, stabilization, and sustainable land use.

2. Cut-off date for entitlement:

Demographic surveys of 2019 is recommended by the Committee as final survey for entitlement. No revisions in the cut-off date is allowed. As per the survey, there are 1130 LTH families (subject to further verification of documents), 13301 Non-LTH families & 649 BCCL families who will be rehabilitated. BCCL and JRDA will take all measures to ensure that no new encroachment takes place in the Jharia Master Plan area and all acquired houses will be demolished and land to be possessed.

3. Compensation package:

	Types of Assistance	**LTH**	**Non-LTH**
a.	Compensation	Compensation for land and Assets + 50m^2 house or Rs. 5 Lakh cash*	38.92 m2 house **(each family will be allotted two units)** or Rs. 5 Lakh cash*
b.	Livelihoods grant	Rs. 1 Lakh	Rs. 1 Lakh
c.	Rental Assistance	Rs. 1 Lakh	Rs. 1 Lakh

d.	Cost of shifting	Rs. 50,000	Rs. 50,000
e.	One time grant in lieu of annuity/employment	Rs. 5 Lakh	-
	Total	Compensation +House/ Rs. 5 Lakh + Rs. 7.50 Lakh	House **(each family will be allotted two units)** /Rs 5 Lakh+ Rs. 2.50 Lakh

Note:

1. * Houses constructed will be allotted on first priority and after the exhaustion of existing houses, cash compensation will be paid.
2. Jharia Alternative Livelihoods Rehabilitation Fund will be set up as part of the rehabilitation plan to support livelihood activities. Along with the Livelihood Grant of ₹ 1 Lakh and loan up to ₹ 3 Lakh through a credit pipeline will be given to both LTH and Non-LTH families.

4. Outlay

Table-1

		FY	**Outlay (Amount in Cr)**
Revised Jharia Master Plan for Dealing with Fire, Subsidence & Rehabilitation in Jharia Coalfield	**Fire Dealing & Rehabilitation of BCCL families**	2025-26	369.27
		2026-27	1105.00
		2027-28	1100.83
		Sub Total	**2575.10**
	Rehabilitation (JRDA)	2025-26	1121.79
		2026-27	1121.79
		2027-28	1121.79
		Sub-Total	**3365.37**
		Total	**5940.47**

4.1. Fund provision for fire dealing of ₹ 2178.40 Cr includes blanketing, viability gap funding (deficit grant), scientific studies & project preparation cost. VGF (Deficit

grant) of ₹ 1114.20 Cr for one unviable site is required by BCCL. Resettlement Land Cost of ₹ 149.20 Cr & Infrastructural Cost of ₹ 247.50 Cr. Refer **Table-2** below for details.

4.2. Tentative fund requirement for rehabilitation of LTH & Non-LTH families in 81 high-risk vulnerable sites, calculated by JRDA based on two methods (i) using cost index of JCF (by CMPDIL) from 2008 to 2023 i.e.; increase of 238.66% and (ii) based on assumptions (a) average cost of asset on homestead land @ ₹ 25 Lakhs per family. (b) Average land of 6 decimals per family @ ₹ 2 Lakhs per decimal. (c) Other compensations as recommended by Committee for LTH families 3 adults per family are considered. (d) One Time grant of ₹ 5 Lakh in lieu of Annuity/Employment amt. for LTH Families as per 2nd Schedule point 4 (b) of LARR Act 2013. On average 3 adults are considered for each LTH family. Refer **Table-3** for detailed fund calculation. However, 2nd method has been considered for more actual estimates.

4.3. The estimates are tentative based on industry best practices, therefore, costs may vary based on market conditions.

Table- 2

Outlay for Fire Dealing & Rehabilitation on BCCL Part

(Amount in Rs. Cr.)

S. No.	Particulars	Amount	Remarks
1.	Infrastructural Cost	247.50	This is the cost amenities & infrastructure for BCCL houses.
2.	Resettlement Land Cost	149.20	The funding requirement for land required for amenities & infrastructure for BCCL houses.
3.	Project preparation Cost	12.50	It includes the Cost of Fire project preparation by CMPDI & other jobs by CMPDI. 1000 Eds have been provisioned per year for this job for 5 years.

4.	Fire Dealing	(A) Blanketing	1001.70	1. NRSC survey indicated 27 fire locations which were projectised by CMPDIL, accordingly 16 projects were found viable/ self-sustainable and are running at present. One project namely Mudidih has a viability gap of ₹ 1114.20 Cr and fire at other 10 non-viable projects /locations will be dealt by blanketing. 2. Cost of 1st phase of Blanketing followed by fencing/plantation at 74 JMP sites is 797.53 & 10 NRSC sites blanketing cost is ₹ ₹ 174.17 Cr. Also, a lumpsum amount of ₹ 30 Cr is kept for approach road.
		(B) Viability Gap Funding	1114.20	Viability Gap Funding for Mudidih Project.
5.	Scientific Studies		50.00	It includes surface fire study by NRSC & any other scientific studies, instrumentation if required & others.
	Sub Total		**2575.10**	

Table -3

Outlay for Rehabilitation on JRDA Part

Sl. No.	Particulars	Rate in ₹ Lakhs	No. of House Holds			Amount (in Cr)	Multiplying Factor as per LARR Act 2013 for Urban Areas	Final Amount (in Crore)	Remarks
			LTH	Non-LTH	Total				
1	House Construction Cost *					120		120	For completion of ongoing works of Belgaria Township.
2	House Compensation (LTH)	25	1130	0	1130	282.50	2	565	Based on increase in index on approved JMP. Multiplying factor of 2 is applied

Sl. No.	Particulars	Rate in ₹ Lakhs	No. of House Holds			Amount (in Cr)	Multiplying Factor as per LARR Act 2013 for Urban Areas	Final Amount (in Crore)	Remarks
			LTH	Non-LTH	Total				
									as per LAAR Act 2013.
3	Land Compensation (LTH)	2	1130	0	1130	135.60	2	271.20	Based on assumption of average 6 Decimal homestead land per family @ Rs.2 Lakhs / Decimal (Avg. rate assumed)
4	Resettlement Land Cost					150	1	150	For procurement of land for infrastructures. Rate taken as per the Govt. Land rate vide letter no. 2255, Dt. 20.07.2022
5	Infrastructural Cost					439.14	1	439.14	Estimated cost based on assessed requirements of basic Utilities such as water supply, electrical works, schools, health centres, parks, Anganwadi, sewerage disposal etc.
6	Cash compensation in lieu of house (LTH + NLTH)	5	3390	13101	16491	824.55	1	824.55	Amount as Per Committee Report, assuming all affected families will opt for cash compensation in lieu of house. On average 3 adults are assumed for each LTH Family.
7	Livelihood Grant (LTH + NLTH)	1	3390	13101	16491	164.91	1	164.91	Amount as Per Committee Report, Provision of additional Loan upto Rs.3 Lakhs through credit pipeline. On average 3 adults are assumed for each LTH Family
8	Rental assistance (LTH + NLTH)	1	3390	13101	16491	164.91	1	164.91	Amount as Per Committee Report. On average 3 adults are assumed for each LTH Family
9	Cost of Shifting (LTH + NLTH)	0.5	3390	13101	16491	8245.50	1	82.45	-do-
10	One Time Grant in Lieu of Annuity	5	3390	-	3390	169.50	1	169.50	Proposed as per Second Schedule Point 4.(b.) of LARR Act 2013. On average 3 adults are

Sl. No.	Particulars	Rate in ₹ Lakhs	No. of House Holds			Amount (in Cr)	Multiplying Factor as per LARR Act 2013 for Urban Areas	Final Amount (in Crore)	Remarks
			LTH	Non-LTH	Total				
	/Employment Amt. (for LTH) **								considered for each LTH Family
11	Additional Cost of Stamp Duty and Registration Fee ***							73.12	Proposed as per Second Schedule Point 11 of LARR Act 2014 (Stamp Duty @ 4% and Registration fees @ 3%)
12	Skill Development / Livelihood							80	Proposed
13	Survey and Valuation of Structures on Homestead Lands of LTH Families							11.30	Assumed 2% of the house compensation cost.
	Sub-Total							**3116.08**	
14	Add: Contingencies @ 3%							93.48	
15	Add: Supervision Charges @ 5%							155.80	
	Grand Total							**3365.36**	

Note:

1. * As per the Committee report no new houses to be constructed. The committed balance amount for this head is required for completion of the ongoing works.
2. For Sl. No. 6 to 11 on an average 3 adults are assumed for each LTH Family.
3. ** The Sl. No 10 is proposed to be incorporated as per Second Schedule Point 4.(b.) LARR 2013 Act.
4. *** The Sl.No 11 is proposed to be incorporated in line with point 11 of Second Schedule of the LARR 2013 Act.
5. This Budget estimate is for initial phase of 81 High Risk Sites only.
6. The data regarding quantum of land and valuation of assets for LTH is not available. For calculation, it is assumed that on average families will have 6 decimals of land and avg. cost of assets on homestead land is assumed as Rs.25 Lakhs / LTH family. The cost of homestead land is also assumed as Rs. 2 Lakhs per decimal. The above assumptions may vary in a wider range as per actual measurements.

5. Source of Funding:

Balance amount from Jharia Master Plan.	₹ 6663.02 Cr
Additional funding by CIL @ Rs 500 Cr/Year (for 3 Years)	₹ 1500.00 Cr
Interest earned thereon	-
Revenue from mineable areas	-
Total	₹ 8163.02 Cr

5.1. Funding of Rs 500 Cr/year from CIL will continue and a corpus is to be created for future phases of revised Jharia Master Plan, if required. Also. funding from the District Mineral Foundation (DMF) will be utilised by DC, Dhanbad, whenever required.

5.2. All the surplus revenues from the seven mineable sites in Jharia coal field will be deposited in an escrow account. The moneys in this account will only be used with permission of CIL Board and primarily for the purpose of rehabilitation under JMP. Suitable sums from this account can also be used for operations and functioning of BCCL with the approval of CIL Board.

6. Monitoring and Evaluation:

6.1. **Monitoring Committee:**

i. Secretary (Coal), Co-Chairman
ii. Chief Secretary, Govt. of Jharkhand-Co-Chairman
iii. Secretary Mines, Govt. of Jharkhand-Member
iv. Secretary, Department of Home, Jail & Disaster Management, Govt. of Jharkhand-Member
v. Chairman, Coal India Ltd.-Member
vi. CMD, BCCL-Member
vii. Director General, DGMS-Member

6.2. **Implementing Committee**

(a) Leadership: CEO, JRDA would be a Retired/Serving Joint Secretary-ranked officer from Govt. of Jharkhand, for the term of Revised Jharia Master Plan. This will ensure strong and effective leadership for the duration of the plan.

(b) Deputy CEO: The Deputy Commissioner (DC) of Dhanbad would serve as the Deputy CEO of JRDA, playing a key role in the local administration and decision-making processes.

(c) Directors: JRDA to have four directors, each overseeing key verticals:

i. Director (Infrastructure)-ED or Equivalent rank officer of CIL
ii. Director (Finance) – ED/GM rank officer of CIL, JRDA
iii. Director (Skill Development)-ED or Equivalent rank officer of CIL or Recruitment from market
iv. Director (Estate and R &R)- Additional Collector Level officer from Govt. of Jharkhand

6.3. Development of MIS-

BCCL has prepared MIS https://bcclweb.in/JMP for the whole system & complete data of 81 sites is in process of digitization. Initial data of 81 sites based upon the defined parameters has been captured. It is further being upgraded with geotagged photographs. Test run for all the areas of BCCL has been completed.

Annexure-III

Additional components of Revised Jharia Master Plan, along the responsibilities and timelines

(a) Short-term (within 6 Months)

S. No.	Milestones	Responsibility	Timelines
1.	Maintenance of existing units of houses to make them in liveable condition- Hiring of an agency for maintenance of houses and sewerage.	JRDA through an outsourcing agency	December 2025
2.	Deployment of Electric buses at rehabilitation sites for residents. Providing E-Rickshaw as a means of livelihood activity.	BCCL	Buses Implemented & E-Rickshaw by August 2025
3.	Additional infrastructures such as Schools, Hospitals, ICDS, PDS shops etc. shall be assessed and a comprehensive proposal shall be sent to State Govt. for approval.	JRDA	October 2025
4.	100 percent distribution of ration cards and enrolment to insurance schemes, UJJWALA Yojna, Ayushman Bharat, and old age pension schemes shall be achieved. Eligible families also to be provided with MNREGA job cards.	JRDA	December 2025
5.	Police post at Belgaria shall be established	JRDA with the help of SSP, Dhanbad	August 2025
6.	The representatives of MSME, MSDE, MoRD (NRLM) will jointly visit to interact with the DC, Dhanbad and BCCL teams and submit comprehensive proposal for Skill development & livelihood.	MSME, MSDE, MoRD	August 2025

7.	Development of Microenterprise- EOI to be floated for shortlisting the agency	BCCL	July 2025
8.	Career cum counselling centres shall be established for student and youths and Market mapping of skill requirement in Dhanbad city.	BCCL	August 2025
9.	Organisation of awareness drive about Revised Jharia Master Plan to encourage shifting	BCCL & JRDA	September 2025
10.	Verification of LTH families with support from district officials & uploading certified data on the portal	BCCL, JRDA	December 2025
11.	Stamp duty & Registration fee on the house to be allotted shall be Waived off	Govt. of Jharkhand	
12.	Establishment of an online grievance redressal system for convenient grievance registration, and sensitization of people about its usage.	JRDA	August 2025
13.	Resident welfare association (RWA) to be formed with seed funding for the corpus and support for 3 years	BCCL, JRDA	August 2025
14.	Coverage of all women above 18 years under Self Help Group (SHG) under NRLM (MoRD). Further creation of sufficient Panchayat Level Federations and Block Level Federations under NRLM	JRDA, MoRD	December 2025
15.	Approval of the individual electricity connections, infrastructure for street lighting and water pipelines from Damodar River.	JRDA through JBVNL & PHED	

(b) Medium-term (6 Months to One year)

S. No.	Milestones	Responsibility	Timelines
1.	Installation of Individual house electricity connections by providing smart meters.	JRDA through JBVNL	June 2026
2.	Installation of infrastructure for street lighting in all phases of construction		
3.	PM Surya Ghar Yojna for rooftop solar generation	BCCL	September 2025
4.	Development of four-lane Ring road around Jharia Coalfield- To submit requirement to the concerned department/ organization	BCCL & JRDA	December 2025
5.	Waste collection services, segregation, and recycling units shall be set up.	JRDA & BCCL for three years. Through RWA thereafter	June 2026
6.	Development Widening & maintenance of colony Roads and approach roads.	JRDA through PWD	June 2026
7.	Restructuring of JRDA headed by Retd./Serving Joint Secretary level officer from GoJH	Govt. of Jharkhand	December 2025
8.	Establishment of Skill Development centers at Karmatand Rehabilitation Site identified for handover by BCCL to JRDA	BCCL	December 2025
9.	Establishment of commercial dairy farming and Poultry farming with cooperatives and self-help	BCCL	June 2026

	groups with involvement of NRLM along with JRDA		
10.	Remaining house construction should be expedited, with quarterly targets set for efficient monitoring.	BCCL & JRDA	December 2025

c) Long-term (within Three Years)

S. No.	Milestones	Responsibility	Timelines
1.	Commissioning of Sewerage Treatment Plan in Belgaria	JRDA with concerned department of State Govt.	December 2026
2.	Installation of pipeline from Damodar Valley for supply of water in Belgaria. Permanent Tap water connections are to be provided in each household	JRDA with PHED	June 2028
3.	Belgaria Township to be notified as municipal body in long run.	JRDA with help of State Govt.	June 2027
4.	Additional Infrastructure Community centre, shopping complexes etc to be built.	JRDA	December 2026
5.	A sub-station (33 KV) and permanent electricity supply along with smart metering to be established at Belgaria township	JRDA through JBVNL	December 2026
6.	Taking possession of vacated sites & ecologically restoring through plantation, stabilization, and sustainable land use	BCCL	Part of fire & subsidence management plan
7.	Promoting self-employment ventures and MSME clusters by BCCL in collaboration with government/private firms, with technical support and advanced	BCCL	December 2026

	training from MSME centers in Jamshedpur.		
8.	Development of Microenterprise	BCCL	June 2026
9.	Expanding skill development through NSDC to cover one member from 18,000 affected families, with advanced technical support from nearby MSME Centers.	BCCL	June 2028

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

(FOR THE MONTH AUGUST, 2025)

E. C. no. J-11015/100/2011-IA.II (M) dated 16.12.2013.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

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EXECUTIVE SUMMARY

1.0 Introduction

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

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

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

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

2.2 Water sampling stations

The Water sampling stations were selected for mine discharge 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 noise levels were recorded in mining areas, washery areas and in residential areas.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_X). Respirable Dust Samplers (RDS) 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 analyzed 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 analyzed for four parameters on fortnightly basis. Thereafter the samples were preserved and analyzed 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.

1.1 The Cluster-XV is in the Western part of the Jharia coalfield. It includes a group of 4 Mines (viz. Kharkharee, Madhuband, Phularitand&Dharmaband). The Cluster – XV is situated about 25 - 30 kms from Dhanbad Railway Station. The mines of this Cluster – XV 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 KhudiaNala.

1.2 The Cluster-XV is designed to produce 0.325 MTPA (normative) and 0.423 MTPA (peak) capacity of coal.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity 0.325 MTPA (normative) and 0.423 MTPA (peak) capacity of coal production vide letter no. J-11015/100/2011-IA.II (M) dated 16th December, 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 PM_{10}, $PM_{2.5}$, SO_2, NOx monitoring. Location of the stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets in consultation with the State Pollution Control Board." And other conditions regarding water / effluent and noise level monitoring.

In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MOEF&CC & SPCB 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

I. CORE ZONE Monitoring Location

i) Kharkharee CISF Office (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 approx. 1.5m above ground level at Project Office.

ii) **Madhuband UGP Office (A33): Industrial Area**

The location of the sampling station is 23°45'24.48'' N 086°11'59.44''E. The sampler was placed at a height of approx. 1.5m above ground level at Project Office.

II. BUFFER ZONE Monitoring Location

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

The location of the sampling station is 23^0 47' 54.00" N & $86^0$16' 20.00" E. The sampler was placed at a height of approx. 1.5m above ground level at Safety Office.

ii) Lohapatti (A20): Industrial Area

The location of the sampling station is 23°44'29.42'' N & 86°16'49.96'' E. The sampler was placed at a height of approx. 1.5m above ground level at Safety Office.

iii) Sadariadih (A43): Residential Area

The location of the sampling station .The sampler was placed at a height of approx. 1.5m above ground level.

iv) Panruabhitha (A44): Residential Area

The location of the sampling station is 23°42’32’’ N & 86°26’38’’ E. The sampler was placed at a height of approx. 1.5m above ground level.

AMBIENT AIR QUALITY DATA

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

CMPDIL, RI-II
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Test Report for Ambient Air Samples

Month & Year	**08/2025**	**Cluster**	**Cluster XV**			**ULR No.**	TC1432125000002010F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.09.2025**
Project	**Kharkharee CISf Office**	**Sample Ref. No.**	**REM/BCCL/2025/08**		**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**	
Date of Sampling	06.08.25	21.08.25	**Period of Analysis**	06.08.25	02.09.25	**Zone of Station:**	**Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4343	**A4412**				
1	PM_{10}	IS-5182(Part 23):2006, R-2017	73	70	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS5182(Part 24):2019	35	35	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	11	10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182(Part-6): 2006 , R-2017	32	34	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

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

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

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

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Ambient Air Quality Test Report

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Test Report for Ambient Air Samples

Month & Year	**08/2025**	**Cluster**	**Cluster XV**	**ULR No.**	TC1432125000002010F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**05.09.2025**
Project	**Madhuband UGP Office**	**Sample Ref. No.**	**REM/BCCL/2025/08**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**
Date of Sampling	12.08.25	22.08.25	**Period of Analysis**	12.08.25 02.09.25	**Zone of Station:** **Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4342	**A4411**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	86	84	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	39	36	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	28	32	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

Environmental Condition : Sunny

** LDL indicates Lower Detection Limit,*

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

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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Test Report for Ambient Air Samples

Month & Year	**08/2025**	**Cluster**	**Cluster XV**	**ULR No.**	TC1432125000002010F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**05.09.2025**
Project	**Block IV Kooridih**	**Sample Ref. No.**	**REM/BCCL/2025/08**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**
Date of Sampling	05.08.25	20.08.25	**Period of Analysis**	05.08.25 – 02.09.25	**Zone of Station:** **Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4335	**A4404**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	75	70	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	37	35	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	35	32	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

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

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

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

TC-14321

Test Report for Ambient Air Samples

Month & Year	**08/2025**	**Cluster**	**Cluster XV**			**ULR No.**	TC1432125000002010F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.09.2025**
Project	**Lohapatti**		**Sample Ref. No.**	**REM/BCCL/2025/08**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**	
Date of Sampling	07.08.25		22.08.25	**Period of Analysis**	07.08.25 – 02.09.25	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4350	**A4418**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	78	76	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	34	30	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	35	33	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

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

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

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

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

CMPDIL, RI-II
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Test Report for Ambient Air Samples

Month & Year	**08/2025**	**Cluster**	**Cluster XV**			**ULR No.**	TC1432125000002010F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.09.2025**
Project	**Sadariadih**	**Sample Ref. No.**	**REM/BCCL/2025/08**		**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**	
Date of Sampling	12.08.25	26.08.25	**Period of Analysis**	12.08.25	02.09.25	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4376	**A4444**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	71	78	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	31	34	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	24	25	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

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

,

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

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Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

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Test Report for Ambient Air Samples

Month & Year	**08/2025**	**Cluster**	**Cluster XV**			**ULR No.**	TC1432125000002010F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.09.2025**
Project	**Panduabhitha**		**Sample Ref. No.**	**REM/BCCL/2025/08**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**	
Date of Sampling	11.08.25		25.08.25	**Period of Analysis**	11.08.25 02.09.25	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4369	**A4437**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	76	79	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	36	36	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	24	26	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

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

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

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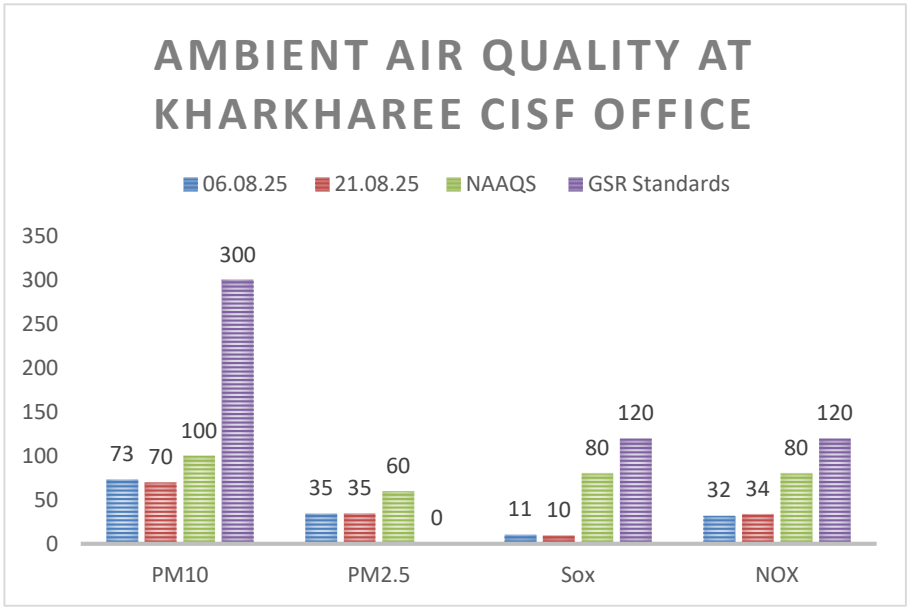
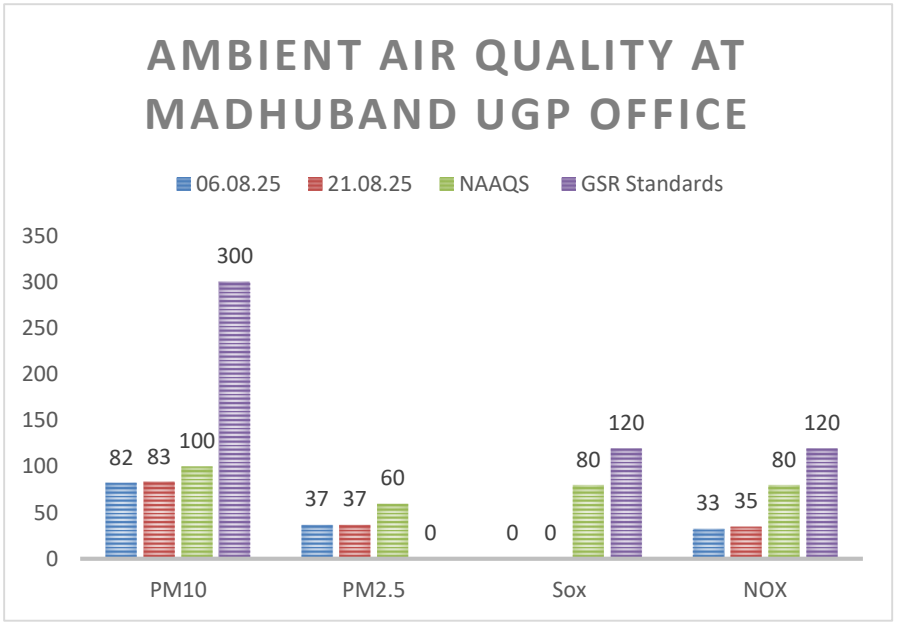

AMBIENT AIR QUALITY AT KHARKHAREE CISF OFFICE
06.08.25
21.08.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
73 70 100 300
35 35 60 0
11 10 80 120
32 34 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MADHUBAND UGP OFFICE
06.08.25
21.08.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
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37 37 60 0
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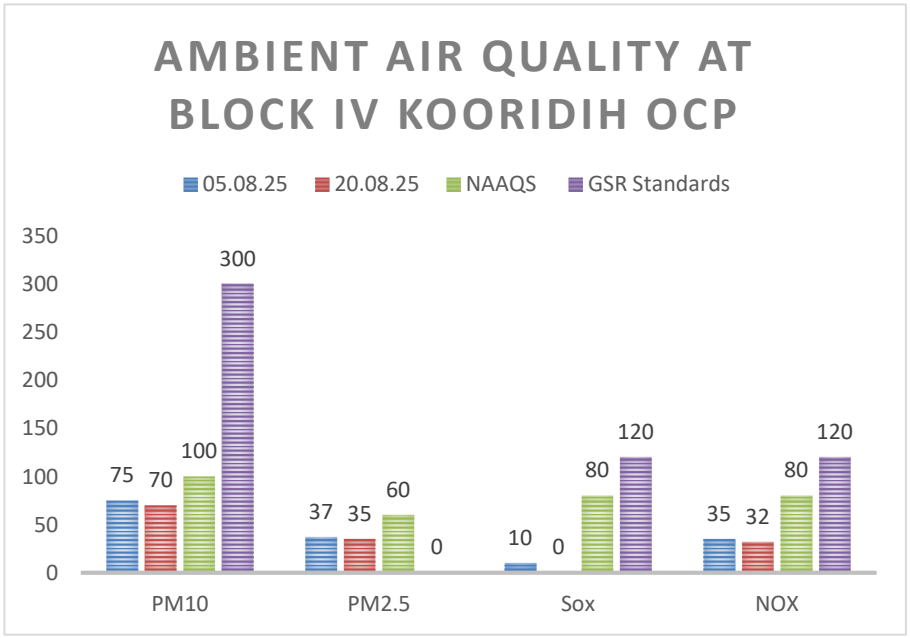
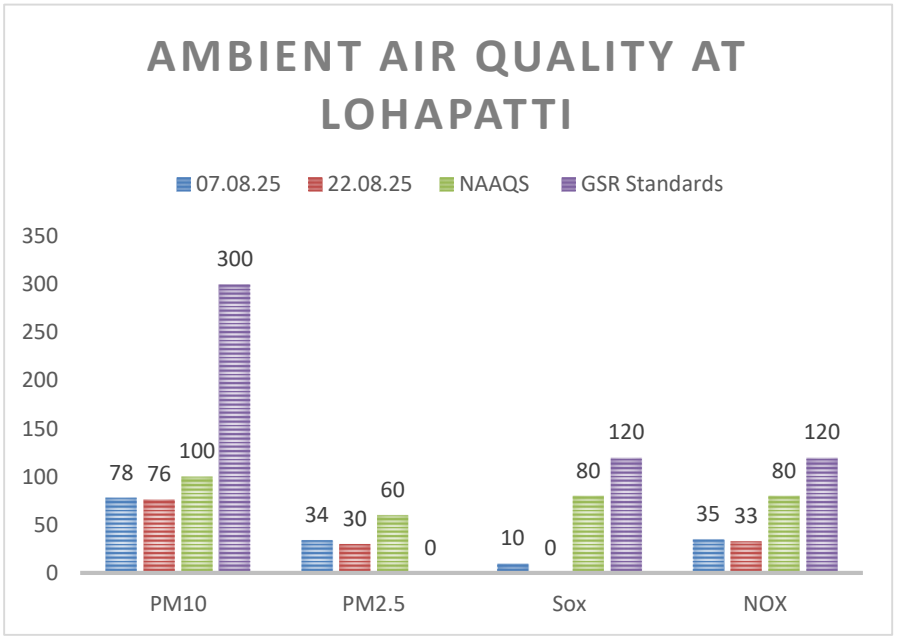
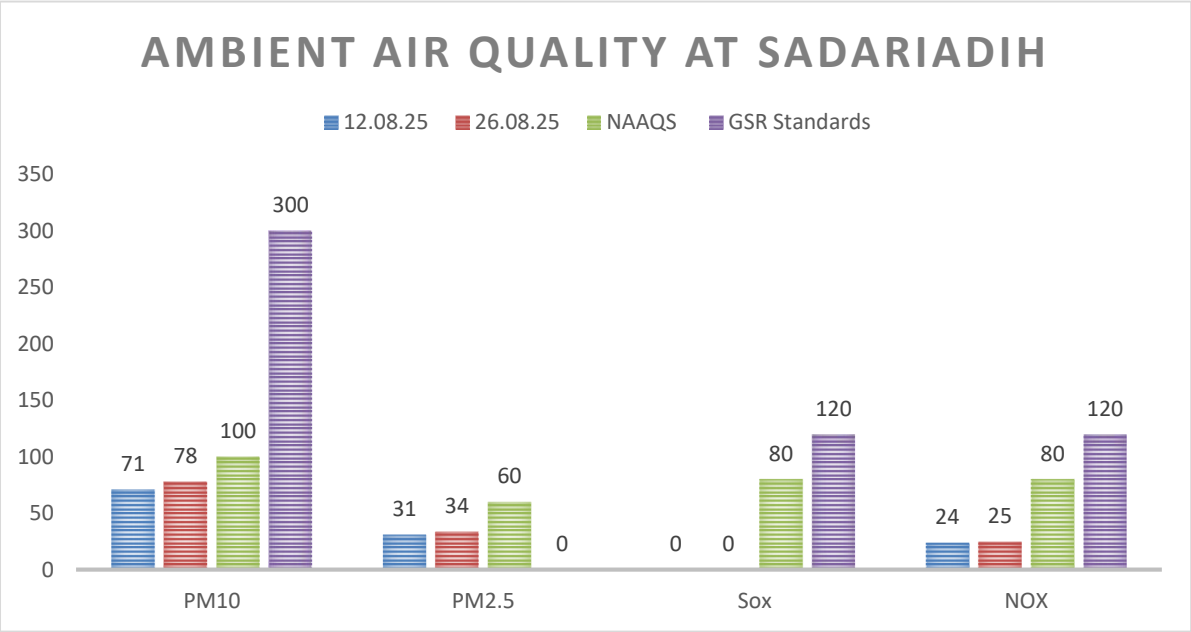
33 35 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH OCP
05.08.25
20.08.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
75 70 100 300
37 35 60 0
10 0 80 120
35 32 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT LOHAPATTI
07.08.25
22.08.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
78 76 100 300
34 30 60 0
10 0 80 120
35 33 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT SADARIADIH
12.08.25
26.08.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
71
78
100
300
31
34
60
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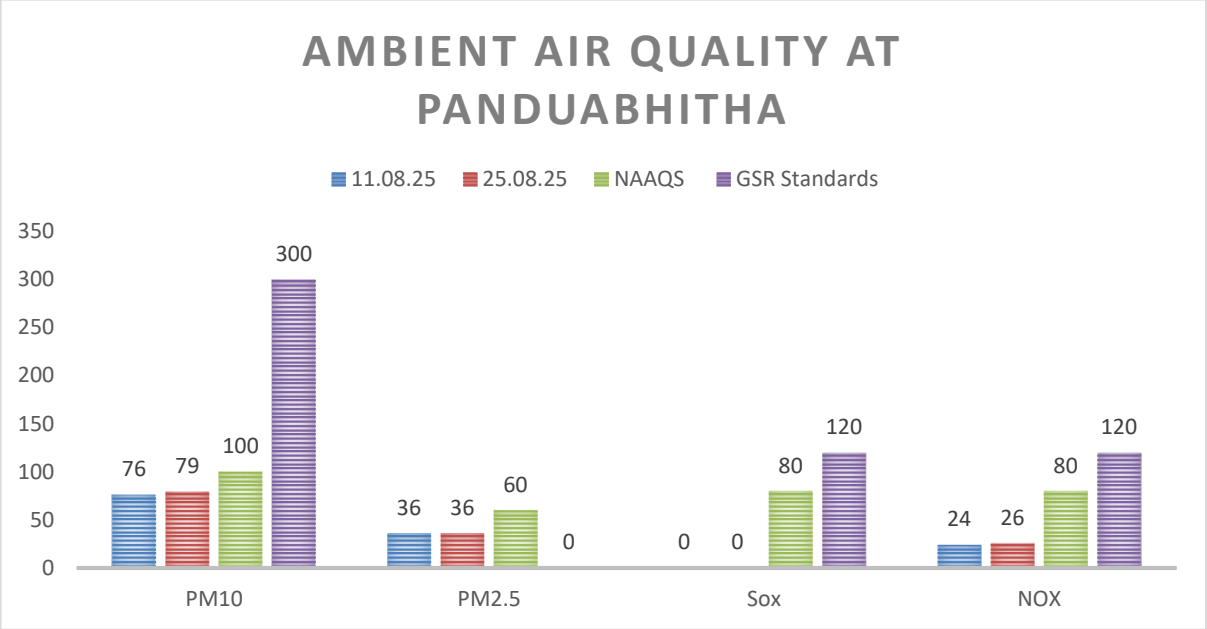
80
120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT PANDUABHITHA
11.08.25
25.08.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
76
79
100
300
36
36
60
0
0
0
80
120
24
26
80
120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) **Mine Discharge of Kharkharee (MW15)**

A sampling point is fixed to assess the effluent quality of Mine discharge.

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.

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

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Test Report for Mine Effluent samples

Month & Year	**08/2025**	**Cluster**	**Cluster XV**	**ULR No.**	TC1432125000002027F	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**				**Date of Issue**	**05.02.2025**
Project		**Sampling Ref. No.**	**REM/BCCL/2025/08**	**Sampling Method**	**IS 3025 (Part-1) CMPDI/RI-II/LPM 13**	
Sampling Stations	**(i)**	**Kharkharee**	**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**		**Period of Analysis**	04.08.2025 to 30.08.2025
			Date of Sampling	04.08.2025 / 18.08.2025		

Sl. No.	Parameter	Method of Analysis	Observed Values		STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
			M1668	M1695		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	40	39	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.93	7.95	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	<4.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	40	36	*250 (Max)*	4

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

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

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

---- End of Report ----

NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

i) **Kharkharee CISF Office (N21)**

ii) **Madhuband UGP Office (N33)**

iii) **Block IV Kooridih OCP (N6)**

ivLohapatti (N20)

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

4.3 Results & Interpretations

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

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TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

Month & Year	**08/2025**	**Cluster**	**Cluster XV**			**ULR No.**	TC1432125000002044F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	05.09.2025
Project		**Sample Ref. No.**	**REM/BCCL/2025/08**		**Sampling Method**	**CMPDI/RI-II/LPM 22**	
Sampling Stations	**i**	**Kharkharee UGP**	**Date of Sampling**	06.08.25	21.08.25	**Zone Category of Station:**	**Core Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	37.9	38.5	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	51.2	51.1					
3		08:00 - 09:00	60.9	61					
4		09:00 – 10:00	60.8	60.6					
5		10:00 - 11:00	57.6	56.6					
6		11:00 - 12:00	55.2	54.8					
7		12:00 - 13:00	53.1	53.9					
8		13:00 - 14:00	51.6	51					
9		14:00 - 15:00	49.7	49.1					
10		15:00 - 16:00	48.3	48.6					
11		16:00 - 17:00	48.6	49.2					
12		17:00 - 18:00	48.4	49					
13		18:00 - 19:00	46.2	46.2					
14		19:00 - 20:00	44.7	44.8					
15		20:00 - 21:00	42.9	43.1					
16		21:00 - 22:00	42.3	42.7					
		Leq Day	54.2	54.1					
1	Noise Level dB(A)Leq -Night	22:00-23:00	41.6	39.7	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	39.1	39.6					
3		00:00- 01:00	39.2	39.6					
4		01.00-02.00	37.6	38.7					
5		02.00-03.00	37.3	34.5					
6		03.00-04.00	36.9	38.1					
7		04.00-05.00	36.7	35.7					
8		05:00-06:00	35.5	33.6					
		Leq Day	38.4	38.0					

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

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

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

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TC-14321

cmpdi A Mini Ratna Company

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

CMPDIL, RI-II
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Month & Year	**08/2025**	**Cluster**	**Cluster XV**			**ULR No.**	TC1432125000002044F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	05.09.2025
Project		**Sample Ref. No.**	**REM/BCCL/2025/08**		**Sampling Method**	**CMPDI/RI-II/LPM 22**	
Sampling Stations	**i**	**Madhuband UGP Office**	**Date of Sampling**	06.08.25	21.08.25	**Zone Category of Station:**	**Core Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	35.5	36	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB (A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	38	37.2					
3		08:00 - 09:00	40.8	41.2					
4		09:00 – 10:00	41.9	41.7					
5		10:00 - 11:00	41.7	41.8					
6		11:00 - 12:00	41.4	41.2					
7		12:00 - 13:00	42.2	42					
8		13:00 - 14:00	45.1	48.2					
9		14:00 - 15:00	46.2	46.2					
10		15:00 - 16:00	46.6	43.8					
11		16:00 - 17:00	40.5	40.6					
12		17:00 - 18:00	39.5	39.5					
13		18:00 - 19:00	39	38.9					
14		19:00 - 20:00	38.9	38.5					
15		20:00 - 21:00	38.7	38.2					
16		21:00 - 22:00	37.7	37.9					
		Leq Day	42.0	42.1					
1	Noise Level dB(A)Leq -Night	22:00-23:00	38.5	38.9	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB (A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	38.4	39					
3		00:00- 01:00	38.3	38.4					
4		01.00-02.00	37.6	38					
5		02.00-03.00	37.3	37.8					
6		03.00-04.00	38.6	38.9					
7		04.00-05.00	38.9	39					
8		05:00-06:00	39.1	39					
		Leq Day	38.4	38.6					

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

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

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

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

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Month & Year	**08/2025**	**Cluster**	**Cluster XV**			**ULR No.**	TC1432125000002044F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	05.09.2025
Project		**Sample Ref. No.**	**REM/BCCL/2025/08**		**Sampling Method**	**CMPDI/RI-II/LPM 22**	
Sampling Stations	**i**	**Block IV Kooridih OCP**	**Date of Sampling**	05.08.25	20.08.25	**Zone Category of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A)) First Fortnight**	**Observed Values (in Leq dB(A)) Second Fortnight**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
								Zones	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	47.3	46.2	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB (A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	50.9	50					
3		08:00 - 09:00	51.7	50.8					
4		09:00 – 10:00	54.8	54					
5		10:00 - 11:00	54.3	53.4					
6		11:00 - 12:00	55.5	55					
7		12:00 - 13:00	55.2	54					
8		13:00 - 14:00	55.4	55.9					
9		14:00 - 15:00	55.7	54.9					
10		15:00 - 16:00	58.2	56.7					
11		16:00 - 17:00	58.9	58.7					
12		17:00 - 18:00	59.7	59.5					
13		18:00 - 19:00	58.6	56.7					
14		19:00 - 20:00	58.2	57.6					
15		20:00 - 21:00	52.5	51.6					
16		21:00 - 22:00	51.4	50.3					
		Leq Day	56.0	55.3					
1	Noise Level dB(A)Leq -Night	22:00-23:00	47	46.7	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB (A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	46.2	44.3					
3		00:00- 01:00	44.7	43.7					
4		01.00-02.00	40	40.3					
5		02.00-03.00	39.6	39.8					
6		03.00-04.00	42.5	41					
7		04.00-05.00	40.7	40.2					
8		05:00-06:00	41	41.9					
		Leq Day	43.6	42.9					

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

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

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

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

Month & Year	**08/2025**	**Cluster**	**Cluster XV**			**ULR No.**	TC1432125000002044F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	05.09.2025
Project		**Sample Ref. No.**	**REM/BCCL/2025/08**		**Sampling Method**	**CMPDI/RI-II/LPM 22**	
Sampling Stations	**i**	**Lohapatti**	**Date of Sampling**	07.08.25	22.08.25	**Zone Category of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A)) First Fortnight**	**Observed Values (in Leq dB(A)) Second Fortnight**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
								Zones	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	31.5	32.2	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 Db (A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	40.7	40					
3		08:00 - 09:00	36.2	40.5					
4		09:00 – 10:00	33.9	35.9					
5		10:00 - 11:00	36.2	37.4					
6		11:00 - 12:00	35	39.5					
7		12:00 - 13:00	35.9	38.2					
8		13:00 - 14:00	37	39.6					
9		14:00 - 15:00	36.5	37.7					
10		15:00 - 16:00	38.7	39					
11		16:00 - 17:00	38.8	38.9					
12		17:00 - 18:00	38.6	39.6					
13		18:00 - 19:00	38.6	39.5					
14		19:00 - 20:00	38.2	37.9					
15		20:00 - 21:00	38.1	38					
16		21:00 - 22:00	38	37.9					
		Leq Day	37.5	38.6					
1	Noise Level dB(A)Leq -Night	22:00-23:00	39.1	39.1	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB (A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	39	38.6					
3		00:00- 01:00	38.8	38.7					
4		01.00-02.00	38.5	39.2					
5		02.00-03.00	38.4	38.6					
6		03.00-04.00	38.3	38.4					
7		04.00-05.00	37.9	38.5					
8		05:00-06:00	38.6	38.9					
		Leq Day	38.6	38.8					

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

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

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Page -1 of 1

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

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

Note:

* Annual Arithmetic mean for the measurements taken in a year, following the guidelines for frequency of sampling laid down in clause2.

** 24hourly/8hourlyvaluesshallbemet 92%ofthetimeinayear.However,8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in supersession of the notification No(s).S.O.384(E), dated 11th April 1994 and S.O.935(E), dated 14th NOVEMBER 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

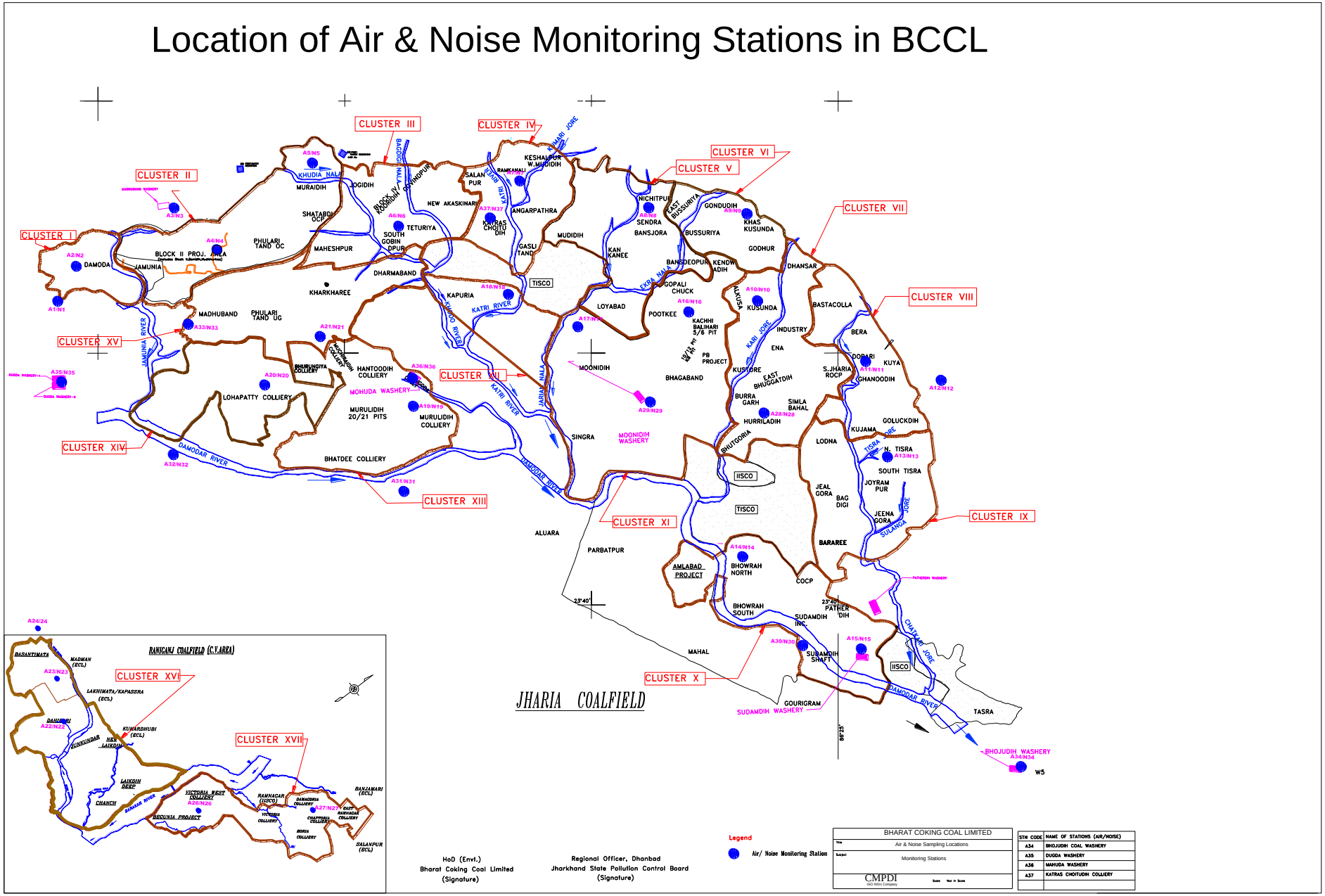
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogendioxide (NO_2), µg/m³	Annual * 24 Hours **	40 80	30 80	-Jacob &Hochheiser modified ($NaOH$-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m³	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) , µg/m³	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) , µg/m³	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
Carbon Monoxide (CO), mg/m³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed byHPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

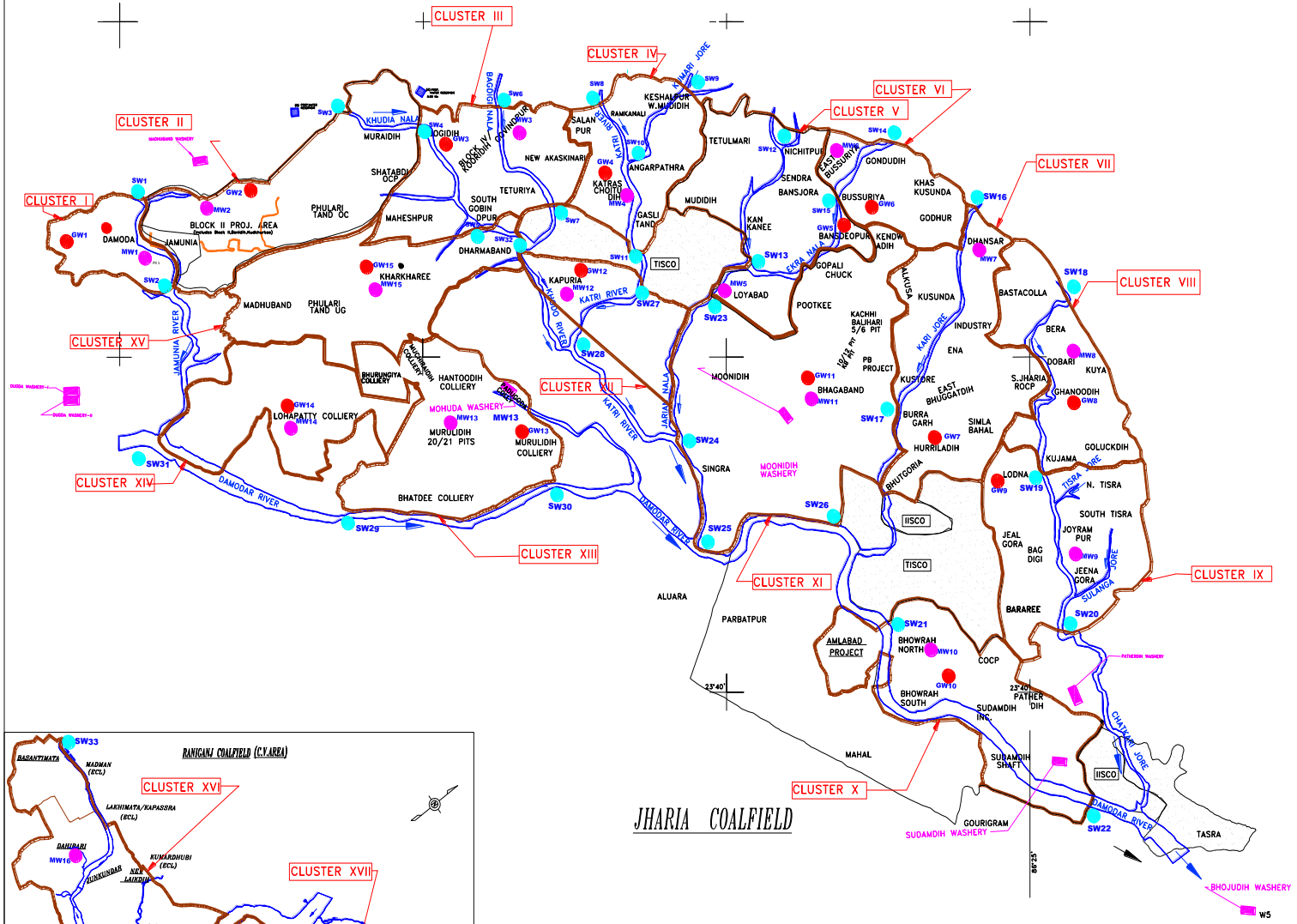
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they JUNE exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective catego

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

Cluster	Suface Water (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Bagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	Katri River, Kumari Jore	MW4	Chotudih	GW4	Kankanee Village
V	SW12, SW13, SW15	Jarian Nala, Ekra Nala	MW5	Mudidih	GW5	Nichitpur
VI	SW14, SW15	Ekra Nala	MW6	East Bassuria UGP	GW6	Bansjora Borewell
VII	SW16, SW17	Kari Jore	MW7	Dhansar UGP	GW7	Hurriladih
VIII	SW18, SW19	Kashi Jore	MW8	Dobari UGP	GW8	Ghanudih
IX	SW19, SW20	Kashi Jore	MW9	Jeenagora	GW9	Lodna
X	SW21, SW22	Damodar River	MW10	Bhowrah North	GW10	Bhowrah South
XI	SW23, SW24, SW25, SW26	Jarian Nala, Damodar River	MW11	Bhagaband h UGP	GW11	Bhagabandh
XII	SW27, SW28	Katri River	MW12	Kapuria	GW12	Kapuria
XIII	SW29, SW30	Damodar River	MW13	Murulidih (20/21)	GW13	Murilidih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Khudia Nala	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34	Khudia River	MW16	Dahibari OCP	GW16	Patlabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria

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WATER QUALITY REPORT
OF
BHARAT COKING COAL LIMITED,
CLUSTER – XV

(FOR THE Q.E. JUNE 2025)

E. C. no. J-11015/100/2011-IA.II (M) dated 16.12.2013.

CMPDI

ISO 9001 Company

Regional Institute-II

Dhanbad, Jharkhand

CLUSTER - XV

(FOR THE Q.E. JUNE 2025)

CONTENTS

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

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 $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEFCC 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 & 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

4.0 Results and interpretations

4.1 Water quality

The test results indicate that the major parameters compared with MoEFCC 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-XV is in the Western part of the Jharia coalfield. It includes a group of 4 Mines (viz. Kharkharee, Madhuband, Phularitand & Dharmaband). The Cluster – XV is situated about 25 - 30 kms from Dhanbad Railway Station. The mines of this Cluster – XV 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 Nala.

1.2 The Cluster-XV is designed to produce 0.325 MTPA (normative) and 0.423 MTPA (peak) capacity of coal.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity 0.325 MTPA (normative) and 0.423 MTPA (peak) capacity of coal production vide letter no. J-11015/100/2011-IA.II (M) dated 16th December, 2013.

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

CHAPTER – II

WATER QUALITY MONITORING

2.1 Location of sampling sites

(Refer **Plate No. - I**)

I) Ground Water quality at **Kharkharee (GW15)**

ii) Surface Water quality at **U/S of Khudia Nala (SW5)**

iii) Surface Water quality at **D/S of Khudia Nala (SW32)**

iv) Mine Water Quality at Kharkharee **(MW15)**

2.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. Effluent samples were analyzed for 25 parameters on quarterly basis & 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

2.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results show that most of the parameters are within the permissible limits.

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**QUARTER ENDING JUNE 2025**	**Name of Cluster**	**CLUSTERXV**	**ULR No.**	**TC1432125000002064P**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.09.2025**
Project	**Kharkharee**	**Sample Ref. No.**	**REM/BCCL/25-26/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**GW15**	**Date of Sampling**	**26.05.25**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**26.05.25** TO **20.07.2025**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values** GW15 G0187	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**IS 10500: 2012** Permissible Limit in the Absence of Alternate Source (Max)
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	84	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	91	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.54	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	45	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	4.60	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 24th Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.03	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	107	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_ac_{03}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	155	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	555	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	395	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.3	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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.

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**QUARTER ENDING JUNE 2025**	**Name of Cluster**	**CLUSTER XV**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.09.2025**
Project	**Kharkharee**	**Sample Ref. No.**	**REM/BCCL/25-26/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**GW15**	**Date of Sampling**	**26.05.25**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**26.05.2025** to **20.07.2025**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			G0187	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 24th Edition, , 4500-Cl- B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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TC-14321

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

Month & Year	QUARTE ENDI NG JUNE 2025	**Name of Cluster**	III &XV	ULR No.	TC1432125000002071 P TC1432125000002098 P
Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)			Date of Issue	16.09.2025
Project	Sample Ref. No.		REM/BCCL/**25-26**/SW /	Sampling Method	(IS 3025 , Part-1) CMPDI/RI-II/LPM 13
Sampling Stations	(i) Downstream of Khudia Nala (Downstream with cluster III , Upstream with cluster XV)(SW5)		Date of Sampling	04.06.2025	Period of Analysis
	(ii) Downstream in khudia Nala(SW32)		Date of Sampling	04.06.2025	04.06.2025 TO 20.08.2025

Sl. No.	Parameter	Method of Analysis	Observed Values (i)	Observed Values (ii)	IS : 2296 INLAND SURFACE WATER [1982] Class 'C	Range of Testing	LDL
1	BOD (3 days 27°C), mg/l	IS 3025 (Part 44) : 1993, R-2019 , 3 day incubation at 27°C	<2.0	<2.0	3	2.00-100.00	2
2	Colour,Hazen Units	APHA 24th edition , 2120-B-:2023	1	2	10	1-500.0	1
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 Argentometric Method	53	57	600	2.0-1500.0	5
4	Copper, mg/l	IS 3025 (Part 42) : 1992 R : 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, R:2003 Winkler Azide Method	6.1	6.5	4	1.0-10.0	0.1
6	Fluoride, mg/l	APHA, 24th edition, SPADNS Method	0.56	0.52	1.5	0.2-2.00	0.2
7	Hexavalent Chromium, mg/l	APHA 24th edition, 1,5-Diphenylcarbohydrazide Method IS 3025 (Part 52) : 2003,R-2019	<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	<0.2	<0.2	50	0.2-10	0.2
9	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	4.36	5.69	50	0.5-45.0	0.5
10	pH value	IS 3025, (Part 11) : 1983 R-2023 Electrometric (Ph Meter) method	7.56	7.44	6.5-8.5	1.0-14.0	2
11	Sulphate, mg/l	APHA –24th edition,4500- S, Turbidity Method	46	26	400	10.0-400.0	10
12	Total Dissolved Solids, mg/l	IS 3025, (Part 16): 1984 R-2023 Gravimetric method	406	481	1500	25.0-10000.0	25
13	Zinc, mg/l	IS 3025(Part 49) : 1994, R : 2019, AAS-Flame Method	<0.1	<0.1	15	0.10 – 10.0	0.1

***Grab 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 Jerricane , Color as observed is transparent*

Analysed by

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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SURFACE WATER ANALYSIS TEST REPORT

Month & Year	QUARTE ENDI NG JUNE 2025	**Name of Cluster**	III &XV			**Report No.**	
Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)					Date of Issue	16.09.2025
Project	Sample Ref. No.		REM/BCCL/**25-26**/SW /		Sampling Method	(IS 3025 , Part-1) CMPDI/RI-II/LPM 13	
Sampling Stations	(i)	Downstream of Khudia Nala (Downstream with cluster III , Upstream with cluster XV)(SW5	Date of Sampling		04.06.2025	Period of Analysis	
	(ii)	Downstream in khudia Nala(SW32)	Date of Sampling		04.06.2025	04.06.2025 TO 20.08.2025	

Sl. No.	Parameter	Method of Analysis	Observed Values (i)	Observed Values (ii)	IS : 2296 INLAND SURFACE WATER [1982] Class 'C	Range of Testing	LDL
1	Arsenic (as As), mg/l, Max	IS-3025,Part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	<0.006	0.2	0.006-10	0.006
2	Lead (as Pb), mg/l, Max	APHA, 24th edition, AAS-GTA	<0.005	<0.005	0.1	0.005-10	0.005
3	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th 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 24th edition, AAS-VGA	<0.007	<0.007	0.05	0.007-10	0.007

***Grab 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 Jerricane , Color as observed is transparent*

(Gaurav Kant)

(Kumar Vaibhav)

Analysed by *REVIEWED BY* *Authorised Signatory*

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

---- End of Report ----

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

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
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TC-14321

Month & Year	**QUARTER ENDING JUNE 2025**	**Name of Cluster**	**CLUSTER XV**	**Report No.**	TC1432125000002123P
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.09.2025**
Project	**Kharkharee UGP**	**Sample Ref. No.**	**REM/BCCL/24-25/MW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**MW15**	**Date of Sampling**	**23.06.2025**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
				Period of Analysis	**23.06.2025 TO 20.08.2025**

Sl. No.	**Parameter**	**Method of Analysis**	**MW15 M1602**	**Range Of Testing**	**LDL**	**MOEF -SCH-VI STANDARDS Class 'A'**
1	B.O.D (3 days 27ºC), mg/l, Max	IS 3025 /44:1993,R:20033 day incubation at 27°C	<2.0	2-10000.0	2	30
2	Colour	APHA,24th edition ,2120-B-:2023	2	1.0-500.0	1	-
3	COD, mg/l, Max	APHA 24th edition 5220 C Titrimetric Method	44	4.0-800.0	4	250
4	Copper (as Cu), mg/l, *Max*	IS 3025(Part42): 1992 R : 2019, AAS-Flame	<0.2	0.2-10.0	0.2	3
5	Dissolved Phosphate (as P), mg/l, Max	IS 3025/ 31, 1988 R 2019	0.091	0.1-5.0	0.1	5
6	Fluoride (as F) mg/l, *Max*	APHA, 24th Edition, Page 4-90 to , 4500 – F- D (SPADNS Method)	0.79	0.2-2.0	0.2	2
7	Hexavalent Chromium, mg/l, Max	IS 3025 (Part 52) : 2003,Reaffirmed 2019	<0.01	0.01-1.40	0.01	0.1
8	Iron (as Fe), mg/l, *Max*	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame	<0.2	0.2-10	0.2	3
9	Manganese(as Mn), mg/l, Max	APHA, 24th edition, AAS-Flame	<0.1	0.1-10	0.1	0.1
10	Nickel (as Ni), mg/l, *Max*	IS-3025(Part 54):2003, R:2019 AAS-Flame	<0.1	0.1-10.0	0.1	3
11	Nitrate Nitrogen, mg/l, *Max*	APHA, 24th Edition,UV-Spectrphotometric	1.87	0.5-45	0.5	10
12	Oil & Grease, mg/l, Max	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	2.0-1000	2	10
13	pH value	IS-3025/11:1983, R-2023, Electrometric	7.68	1 -14	0.1	5.5 to 9.0
14	Temperature (°C)	IS-3025/09:1984, Thermometeric	28.5	1-100	.	Shall not exceed 5º C above the receiving temp.
15	Total Chromium (as Cr), mg/l, *Max*	IS-3025(Part 52):2003, R:2019 AAS-Flame	<0.1	0.1-10.0	0.1	2
16	Total Suspended Solids, mg/l, Max	IS 3025/17:1984, R :2023, Gravimetric	55	10-5000	10	100
17	Zinc (as Zn), mg/l, *Max*	IS 3025 /49 : 1994, R : 2019, AAS-Flame	<0.1	0.1-10.0	0.1	5
18	Odour	APHA, 24th Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Qualitative

****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,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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MINE EFFLUENT ANALYSIS TEST REPORT

Month & Year	**QUARTER ENDING JUNE 2025**	**Name of Cluster**	**CLUSTER XV**	**Report No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.09.2025**
Project	**Kharkharee UGP**	**Sample Ref. No.**	**REM/BCCL/24-25/MW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**MW15**	**Date of Sampling**	**23.06.2025**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	

Period of Analysis **23.06.2025** **TO** **20.08.2025**

Sl. No.	Parameter	Method of Analysis	MW15	Range Of Testing	LDL	MOEF -SCH-VI STANDARDS Class 'A'
1	Ammonical Nitrogen, mg/l, Max	IS 3025/34:1988,R : 2009, Nessler's	<0.02	0.02-100	0.02	50
2	Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-5	0.006	0.2
3	Free Ammonia, mg/l, Max	IS:3025/34:1988, Nesseler's	<0.01	0.01-10	0.01	5
4	Lead (as Pb), mg/l, *Max*	IS-3025(Part 59):2006, R 2023 AAS-GTA/APHA, 24th Edition, 3111B, AAS-GTA	<0.006	0.005-10	0.005	2
5	Phenolic compounds	APHA, 24th edition4-Amino Antipyrine	<0.002	0.002-5	0.002	1
6	Selenium, mg/l, Max	IS-3025,part 56:2003, R-2019/ APHA 24th edition, AAS-VGA	<0.007	0.007-5	0.007	0.05
7	Sulphide (as S^{2-}) mg/l Max.	APHA 24th edition Methylene Blue Method	<0.005	0.005-5	0.005	2
8	Total Kjeldahl Nitrogen, mg/l, Max	IS:3025/34:1988, Nesseler's	<1	1-200	1	100
9	Total Residual Chlorine, mg/l, Max	APHA, 24th Edition, , 4500-Cl B. (Iodometric Method-I)	<0.04	0.04-5.00	0.04	1

****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,*

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

ANALYSED BY

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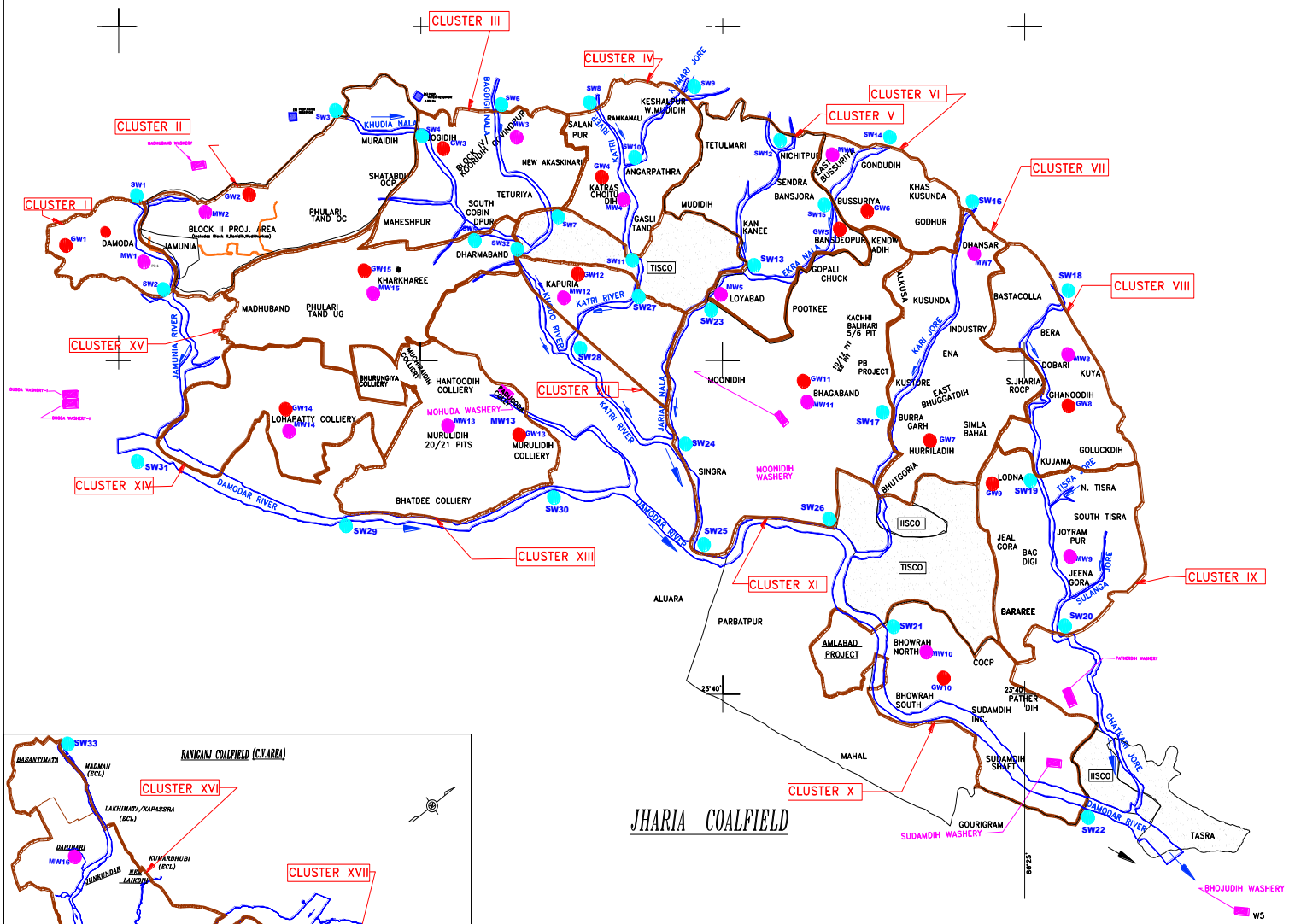
Water Sampling Locations in BCCL



INDEX

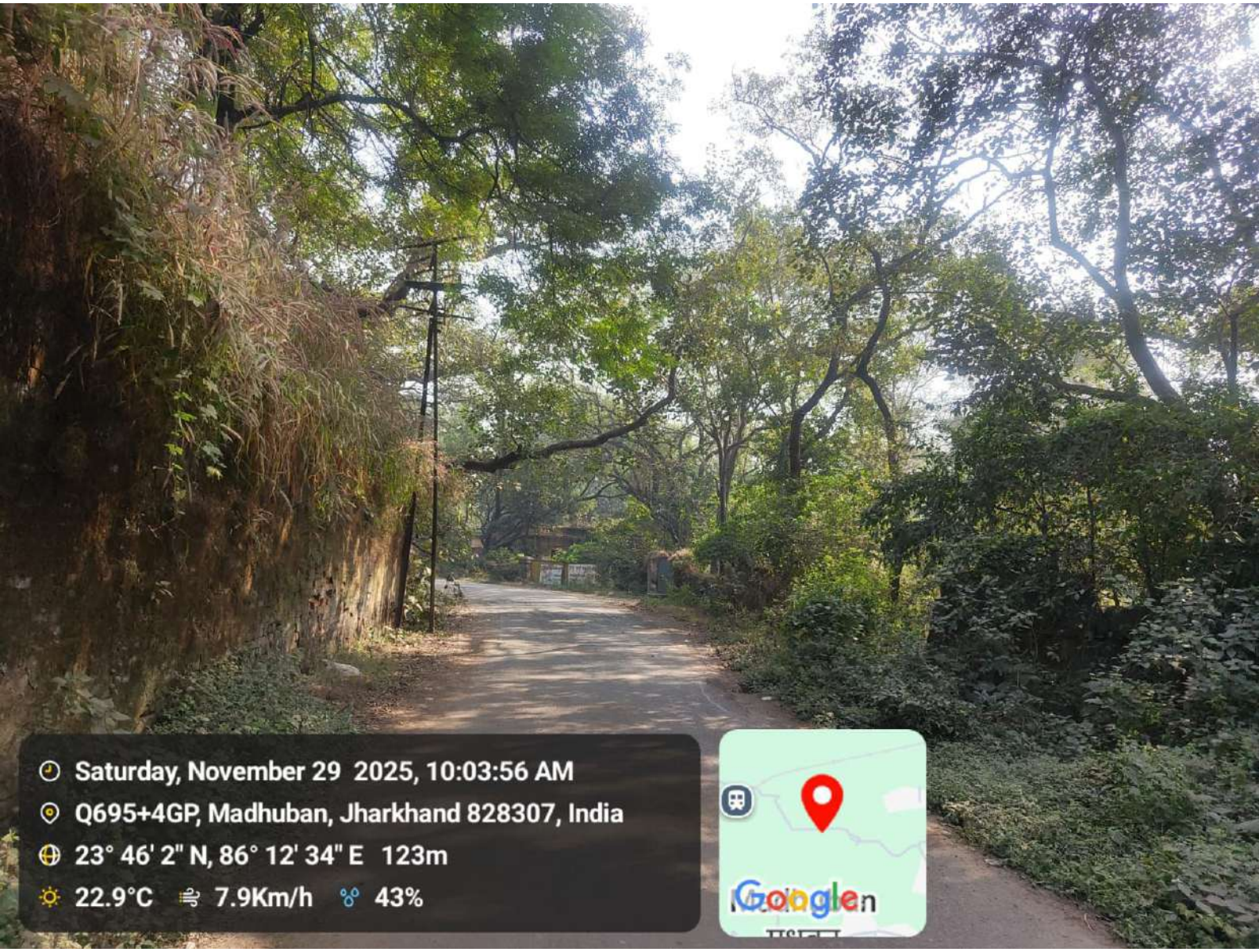
Cluster	Suface Water (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Bagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	Katri River, Kumari Jore	MW4	Chotudih	GW4	Kankanee Village
V	SW12, SW13, SW15	Jarian Nala, Ekra Nala	MW5	Mudidih	GW5	Nichitpur
VI	SW14, SW15	Ekra Nala	MW6	East Bassuria UGP	GW6	Bansjora Borewell
VII	SW16, SW17	Kari Jore	MW7	Dhansar UGP	GW7	Hurriladih
VIII	SW18, SW19	Kashi Jore	MW8	Dobari UGP	GW8	Ghanudih
IX	SW19, SW20	Kashi Jore	MW9	Jeenagora	GW9	Lodna
X	SW21, SW22	Damodar River	MW10	Bhowrah North	GW10	Bhowrah South
XI	SW23, SW24, SW25, SW26	Jarian Nala, Damodar River	MW11	Bhagaband UGP	GW11	Bhagabandh
XII	SW27, SW28	Katri River	MW12	Kapuria	GW12	Kapuria
XIII	SW29, SW30	Damodar River	MW13	Murulidih (20/21)	GW13	Murilidih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Khudia Nala	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34	Khudia River	MW16	Dahibari OCP	GW16	Patlabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria

HoD (Envt.)
Bharat Coking Coal Limited
(Signature)

Regional Officer, Dhanbad
Jharkhand State Pollution Control Board
(Signature)

Legend
- Sampling Locations of Surface Water (Upstream/ Downstream)
- Sampling Locations of Mine Water
- Sampling Locations of Ground/ Drinking Water

Customer	BHARAT COKING COAL LIMITED
Title	WATER SAMPLING LOCATIONS
Subject	MONITORING STATIONS
CMPDI (ISO 9001 Company)	Scale: Not To Scale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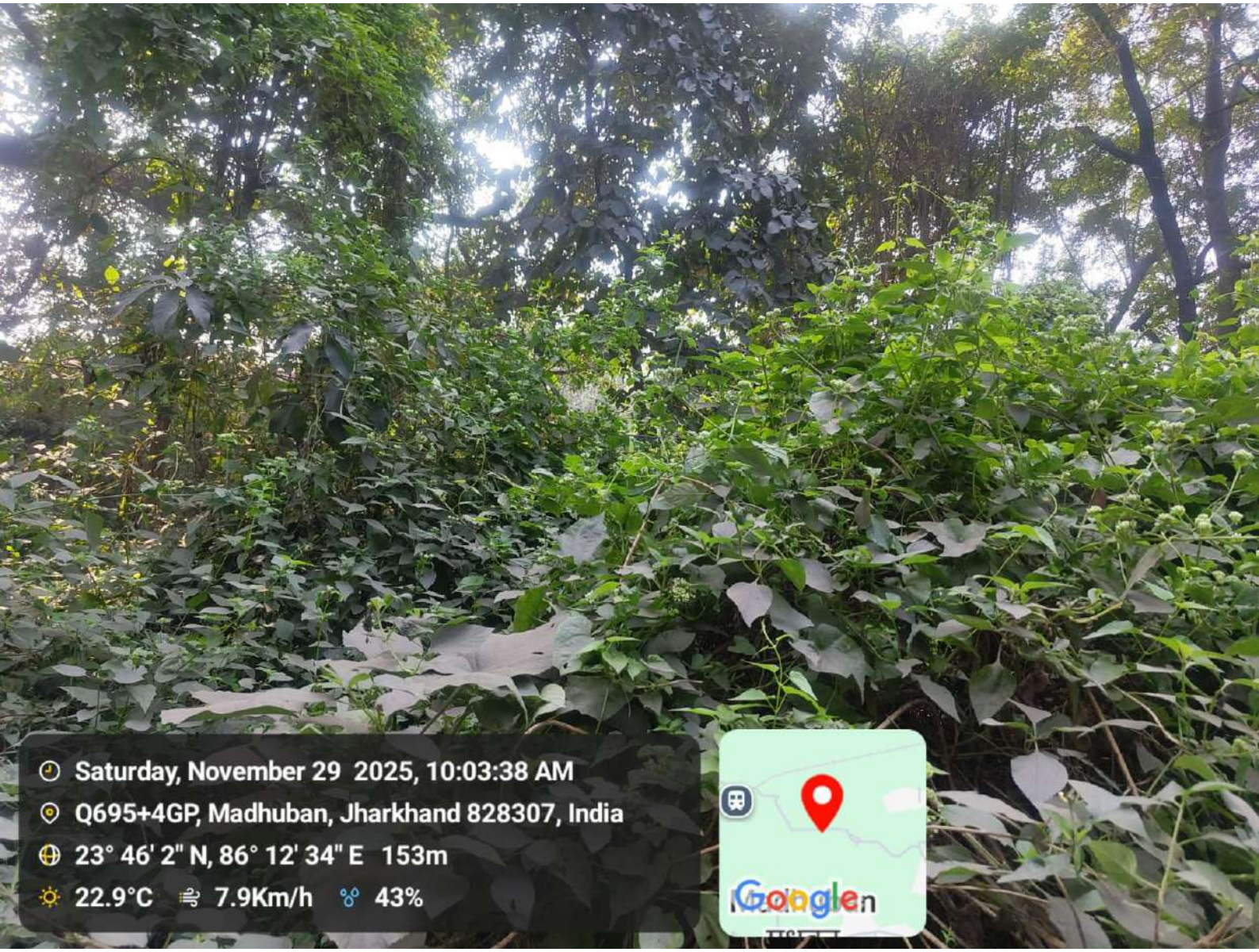
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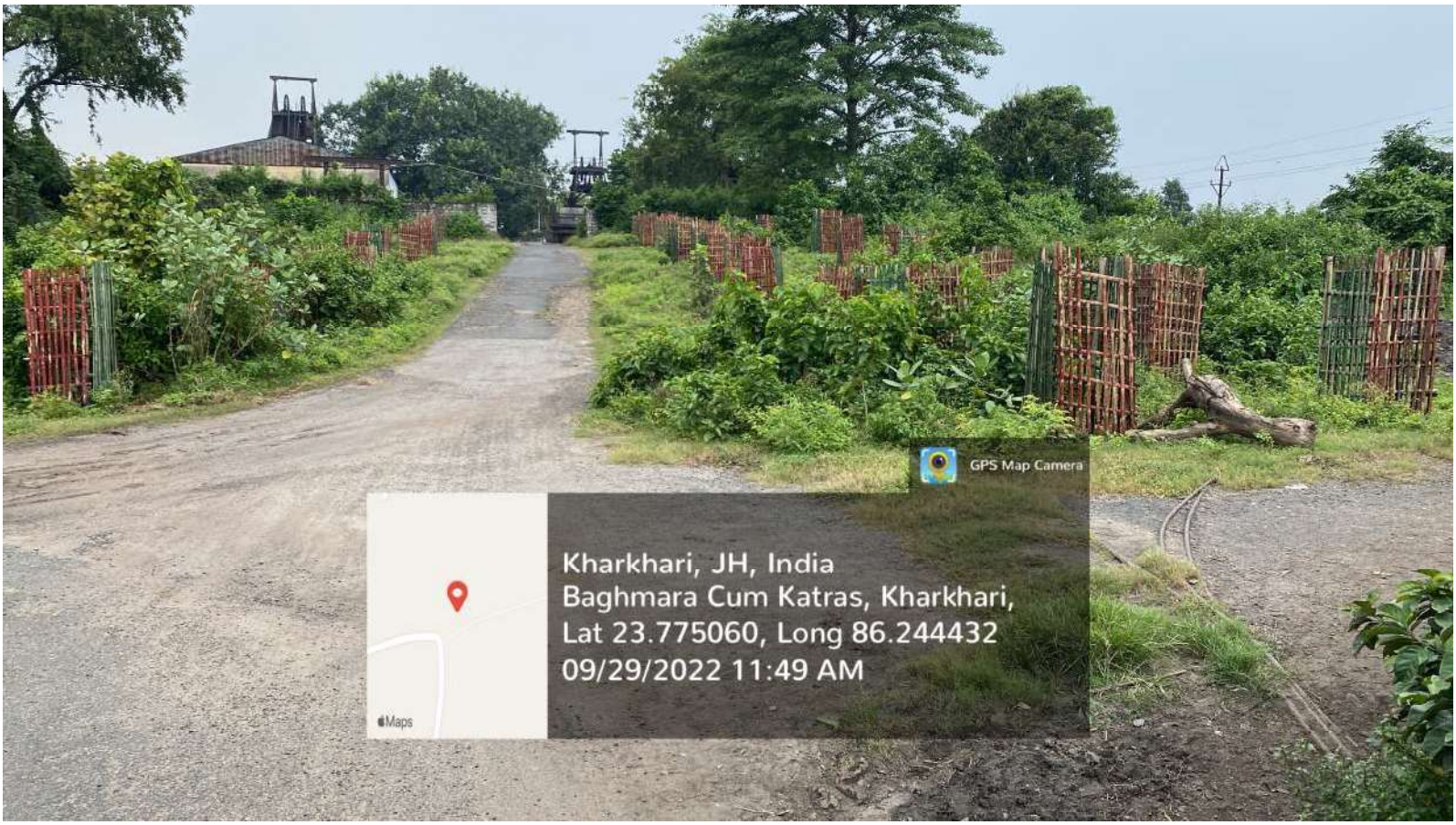
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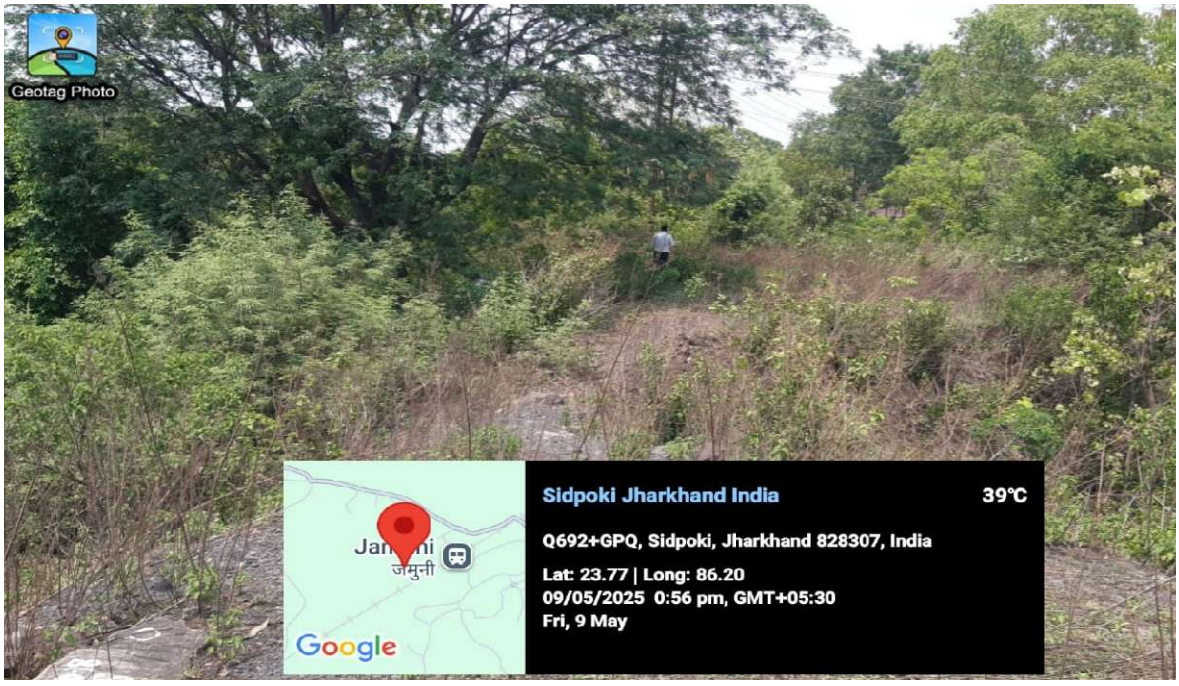
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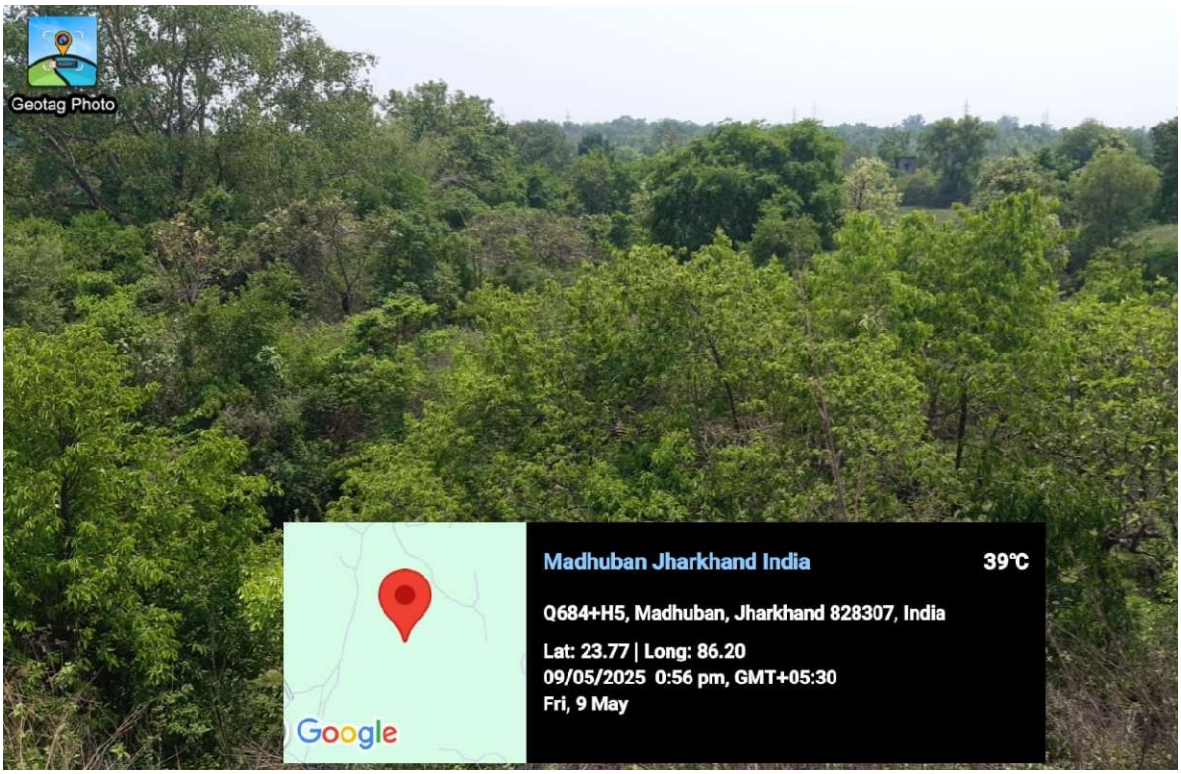
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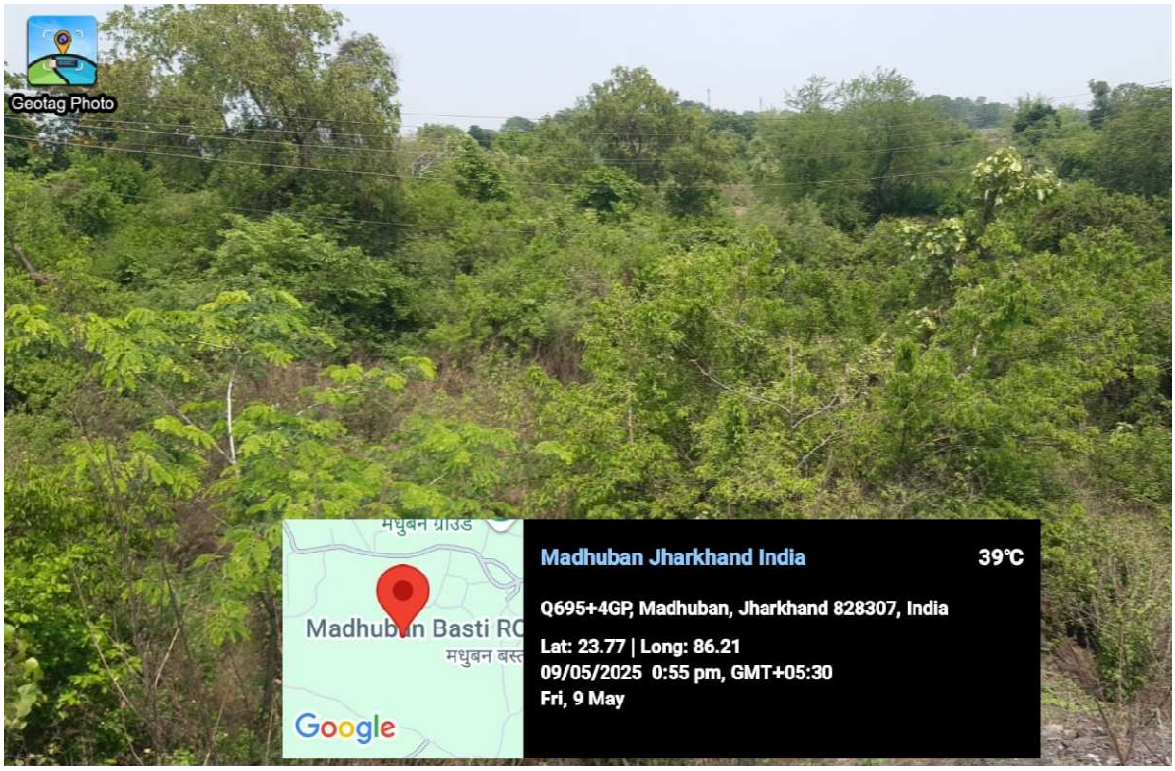
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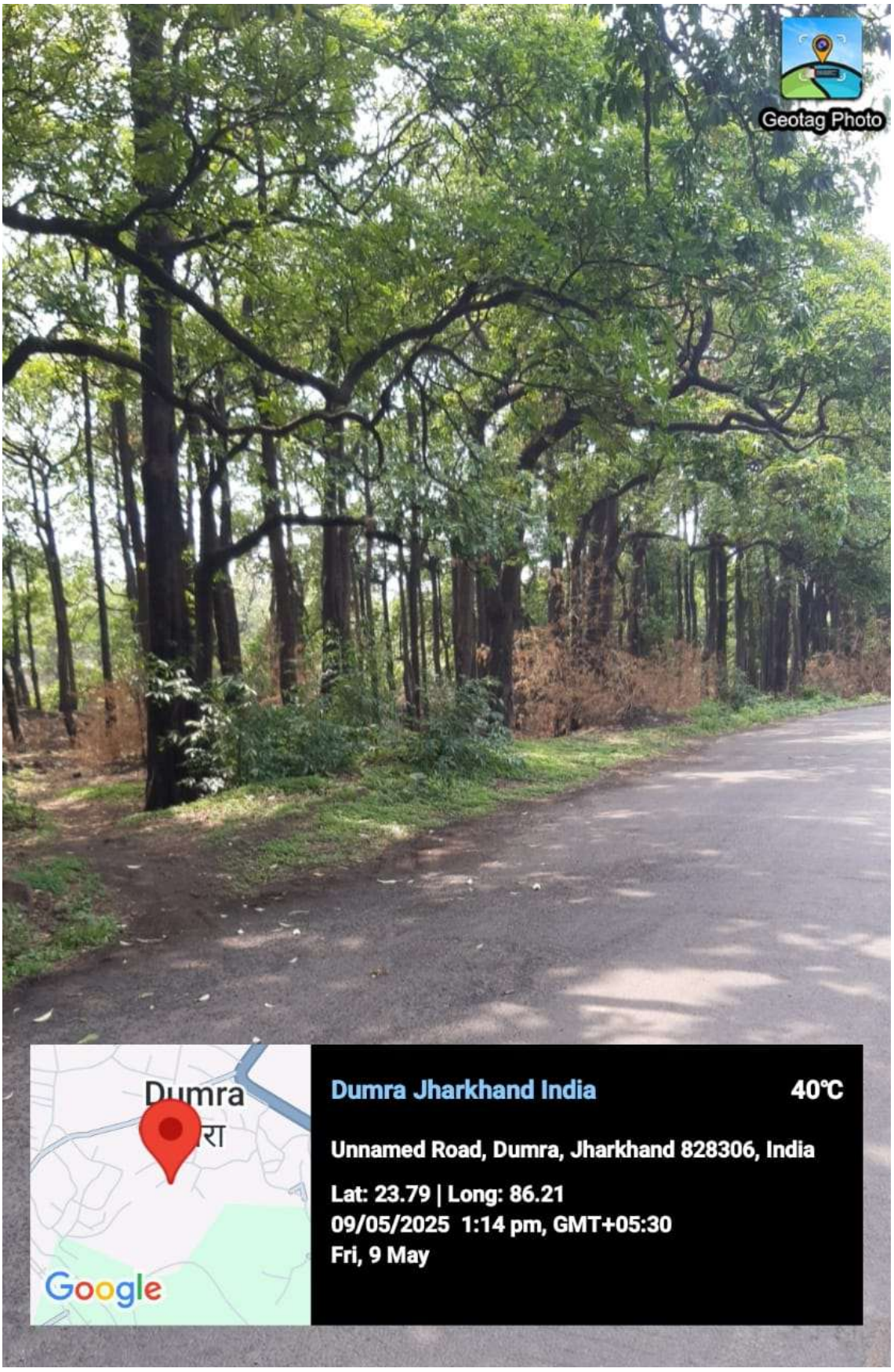
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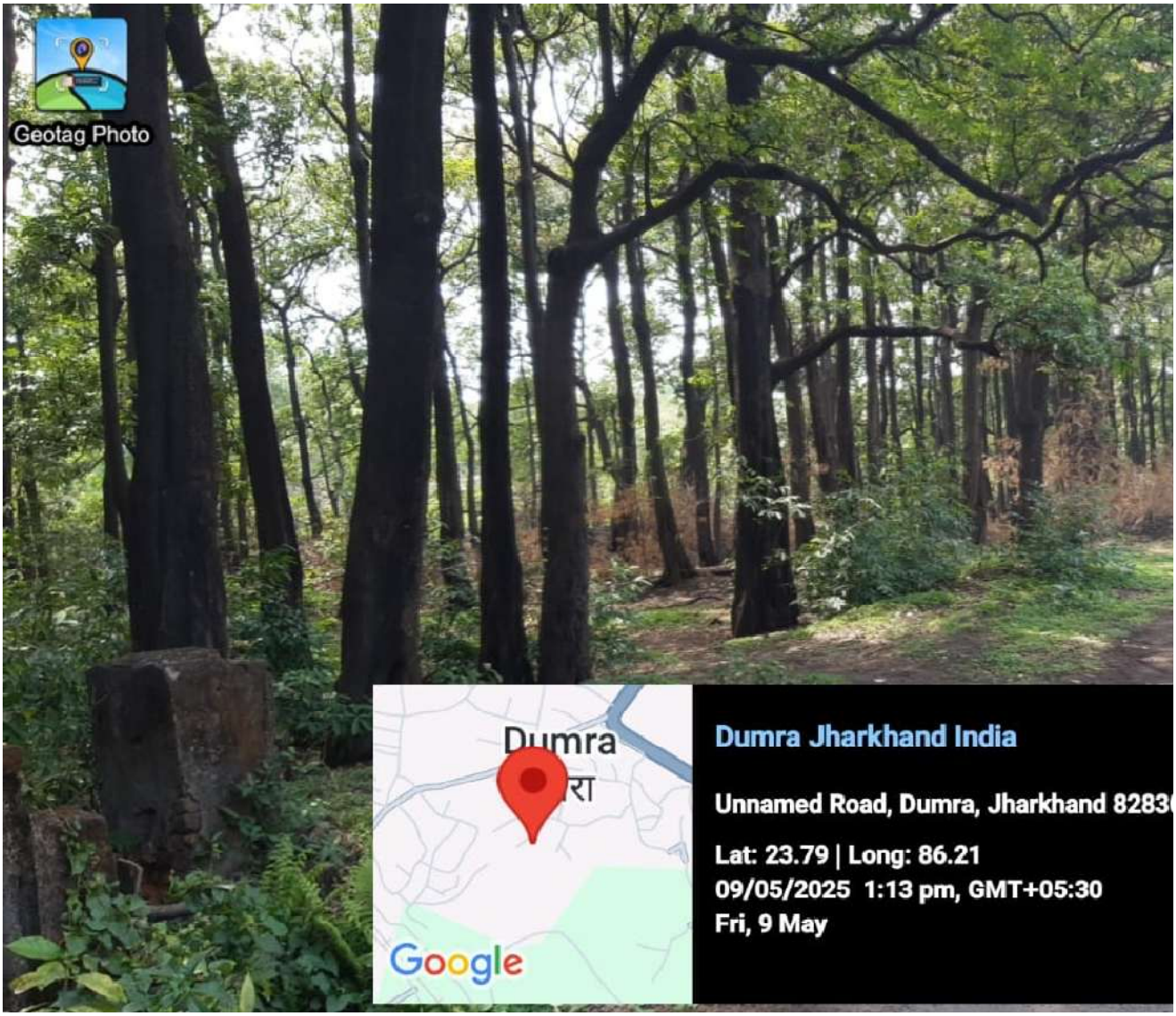
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“Source apportionment of ambient air particulate matter in Jharia coalfields region, Jharkhand”

Sponsor

Bharat Coking Coal Limited (BCCL)

CSIR-National Environmental Engineering

Research Institute, Nagpur

April 2022

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Chapter 1 Introduction

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

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

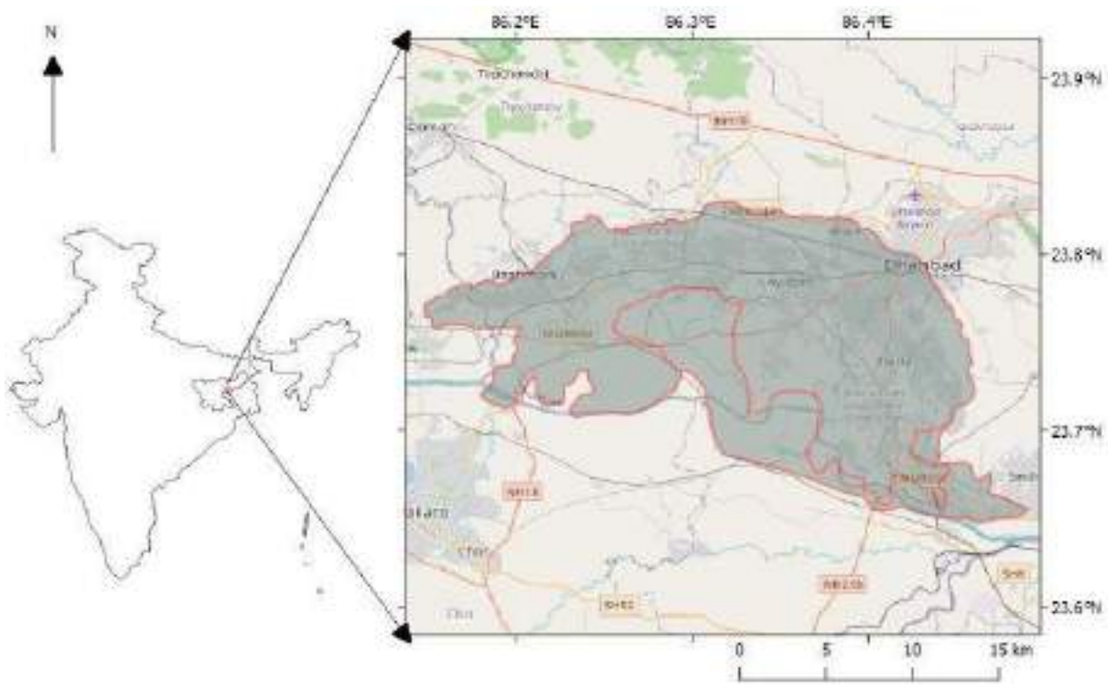


Figure 1.1: Geographical location of Jharia Coalfield in India

1.1. Climate

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

1.2. Land use & Land cover

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

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

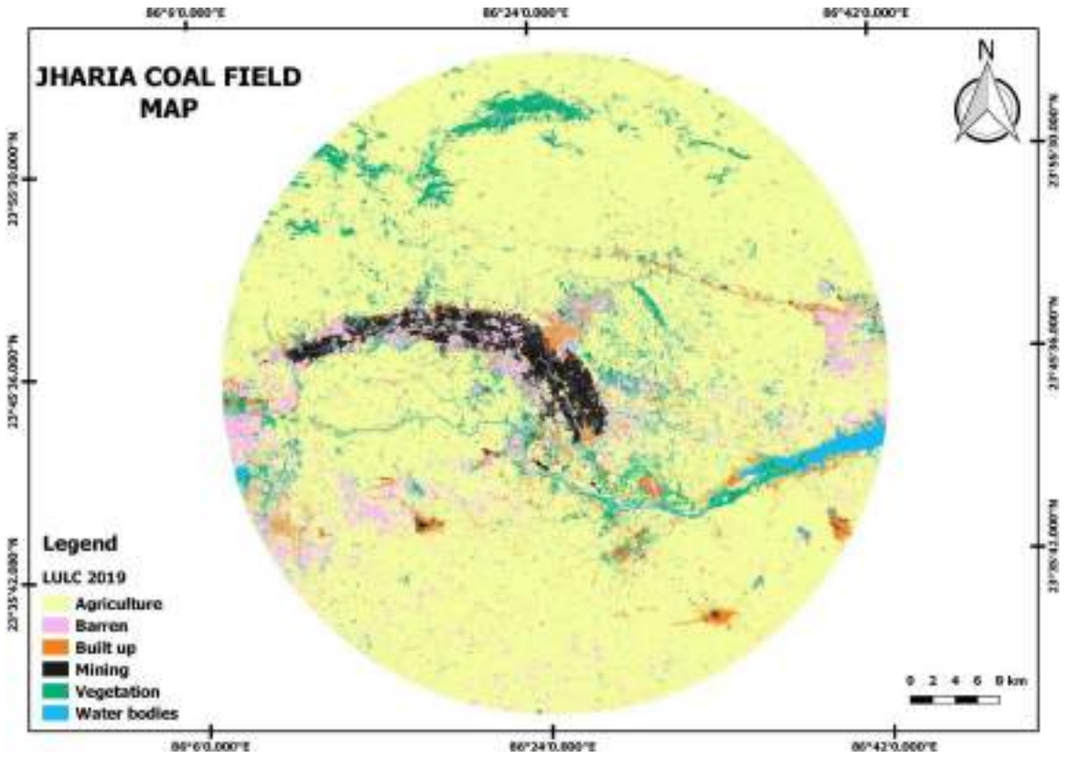


Figure 1.2: Land Use land cover map of Jharia coal field area

Table 1.1: LULC classification of Dhanbad study area

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

1.3. Population

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

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

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

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

1.4. Purpose of Study

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

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

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

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

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

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

The detailed objectives are as follows:

i. Ambient Air Monitoring

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

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

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

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

1.5. Approach of study

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

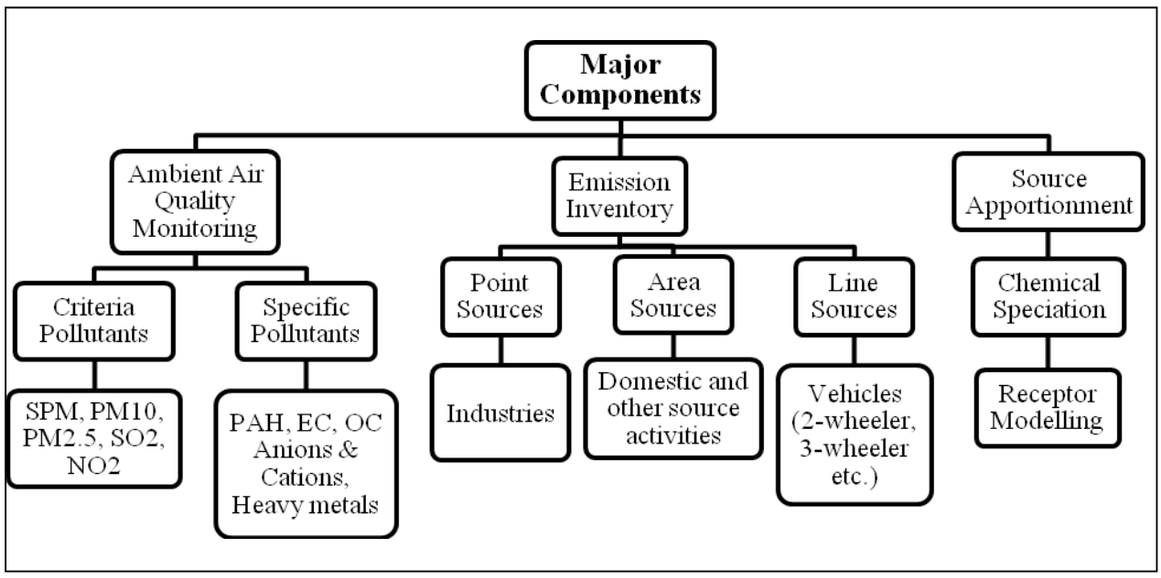


Figure 1.3: Air quality Monitoring & emission source apportionment studies

Chapter 2 Emission Inventory

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

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

2.1. Inventory of Point Sources

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

2.2. Inventory of Area Sources

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

2.3. Inventory of Line Sources

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

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

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

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

Table 2.1a: Daily average vehicle activity on different road network considered during the fieldsurvey

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

Table 2.1b: Average vehicle speed of different categories of vecle in the road network

		Average vehicle speed*			
Label	**Road Network**	**HDV**	**LMV**	**3W**	**2W**
L1	Jharia to Lodna -5 km	20	35	30	40
L2	Pathardih to Sindri -7 km	20	40	35	40
L3	Bastacola to Pathardih -13km	20	40	35	40
L4	Bhuli to Bankmore - 6km	15	30	30	30
L5	Katras to Harina–12.5 km	20	35	30	40
L6	Bankmore to Kusunda -5 km	15	30	20	30
L7	Kusunda to Katras - 10 km	20	40	30	40
L8	Monidih to Kusunda -7 Km	20	35	30	40
L9	Lohpiti to Mahuda Area Colony - 8 km	20	40	30	40
L10	Mahuda to Parasia Chowk -7 km	15	30	20	30

L11	Parasia Chowk To Moonidih - 3 km	20	35	35	40
L12	Bhowra to Parbatpur - 13 Km	20	40	30	40

*** Average travel speed on the road network is considered during traffic surveys and input form Traffic police and vehicle drivers**

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%).

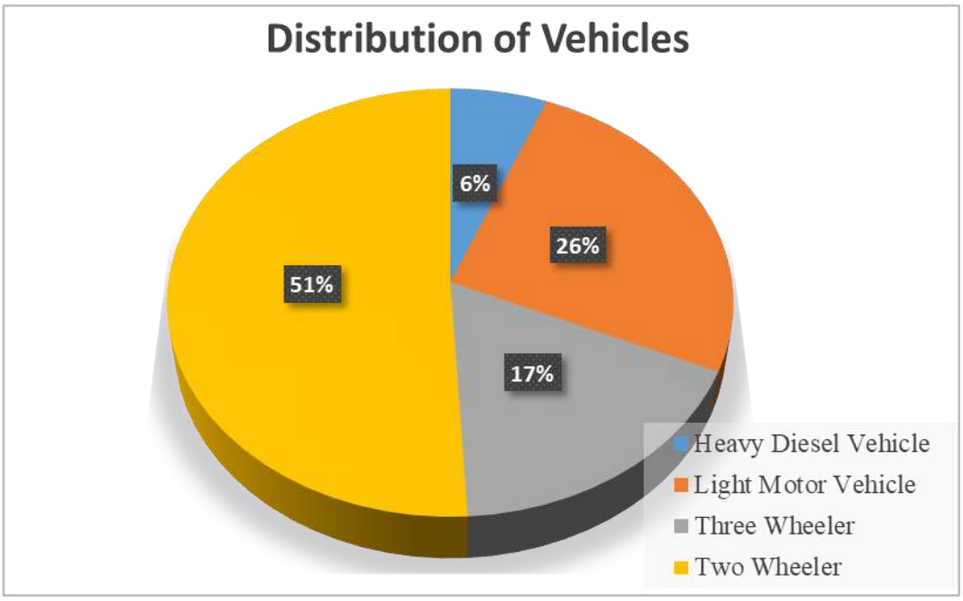


Figure 2.1 Percentage of different types of vehicle surveyed on the road network during the field survey

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
HDV	45.5

2.4. Methodology

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

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

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

N_v is the number of vehicles of a particular type

VKT is the vehicle km travelled

E_i, km is the emission factor for a specific vehicle

Table 2.3a: 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 paved (eq. 2.2a) and unpaved (eq. 2.2b) roads can be appraised by the following equations (adapted from US-EPA, AP-42):

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

$$E = [k. (SL/12).(S/30)^{0.5} (W/3)^{1.5}]/(M/0.5)^{0.2} \quad (2.2b)$$

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

SL is silt load (g/m2);

W is the average weight of the vehicle (Tons);
M is the surface moisture content (%)

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

Table 2.3b: Surface silt load in paved and unpaved road

Label	Road Network (Paved: 97.4%; Unpaved: 2.6%)	Surface Silt load (g/m2)	
		unpaved	paved
L1	Jharia to Lodna -5 km	102.3	18.2
L2	Pathardih to Sindri -7 km	--	16.8
L3	Bastacola to Pathardih -13km	63.2	12.1
L4	Bhuli to Bankmore - 6km	--	17.5
L5	Katras to Harina–12.5 km	92.8	12.6
L6	Bankmore to Kusunda -5 km	--	18
L7	Kusunda to Katras - 10 km	--	17.3
L8	Monidih to Kusunda -7 Km	56.5	12.8
L9	Lohpiti to Mahuda Area Colony - 8 km	--	15.5
L10	Mahuda to Parasia Chowk -7 km	--	19

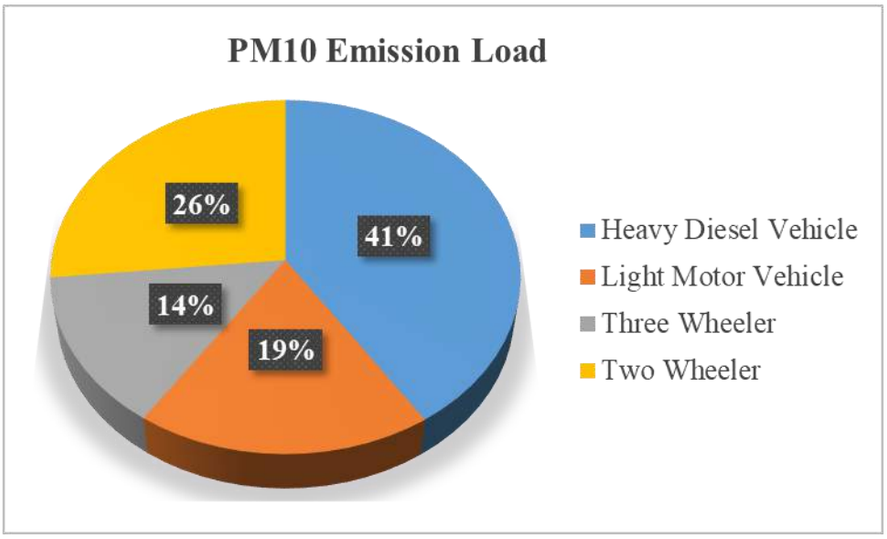


Figure 2.2 PM_{10} emission load for different categories of vehicle

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. The particle size multiplier (k) in the equations 2.2a and 2.2b varies with aerodynamic size range as shown in EPA technical document (13.2.1_paved_roads.pdf (epa.gov)).

Table 2.4: Emission rate for the paved and unpaved road

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

2.5. Results

2.5.1. Industrial Emission

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

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

Table 2.5: Emission factor for coal mining activities

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

Table 2.6: Emission load from Industrial sector in JCF

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 JCF region 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 thusobtained.

- **Emission load from mining activities**

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

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

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

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

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

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

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

- **Cooking operations in slum households**

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

Table 2.9: Emission from coal as fuel

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

- **Emissions from crematorium**

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

Table 2.10: Emission from Crematoria using Wood as fuel

Pollutant	PM_{10}	SO_2	NO_2	CO	HC
Emission Factor (g/kg)	17.3	0.2	1.3	126.3	114.5
Emission (T/Year)	28.88	0.033	0.216	20.99	19.03

- **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)	81.10	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)	140.7	9.36	2.81	17.54	0.35

2.5.3. Grid wise emission inventory

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

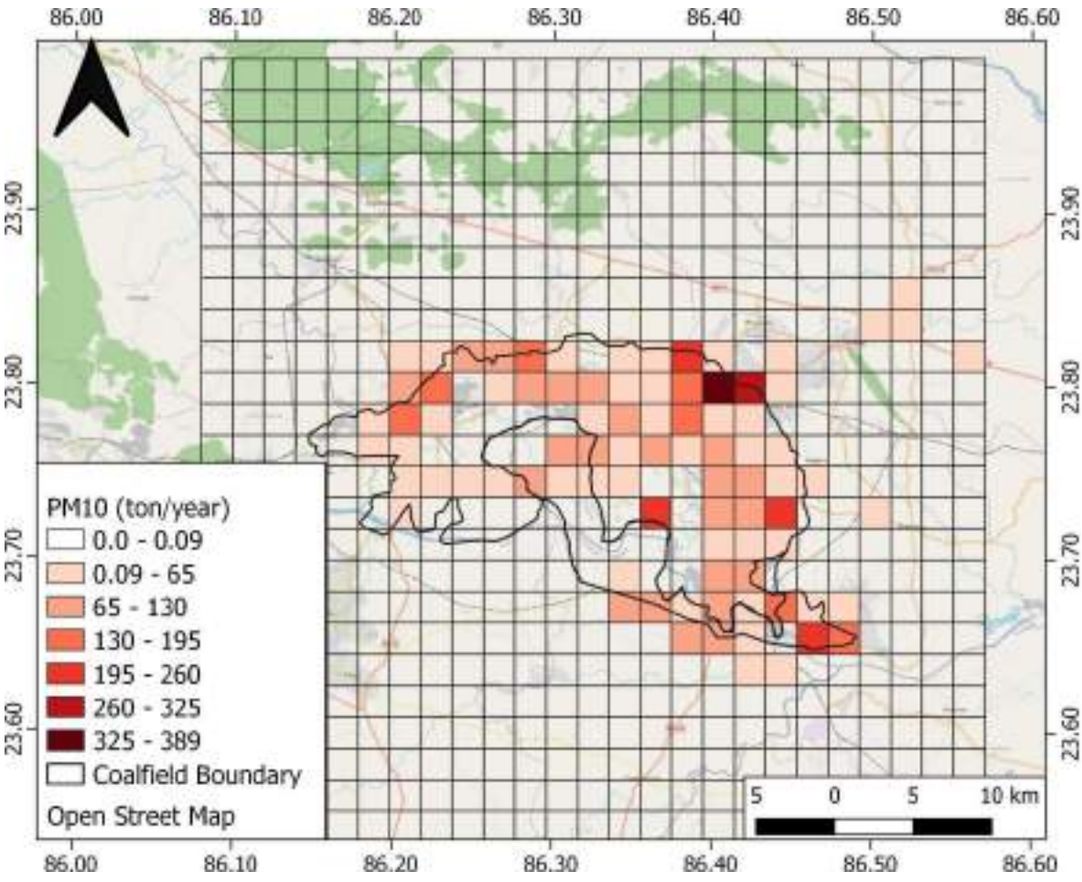


Figure 2.3 Grid-wise emission inventory of PM_{10} in tons/year over the study area

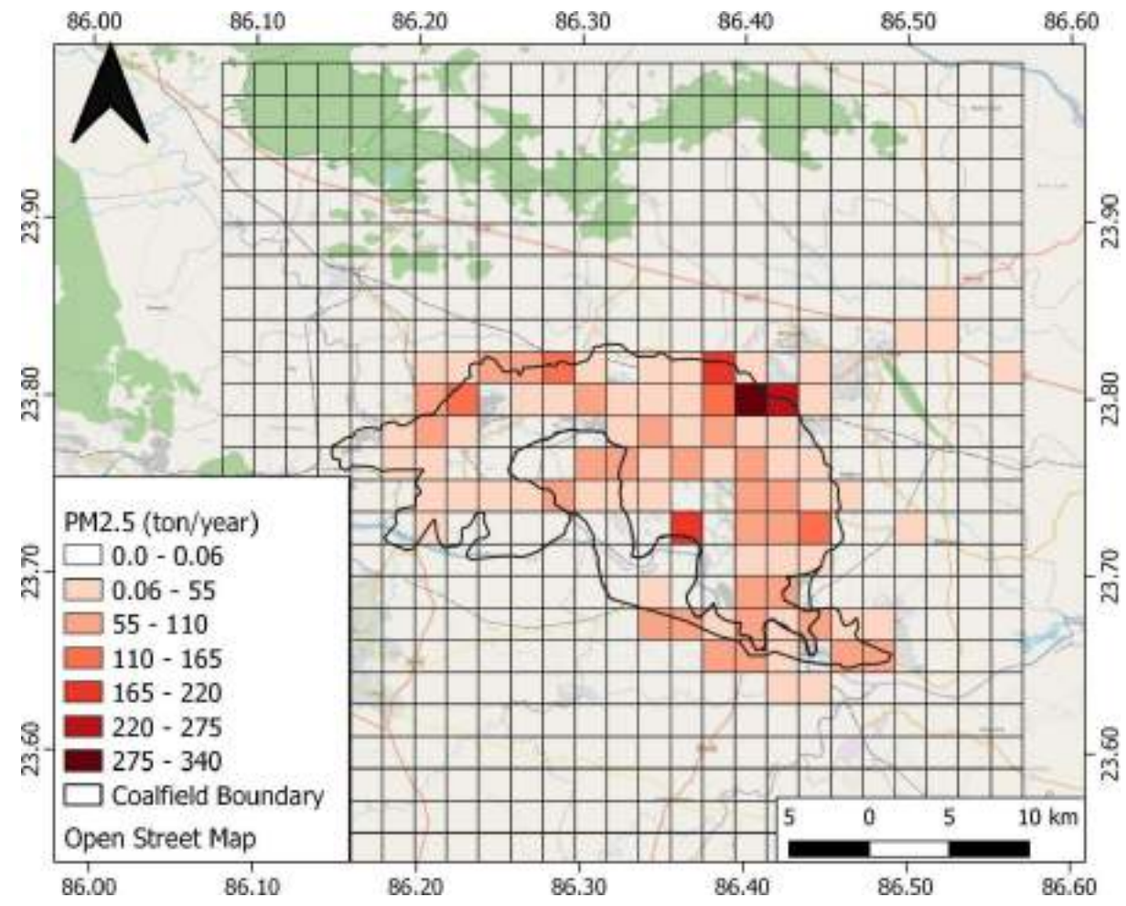
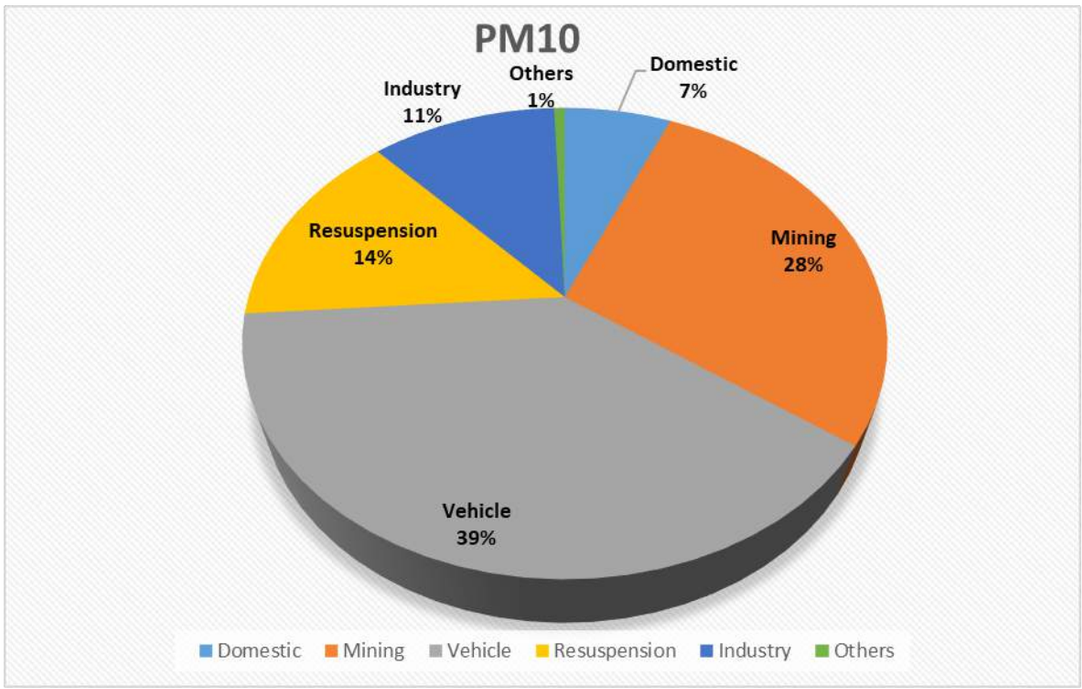


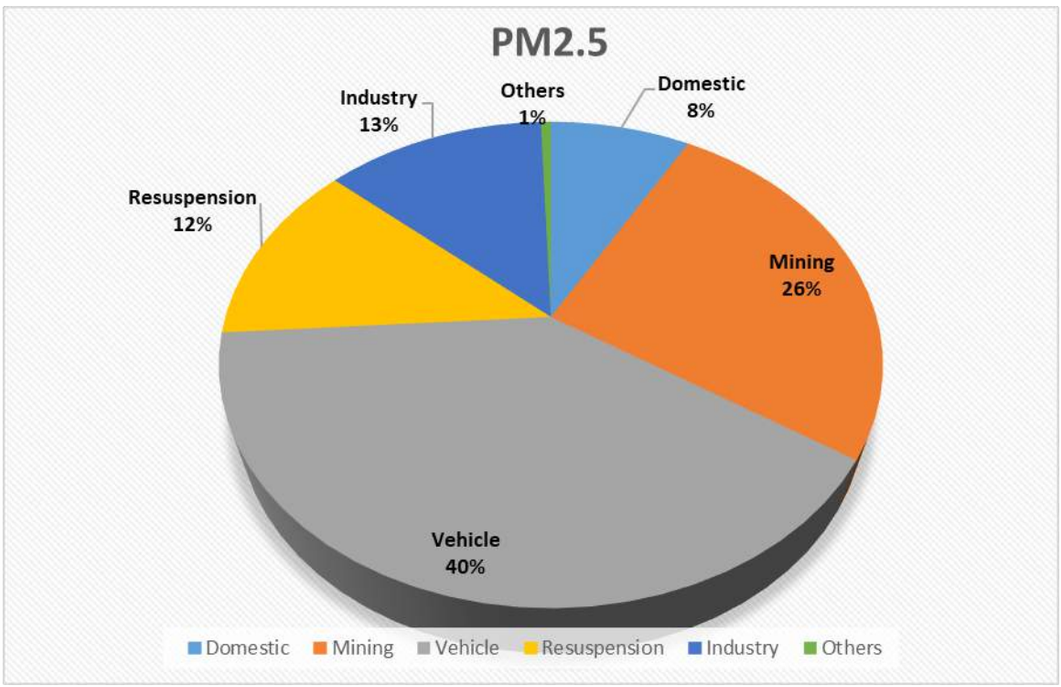
Figure 2.4 Grid-wise emission inventory of PM2.5 in tons/year over the study area

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

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



(a)



(b)

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

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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 REPOR T-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.

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.

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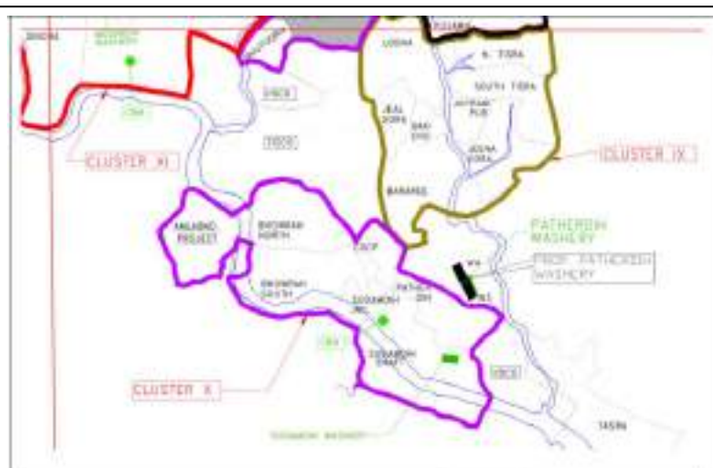
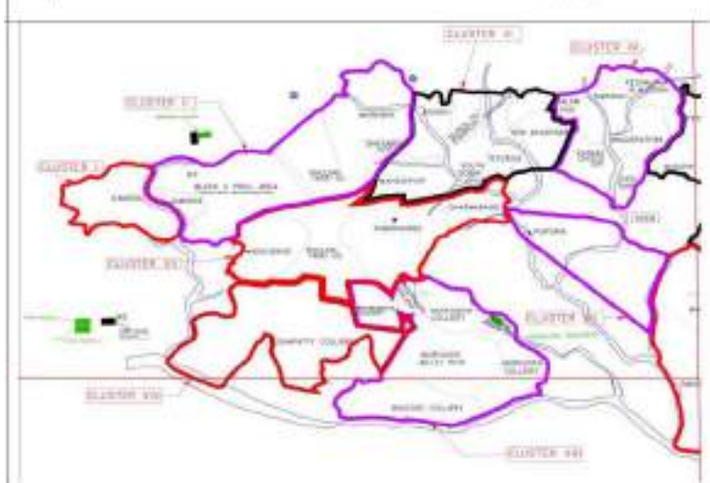
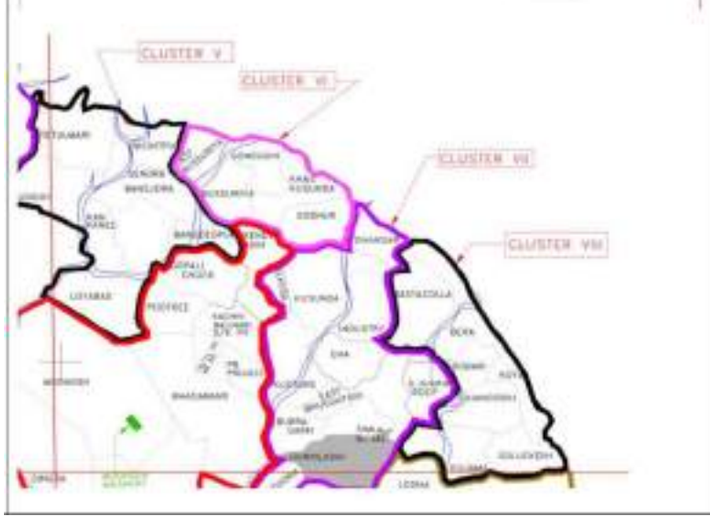
Chapter 3 Air Quality Monitoring and Receptor modelling

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

Table 3.3.1: The details of mine cluster in Jharia Coalfield

	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

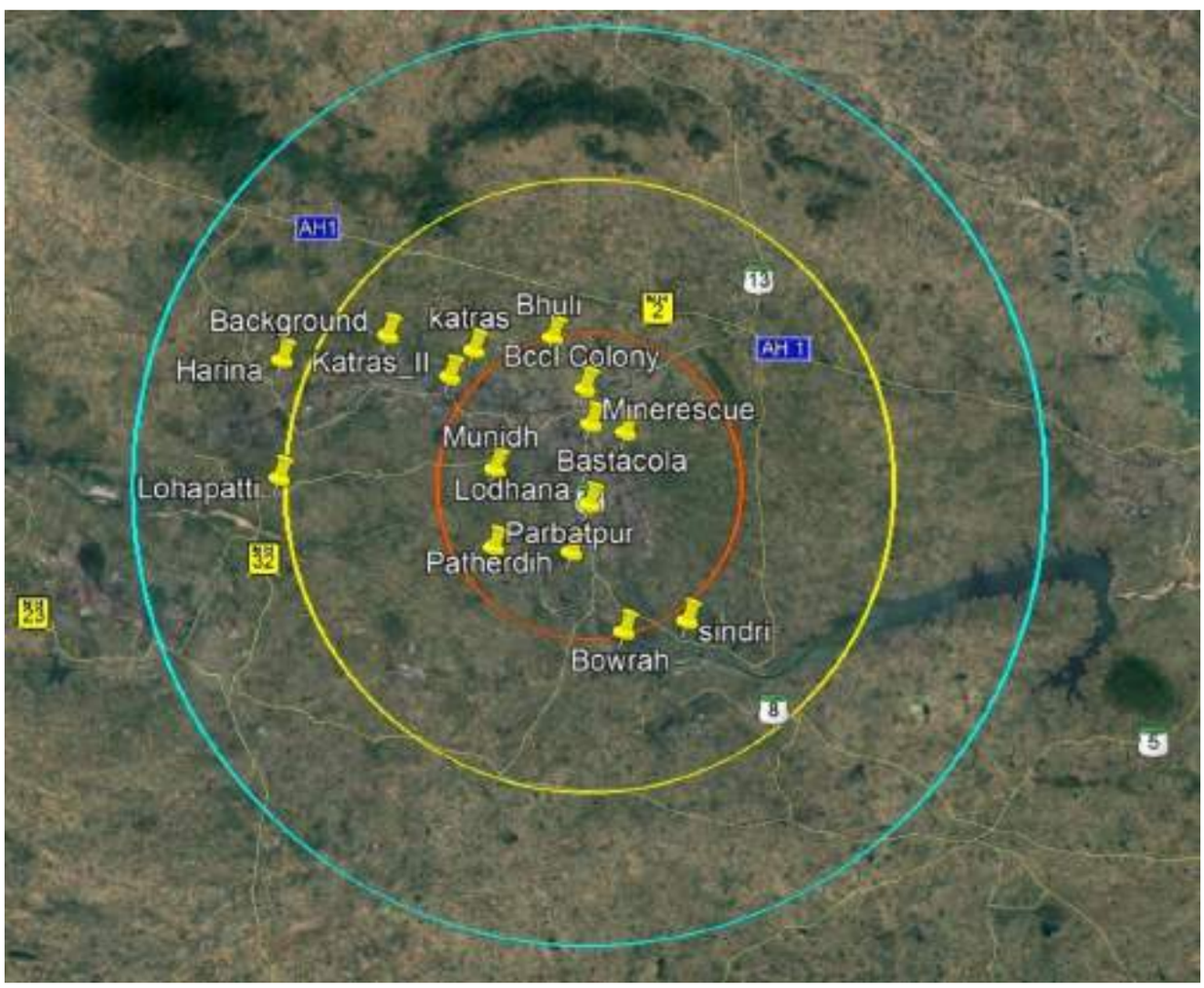


Figure 3.1: Air monitoring sites under 30 km buffer area

3.1. Sampling Method and Schedule

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

Table 3.3.2: Frequency of Air pollutants sampling in Jharia Coalfields

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

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

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

Table 3.3.4: National Ambient Air Quality Standards (2009)

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

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

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

3.2. Chemical Analysis

3.2.1. Gravimetric analysis

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

3.2.2. Elemental analysis

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

3.2.3. Analysis of SO_2 and NO_2

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

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

3.2.4. Ion analysis

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

3.2.5. Polycyclic Aromatic Hydrocarbons (PAH) analysis

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

3.2.6. EC & OC analysis

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

3.3. Results

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

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

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

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

Monitoring Sites		**Average Concentration (µg/m^3)-Summer**	
	Site Description	**PM_{10} (µg/m^3)**	**$PM_{2.5}$ (µg/m^3)**
Lohapatti	Core Zone	133.7	49.42
		(83-203)	(44-83)
Mines Rescue	Core Zone	184.8	83.43
		(124-255)	(55-205)
Katras	Core Zone	141.4	80.01
		(100-216)	(42-150)
Lodhna	Core Zone	156.8	63.98
		(100-303)	(32-99)
Moonidih	Core Zone	118.4	62.84
		(80-153)	(34-94)
Patherdih	Core Zone	94.7	67.22
		(50-119)	(37-91)
Bastacola	Core Zone	104.32	93.27
		(154 -316)	(64-158)
BCCL colony	Buffer Zone	157.35	74.37
		(113-222)	(47-103)
Harina	Buffer Zone	177.7	117.3
		(73-265)	(42-175)
Bhuli	Buffer Zone	141.7	105.89
		(85-243)	(44-161)
Sindri	Buffer Zone	122.2	76.05
		(82-139)	(18-127)
Parabatpur	Buffer Zone	122.4	110.98
		(86-171)	(70-150)
Background	Buffer Zone	144.4	57.13
		(24-255)	(23-97)

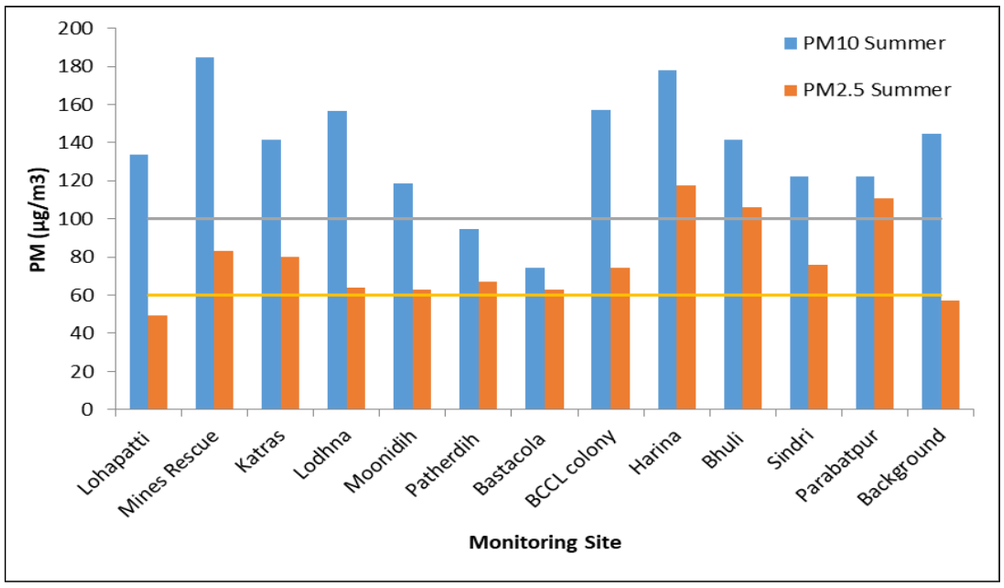


Figure 3.2: Average concentration of PM_{10} and $PM_{2.5}$ in JCF region in summer compared to NAAQS (2009)

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

Monitoring Sites	Site Description	Average Concentration (µg/m^3)-Winter	
		PM_{10} (µg/m^3)	**$PM_{2.5}$ (µg/m^3)**
Lohapatti	Core Zone	174.28	139.59
		(122-241)	(114-236)
Mines Rescue	Core Zone	303.49	176.97
		(175-350)	(114-233)
Katras	Core Zone	230.06	50.87
		(134-332)	(24-78)
Lodhna	Core Zone	322.8	112.17
		(243-412)	(98-209)
Moonidih	Core Zone	300.16	188.27
		(128-728)	(64-600)
Patherdih	Core Zone	222.71	113.23
		(182-246)	(111-167)
Bastacola	Core Zone	332.05	176.48
		(251-663)	(54-425)
BCCL colony	Buffer Zone	219.98	128.79
		(155-300)	(94-175)
Harina	Buffer Zone	130.73	42.93
		(65-215)	(44-98)
Bhuli	Buffer Zone	174.75	151.66
		(150-200)	(89-180)
Sindri	Buffer Zone	171.82	167.07
		(81-210)	(142-184)
Parabatpur	Buffer Zone	228.76	148.16
		(75-660)	(101-192)
Background	Buffer Zone	233	121.18
		(195-254)	(63-170)
Katras II		107.13	98.42
	Core Zone	(128-181)	(94-104)

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

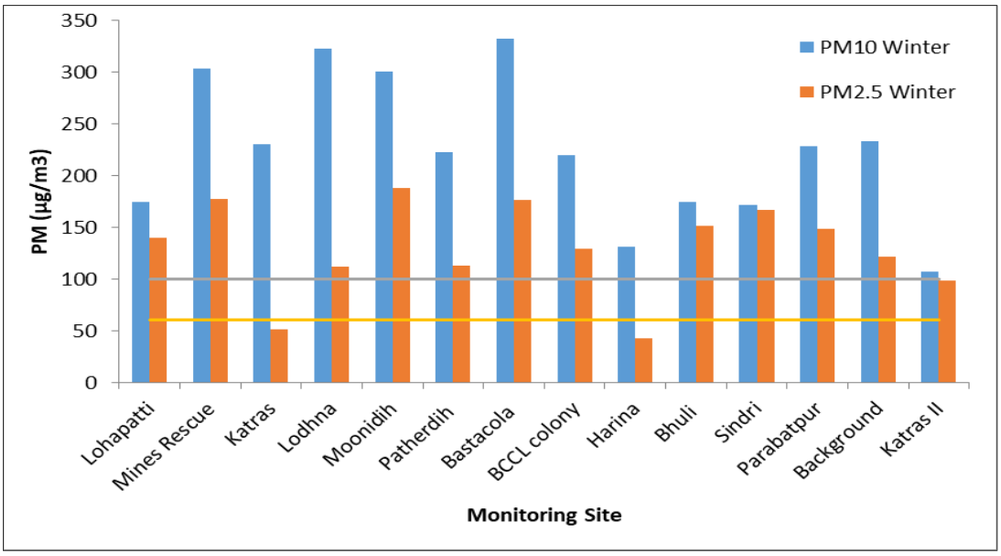


Figure 3.3: Average concentration of PM_{10} and $PM_{2.5}$ in JCF region during Winter compared to NAAQS (2009)

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

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

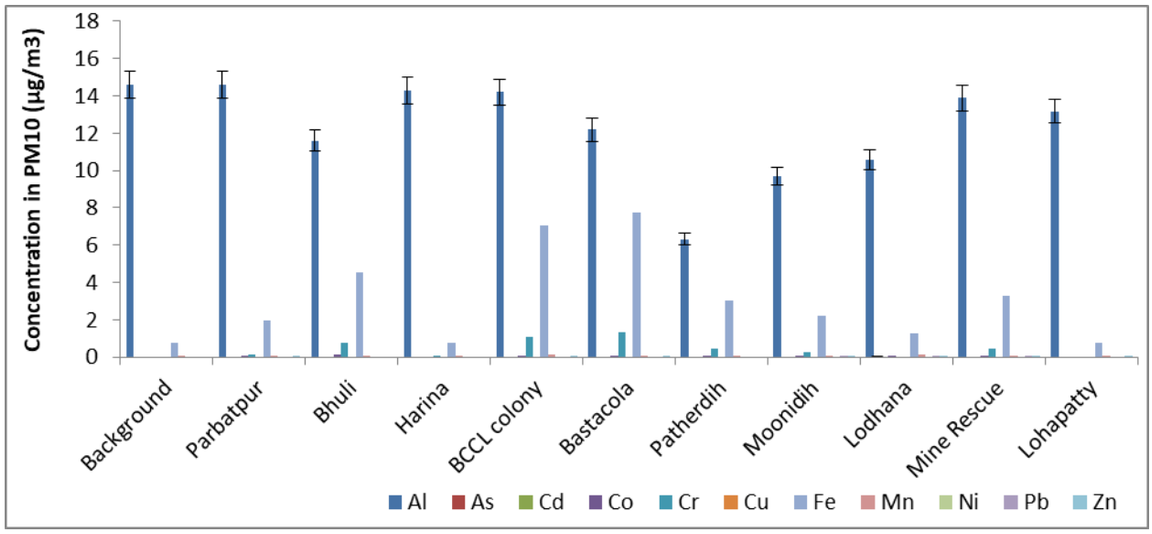


Figure 3.4: Metal concentration of PM_{10} in the summer season

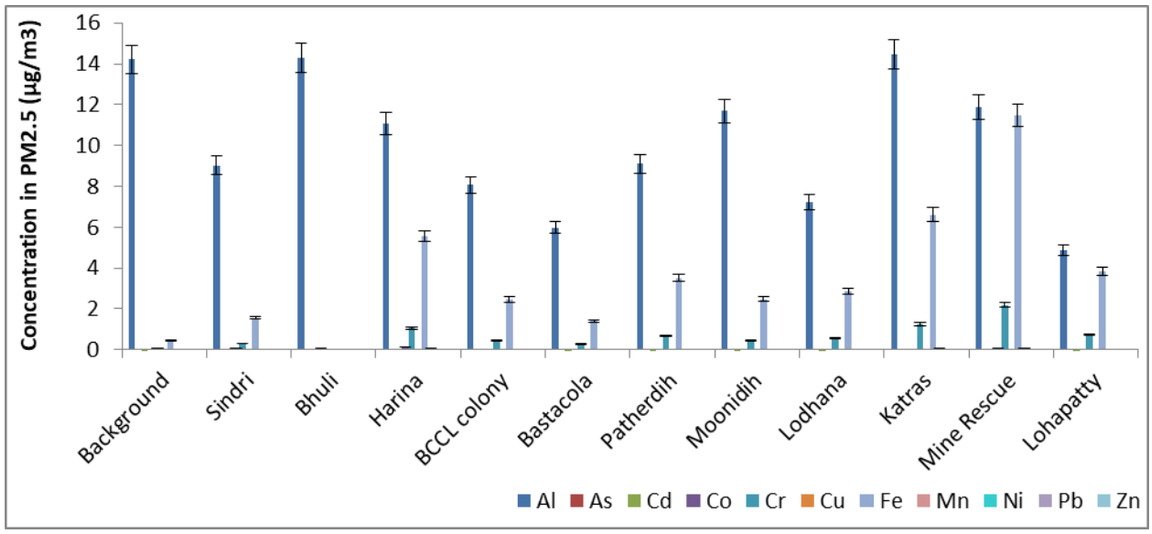


Figure 3.5: Metal concentration of $PM_{2.5}$ in the summer season

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

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

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

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

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

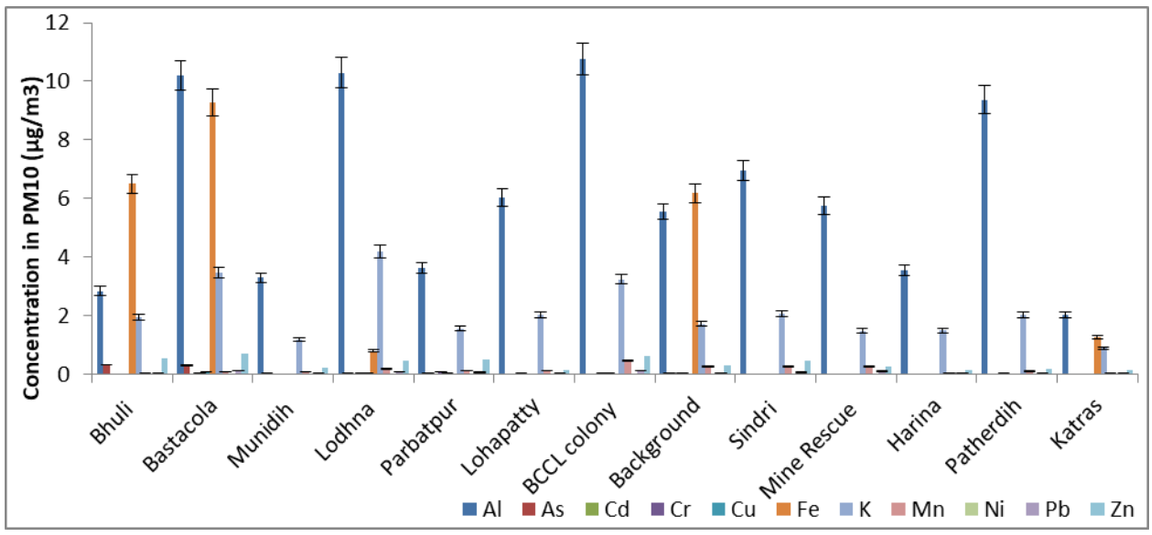


Figure 3.6: Metal concentration of PM_{10} in winter season

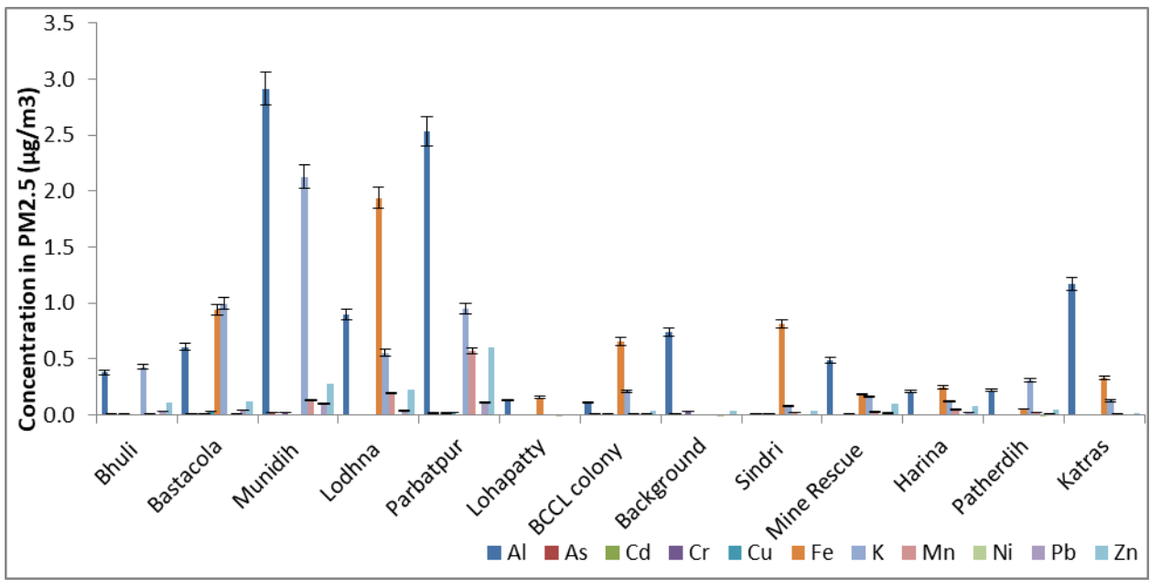


Figure 3.7: Metal concentration of PM 2.5 in winter season

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

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

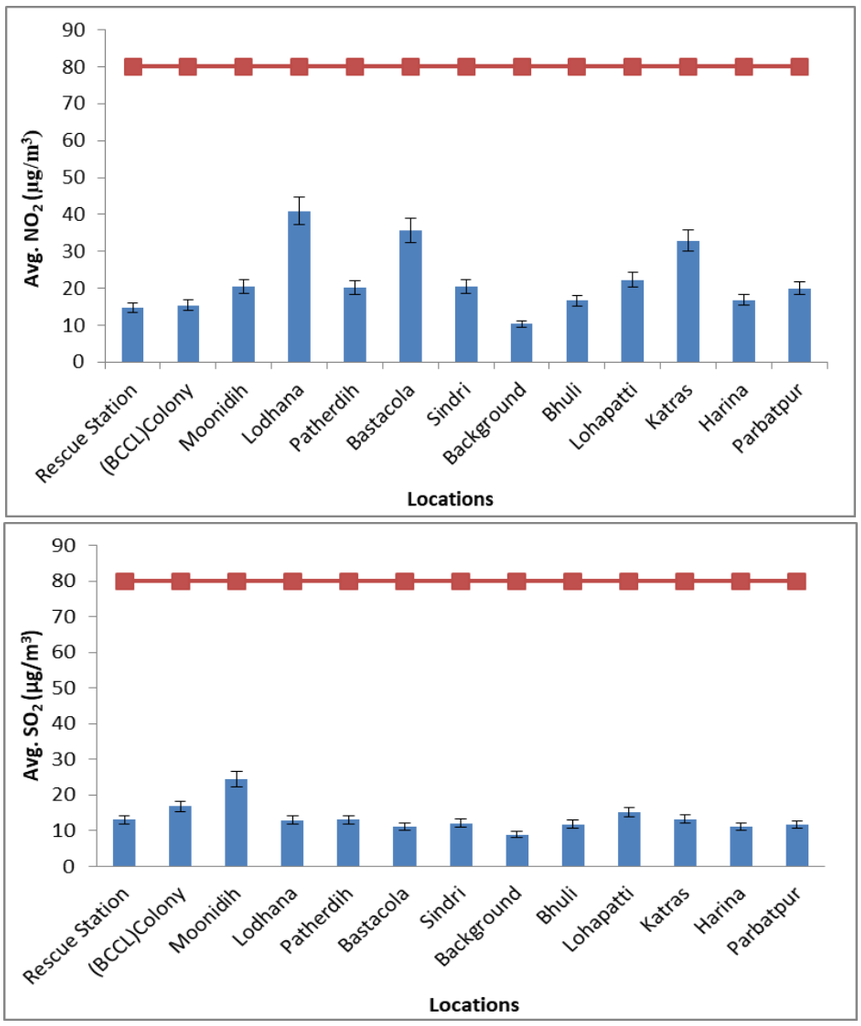


Figure 3.8: NO_2 and SO_2 Concentration of all monitoring sites in summer season

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

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

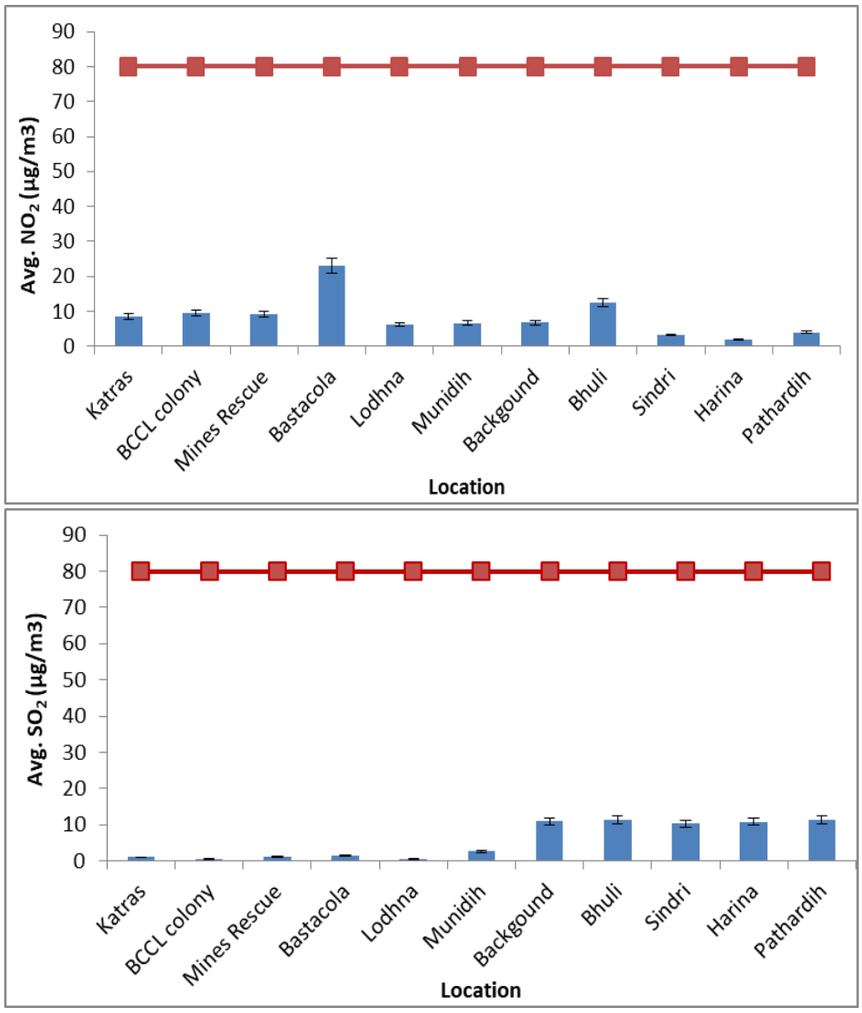


Figure 3.9: NO_2 and SO_2 Concentration of all monitoring sites in Winter season

3.3.6. Carbonaceous Aerosol/EC & OC in Summer

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

3.3.7. Carbonaceous Aerosol/EC & OC in winter

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

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

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

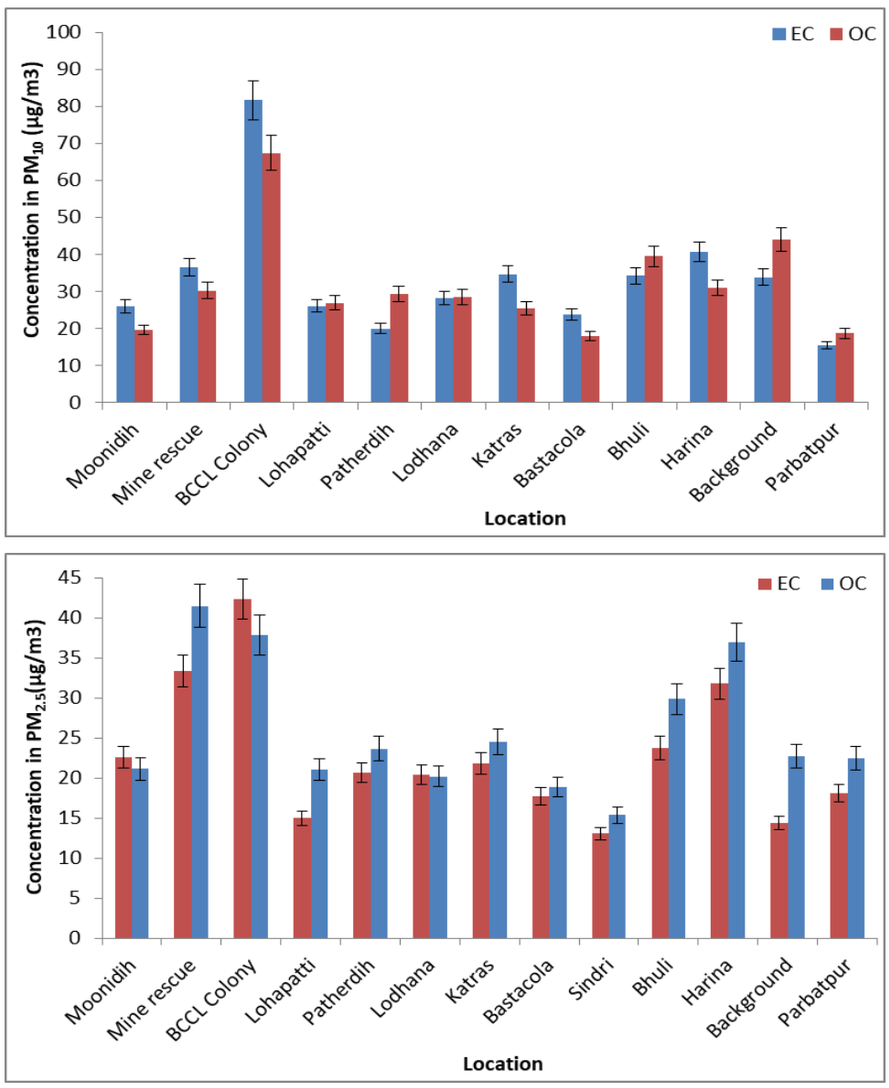


Figure 3.10: EC & OC concentration in PM_{10} and $PM_{2.5}$ in Summer season

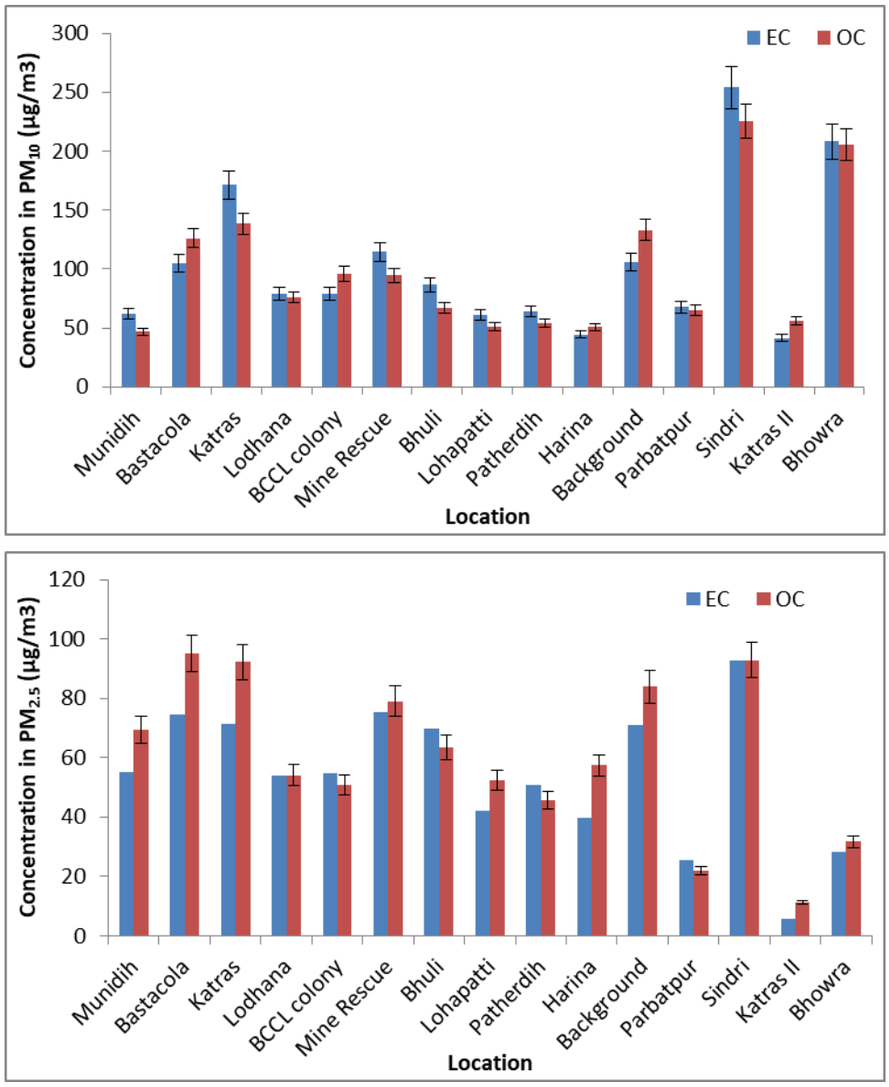


Figure 3.11: EC & OC concentration in PM_{10} and $PM_{2.5}$ in Winter Season

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

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

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

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

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

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

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

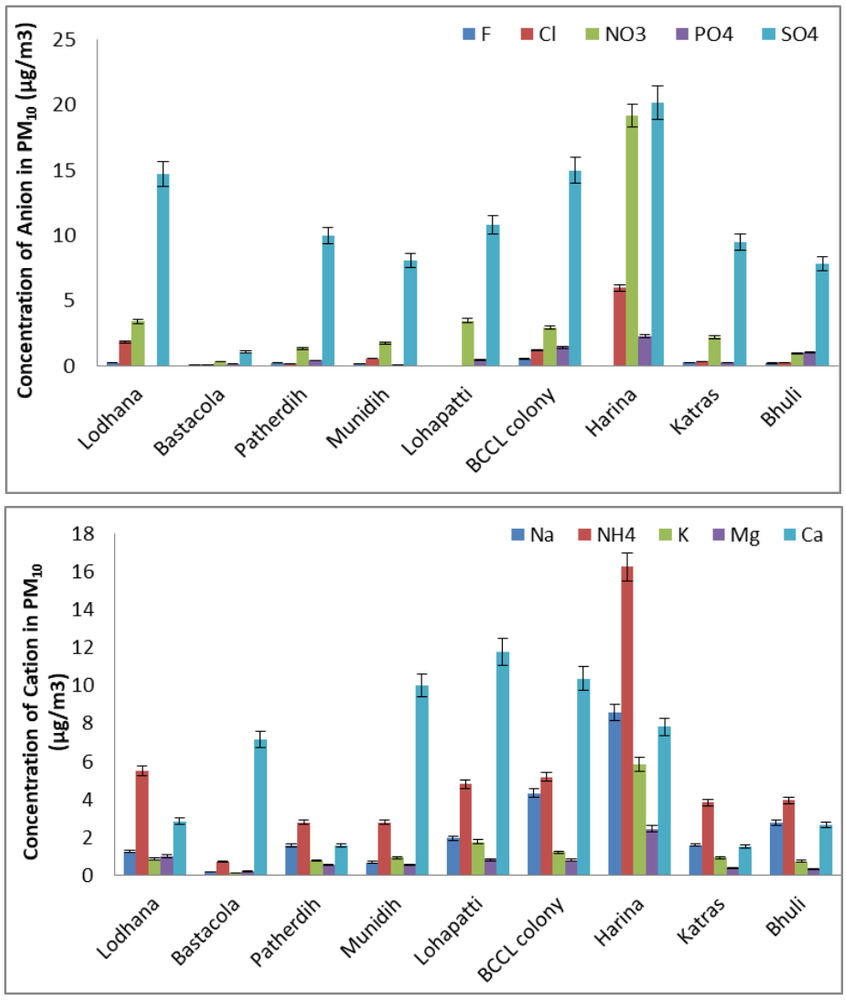


Figure 3.12: Anion and Cation concentration in PM_{10} in summer

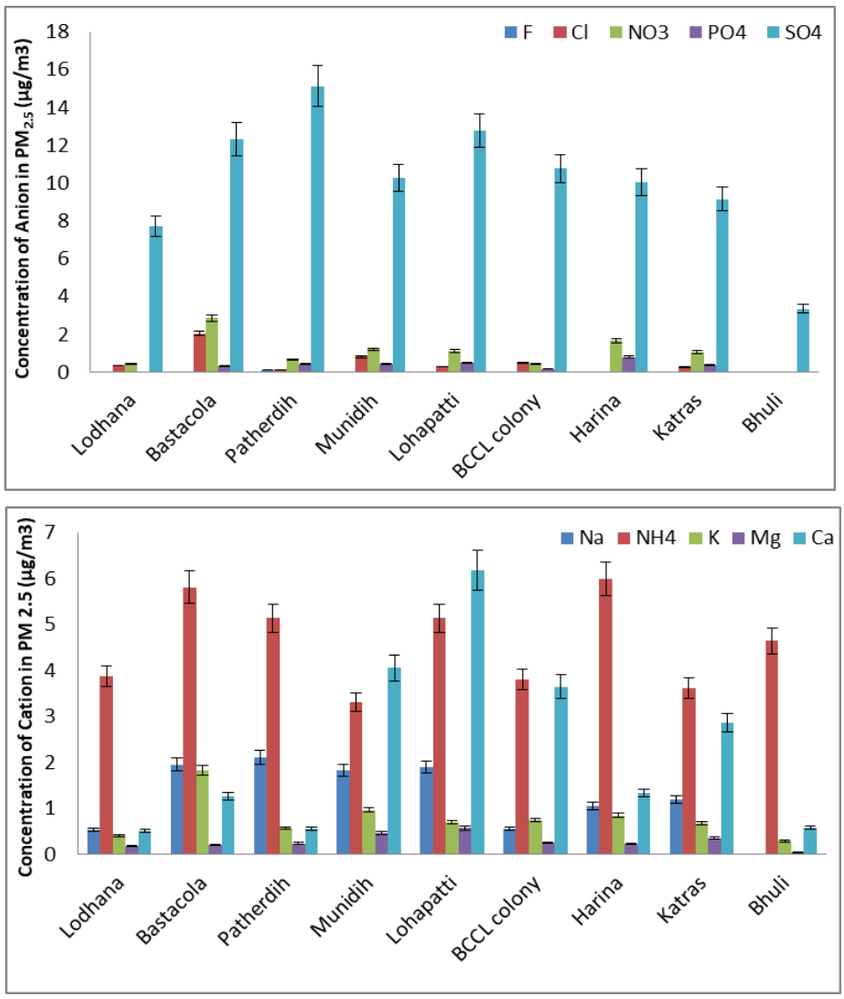


Figure 3.13: Anion and Cation concentration in $PM_{2.5}$ in summer

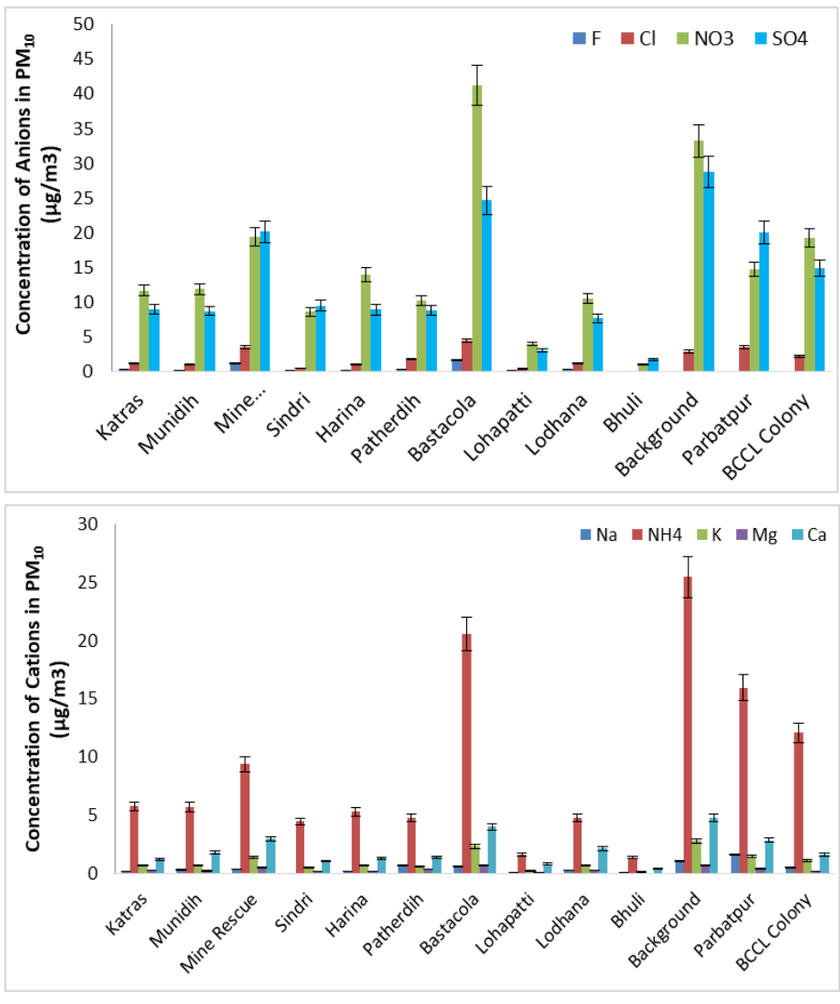


Figure 3.14: Anion and Cation concentration in PM_{10} in winter

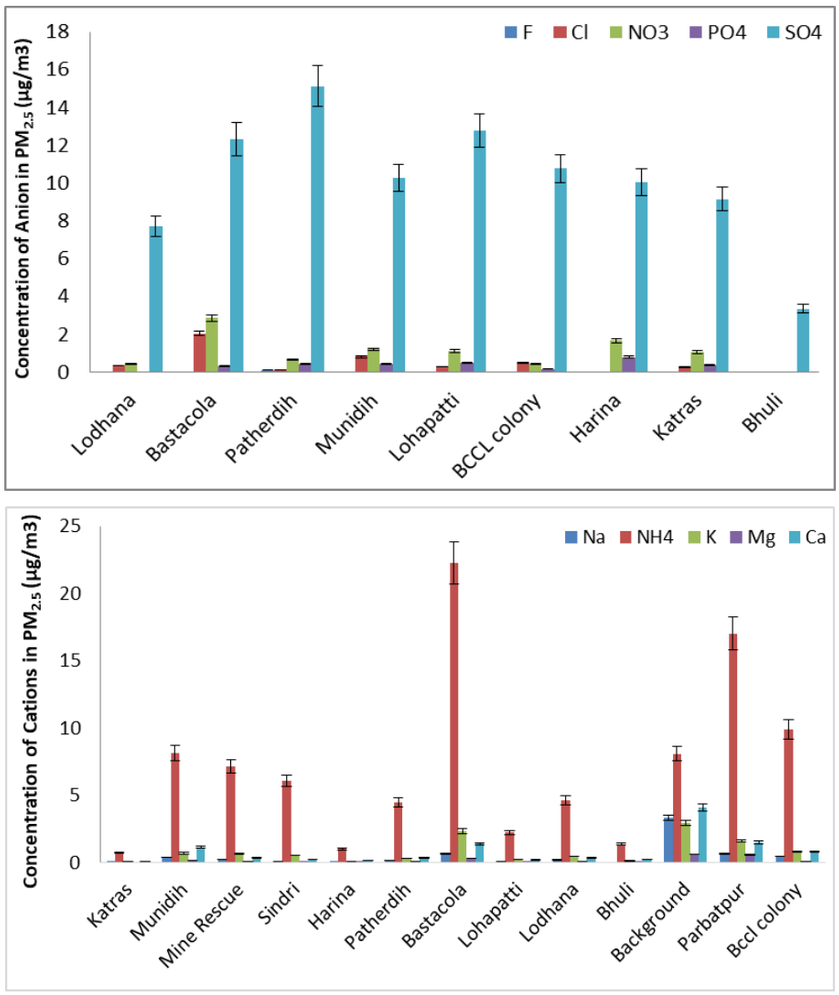


Figure 3.15: Anion and Cation concentration in $PM_{2.5}$ in winter

Chapter 4 Receptor modelling

4.1. Source Apportionment

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

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

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

4.1.1. Chemical Mass Balance (CMB)

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

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

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

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

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

The CMB model assumptions are:

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

The following steps are followed for running the CMB model:

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

For source apportionment of PM_{10}, CMB 8.2 software (USEPA 1997) provides many goodness‟s of fit tests to verify the accuracy of the model. The normal checks, as specified in the manual by USEPA (1997) to accept the model are; t-statistics i.e., source contribution divided by the error of source contribution should be greater than 2, χ^2 (chi-square) is the weighted sum of squares of the differences between calculated and measured fitting species concentrations divided by the effective variance and the degrees of freedom, it should be less than 4. The weighting is inversely proportional to the squares of the precision in the source profiles and ambient data for each species. Ideally, χ^2 would be zero, there would be no difference between calculated and measured species concentrations. The χ^2 less than one indicate a very good fit for the data. Values greater than 4 indicate that one or more of the fitting species concentrations are

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

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

4.1.2. Source profiling

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

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

4.1.3. Ambient profiling

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

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

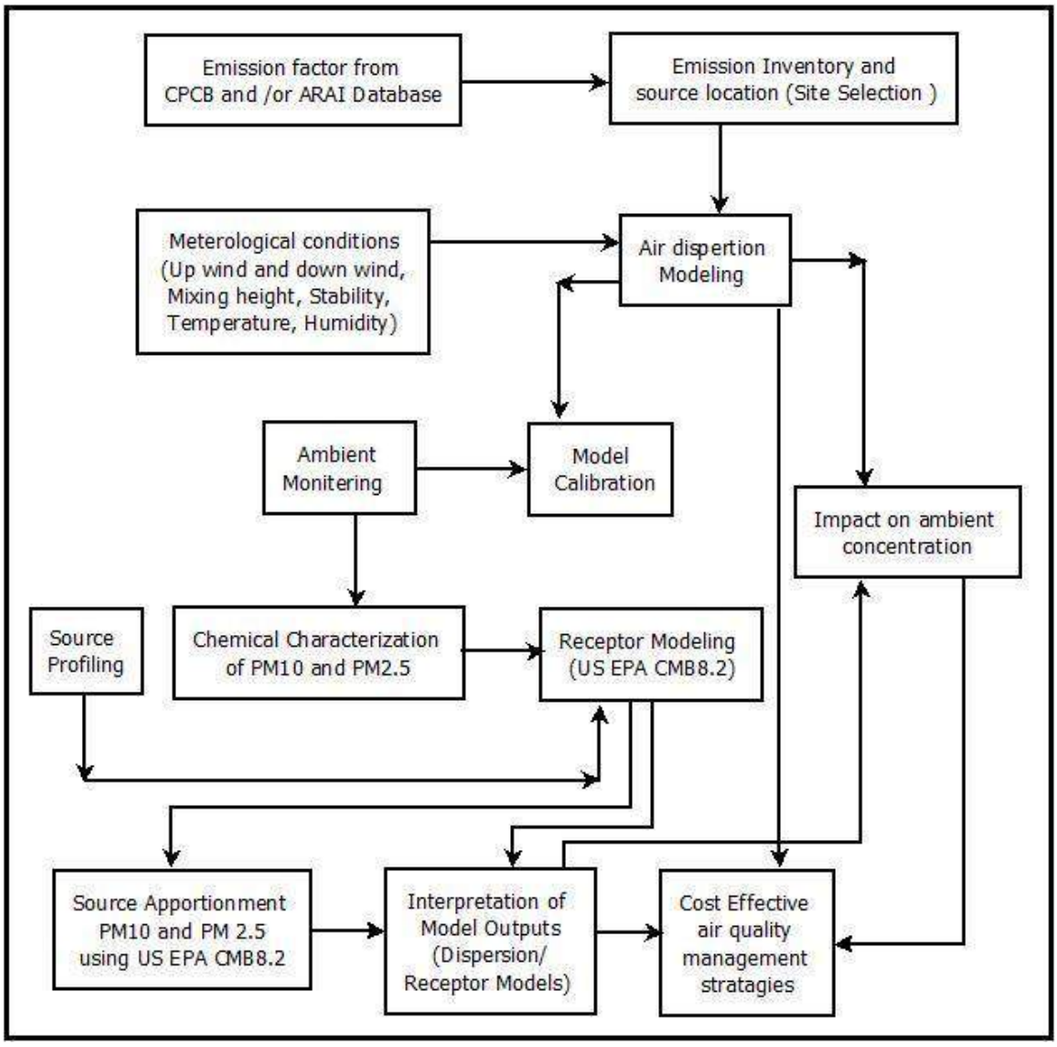


Figure 4.1: General methodology followed in the source apportionment studies

4.2. Results of the Chemical Mass Balance

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

4.2.1. Domestic combustion

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

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

4.2.2. Industrial Emission

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

4.2.3. Coal Mining

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

4.2.4. Transportation

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

4.2.5. Secondary Inorganic Aerosol

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

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

4.2.6. Agriculture

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

4.2.7. Open burning

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

4.2.8. Road Resuspension dust

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

4.2.9. Other emission Contribution

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

4.3 Inferences

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

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

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

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

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

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

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

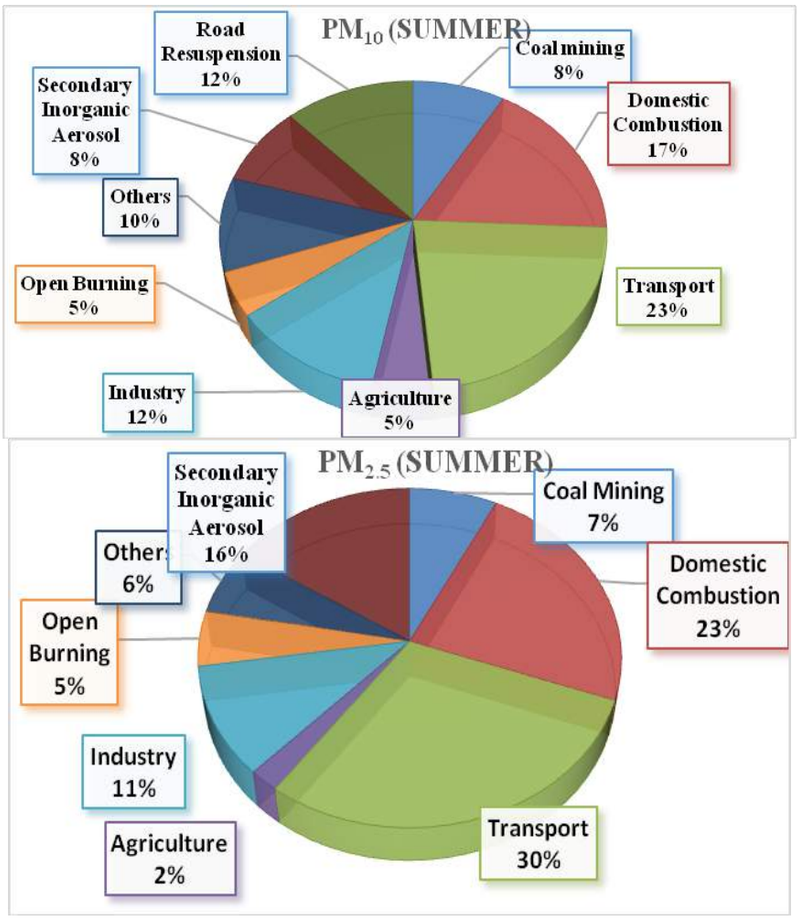


Figure 4.2: Source contribution at receptor locations of PM_{10} and $PM_{2.5}$ in summer

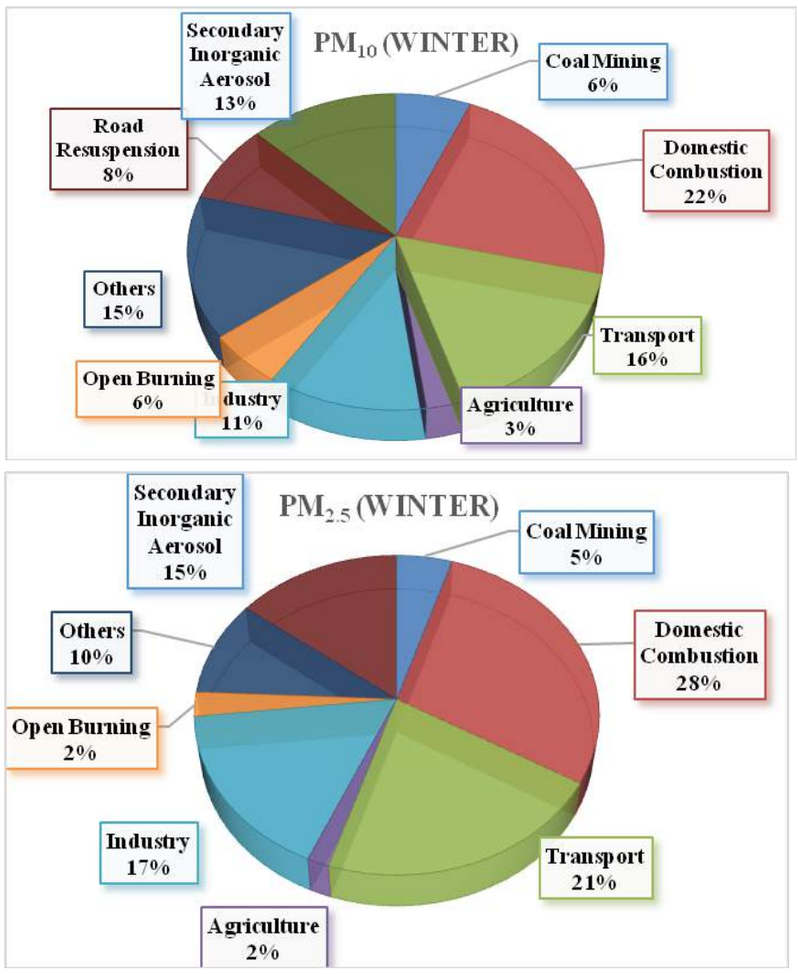


Figure 4.3: Source contribution at receptor locations of PM_{10} and $PM_{2.5}$ in winter

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

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

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

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

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Chapter 5 Dispersion Modelling

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

5.1. Wind data analysis

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

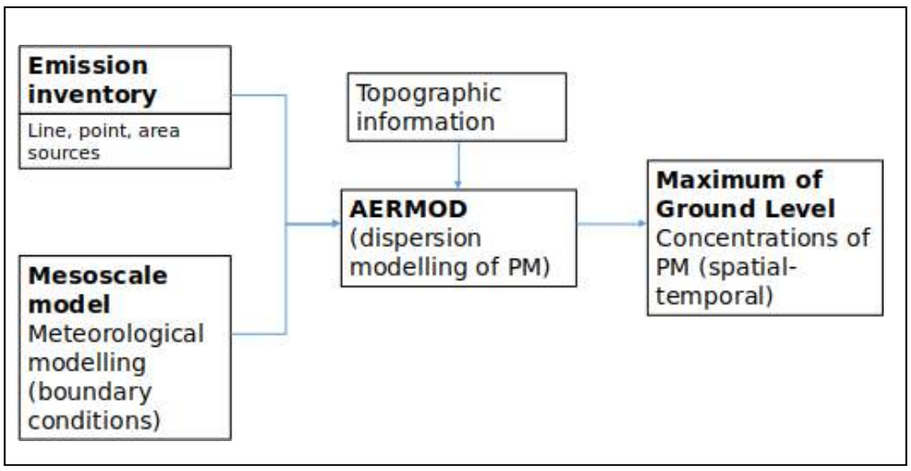


Figure 5.1: Methodology followed in the study.

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

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

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

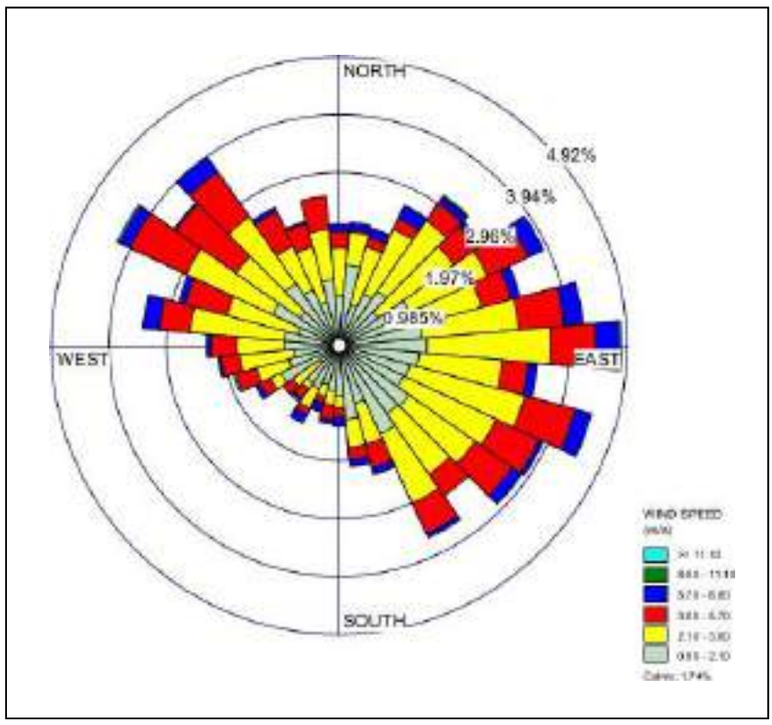


Figure 5.2: Windrose of the study area during March-June, 2019 (wind direction blowing towards the center)

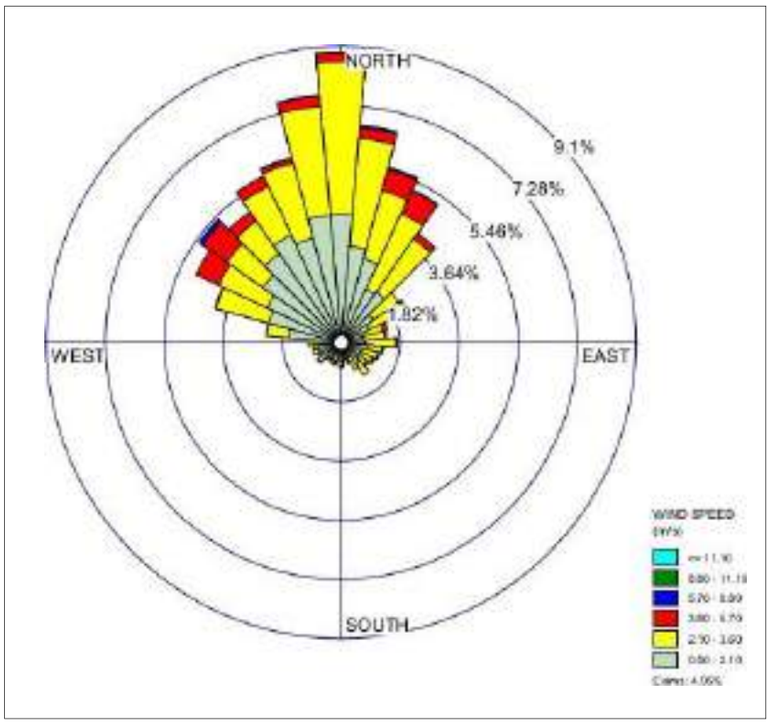


Figure 5.3: Windrose of the study area during November-December 2019 (wind direction blowing towards the centre)

5.2. Dispersion of Particulate matter

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

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

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

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

The wind blowing from different directions in the study area determines the direction of pollution dispersion. The Gaussian plume equation used in the AERMOD model estimates the diffusion and advection of the pollutants concerning the emission rates and meteorology (wind speed, direction and atmospheric stability categories). The model simulated maximum ground level concentration of the particulate matter (PM_{10} and $PM_{2.5}$) in the study area covering the JCF is shown through the isopleths. The isopleths (contours connecting the regions with the same ground level concentration in the context of the present study) of maximum GLC of PM_{10} and $PM_{2.5}$ were observed to form a pattern according to the predominant wind directions flowing in different monitoring seasons. It is observed that the line sources in the study area have contributed the maximum to the surface GLC of PM_{10}, following the open cast mines. The AERMOD model simulated the value of GLC of PM_{10} due to line sources, open cast mines, and all sources are 927, 286, and 978µg/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 835µg/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 1679µg/m^3, respectively. The $PM_{2.5}$ maximum GLCs during the winter are 1004, 299, 1167µg/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 µg/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 200-900µg/m^3. The fringes of the JCF have recorded the PM_{10} concentrations in the range of 100-250µg/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} < 100µg/m^3, however, the area extending from south of Dhanbad City and Sudamdih mine have relatively high PM_{10} concentration in the range of 100-500µg/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 100-500µg/m^3.

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

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

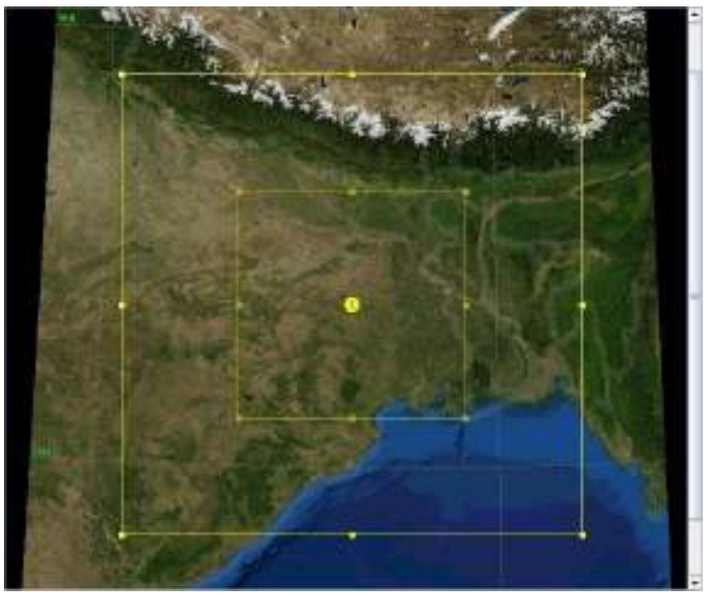


Figure 5.4: AERMOD grid covering the Jharia Coal Fields (JCF). The line, area, and point sources covered in the study are indicated in red color. The UTM coordinates of the left bottom point are x=406111 and y=2603492, and the coordinates of the right top point are x=456248 and y=2653417.

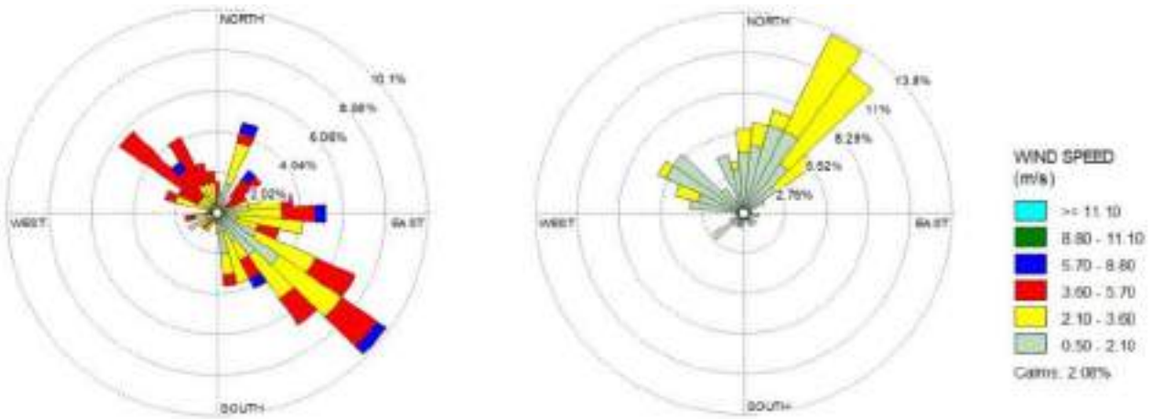
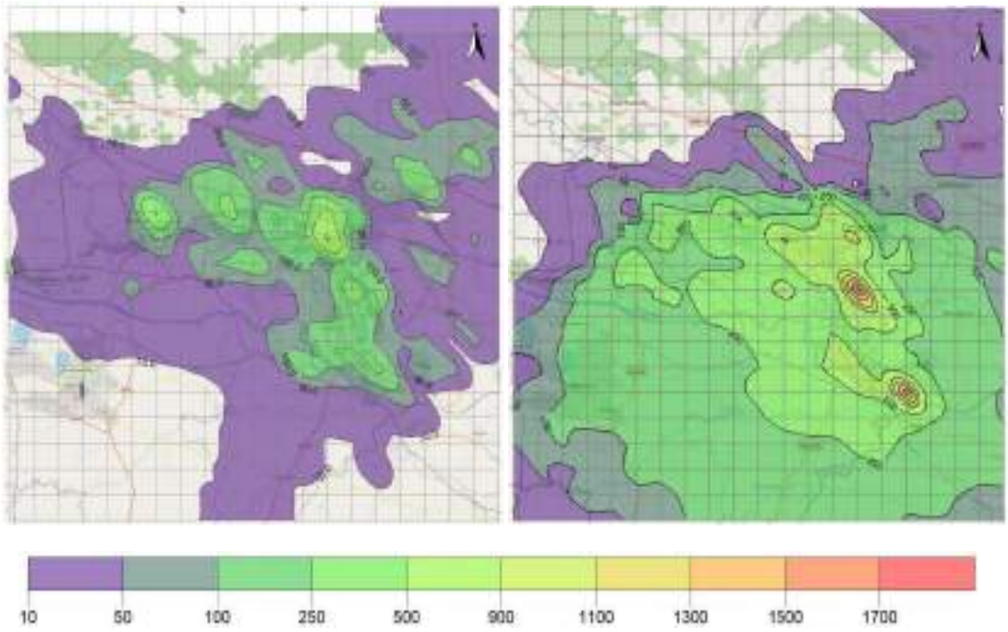
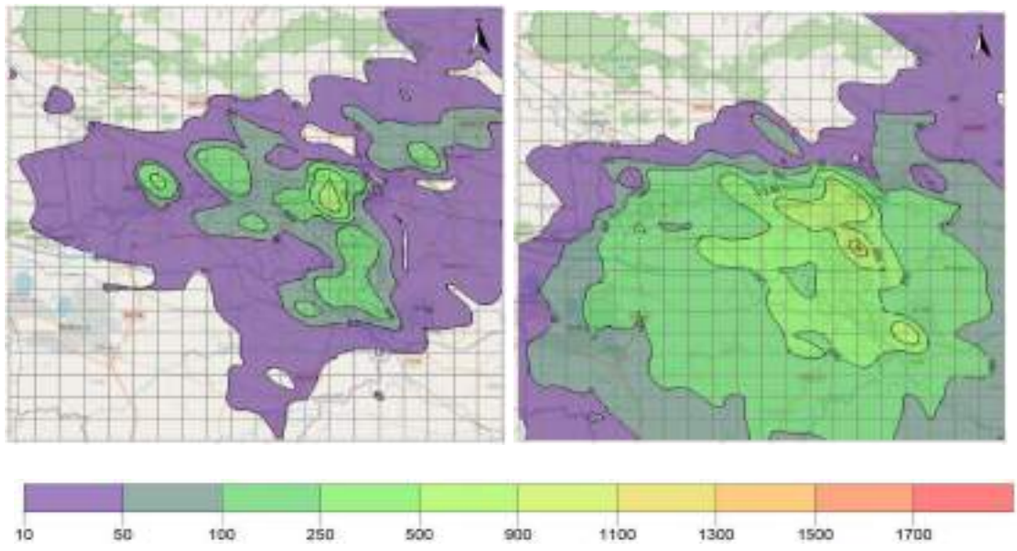


Figure 5.5: Windrose diagram for the summer (left) and winter seasons (right) at Jharia Coal Fields during the sampling period. Wind direction is flowing towards the centre.



(a)



(b)

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

5.3 Validation of the model

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

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

Table 5.1 Performance Stimulation Metric

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

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

Chapter 6 Recommendation

6.1. Mine industries

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

6.2. Area Sources

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

1. Construction and demolition of buildings in the urban area give high local dust contribution resulting health problems. These practices need to follow compliance guidelines to reduce emissions.
2. Road and pavement should be well constructed to suppress road dust. The standard specifications and code of practice for road construction should be followed and implemented as per the Indian Road Congress (IRC) guidelines or international standard guidelines.
3. Strategically placed green cover in urban and semi-urban areas can help to improve localair 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		

Annexure -2

Emission Inventory Data

Name of Mine:

S.no	Operation	Quantity Kg/day	Type of fuel & quantity (litre/day)	Moisture content %	Silt content %	Details
Point source						
1	Drilling					Hole dia ---mm & Frequency ---/day
2	Blasting					----/day
3.	Overburden loading					Drop height ----m; Frequency ------/day
4	Coal loading					Drop height ----m; Frequency -----/day
5	Overburden unloading					Drop height -----m; Frequency ----/day
6	Coal unloading					Drop height ----m; Frequency ------/day
7	Top soil removal					
8	Crushing					
9	DG sets					
Line source						
10	Transfer of coal through haul road					Average speed ------- km/hr & frequency -------/day Distance ---- km Width ------m
11	Transfer of OB through haul road					Average speed -----km/hr & frequency -------/day Distance -----km
12	Transport road					Average speed -----km/hr Distance ------ km
13	Haul Road length (km)					-----Km
Area Source						
14	Stockyard					Unloading freq. -------/day & Coal Loading ------T/day Area -------- m^2
15	Workshop (m^2)					Area
16	Exposed pit (km^2)					
17	Colony					Fuel for cooking :-----

बोर्ड सचिवालय/Board Secretariat

पत्रांक: बीसीसीएल/सीएस/एफ 1(A)/३१९ (H) दिनांक 07.07.2025

CSR DEPARTMENT
Sl No. 105 (H)
Date 07/07/25

सेवा मे,

महाप्रबंधक (सी एस आर)
बीसीसीएल, कोयला भवन, धनबाद।

विषय: **Certified copy of Minutes of 425th Board Meeting held on 25.06.2025.**

Dear Sir,

We send herewith certified copy of Minutes of Item No. 425.PoT-6 of 425th Meeting of the Board of Directors of Bharat Coking Coal Limited held at Regd. Office, Koyla Bhawan, Dhanbad on 25.06.2025 for taking necessary action at your end.

You are requested to send the Action Taken Report (ATR) on the above, duly approved by the concerned Director, for placing before the next Board Meeting as per the format given below. Soft copy of the same in MS word format to the mail id cos.bccl@coalindia.in **.**

Format of ATR:

Department:			
Item No.	**Subject**	**Decision of the Board**	**Action Taken**

भवदीय,

Encl: As above

बी.के.पारूई
कंपनी सचिव

Item No.425.PoT-6

Agenda note for approval of "Annual CSR Action Plan of FY 2025-26 and displaying the same on the website of BCCL.

Background:-

As per rule 5, sub-rule (2) of Companies (CSR Policy) Amendment Rule 2021, "The CSR Committee shall formulate and recommend to the Board, an Annual Action Plan is pursuance of its CSR Policy.

The proposal was put up before 43rd CSR Committee meeting held on 24.06.2025 and the proposal has been recommended for put up before Board for approval.

Decision:-

Board after detailed deliberation agreed with the recommendation of CSR Committee and approved the Annual CSR Action Plan for FY 2025-26 with total CSR budget amount of ₹28.83 Cr. (Rupees twenty eight crore eighty three lakhs only). Further it was advised by the Board to display the Annual Action Plan of 2025-26 on the website of BCCL.

Further, it was advised by the Board that the CSR committee shall implement and monitor the Action Plan as approved and a responsibility statement thereto may be submitted at the end of the year in the Board.

Action:- GM (CSR)

Certified to be True Copy

B. K. Paru
Company Secretary
Bharat Coking Coal Limited
Koyla Bhawan
Dhanbad- 826005

Annual CSR Action Plan for FY 2025-26							
Sl. No.	**CSR Project/Programme**	**Item from the list of the activities in schedule VII to the act**	**Estimated Budget (₹ in Lakhs)**	**Manner of execution/Executing Agency**	**Implementation Schedule**	**Monitoring and reporting mechanism**	**Details of need and impact assessment **, if any; as evaluated by BCCL**
CSR projects/activities under HQ							
1	Skill development program through Central Tool Room, Kolkata for 250 candidates	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	300.10	BCCL through Central Tool Room, Kolkata	1.Signing of MoU: July 2025 2.Selection of candidates: July - August 2025 3.Training of candidates: August 2025 - February 2026	Central Tool Room, Kolkata	Benefit to 250 candidates. Impact assessment mandatory
2	Skill development program through CIPET, Ranchi for 160 candidates	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	124.96	BCCL through CIPET, Ranchi	1.Signing of MoU: July 2025 2.Selection of candidates: July - August 2025 3.Training of candidates: August 2025 - February 2026	CIPET, Ranchi	Benefit to 160 candidates. Impact assessment mandatory
3	Skill development program through CIPET, Raipur for 120 candidates	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	132.00	BCCL through CIPET, Raipur	1.Signing of MoU: July 2025 2.Selection of candidates: July - August 2025 3.Training of candidates: August 2025 - February 2026	CIPET, Raipur	Benefit to 120 candidates. Impact assessment mandatory
4	Skill development program through National Skill Training Institute Hyderabad for 100 candidates	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	99.13	BCCL through National Skill Training Institute Hyderabad	1.Signing of MoU: July 2025 2.Selection of candidates: August-September 2025 3.Training of candidates: September 2025 - March 2026	National Skill Training Institute Hyderabad	Benefit to 100 candidates. Impact assessment not mandatory (IANM)
5	Teacher Training Programme for skill upgradation of teachers	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	18.75	BCCL through implementing agency	1.Signing of MoU: July 2025 2.Project period:- Six months	Implementing Agency	Benefit to teachers & students of 2 schools,IANM
6	Mega Health Camp	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water	50.00	BCCL through implementing agency	1. Approval of estimate: within 1 month after approval of action plan 3. Camp: 02 - 05 days	Implementing Agency	Benefit to large populace of Dhanbad,IANM
7	Installation of Mini Science Centre Labs through Child Rights and You (CRY) (extension of pilot project of 2024-25)	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water	82.25	BCCL through CRY	1.Project start: July-August 2025 2.Project period: 12 months	CRY	Benefit to approximately 15000 students,IANM

8	Operation of two electric buses for three years primarily for the people of Belgaria rehabilitation township, 2 buses, Estimate: ₹ 3.28 Cr. for 03 years (procurement + 1st year = ₹ 1.92 Cr.). Multi year project.	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water	192.00	BCCL through implementing agency	1. Floating of tender: within 1 month after approval of action plan and obtainment of NOC (as applicable) 2. Selection of executing party: within 2 months 3. Initiation of operation of the project: within 4 months after award of work	Implementing Agency	Primarily targetting polulation of Belgaria. Impact assessment mandatory
9	Construction of boundary wall of Shibu Soren Degree college	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	73.24	BCCL	1. Project period: 90 days	BCCL	Targetting 200 students, IANM
10	Construction of rotary for Birsa Munda Statue	Protection of national heritage, art and culture including restoration of buildings and sites of historical importance and works of art; setting up public libraries; promotion and development of traditional art and handicrafts	5.74	BCCL	1. Project period: 60 days	BCCL	Targetting local populace towards promotion of art & culture, IANM
11	Skill development project through Multi Skill Development Institute (MSDI), (set up through NSDC) (additional budget for project)	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	78.90	NSDC	1. Project completion period: 1 year	NSDC	Benefitting 300 candidates, IANM
12	Installation of smart classroom in Utkramit middle school and Upgradation of school building at Utkramit Madhya Vidyalaya, Chatatand, Belgaria and Naya Vihar Primary school, Jharia Vihar Belgaria And installation of smart classroom in Utkramit Madhya Vidyaylaya	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	14.50	BCCL	1. Selection of executing Party- Within two months of approval of action plan 2. Award of work-with in 45 days of tender opening 3. Project period: 120 days	BCCL	Benefit to 200 students, IANM
13	Promoting STEM education through IIT (ISM) in 40 Govt. Schools (extension of pilot project of 2024-25)	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	99.88	BCCL through IIT(ISM)	1.Signing of MoU: July-August 2025 2.Project start: August-September 2025 3.Project period: 12 months	IIT(ISM)	Benefit to students of 40 schools,IANM
14	Project Intergenerational Learning Centre (IGLC) through Healthy Aging India (extension of pilot project of 2023-24)	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	36.33	BCCL through Healthy Aging India	1.Signing of MoU: July-August 2025 2.Project start: August-September 2025 3.Project period: 12 months	Healthy Aging India	Benefit to approximately 1500 students and elderly,IANM

15	Upgradation of Hindu Mission orphanage Hirapur, Dhanbad	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water	47.92	BCCL	1. Selection of executing Party- Within two months of approval of action plan 2. Award of work-with in 60 days of tender opening 3. Project period: 120 days	BCCL	Benefit to approximately 20 students,IANM
16	Upgradation of Abhoya Sundari Girls High School, Hirapur, Dhanbad	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	40.00	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--Within two months after approval of action plan and obtainment of NOC (as applicable) 3. Award of work-with in 60 days of tender opening 4. Project period: 120 days	BCCL	Benefit to approximately 200 students,IANM
17	Upgradation of Lindsay Club and library, Hirapur, Dhanbad	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	23.95	BCCL	1. Estimate preparation- prepared 2. Approval of estimate--Within two months after approval of action plan and obtainment of NOC (as applicable) 3. Award of work-with in 60 days of tender opening 4. Project period: 120 days	BCCL	Benefit to local populace,IANM
18	Skill development training on bamboo crafts through IIT(ISM)	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	30.50	BCCL through IIT(ISM)	1.Signing of MoU: July-August 2025 2.Project start: August-September 2025 3.Project period: 12 months	IIT(ISM)	Benefit to approximately 100 persons,IANM
19	Construction of community hall at Tumadaha	Rural development	35.00	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--Within two months after approval of action plan and obtainment of NOC (as applicable) 3. Award of work-with in 60 days of tender opening 4. Project period: 120 days	BCCL	Benefit to local populace,IANM
20	Operation of two Mobile Medical Vans, Estimate: ₹ 4.13 Cr.	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water	137.00	BCCL through implementing agency	1. Approval of estimate: Within one month of approval of action plan 2. Selection of executing Party- Within four months of approval of action plan 3. Project period: 1 year	Implementing agency	Benefit to local populace of Dhanbad, Impact Assessment mandatory
21	Construction of hall with kitchen space and allied upgradation work for the underprivileged at Hirapur	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water	30.00	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--Within two months after approval of action plan and obtainment of NOC (as applicable) 3. Award of work-with in 60 days of tender opening 4. Project period: 120 days	BCCL	Free food, vocational training and free cultural ceremonies to approx. 1,00,000 people annually,IANM
	Sub-total		**1652.15**				

Projects by Areas							
22	Providing modern stitching machine to 550 women self-help groups of Chandrapura panchayat **(Barora Area)**	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement project	20.00	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--Within two months after approval of action plan and obtainment of NOC (as applicable) 3. Award of work-with in 60 days of tender opening 4. Project period: 60 days	BCCL	Benefit to 550 women, IANM
23	Construction of hall at Saraswati Shishu Vidya Mandir, Baghmara	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement project	35.00	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--Within two months after approval of action plan and obtainment of NOC (as applicable) 3. Award of work-with in 60 days of tender opening 4. Project period: 60 days	BCCL	Benefit to students of the region,IANM
24	Infrastruction upgradation work at Ambedkar Academy, Loyabad **(Sijua Area)**	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects.	21.28	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--within 1 month after approval of action plan and obtainment of NOC (as applicable) 3. Tender call-with in 10 days of estimate approval 4. Award of work-with in 45 days of tender opening 5. Project period: 90 days	BCCL	Benefit to 280 students, IANM
25	Rejuvenation of Shivshankar Nagar Pond **(PB Area)**	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water. Ensuring environmental sustainability, ecological balance, protection of flora and fauna, animal welfare, agroforestry, conservation of natural resources and maintaining quality of soil, air and water including contribution to the Clean Ganga Fund set-up by the Central Government for rejuvenation of river Ganga	98.90	BCCL	1. Estimate preparation- prepared 2. Approval of estimate--within 1 month after approval of action plan and obtainment of NOC (as applicable) 3. Tender call-with in 10 days of estimate approval 4. Award of work-with in 120 days of tender opening 5. Project period: 180 days	BCCL	Benefit to approximately 1000 persons, IANM
26	Rejuvenation of two nos. of pond **(W.J. Area)**	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water Ensuring environmental sustainability, ecological balance, protection of flora and fauna, animal welfare, agroforestry, conservation of natural resources and maintaining quality of soil, air and water including contribution to the Clean Ganga Fund set-up by the Central Government for rejuvenation of river Ganga	150.00	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--within 1 month after approval of action plan and obtainment of NOC (as applicable) 3. Tender call-with in 10 days of estimate approval 4. Award of work-with in 45 days of tender opening 5. Project period: 180 days	BCCL	Benefit to approximately 2000 persons, Impact assessment mandatory

27	Construction of Shaded platform for Birsa Statue at Birsa Bridge **(EJ Area)**	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water Ensuring environmental sustainability, ecological balance, protection of flora and fauna, animal welfare, agroforestry, conservation of natural resources and maintaining quality of soil, air and water including contribution to the Clean Ganga Fund set-up by the Central Government for rejuvenation of river Ganga	5.00	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--within 1 month after approval of action plan and obtainment of NOC (as applicable) 3. Tender call-with in 10 days of estimate approval 4. Award of work-with in 45 days of tender opening 5. Project period: 45 days	BCCL	Benefit to local polucace through promotion of art & culture,IANM
28	Providing And Laying Pit Water Pipe Line At 2 No. Pit Jealgora To Dumariatand Basti **(Lodna Area)**	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water	13.21	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--within 1 month after approval of action plan and obtainment of NOC (as applicable) 3. Tender call-with in 10 days of estimate approval 4. Award of work-with in 45 days of tender opening 5. Project period: 60 days	BCCL	Benefit to approximately 1000 residents,IANM
29	Upgradation of Utkrahmit Madhya Vidyalaya Surunga **(Lodna Area)**	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	30.00	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--within 1 month after approval of action plan and obtainment of NOC (as applicable) 3. Tender call-with in 10 days of estimate approval 4. Award of work-with in 45 days of tender opening 5. Project period: 120 days	BCCL	Benefit to 500 students ,IANM
30	Upgradation at Jharia Gujrati Sanskrit School, Jharia	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	21.80	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--within 1 month after approval of action plan and obtainment of NOC (as applicable) 3. Tender call-with in 10 days of estimate approval 4. Award of work-with in 45 days of tender opening 5. Project period: 120 days	BCCL	Benefit to approximately 500 students,IANM
31	Construction of Indian Medical Association (IMA) multipurpose hall, Kumardubi **(CV Area)**	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water	37.00	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--within 1 month after approval of action plan and obtainment of NOC (as applicable) 3. Tender call-with in 10 days of estimate approval 4. Award of work-with in 45 days of tender opening 5. Project period: 90 days	BCCL	Benefit to local populace,IANM
32	Providing three units of water purifier and one noiseless generator for Saraswati Vidyamandir Sr. Sec. School, Dugdha **(Washery)**	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water	15.76	BCCL	1. Estimate preparation- prepared and approved 2. Tender call-with in 10 days of estimate approval 3. Award of work-with in 45 days of tender opening 5. Project period: 90 days	BCCL	Benefit to approximately 100 students,IANM

33	Construction of park at Barmasiya **(Barora Area)**	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water	429.00	BCCL	1. Project period: 120 days	BCCL	Benefit to local populace, Impact assessment mandatory, Impact Assessment mandatory
34	Upgradation work at DAV Mahila Mahavidyalaya, Katras **(Katras Area)**	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	33.50	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--within 1 month after approval of action plan and obtainment of NOC (as applicable) 3. Tender call-with in 10 days of estimate approval 4. Award of work-with in 45 days of tender opening 5. Project period: 120 days	BCCL	Benefit to 2100 rural female students,IANM
35	Construction of Hall with changing room and separate toilets for boys and girls at Suryadeo Singh Foundation School, Dhanbad	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly and the differently abled and livelihood enhancement projects	40.00	BCCL	1. Estimate preparation- under preparation 2. Approval of estimate--within 1 month after approval of action plan and obtainment of NOC (as applicable) 3. Tender call-with in 10 days of estimate approval 4. Award of work-with in 45 days of tender opening 5. Project period: 120 days	BCCL	Benefit to 458 students,IANM
36	Construction of toilet block at Durgapur airport, West Bengal	Eradicating hunger, poverty and malnutrition, promoting health care including preventive health and sanitation including contribution to the Swatch Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water	10.82	BCCL	1. Estimate preparation- under technical vetting 3. Tender call-with in 10 days of estimate approval 4. Award of work-with in 45 days of tender opening 5. Project period: 90 days	BCCL	Targetting the persons associated with the airport and visitors/workers etc.,IANM
	Sub-total		**961.27**				
	Total		**2613.42**				
	Contingent budget	For activities listed under Schedule VII	**269.58**				
	Grand Total		**2883.00**				

Study of Occupational diseases and Hearing impairments of Coal Mines workers of BCCL directly involved in active mining operations

CMS/699(2)/11/10/19

11/10/19

GM (Environment)

REGIONAL OCCUPATIONAL HEALTH CENTRE (EASTERN), KOLKATA

&

NATIONAL INSTITUTE OF OCCUPATIONAL HEALTH, AHMEDABAD

(Indian Council of Medical research)

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Study of Occupational diseases and Hearing impairments of Coal Miues workers of BCCL directly involved in active mining operations

REGIONAL OCCUPATIONAL HEALTH CENTRE (EASTERN), KOLKATA

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BACKGROUND

Although coal remains a major energy resource worldwide, coal mining causes environmental problems, whereas the inhaled coal particles at the work place may lead to the development of coal workers' pneumoconiosis (CWP). Typically, coal workers pneumoconiosis takes many years to develop and to be manifested. Further, once initiated the disease is progressive in nature, often leading to lungfunction impairment, disability. The workers' exposure to coal dust generally occurs during mining operations. Coal mining can also increase the risk of developing asthma and chronic obstructive pulmonary disease (COPD), such as emphysema and chronic bronchitis. It is suggested that coal mining operations may also induce noise induced hearing impairment among the workers.

A request was received from Bharat Coking Coal Limited, Dhanbad to assess the health status of their workers involved in the mining activities in Cluster 11 and 15 areas around Dhanbad. About 10% of the subjects involved in mining activities were to be included in this study. The workers were to be assessed for their health status, presence of any occupational disease and hearing impairments. Under this circumstance, in consultation of the scientists of National Institute of Occupational Health (NIOH) and the concerned officers of Bharat Coking Coal Limited, it was decided that an epidemiological study would be carried out involving workers involved in mining activities.

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INTRODUCTION

Coal is an aggregate of heterogeneous substances composed of organic and inorganic materials. The four major coal types ranked in order of increasing heat value are lignite, sub-bituminous, bituminous, and anthracite. The inorganic portion of coal can range from a few percent to >50% (by weight) and is composed of phyllo-silicates (kaolinite, illite, etc.), quartz, carbonates, sulfides, sulfates, and other minerals. In general, aluminum and iron are the main metals in the coals. Arsenic, nickel, zinc, cadmium, cobalt, and copper are trace metals that represent only a very small fraction of the mineral matter[1].

Coal mining in India has a long history of commercial exploitation covering nearly 220 years starting in 1774 in the Raniganj Coalfield along the Western bank of river Damodar. However, for about a century the growth of Indian coal mining remained sluggish for want of demand but the introduction of steam locomotives in 1853 gave a fillip to it. As on 2011, India had 285 billion tonnes of resource. The production of coal was 532.69 million tonnes in 2010-11. The production of lignite was 37.73 million tonnes in 2010-11. As on 2011, India ranked 3rd in world coal production.[2]

Coal remains a major energy resource worldwide. In the United States, > 50% of electricity is generated in coal-fired power plants. However, coal mining causes environmental problems such as acid mine drainage, whereas the inhaled coal particles at the work place may lead to the development of coal workers' pneumoconiosis (CWP) [3,4]Typically, coal workers pneumoconiosis takes many years to develop and be manifested requiring a surveillance for a longer duration. Further once initiated the disease is progressive in nature often leading to lung function impairment, disability, and premature death.

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Coal mining can also increase the risk of developing asthma and chronic obstructive pulmonary disease (COPD), such as emphysema and chronic bronchitis.[5-7] It is suggested that coal dust stimulates the recruitment of neutrophils to the lungs and both these neutrophils and resident alveolar macrophages show evidence of activation, secreting free radicals and proteolytic enzymes, plausible mediators of tissue injury in emphysema[8-10].

Considering the environmental – occupational hazards involved, regular and periodic monitoring of environmental conditions and the health status of the workers is always advised and recommended. A request was received from Bharat Coking Coal Limited, Dhanbad to assess the health status of their workers involved in the mining activities in Cluster 11 and 15 areas around Dhanbad. The workers were to be assessed for their health status, presence of any occupational disease and hearing impairments. Under this background the present project is developed with the aim of studying the coal mining as well as coal dust related health effects in the mining workers.

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AIM AND OBJECTIVES

AIMS

To study the coal mining as well as coal dust related health effects in the coal mining workers.

OBJECTIVES

1. To understand health status of workers through questionnaire survey, health examination.
2. To study respiratory health in coal field mining workers.
3. To assess ventilatory functions of coal field mining workers.
4. To analyze hearing ability through audiometric evaluation.

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METHODOLOGY

An occupational health study was conducted involving different mines of Cluster 11 and 15 of Bharat coking Coal Limited, Dhanbad. This study was undertaken among the exposed workers mainly from active mining activity. Representative sample from workers working in such occupations is included in this study. Initially the aim of the study was explained to the workers, informed consent was obtained after which they were enrolled for this study. Every individual subject was interviewed with a pre-designed questionnaire to collect information in relation to personal, occupational and morbidity details of the workers. The participants of this study were subjected to following interview/examination/investigations:

- Detailed personal, occupational and medical history.
- Clinical examination with special emphasis on examination of respiratory system.
- Haematological examination.
- Lung function test.
- Audiometry.
- Ophthalmological assessment.

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Study design: Cross sectional study

Study subjects: This study covered 351 subjects from Kustore sector and 140 subjects from Bagmara sector of BCCL Collieries. Among the subjects of Kustore sector 49 were from Kachi Balihari mines, 51 from Bhagabandh mines, 40 from Gopali Chawk mines and 100 from Munidi mines. PB project mines contributed 111 subjects. Similarly among the subjects of Bagmara sector, Kharkharee mines and Phularitand mines contributed 75 subjects and 65 subjects respectively. Workers actively involved in mining actively were mainly included in this study. However, few subjects of this study were enrolled from supervisory staffs in order to have a complete and comprehensive understanding of the occupational health condition. These workers were randomly selected from the total workforce in the selected clusters and mines.

Data collection: The information regarding demographic, occupational and clinical history was collected on a pre-designed and pre-tested proforma through interview of subject. This was followed by complete clinical examination, spirometry, audiometry and chest radiography of each subject. The audiometer and spirometer were brought by NIOH team while for chest radiography the facilities at BCCL hospitals were used. The processing of exposed films was done by the technicians at BCCL hospital. The ophthalmological examination and haematological – biochemical estimations were also done using facilities and expertise at BCCL hospitals.

Data analysis: Data entry and analysis were done in standard statistical software. The statistical analysis included calculation of differences, proportions and application of tests of significance etc, to ascertain health effects especially respiratory health conditions.

Lung function test was carried out in all subjects. Forced vital capacity (FVC), and Peak Expiratory Flow Rate (PEFR) were recorded by Spirovit-sp-10 (Schiller Health Care Ltd, Switzerland). Three successive recording of FVC and PEFR were made in standing posture and the nose clip was used. The best of the three performances was considered for calculation purpose. The different flow volumes like FEV_1, FEV_1% was calculated from the same tracings. All volumes

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obtained were expressed in body temperature on atmospheric pressure of air saturated with water vapour (BTPS). Body height and body weight were measured in bare feet on a standard scale. Pulmonary function test values were predicted from the standard prediction equation. The instrument was calibrated every day before starting the experiment.

Blood was collected from each worker by venipuncture taking all aseptic precautions. Hematological and biochemical analysis was carried out using standard procedure.

Audiometric Evaluation of Hearing:

The following criteria were maintained for non- inclusion of workers as subjects in audiometry:

- Whose present hearing level was not amenable to quantitative description, who had served in the armed forces, or had been exposed to gunfire, or whose past noise exposure was different from that of their present occupation.
- Who were known to have existing or previous ear disease or abnormality.
- Head injury with history of unconsciousness or skull fracture.

Criteria for acceptance (inclusion criteria) as test subjects:

The following criteria were applied for categorizing ears as acceptable for the test

- Tympanic membrane intact
- No history of congenital or acquired conditions associated with sensory neural hearing loss e.g. congenital deafness, meningitis, unconsciousness, treatment with ototoxic drugs, vertigo, etc.

Criteria for normal hearing:

Hearing impairment is considered to occur when the average of the hearing threshold levels at audiometric frequencies of both ears exceed 25 dBA. Pure tone air conduction hearing threshold

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was obtained in a quiet room. Threshold of hearing is defined as the minimum decibel level (dB) at which the subjects respond at least two times on ascending trial. The data for each subject was obtained. Pure tone threshold were obtained using descending- ascending threshold crossing technique. The data was analyzed for each ear of the subjects for all test frequencies. Hearing threshold at test frequencies was averaged for all subjects to assess hearing sensitivity.

Measurement of hearing:

Pure tone audiometry was carried out for the present investigation. In the individual experimeot, subjects were briefed about the nature and purpose of the study. He was then seated in a chair, the earphones were fitted on his ears, and the door of the room was closed. They were instructed to respond by raisiug their fingers when they could just hear the tone lasting for 2 sec. The pulsing of the tone was set at 0.5/ sec. The intensity of the tone was raised by 5 dB until the threshold of hearing was determined at each test frequency viz 125Hz, 250Hz, 500Hz, 1KHz, 1.5KHz, 2KHz, 3KHz, 4KHz, 6KHz.and 8KHz. The actual measurement was started following a brief practice trial session. The better ear followed by the other ear was tested. The right ear was tested first in cases where both the ears were reported to be nearly equal in hearing sensitivity. It was ensured that the subject would fully cooperate. Care was taken to ensure reliable reporting of the subjects' 'just audible sound'. Misses (error of omission) and false alarms (error of commission) were avoided.

Equipment (Audiometer):

An audiometer was used as the source of pure tone audiometry. It has all the facilities of mask attenuation, frequency setting (125-8000 Hz.), decibel setting of pure tone and pulse setting. It has also a pair of earphone attachment. The audiometer is calibrated periodically as per the specification of International Standards Organization.

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Questionnaire survey

Medical Examination

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Pulmonary Function Test

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Information- Communication

Audiometry

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Haematology & Radiology Examination

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RESULT

&

DISCUSSION

(Total subjects)

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This study covered 351 subjects from Kustore sector and 140 subjects from Baghmara sector of BCCL Collieries. Among the subjects of Kustore sector 49 were from Kachi Balihari mines, 51 from Bhagabandh mines, 40 from Gopali Chawk mines and 100 from Munidi mines. PB project mines contributed 111 subjects (Table 1). Similarly among the subjects of Baghmara sector, Kharkharee mines and Phularitand mines contributed 75 subjects and 65 subjects respectively. Workers actively involved in mining activity were mainly included in this study. However, about 10% subjects of this study were enrolled from supervisory staffs in order to have a complete and comprehensive understanding of the occupational health condition.

Table 1: Distribution of Supervisory workers and coal miners according to the name of the mine

Sector	Mine Name	Supervisory workers	Coal Miners	Total
		N (%)	N (%)	N (%)
Kustore	10/12 KACHI BALIHARI PITS	8 (2)	41 (12)	49 (14)
	BHAGABANDH COLLIARY	10 (3)	41 (12)	51 (15)
	GOPALI CHAWK COLLIARY	7 (2)	33 (9)	40 (11)
	MUNIDI COLLIARY	17 (5)	83 (24)	100 (29)
	P.B.PROJECT COLLIARY	5 (1)	106 (30)	111 (31)
Total		47 (13)	304 (87)	351
Baghmara	KHARKHAREE COLLIARY	5 (4)	70 (50)	75 (54)
	PHULARITAND COLLIARY	1 (1)	64 (45)	65 (46)
Total		6 (5)	134 (95)	140
Grand Total		53 (10)	438 (90)	491 (100)

Mean age of the workers was 45.9 ± 8.36 years. Most of the workers were between 35-54 years age group. Mean age of supervisory staffs was slightly higher than that of miners. About 98% workers were married. As far as education is concerned majority (56%) had middle school education. Only 4% subjects had graduate level education or higher (Table 2).

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Table 2: Demographic characteristics of the study subjects

Demographic characteristics	Supervisory workers	Coal Miners	Total
Age group (in years)	**N (%)**	**N (%)**	**N (%)**
<25	0(0)	4(1)	4(1)
25 - 34	5(1)	34(7)	39(8)
35 - 44	9(2)	148(30)	157(32)
45 - 54	18(4)	175(36)	193(40)
≥55	16(3)	77(16)	93(19)
Mean age (in years)	**48.31 ± 9.47**	**45.55 ± 8.189**	**45.9 ± 8.36**
Marital status			
Single	2(0.5)	6(1.5)	8(2)
Married	46(8.5)	432(89.5)	478(98)
Education status			
Illiterate	0(0)	102(21)	102(21)
Primary schooling	1(0)	15(3)	16(3)
Middle schooling	18(4)	256(53)	274(56)
Secondary schooling	19(4)	56(12)	75(15)
Graduate and above	10(2)	9(2)	19(4)

So far as personal habits are concerned, 86% of subjects were non-smokers, 10% were smokers and 3% were ex-smokers. Tobacco chewing habit was present in 61% subjects and occasional alcohol intake history was found in 39% workers (Table 3).

Table 3: Personal habits of the study subjects

Demographic characteristics	Supervisory workers	Coal Miners	Total
Smoking habits	N (%)	N (%)	N (%)
Non-smoker	38(8)	382(79)	420(86)
Smoker	9(2)	40(8)	49(10)
Ex-smoker	1(0)	16(3)	17(3)
Tobacco chewer			
No	27(6)	160(33)	187(39)
Yes	21(4)	283(57)	304(61)
Alcohol drinking habit			
No	34(7)	264(54)	298(61)
Yes	14(3)	174(36)	188(39)

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Mean job experience was 11.72 ± 8.49 years. About 83% workers had job experience of up to 20 years, 3% workers had experience more than 30 years (Table 4). Mean experience was a little higher in supervisory employee group than miners group.

Table 4: Occupational characteristics of Supervisory workers & Coal miners

Demographic characteristics	Supervisory workers	Coal Miners	Total
Duration of job (in years)	N (%)	N (%)	N (%)
<10	23(5)	241(49)	264(54)
10 - 20	12(2)	129(26)	141(29)
21 - 30	13(3)	60(12)	73(15)
>30	0(0)	13(3)	13(3)
Mean duration of job (years)	**12.65 ± 9.31**	**11.61 ± 8.39**	**11.72 ± 8.49**

Most common symptoms complained by study subjects were musculoskeletal pain (34%) (Table 5). Other complaints were Cough, difficulty in breathing, chest pain, loose teeth, and soreness of mouth and colicky pain in abdomen. Headache, sleep disturbance, weakness, tremor in fingers was also experienced by some subjects.

Table 5: Distribution of symptoms among study subjects

Symptoms	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
Cough	1 (0.5)	23 (4.5)	24 (5)
Cough with Phlegm	0 (0)	7 (1)	7 (1)
Difficulty in Breathing	2 (0.5)	27 (5.5)	29 (6)
Chest Pain	2 (0.5)	23 (4.5)	25 (5)
Colicky pain	1 (0.5)	14 (2.5)	15 (3)
Loose Teeth	5 (1)	36 (7)	41 (8)
Soreness of mouth/throat	3 (1)	21 (4)	24 (5)
Urinary problems	1 (0.25)	5 (0.75)	6 (1)
Musculoskeletal pain	21 (4)	146 (30)	167 (34)
Headache/sleep difficulty /weakness/dizziness/tremor	6 (2)	46 (9)	52 (11)

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Table 8: Pulmonary function impairments among study subjects

Pulmonary function category	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
FVC/PFVC			
<80%	0 (0.0)	15 (3.0)	15 (3.0)
≥80%	53 (11.0)	423 (86.0)	476 (97.0)
$FEV_{1\%}$			
< 70 %	2 (0.5)	29 (6.0)	31 (6.5)
70- 79.99 %	21 (4.5)	158 (32.0)	179 (36.5)
≥ 80 %	30 (6.0)	251 (51.0)	281 (57.0)
FVC/PFVC <80% + $FEV_{1\%}$ <70%	0 (0.0)	3 (0.6)	3 (0.6)

FVC – Forced Vital Capacity; PFVC – Predicted Forced Vital Capacity; FEV_1 – Forced Expiratory Volume in first second

Table 9: Forced Vital Capacity according to study variables among study subjects

Study variables	Forced Vital Capacity [Mean ± SD (litres)]		
	Supervisory workers	Coal Miners	Total
Age group (in years)	**Mean ± SD (litres)**	**Mean ± SD (litres)**	**Mean ± SD (litres)**
< 45	3.85 ± 0.585	3.71 ± 0.646	3.72 ± 0.641
≥ 45	3.53 ± 0.576	3.36 ± 0.64	3.38 ± 0.634
	t = 3.120;df =1;p=0.083	t=30.586;df=1;p=0.00	t=32.016;df=1;p=0.00
Duration of exposure (yrs)			
< 20	3.64 ± 0.562	3.52 ± 0.65	3.53 ± 0.643
≥ 20	3.55 ± 0.672	3.47 ± 0.71	3.48 ± 0.702
	t=0.264;df=1;p=0.610	t=0.430;df=1;p=0.512	t=0.519;df=1;p=0.472
Smoking habit			
Never smoker	3.6 ± 0.587	3.5 ± 0.655	3.51 ± 0.649
Ever smoker	3.76 ± 0.613	3.49 ± 0.616	3.54 ± 0.619
	t=0.210;df=1;p=0.649	t=0.115;df=1;p=0.735	t=0.317;df=1;p=0.574

Similar trend was observed in case of FEV1 values also (Table 10). Significant difference was observed between subject of less than 45 years and rest of the workers. This difference was more prominent in miners than supervisory staffs. No such remarkable difference was observed when compared in relation to job experience and smoking habit.

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Table 10: Forced Expiratory Volume in first second according to study variables among study subjects

Study variables	Forced Expiratory Volume in first second [Mean ± SD (litres)]		
	Supervisory workers	Coal Miners	Total
Age group (in years)	**Mean ± SD (litres)**	**Mean ± SD (litres)**	**Mean ± SD (litres)**
<45	3.073 ± 0.3887	3.028 ± 0.5229	3.031 ± 0.5139
≥45	2.837 ± 0.4553	2.685 ± 0.5597	2.705 ± 0.5486
	t=2.95;df=1;p=0.092	t=42.02;df=1;p=0.001	t=43.53;df=1;p=0.001
Duration of exposure (yrs)			
<20	2.945 ± 0.4025	2.844 ± 0.5556	2.854 ± 0.5427
≥20	2.791 ± 0.5426	2.769 ± 0.6072	2.772 ± 0.5962
	t=1.259;df=1;p=0.267	t=1.319;df=1;p=0.25	t=1.872;df=1;p=0.172
Smoking habit			
Never smoker	2.886 ± 0.4428	2.836 ± 0.5617	2.841 ± 0.5509
Ever smoker	2.972 ± 0.5042	2.763 ± 0.5127	2.805 ± 0.5129
	t=0.208;df=1;p=0.650	t=0.131;df=1;p=0.72	t=0.018;df=1;p=0.895

Same pattern could be found in case of Peak Expiratory Flow Rate also (Table 11). Significant difference was present in relation to age (more so in miners than supervisor), however, smoking and duration of exposure wise classification did not show any significant difference.

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Table 11: Peak Expiratory Flow Rate according to study variables among study subjects

Study variables	Peak Expiratory Flow Rate [Mean ± SD (litres/minute)]		
	Supervisory workers	Coal Miners	Total
Age group (in years)	Mean±SD (litres/minute)	Mean±SD (litres/minute)	Mean ± SD (litres/minute)
< 45	465 ± 63.579	473.23 ± 65.358	472.65 ± 65.113
≥ 45	479.47 ± 60.402	444.83 ± 85.172	449.4 ± 83.078
	t=0.571;df=1;p=0.458	t=14.37;df=1;p=0.00	t=10.97;df=1;p=0.001
Duration of exposure (yrs)			
< 20	474.86 ± 59.704	458.15 ± 75.028	459.79 ± 73.769
≥ 20	477.33 ± 66.167	450.2 ± 89.349	453.97 ± 86.752
	t=0.01;df=1;p=0.896	t=0.785;df=1;p=0.376	t=0.506;df=1;p=0.477
Smoking habit			
Never smoker	475.37 ± 61.851	456.31 ± 78.316	458.17 ± 77.012
Ever smoker	475 ± 63.64	461.75 ± 76.691	464.4 ± 73.849
	t=0.002;df=1;p=0.962	t=0.193;df=1;p=0.661	t=0.301;df=1;p=0.583

So far as chest radiographic findings are concerned, 93% subjects (Table 12) had findings within normal limits. 3% subjects showed findings suggestive of opacities in lung and almost 1.5% had other features on chest X-ray (mostly suggestive of Koch's infection of lung).

Table 12: Chest radiographic findings among the study subjects

Chest X ray findings	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
Within normal limit	50 (10)	408 (83)	458 (93)
Pulmonary Opacities	1 (0.5)	12 (2.5)	13 (3)
Koch's infection	0 (0)	7 (1.5)	7 (1.5)
Not Done	2 (0.5)	11(2.0)	13(2.5)
Total	**53 (11)**	**438 (89)**	**491 (100)**

Haematological and biochemical findings of the subjects were mostly within normal limits. Almost 11% workers had random blood sugar level >140. Mean Hemoglobin level in 13.1±0.8 gm%. Mean ESR was 7.0±2.1 unit. Random Blood sugar, blood urea and creatinine was 114.7±36.4 unit, 22.7±3.6 unit and 0.8±0.1unit respectively (Table 13).

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Table 13: Haematological & Biochemical findings of study subjects

Parameter	Minimum	Maximum	Mean ± SD
Haemoglobin (g/dL)	10	15	13.15 ± 0.845
Erythrocyte Sedimentation Rate (mm/h)	3	20	7.046 ± 2.144
Total Leucocyte Count (mcL)	5500	12600	9064.61 ± 1167.13
Neutrophil	46	89	61.77 ± 5.826
Lymphocyte	20	62	31.97 ± 6.013
Eosinophil	2	13	5.62 ± 1.77
Monocyte	0	8	0.80 ± 0.905
Besophil	0	0	0.00
Random Blood Sugar (mg/dL)	55	300	114.74 ± 36.46
Blood Urea (mg/dL)	14	38	22.75 ± 3.63
Serum Creatinine (mg/dL)	.30	7.00	0.83 ± 0.32

As far as ophthalmological findings are concerned, 5% subjects had uncorrected vision (although using spectacles) and 9% subjects had Cataract in eyes. Colour blindness was also observed in few subjects (Table 14).

Table 14: Ophthalmological findings of study subjects

	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
People having uncorrected vision after correction	1 (0.5)	24 (4.5)	25 (5)
Colour Blindness	0	6 (1)	6 (1)
Cataract	4 (1)	29 (8)	33 (9)
Glaucoma	0 (0)	2 (1)	2 (1)
Muscular Pathology	0	1	1
Pterygium	0	1	1

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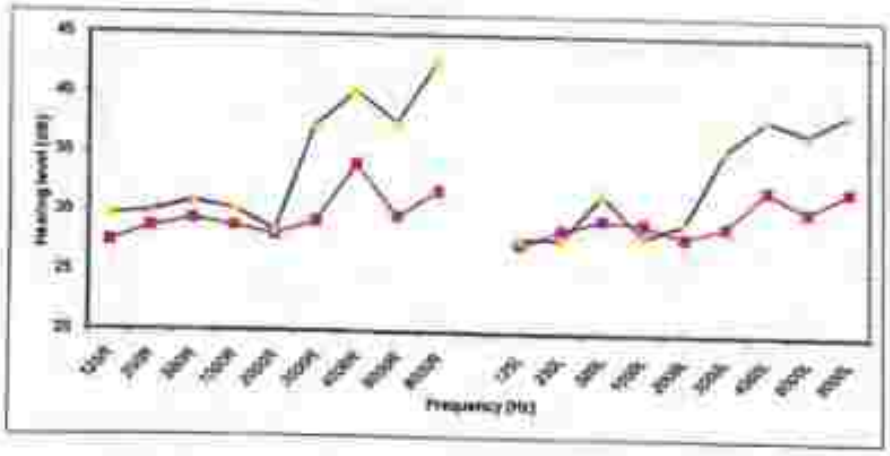
Figure 1 describes hearing ability of workers examined by audiometry. Two curves depict the median hearing ability of subjects with <10 years (lower curve), and ≥ 10 years (higher curve) of job experience. On preliminary observation, decreased hearing ability at high frequency was observed in some workers. Difference of hearing ability with increasing duration of exposure was also observed at higher frequency; however, this observation also is subject to adjustment for age and other probable factors that can affect hearing ability. Moreover, hearing assessment was done in field condition where despite best efforts ideal experimental chamber condition could not be achieved, which may also be a contributing factor.

Figure 1: Distribution of hearing ability according to job experience



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RESULT

&

DISCUSSION

(Kustore area subjects)

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This study covered 351 subjects from Kustore sector of BCCL Collieries. Among the subjects of Kustore sector 49 were from Kachi Balihari mines, 51 from Bhagabandh mines, 40 from Gopali Chawk mines and 100 from Munidi mines. PB project mines contributed 111 subjects (Table 15). Workers actively involved in mining activity were mainly included in this study.

Table 15: Distribution of Supervisory workers and coal miners of Kustore area

Sector	Mine Name	Supervisory workers	Coal Miners	Total
		N (%)	N (%)	N (%)
Kustore	10/12 KACHI BALIHARI PITS	8 (2)	41 (12)	49 (14)
	BHAGABANDH COLLIARY	10 (3)	41 (12)	51 (15)
	GOPALI CHAWK COLLIARY	7 (2)	33 (9)	40 (11)
	MUNIDI COLLIARY	17 (5)	83 (24)	100 (29)
	P.B.PROJECT COLLIARY	5 (1)	106 (30)	111 (31)
	Total	47 (13)	304 (87)	351

Mean age of the workers was 46.3 ± 8.36 years. Most of the workers were between 35-54 years age group. Mean age of supervisory staffs was slightly higher than that of miners. About 98% workers were married. As far as education is concerned majority (53%) had middle school education. Only 5% subjects had graduate level education or higher (Table 16).

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Table 16: Demographic characteristics of the study subjects of Kustore area

Demographic characteristics	Supervisory workers	Coal Miners	Total
Age group (in years)	N (%)	N (%)	N (%)
< 25	0 (0)	2 (1)	2 (1)
25-34	4 (1)	22 (6)	26 (7)
35-44	8 (2)	104 (30)	112 (32)
45-54	18 (5)	118 (34)	136 (39)
≥ 55	17 (5)	58 (17)	75 (21)
Mean age (in years)	49.06 ± 8.928	48.87 ± 8.21	46.30 ± 8.368
Marital status			
Single	2 (1)	5 (1)	7 (2)
Married	45 (13)	299 (85)	344 (98)
Education status			
Illiterate	0 (0)	72 (20)	72 (20)
Primary schooling	1 (0.5)	12 (3.5)	13 (4)
Middle schooling	17 (5)	169 (48)	186 (53)
Secondary schooling	18 (5)	44 (13)	62 (18)
Graduate and above	11 (3)	7 (2)	18 (5)

So far as personal habits are concerned (Table 17), 83% of subjects were non-smokers, 12% were smokers and 5% were ex-smokers. Tobacco chewing habit was present in 61% subjects and occasional alcohol intake history was found in 38% workers.

Table 17: Personal habits of the study subjects of Kustore area

Demographic characteristics	Supervisory workers	Coal Miners	Total
Smoking habits	N (%)	N (%)	N (%)
Non-smoker	38 (11)	254 (72)	292 (83)
Smoker	8 (2)	34 (10)	42 (12)
Ex-smoker	1 (0.5)	16 (4.5)	17 (5)
Tobacco chewer			
Yes	22 (6)	193 (55)	215 (61)
No	25 (7)	111 (32)	136 (39)
Alcohol drinking habit			
No	35 (10)	183 (52)	218 (62)
Yes	12 (3)	121 (34)	133 (38)

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Mean job experience was 12.68 ± 8.9 years. About 78% workers had job experience of up to 20 years, 3% workers had experience more than 30 years. Mean experience was a little higher in supervisory employee group than miners group (Table 18).

Table 18: Occupational characteristics of Supervisory workers & Coal miners of Kustore area

Demographic characteristics	Supervisory workers	Coal Miners	Total
Duration of job (in years)	N (%)	N (%)	N (%)
<10	21 (6)	153 (43)	174 (49)
10 - 20	13 (4)	88 (25)	101 (29)
21 - 30	13 (4)	52 (15)	65 (19)
>30	0 (0)	11 (3)	11 (3)
Mean duration of job (years)	13.48 ± 9.28	12.56 ± 8.85	12.68 ± 8.90

Most common symptoms complained by study subjects were musculoskeletal pain (34%). Other complaints were Cough, difficulty in breathing, and loose teeth. Headache, sleep disturbance, weakness, tremor in fingers was also experienced by some subjects (9%) (Table 19).

Table 19: Distribution of symptoms among study subjects of Kustore area

Symptoms	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
Cough	2 (1)	18 (5)	20 (6)
Cough with Phlegm	1 (0.5)	4 (1)	5 (1.5)
Difficulty in Breathing	3 (1)	18 (5)	21 (6)
Chest Pain	2 (1)	12 (3)	14 (4)
Colicky pain	1 (0.5)	10 (2.5)	11 (3)
Loose Teeth	5 (1)	30 (9)	35 (10)
Soreness of mouth/throat	3 (1)	8 (2)	11 (3)
Urinary problems	0 (0)	3 (1)	3 (1)
Musculoskletal pain	19 (5)	99 (28)	118 (34)
Headache/sleep difficulty/weakness/dizziness/tremor	5 (2)	26 (7)	31 (9)

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Mean height was 160.8 ± 6.3 cm and mean weight was 66.1 ± 11.9 kg for miners. Mean height was slightly higher in supervisory staffs whereas mean weight was considerably higher. This may be result of sedentary lifestyle and relative lack of exercise. Mean systolic and diastolic blood pressure of miners was 131.4±19.1 and 85.0± 10.6 mm of Mercury (Table 20). About 19% subjects had systolic blood pressure >140 as well as diastolic blood pressure > 90 mm of Mercury. 10% workers had only higher systolic blood pressure and 13% had only higher diastolic blood pressure (Table 21).

Table 20: Distribution of salient clinical findings among study subjects of Kustore area

Clinical examination findings	Supervisory workers	Coal Miners	Total
	Mean ± SD	Mean ± SD	Mean ± SD
Mean Height (cm)	162.53 ± 5.88	160.84 ± 6.37	161.07 ± 6.33
Mean Weight (Kgs)	71.94 ± 9.78	66.19 ± 11.93	66.96 ± 11.81
MSBP (mm Hg)	131.11 ± 15.79	131.42 ± 19.11	131.37 ± 18.68
MDBP (mm Hg)	85.57 ± 8.78	85.02 ± 10.62	85.10 ± 10.38

MSBP - Mean Systolic Blood Pressure; MDBP - Mean Diastolic Blood Pressure

Table 21: Distribution of Blood pressure among study subjects of Kustore area

	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
Blood Pressure (mm Hg) >140 & <90	4 (1)	32 (9)	36 (10)
Blood Pressure (mm Hg) <140 & >90	8 (2)	37 (11)	45 (13)
Blood Pressure (mm Hg) <140 & <90	26 (7)	179 (51)	205 (58)
Blood Pressure (mm Hg) >140 & >90	9 (3)	56 (16)	65 (19)

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As far as pulmonary functional status of study subjects in concerned, about 3 % subjects had restrictive type of abnormality (FVC/PFVC < 80%) and 0.3% subjects had combined type of abnormality (FVC/PFVC <80 % and $FEV_{1\%}$ <70%). A good number of subjects (40.5%) had $FEV_{1\%}$ values between 70% and 80% (Table 22).

Table 22: Pulmonary function impairments among study subjects of Kustore area

Pulmonary function category	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
FVC/PFVC			
<80%	0 (0.0)	10 (3.0)	10 (3.0)
≥80%	47 (13.0)	294 (84.0)	341 (97.0)
$FEV_{1\%}$			
< 70 %	2 (0.5)	17 (5.0)	19 (5.5)
70- 79.99 %	17 (5.0)	125 (35.5)	142 (40.5)
≥ 80 %	28 (8.0)	162 (46.0)	190 (54.0)
FVC/PFVC <80% + $FEV_{1\%}$ <70%	0 (0.0)	1 (0.3)	1 (0.3)

FVC – Forced Vital Capacity; PFVC – Predicted Forced Vital Capacity; FEV_1 – Forced Expiratory Volume in first second

Mean FVC values were lower among the subjects of age 45 years or above. The difference was significant among the miners but not significant statistically among the supervisory staffs. Such significant difference of FVC values was not observed when compared between higher and lower job experience groups. Similarly difference was not prominent in relation to smoking habit of the subjects (Table 23).

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Table 23: Forced Vital Capacity according to study variables among study subjects of Kustore area

Study variables	Forced Vital Capacity [Mean ± SD (litres)]		
	Supervisory workers	Coal Miners	Total
Age group (in years)	Mean ± SD (litres)	Mean ± SD (litres)	Mean ± SD (litres)
< 45	3.86 ± 0.60	3.82 ± 0.66	3.82 ± 0.65
≥ 45	3.61 ± 0.55	3.46 ± 0.67	3.48 ± 0.65
	t=0.192;df=1;p=0.19	t=21.85;df=1;p= 0.00	t=0.344;df=1;p=0.558
Duration of exposure (yrs)			
< 20	3.69 ± 0.56	3.63 ± 0.67	3.64 ± 0.66
≥ 20	3.64 ± 0.61	3.52 ± 0.72	3.54 ± 0.70
	t =0.071;df=1;p=0.791	t=1.536;df=1;p=0.216	t=1.533;df=1;p=0.217
Smoking habit			
Never smoker	3.67 ± 0.56	3.63 ± 0.68	3.63 ± 0.66
Ever smoker	3.67 ± 0.65	3.52 ± 0.75	3.55 ± 0.73
	t=0.000;df=1;p=0.996	t=0.905;df=1;p=0.342	t=0.768;df=1;p=0.381

Similar trend was observed in case of FEV1 values also (Table 24). Significant difference was observed between subject of less than 45 years and rest of the workers. This difference was more prominent in miners than supervisory staffs. No such remarkable difference was observed when compared in relation to job experience and smoking habit.

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Table 24: Forced Expiratory Volume in first second according to study variables among study subjects of Kustore area

Study variables	Forced Expiratory Volume in first second [Mean ± SD (litres)]		
	Supervisory workers	Coal Miners	Total
Age group (in years)	Mean ± SD (litres)	Mean ± SD (litres)	Mean ± SD (litres)
< 45	3.075 ± 0.40	3.10 ± 0.52	3.09 ± 0.51
≥ 45	2.91 ± 0.41	2.75 ± 0.58	2.78 ± 0.56
	t=1.388;df=1;p=0.245	t=28.214;df=1;p=0.00	t=28.69;df=1;p= 0.00
Duration of exposure (yrs)			
< 20	2.99 ± 0.37	2.93 ± 0.56	2.93 ± 0.54
≥ 20	2.86 ± 0.48	2.82 ± 0.63	2.82 ± 0.60
	t=1.025;df=1;p=0.317	t=2.033;df=1;p=0.155	t=2.64;df=1;p=0.105
Smoking habit			
Never smoker	2.95 ± 0.40	2.92 ± 0.57	2.93 ± 0.55
Ever smoker	2.98 ± 0.47	2.79 ± 0.63	2.82 ± 0.61
	t=0.035;df=1;p=0.853	t=2.156;df=1;p=0.143	t=1.769;df=1;p=0.184

Same pattern could be found in case of Peak Expiratory Flow Rate also (Table 25). Significant difference was present in relation to age (more so in miners than supervisor), however, smoking and duration of exposure wise classification did not show any significant difference.

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Table 25: Peak Expiratory Flow Rate according to study variables among study subjects of Kustore area

Study variables	Peak Expiratory Flow Rate [Mean ± SD (litres/minute)]		
	Supervisory workers	Coal Miners	Total
Age group (in years)	Mean ± SD (litres/minute)	Mean ± SD (litres/minute)	Mean ± SD (litres/minute)
< 45	460 ± 67.42	474.38 ± 65.54	473.14 ± 65.58
≥ 45	486.18 ± 57.74	447.8 ± 87.25	454.02 ± 84.27
	t=1.671;df=1;p=0.20	t=8.416;df=1;p=0.004	t=5.137;df =1;p= 0.02
Duration of exposure (yrs)			
< 20	476.56 ± 61.88	460.98 ± 74.17	462.93 ± 72.82
≥ 20	485.71 ± 59.83	451.31 ± 92.80	456.49 ± 89.22
	t=0.217;df=1;p=0.64	t=0.867;df=1;p=0.353	t=0.471;df=1;p=0.493
Smoking habit			
Never smoker	478.92 ± 60.50	458.56 ± 79.93	461.15 ± 77.94
Ever smoker	481.11 ± 65.47	461.2 ± 79.94	464.24 ± 77.73
	t=0.009;df=1;p=0.92	t=0.046;df=1;p=0.83	t=0.077;df=1;p=0.781

So far as chest radiographic findings are concerned, about 94% subjects had findings within normal limits. About 2.5% subjects showed findings suggestive of opacities in lung and almost 1% had other features on chest X-ray (mostly suggestive of Koch's infection of lung) (Table 26).

Table 26: Chest radiographic findings among the study subjects of Kustore area

Chest X ray findings	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
Within normal limit	44 (13)	285 (81)	329 (94)
Pulmonary Opacities	1 (0.5)	7 (2.0)	8 (2.5)
Koch's infection	0 (0)	4 (1)	4 (1)
Not Done	2 (0.5)	8 (2.0)	10 (2.5)
Total	**47 (14)**	**304 (86)**	**351 (100)**

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Haematological and biochemical findings of the subjects were mostly within normal limits. 9% workers had random blood sugar level >140. Mean Hemoglobin level in 13.4±0.4 gm%. Mean ESR was 7.0±2.1 mm/h. Random Blood sugar, Blood urea and Serum creatinine was 117.6±35.3 mg/dl, 23.5±2.7 mg/dl and 0.9±0.05 mg/dl respectively (Table 27).

Table 27: Haematological & Biochemical findings of study participants of Kustore area

Parameters	Minimum	Maximum	Mean ± SD
Haemoglobin (g/dL)	12	14	13.47 ± 0.483
Erythrocyte Sedimentation Rate (mm/h)	3	20	7.046 ± 2.14
Total Leucocyte Count (mcL)	6100	12600	9509.86 ± 838.53
Neutrophil	50	72	61.48 ± 5.60
Lymphocyte	23	62	33.072 ± 5.15
Eosinophil	3	9	5.01 ± 0.91
Monocyte	0	2	0.56 ± 0.65
Besophil	0	0	0.00
Random Blood Sugar (mg/dL)	75	270	117.64 ± 35.35
Blood Urea (mg/dL)	18	36	23.57 ± 2.77
Serum Creatinine (mg/dL)	.71	1.00	0.90 ± 0.05

Table 28: Ophthalmological findings of study participants of Kustore area

Findings	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
People having uncorrected vision after correction	1 (0.5)	16 (4.5)	17 (5)
Cataract	4 (1)	29 (8)	33 (9)
Glaucoma	0 (0)	2 (1)	2 (1)
Masculur Pathology	0	1	1
Pterygium	0	1	1

As far as ophthalmological findings are concerned, 5% subjects had uncorrected vision (although using spectacles) and 9% subjects had Cataract in eyes (Table 28).

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RESULT

&

DISCUSSION

(Baghmara area subjects)

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This study covered 140 subjects from Baghmara sector of BCCL Collieries (Table 29). Among the subjects of Baghmara sector, Kharkharee mines and Phularitand mines contributed 75 subjects and 65 subjects respectively. Workers actively involved in mining activity were mainly included in this study. However, about 5% subjects of this study were enrolled from supervisory staffs in order to have a complete and comprehensive understanding of the occupational health condition.

Table 29: Distribution of Supervisory workers and coal miners of Baghmara area

Sector	Mine Name	Supervisory workers	Coal Miners	Total
		N (%)	N (%)	N (%)
Baghmara	KHARKHAREE COLLIARY	5(4)	70(50)	75(54)
	PHULARITAND COLLIARY	1(1)	64(45)	65(46)
Total		6 (5)	134 (95)	140 (100)

Mean age of the workers was 44.9 ± 8.2 years. Most of the workers were between 35-54 years age group. Mean age of supervisory staffs was slightly higher than that of miners. About 99% workers were married. As far as education is concerned majority (66%) had middle school education. Only 1% subjects had graduate level education or higher (Table 30).

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Mean job experience was 9.4 ± 6.8 years. About 93% workers had job experience of up to 20 years. Mean experience was a little higher in supervisory employee group than miners group (Table 32).

Table 32: Occupational characteristics of Supervisory workers & Coal miners of Baghmara area

Demographic characteristics	Supervisory workers	Coal Miners	Total
Duration of job (in years)			
<10	5 (3)	85 (61)	90 (64)
10 - 20	1 (1)	39 (28)	40 (29)
21-30	0 (0)	8 (6)	8 (6)
>30	0 (0)	2 (1)	2 (1)
Mean duration of job (years)	**6.17 ± 7.17**	**9.56 ± 6.83**	**9.41 ± 6.85**

Most common symptoms complained by study subjects were musculoskeletal pain (36%). Other complaints were difficulty in breathing, chest pain and soreness of mouth. Headache, sleep disturbance, weakness, tremor in fingers was also experienced by good number of subjects (15%) (Table 33).

Table 33: Distribution of symptoms among study subjects of Baghmara area

Symptoms	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
Cough	0 (0)	5 (4)	5 (4)
Cough with Phlegm	0 (0)	3 (2)	3 (2)
Difficulty in Breathing	0 (0)	9 (6)	9 (6)
Chest Pain	0 (0)	11 (8)	11 (8)
Colicky pain	0 (0)	4 (3)	4 (3)
Loose Teeth	0 (0)	6 (4)	6 (4)
Soreness of mouth/throat	0 (0)	13 (9)	13 (9)
Urinary problems	1 (1)	2 (1)	3 (2)
Musculoskletal pain	4 (2)	47 (34)	51 (36)
Headache/sleep dificulty/weakness/dizziness/tremor	1 (1)	20 (14)	21 (15)

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Mean highly was 159.3 ± 6.7 cm and mean weight was 61.9 ± 11.5 kg. Mean systolic and diastolic blood pressure was 130.1± 19.2 and 82.9± 10.7 mm of Mercury (Table -34).

Table 34: Distribution of salient clinical findings among study subjects of Baghmara area

Clinical examination findings	Supervisory workers	Coal Miners	Total
	Mean ± SD	Mean ± SD	Mean ± SD
Mean Height (cm)	163.67 ± 6.28	159.18 ± 6.72	159.37 ± 6.74
Mean Weight (Kgs)	67.83 ± 11.0	61.70 ± 11.50	61.96 ± 11.51
MSBP (mm Hg)	134.33 ± 19.16	129.97 ± 19.26	130.16 ± 19.21
MDBP (mm Hg)	80.67 ± 9.35	83.01 ± 10.86	82.91 ± 10.78

MSBP – Mean Systolic Blood Pressure; MDBP - Mean Diastolic Blood Pressure

About 23% subjects had systolic blood pressure >140 as well as diastolic blood pressure > 90 mm of Mercury. 6% workers had only higher systolic blood pressure and 6% had only higher diastolic blood pressure (Table 35).

Table 35: Distribution of Blood pressure among study subjects of Baghmara area

	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
Blood Pressure (mm Hg) >140 & <90	3 (2)	6 (4)	9 (6)
Blood Pressure (mm Hg) <140 & >90	0 (0)	9 (6)	9 (6)
Blood Pressure (mm Hg) <140 & <90	2 (1)	88 (63)	90 (64)
Blood Pressure (mm Hg) >140 & >90	1 (1)	31 (22)	32 (23)

As far as pulmonary functional status of study subjects in concerned, about 3.5 % subjects had restrictive type of abnormality (FVC/PFVC < 80%) and 1.43% subjects had combined type of abnormality (FVC/PFVC <80 % and $FEV_{1\%}$ <70%). A good number of subjects (26.5%) had $FEV_{1\%}$ values between 70% and 80% (Table 36).

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Table 36: Pulmonary function impairments among study subjects of Baghmara area

Pulmonary function category	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
FVC/PFVC			
<80%	0 (0.0)	5 (3.5)	5 (3.5)
≥80%	6 (4.5)	129 (92.0)	135 (96.5)
$FEV_{1\%}$			
< 70 %	0 (0.0)	12 (8.5)	12 (8.5)
70- 79.99 %	4 (3.0)	33 (23.5)	37 (26.5)
≥ 80 %	2 (1.0)	89 (64.0)	91 (65.0)
FVC/PFVC <80% + $FEV_{1\%}$ <70%	0 (0.0)	2 (1.43)	2 (1.43)

FVC – Forced Vital Capacity; PFVC – Predicted Forced Vital Capacity; FEV_1 – Forced Expiratory Volume in first second

Mean FVC values were significantly lower among the subjects of age 45 years or above (Table 37). The difference was more prominent among the miners in comparison to supervisory staffs. Such significant difference of FVC values was not observed when compared between higher and lower job experience groups. Similarly difference was not prominent in relation to smoking habit of the subjects.

Table 37: Forced Vital Capacity according to study variables among study subjects of Baghmara area

Study variables	Forced Vital Capacity [Mean ± SD (litres)]		
	Supervisory workers	Coal Miners	Total
Age group (in years)	**Mean ± SD (litres)**	**Mean ± SD (litres)**	**Mean ± SD (litres)**
< 45	3.82 ± 0.68	3.46 ± 0.53	3.47 ± 0.53
≥ 45	2.90 ± 0.41	3.13 ± 0.50	3.12 ± 0.50
	df=1;p=0.098	df=1;p= 0.00	df=1;p= 0.00
Duration of exposure (yrs)			
< 20	3.38 ± 0.55	3.29 ± 0.54	3.29 ± 0.54
≥ 20	2.35	3.14 ± 0.55	3.09 ± 0.56
	df=1;p=0.162	df=1;p=0.316	df=1;p=0.158
Smoking habit			
Never smoker	2.99 ± 0.44	3.26 ± 0.53	3.25 ± 0.53
Ever smoker	3.18 ± 0.74	3.34 ± 0.56	3.42 ± 0.55
	df=1;p=0.138	df=1;p=0.187	df=1;p = 0.099

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Similar trend was observed in case of FEV1 values also. Significant difference was observed between subject of less than 45 years and rest of the workers. This difference was prominent in miners and supervisory staffs. No such remarkable difference was observed when compared in relation to job experience and smoking habit (Table 38).

Table 38: Forced Expiratory Volume in first second according to study variables among study subjects of Baghmara area

Study variables	Forced Expiratory Volume in first second [Mean ± SD (litres)]		
	Supervisory workers	Coal Miners	Total
Age group (in years)	Mean ± SD (litres)	Mean ± SD (litres)	Mean ± SD (litres)
< 45	3.06 ± 0.44	2.87 ± 0.49	2.87 ± 0.49
≥ 45	2.18 ± 0.27	2.52 ± 0.46	2.50 ± 0.46
	t=9.88;df=1;p=0.035	t=17.48;df=1;p=0.00	t=21.13;df=1;p=0.00
Duration of exposure (yrs)			
< 20	2.614 ± 0.46	2.69 ± 0.51	2.69 ± 0.51
≥ 20	1.780	2.5 ± 0.41	2.45 ± 0.43
	t=2.687;df=1;p=0.176	t=1.863;df=1,p=0.175	t=3.03;df=1;p=0.084
Smoking habit			
Never smoker	2.29 ± 0.40	2.66 ± 0.50	2.65 ± 0.50
Ever smoker	2.85 ± 0.74	2.94 ± 0.61	2.92 ± 0.59
	t=1.654;df=1;p=0.268	t=1.77;df=1;p=0.186	t=2.152;df=1;p=0.145

Same pattern could be found in case of Peak Expiratory Flow Rate also (Table 39). Significant difference was present in relation to age (more so in miners than supervisor), however, smoking and duration of exposure wise classification did not show any significant difference.

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Table 39: Peak Expiratory Flow Rate according to study variables among study subjects of Baghmara area

Study variables	Peak Expiratory Flow Rate | Mean ± SD (litres/minute)]		
	Supervisory workers	Coal Miners	Total
Age group (in years)	Mean ± SD (litres/minute)	Mean ± SD (litres/minute)	Mean ± SD (litres/minute)
< 45	495 ± 21.21	470.69 ± 65.45	471.5 ± 64.54
≥ 45	422.5 ± 59.09	437.77 ± 80.15	436.99 ± 78.98
	t=2.566;df=1;p=0.18	t=6.423;df=1;p=0.012	t=7.56;df=1;p=0.007
Duration of exposure (yrs)			
< 20	464 ± 47.22	453.22 ± 76.53	453.66 ± 75.46
≥ 20	360.00	443.93 ± 69.12	438.33 ± 70.04
	t=4.042;df=1;p=0.115	t=0.188;df=1;p=0.665	t=0.559;df=1;p=0.456
Smoking habit			
Never smoker	442.5 ± 74.11	451.79 ± 75.05	451.5 ± 74.76
Ever smoker	455 ± 35.36	461.67 ± 93.47	460 ± 80.18
	t=0.047;df=1;p=0.839	t=0.09;df=1;p=0.756	t=0.097;df=1;p=0.756

So far as chest radiographic findings are concerned, about 92% subjects had findings within normal limits, 4% subjects showed findings suggestive of opacities in lung and almost 2% had other features on chest X-ray (mostly suggestive of Koch's infection of lung) (Table 40).

Table 40: Chest radiographic findings among the study participants of Baghmara area

Chest X ray findings	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
Within normal limit	6 (4)	123 (88)	129 (92)
Pulmonary Opacities	0 (0)	5 (4)	5 (4)
Koch's infection	0 (0)	3 (2)	3 (2)
Not Done	0 (0)	3 (2)	3 (2)
Total	6 (4)	134 (96)	140 (100)

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Haematological and biochemical findings of the subjects were mostly within normal limits. 15% workers had random blood sugar level >140. Mean hemoglobin level in 11.9±0.8 gm%. Random Blood sugar, blood urea and Serum creatinine was 107.5±38.2 unit, 20.7±4.5 unit and 0.6±0.5 unit respectively (Table 41).

Table 41: Haematological & Biochemical findings of study participants of Baghmara area

Parameters	Minimum	Maximum	Mean
Haemoglobin (g/dL)	10	15	11.98 ± 0.87
Total Leucocyte Count (mcL)	5500	10500	7957.86 ± 1134. 57
Neutrophil	46	89	62.49 ± 7.37
Lymphocyte	20	50	29.24 ± 7.06
Eosinophil	2	13	7.13 ± 2.40
Monocyte	0	8	1.38 ± 1.16
Besophil	0	0	0.00
Random Blood Sugar (mg/dL)	55	300	107.51 ± 38.28
Blood Urea (mg/dL)	14	38	20.7 ± 4.57
Serum Creatinine (mg/dL)	.30	7.00	0.64 ± 0.55

As far as ophthalmological findings are concerned, 6% subjects had uncorrected vision (although using spectacles). Colour blindness was also observed in few subjects (Table 42).

Table 42: Ophthalmological findings of study participants of Baghmara area

	Supervisory workers	Coal Miners	Total
	N (%)	N (%)	N (%)
People having uncorrected vision after correction	0 (0)	8 (6)	8 (6)
Colour Blindness	0 (0)	6 (4)	6 (4)

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CONCLUSION

&

RECOMMENDATION

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CONCLUSION

- This study covered 351 subjects from Kustore sector and 140 subjects from Baghmara sector of BCCL Collieries. Mean age of the workers was 45.9 ± 8.36 years. Most of the workers were between 35-54 years age. Mean job experience was 11.72 ± 8.49 years.

- Most common symptoms complained by study subjects were musculoskeletal pain (34%). Other complaints were Cough, difficulty in breathing, chest pain, soreness of mouth etc. Headache, sleep disturbance, weakness, tremor in fingers was also experienced by some subjects.

- About 20% subjects had systolic blood pressure >140 as well as diastolic blood pressure > 90 mm of Mercury. 9% workers had only higher systolic blood pressure and 11% had only higher diastolic blood pressure.

- As far as pulmonary functional status of study subjects in concerned, about 3% subjects had restrictive type of abnormality (FVC/PFVC < 80%) and 0.6 % subjects had combined type of abnormality (FVC/PFVC <80 % and FEV1% <70%). A good number of subjects (36.5%) had FEV1% values between 70% and 80%. Mean FVC values were significantly lower among the subjects of age 45 years or above.

- So far as chest radiographic findings are concerned, 93% subjects had findings within normal limits. 3% subjects showed findings suggestive of opacities in lung and almost 1.5% had other features on chest X-ray (mostly suggestive of Koch's infection of lung). Such findings may be due to pneumoconiotic changes in lung, hence these subjects should be properly followed up and necessary medical, ethical, legal, administrative actions may be initiated as necessary.

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- Haematological and biochemical findings of the subjects were mostly within normal limits. Almost 11% workers had random blood sugar level more than 140 units. As far as ophthalmological findings are concerned, 5% subjects had uncorrected vision and 9% subjects had Cataract in eyes.

- Decline in hearing ability with increasing duration of exposure was observed more at higher frequency, however, this observation is subject to adjustment for age and other probable factors.

- The subjects for this study are selected from workplaces identified by BCCL, Govt. of India, as required for the purpose of this study. The findings of this study may thus be restricted to the concerned workplaces and may not be generalisable.

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RECOMMENDATION

- Prevalence of musculoskeletal pain during work in a good number of workers reflects that manual work of the work processes might be causing some discomfort for the workers. Training on proper method of manual material handling may prove useful of these workers. On the other hand regular proper exercise should be promoted among workers especially supervisory employees to get rid of ill effects of sedentary activities.

- Special emphasis should be given to protection of respiratory health, hearing ability. Periodic relevant examination (lung function test, audiometry) at regular interval is recommended.

- Industrial hygiene survey (periodic monitoring of dust and other environmental hazards) at regular interval should be undertaken including noise level monitoring in different operations.

- Some prevalent symptoms observed may be representation of nervous system effect due to exposures to toxicants. In order to exclude the possibility of exposure from occupational environment, environmental study should include assessment of exposure to metals.

- Measures like using protective appliances (e.g. PPEs), pre-placement- and periodic medical examination, for the control and prevention of relevant health hazards, are to be implemented and maintained by all the mining areas to protect the health of the workers.

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EXECUTIVE SUMMARY

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BACKGROUND

Although coal remains a major energy resource worldwide, coal mining causes environment problems, whereas the inhaled coal particles at the work place may lead to the development of coal workers' pneumoconiosis (CWP). Typically, coal workers pneumoconiosis takes many years to develop and to be manifested. Further, once initiated the disease is progressive in nature, often leading to lungfunction impairment, disability.
The workers' exposure to coal dust generally occurs during mining operations.
Coal mining can also increase the risk of developing asthma and chronic obstructive pulmonary disease (COPD), such as emphysema and chronic bronchitis. It is suggested that coal mining operations may also induce noise induced hearing impairment among the workers.

A request was received from Bharat Coking Coal Limited, Dhanbad to assess the health status of their workers involved in the mining activities in Cluster 11 and 15 areas around Dhanbad. About 10% of the subjects involved in mining activities were to be included in this study. The workers were to be assessed for their health status, presence of any occupational disease and hearing impairments. Under this circumstance, in consultation of the scientists of National Institute of Occupational Health (NIOH) and the concerned officers of Bharat Coking Coal Limited, it was decided that an epidemiological study would be carried out involving workers involved in mining activities.

OBJECTIVES

5. To understand health status of workers through questionnaire survey, health examination.
6. To study respiratory health in coal field mining workers.
7. To assess ventilatory functions of coal field mining workers.
8. To analyze hearing ability through audiometric evaluation.

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METHODOLOGY

An occupational health study was conducted involving different mines of Cluster 11 and 15 of Bharat coking Coal Limited, Dhanbad. This study was undertaken among the exposed workers mainly from active mining activity. Representative sample from workers working in such occupations is included in this study. Initially the aim of the study was explained to the workers, informed consent was obtained after which they were enrolled for this study. Every individual subject was interviewed with a pre-designed questionnaire to collect information in relation to personal, occupational and morbidity details of the workers. The participants of this study were subjected to following interview/examination/investigations:

- Detailed personal, occupational and medical history.
- Clinical examination with special emphasis on examination of respiratory system.
- Haematological examination.
- Lung function test.
- Audiometry.
- Ophthalmological assessment.

Study design: Cross sectional study

Study subjects: This study covered 351 subjects from Kustore sector and 140 subjects from Bagmara sector of BCCL Collieries. Among the subjects of Kustore sector 49 were from Kachi Balihari mines, 51 from Bhagabandh mines, 40 from Gopali Chawk mines and 100 from Munidi mines. PB project mines contributed 111 subjects. Similarly among the subjects of Bagmara sector, Kharkharee mines and Phularitand mines contributed 75 subjects and 65 subjects respectively. Workers actively involved in mining actively were mainly included in this study. However, few subjects of this study were enrolled from supervisory staffs in order to have a complete and comprehensive understanding of the occupational health condition. These workers were randomly selected from the total workforce in the selected clusters and mines.

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Data collection: The information regarding demographic, occupational and clinical history was collected on a pre-designed and pre-tested proforma through interview of subject. This was followed by complete clinical examination, spirometry, audiometry and chest radiography of each subject. The audiometer and spirometer were brought by NIOH team while for chest radiography the facilities at BCCL hospitals were used. The processing of exposed films was done by the technicians at BCCL hospital. The ophthalmological examination and haematological – biochemical estimations were also done using facilities and expertise at BCCL hospitals.

Data analysis: Data entry and analysis were done in standard statistical software. The statistical analysis included calculation of differences, proportions and application of tests of significance etc, to ascertain health effects especially respiratory health conditions.

RESULTS

- This study covered 351 subjects from Kustore sector and 140 subjects from Baghmara sector of BCCL Collieries. Mean age of the workers was 45.9 ± 8.36 years. Most of the workers were between 35-54 years age. Mean job experience was 11.72 ± 8.49 years.

- Most common symptoms complained by study subjects were musculoskeletal pain (34%). Other complaints were Cough, difficulty in breathing, chest pain, soreness of mouth etc. Headache, sleep disturbance, weakness, tremor in fingers was also experienced by some subjects.

- About 20% subjects had systolic blood pressure >140 as well as diastolic blood pressure > 90 mm of Mercury. 9% workers had only higher systolic blood pressure and 11% had only higher diastolic blood pressure.

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- As far as pulmonary functional status of study subjects in concerned, about 3% subjects had restrictive type of abnormality (FVC/PFVC < 80%) and 0.6 % subjects had combined type of abnormality (FVC/PFVC <80 % and FEV1% <70%). A good number of subjects (36.5%) had FEV1% values between 70% and 80%. Mean FVC values were significantly lower among the subjects of age 45 years or above.

- So far as chest radiographic findings are concerned, 93% subjects had findings within normal limits. 3% subjects showed findings suggestive of opacities in lung and almost 1.5% had other features on chest X-ray (mostly suggestive of Koch's infection of lung). Such findings may be due to pneumoconiotic changes in lung, hence these subjects should be properly followed up and necessary medical, ethical, legal, administrative actions may be initiated as necessary.

- Haematological and biochemical findings of the subjects were mostly within normal limits. Almost 11% workers had random blood sugar level more than 140 units. As far as ophthalmological findings are concerned, 5% subjects had uncorrected vision and 9% subjects had Cataract in eyes.

- Decline in hearing ability with increasing duration of exposure was observed more at higher frequency; however, this observation is subject to adjustment for age and other probable factors.

- The subjects for this study are selected from workplaces identified by BCCL, Govt. of India, as required for the purpose of this study. The findings of this study may thus be restricted to the concerned workplaces and may not be generalisable.

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RECOMMENDATION

- Prevalence of musculoskeletal pain during work in a good number of workers reflects that manual work of the work processes might be causing some discomfort for the workers. Training on proper method of manual material handling may prove useful of these workers. On the other hand regular proper exercise should be promoted among workers especially supervisory employees to get rid of ill effects of sedentary activities.

- Special emphasis should be given to protection of respiratory health, hearing ability. Periodic relevant examination (lung function test, audiometry) at regular interval is recommended.

- Industrial hygiene survey (periodic monitoring of dust and other environmental hazards) at regular interval should be undertaken including noise level monitoring in different operations.

- Some prevalent symptoms observed may be representation of nervous system effect due to exposures to toxicants. In order to exclude the possibility of exposure from occupational environment, environmental study should include assessment of exposure to metals.

- Measures like using protective appliances (e.g. PPEs), pre-placement- and periodic medical examination, for the control and prevention of relevant health hazards, are to be implemented and maintained by all the mining areas to protect the health of the workers.

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ANNEXURE

(Sample proforma for undertaking occupational health studies)

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Study of occupational diseases and hearing impairments of coalmine workers directly involved in active mining operations

Date:□□/□□/□□□□ Code No.□□□

PERSONAL AND RESIDENTIAL INFORMATION

Name: _____

Age (completed years): Sex: 1.Male 2. Female

Marital status: 1. Single 2. Married 3. Divorcee 4. Widow(er)

Education: 1) Illiterate 2) 1-4 3) 5-10 4) 11-12 5) College

Number of family members: Mine Name: _____

Residential address: _____

Smoking history: 1) Non-smoker 2) Smoker 3) Past smoker

A. *Type of smoking* 1) Beedi 2) Cigarette 3) Other (specify)

B. *Frequency (Number per day)* C. *Duration (years)*

Reason from Abstaining From Smoking: 1. Respiratory Problem 2.Any Other Reason

Do You Chew Tobacco: 1. Yes 2. No If Yes, Duration (Yrs.) Frequency: No/day

Do You Drink Alcohol?: 1. Yes 2. No If yes, Duration (Yrs)

Frequency: 1. Regularly 2. Occasionally

OCCUPATIONAL HISTORY

Since how many years you are working in this job

Present Occupational History

No	Designation	Nature of job	Duration (years)
1.			
2.			
3.			

Past Occupational History

No	Designation	Nature of job	Duration (years)
1.			
2.			
3.			

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PAST MEDICALHISTORY:

Have you suffered from any of the following diseases in the past?

PTB☐Chronic bronchitis☐Recurrent cough and cold☐Bronchial asthma☐HT☐Jaundice☐CKD☐

Any other major illness 1. No 2. Yes☐If yes, specify _____

Family history: Has anybody in your family or blood relation suffered from any of the following diseases? (Also mention the relationship)

PTB☐Chronic bronchitis☐Recurrent cough and cold☐Bronchial asthma☐HT☐Jaundice☐CKD☐

Any other major illness 1. No 2. Yes☐If yes, specify _____

PRESENT MEDICAL HISTORY:

Cough:Do you have cough? 1. No 2. Yes☐If 'Yes',Is it Productive☐Non productive☐
If productive go to next symptom

Phlegm:Do you usually bring up phlegm from your chest first thing in the morning? 1. No 2. Yes☐
(If 'Yes, please go to the next question. If 'No', go to the next symptom)

Do you bring up phlegm like this on most days for as much as 3 months per year? 1 No 2.Yes☐
If yes since how many years☐☐
Have you ever coughed up blood in sputum? 1. No 2. Yes☐
If 'Yes', when did you have the last haemoptysis (weeks back)?☐☐

Dyspnoea: Do you suffer from breathlessness? 1. No 2.Yes☐*(If 'Yes', go to next question. If 'No' go to next symptom)*

Are you ever troubled by shortness of breath, while hurrying on the level or walking up a slight hill?

1. No 2. Yes☐ *(If 'No', grade is 1. If 'Yes', proceed to next question)*

Do you get short of breath while walking with a person of approximately your age and sex?
1. No 2. Yes☐ *(If 'No', grade is 2. If 'Yes', proceed to next question)*

Do you have to stop for breath when walking at your pace on the level?
1. No 2. Yes☐ *(If 'No', grade is 3. If 'Yes', proceed to next question)*

Are you short of breath while washing or dressing up or other routine activity?1. No 2. Yes☐
(If 'No', grade is 4. If 'Yes', grade is 5)

Final assessment of the grade of dyspnoea (grade 1-5) ☐

Do you have attacks of breathlessness at night? 1. No 2. Yes☐

Chest pain:Do you have chest pain? 1. No 2. Yes☐*(If 'Yes', go to the next question. If 'No', go to next symptom.)*

Is it increased by deep inspiration/Coughing/Sneezing 1. No 2. Yes☐

Mention the site(s) of chest pain _____
Any other information, specify_____

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Do you have following symptoms

Symptom	1.Present/ 2.Absent	Duration (years)	Symptom	1.Present/ 2.Absent	Duration (years)
GENERAL AND SKIN			**D. MUSCULOSKELETAL**		
Tiredness	☐	☐☐	Muscle cramps	☐	☐☐
Weight loss	☐	☐☐	Muscle pains	☐	☐☐
Recurrent infections	☐	☐☐	Backache	☐	☐☐
Skin rashes	☐	☐☐			
Itching	☐	☐☐	**E. CENTRAL NERVOUS SYSTEM**		
ORAL CAVITY AND G.I.TRACT			Headache	☐	☐☐
Excessive salivation	☐	☐☐	Dizziness	☐	☐☐
Loose teeth	☐	☐☐			
Soreness of throat	☐	☐☐	Difficulty in hearing	☐	☐☐
Soreness of mouth	☐	☐☐	Difficulty in speech	☐	☐☐
			Irritability	☐	☐☐
Loss of appetite	☐	☐☐	Inability to concentrate	☐	☐☐
Nausea	☐	☐☐	Forgetfulness	☐	☐☐
Vomiting	☐	☐☐			
Diarrhoea	☐	☐☐	Sleep difficulty / disturbances	☐	☐☐
Colicky pain in abdomen	☐	☐☐	Muscular weakness	☐	☐☐
RENAL			Tingling in extremities	☐	☐☐
Decreased urine	☐	☐☐	Numbness in extremities	☐	☐☐
Hematuria	☐	☐☐			
Edema over face	☐	☐☐	Tremors	☐	☐☐
			Convulsions	☐	☐☐

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MEDICAL EXAMINATION

General Examination

Height(cms)_____ Weight (kgs)_____Pulse/min.☐☐☐

BSA (m^2)_____ Pallor: 1.Present 2. Absent☐

B P: Systolic:_____mm/Hg Diastolic:_____mm/Hg

Nails: 1. Normal 2. Abnormal Specify_____

Cyanosis: 1. Present 2. Absent Others(oedema, LNpathy, varicose etc.): 1. Present 2. Absent

Skin: 1. Normal 2. Abnormal ☐ Specify abnormality _____

Mouth and lips: 1. Normal 2. Angular stomatitis 3.Pigmentation 4.Ulceration 5. Blue line over gums

Systemic Examination

Respiratory System

Inspection: 1. Normal 2. Abnormal ☐ Specify abnormality _____

Palpation: 1. Normal 2. Abnormal ☐ Specify abnormality _____

Percussion: 1. Normal 2. Abnormal ☐ Specify abnormality _____

Auscultation: 1. Normal 2. Abnormal ☐ Specify abnormality _____

Intensity: 1. Normal 2.Increased 3. Decreased ☐

Character: 1. Vesicular 2.Broncho-vesicular 3. Bronchial ☐

Added sounds: 1. Fine crepts 2.Coarse crepts 3.Rhonchi 4. Rub ☐

Basal Crepitations: 1. Present 2. Absent ☐

If present, which side: 1. Right 2. Left ☐

Other Systems

Abdomen: Liver 1. Normal 2.Enlarged ☐ Spleen: 1. Normal 2.Enlarged

CVS: 1. Normal 2. Abnormal ☐ Specify abnormality _____

CNS: Higher functions 1. Normal 2. Abnormal ☐ Specify abnormality _____

Tremors: 1. Present 2. Absent ☐ If present, specify _____

Motor system abnormality: 1. Present 2. Absent If present, specify _____

Sensory system abnormality: 1. Present 2. Absent If present, specify _____

Abnormal Reflexes: 1. Present 2. Absent If present, specify _____

Any other abnormality: 1. Present 2. Absent If present, specify _____

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PULMONARY FUNCTION TESTS

Physical Characteristics:

1. Age: _____ Yrs. 2. Height: _____ Cm 3. Weight: _____ Kg 4. BSA: _____ m^2

Pulmonary Function Test

SVC_____ (l) FVC_____ (l)
FEV 1.0_____ (l) FEV1.0/FVC_____
FEF0.2 – 1.21_____ (l/s) FEF 25 -75 %_____ (l/s)
FEF 75 – 85 %_____ (l/s)
PEFR_____ (l/m)

PFT Diagnosis: 1. Normal 2.Obstructive 3.Restrictive 4. Combined ☐

X Ray findings: _____

Final Diagnosis: _____

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Impact Assessment of CSR projects undertaken by Bharat Coking Coal Limited, Dhanbad FY(2015-16)

By

National CSR Hub

Tata Institute of Social Sciences, Mumbai

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This Impact Assessment Study of CSR project of Bharat Coking Coal Limited, Dhanbad for the FY 2015-16 has been undertaken by National CSR Hub, Tata Institute of Social Sciences (TISS) as a part of the MoU with CIL and TISS.

At the outset, we would like to thank BCCL for granting this project to National CSR Hub, TISS. We express heartfelt gratitude to Director (Personnel), BCCL for giving us the opportunity to carry out the Impact Assessment study of CSR projects for the FY 2015-16. We express our gratitude to the General Manager, CSR and the entire CSR department of BCCL for their continuous support and guidance to the research team of NCSR Hub.

We also extend our gratefulness to respective area General Managers, Medical Officers (Health Department) and concerned project in-charge appointed by BCCL (CSR officials) for making all the arrangements for the study and making us comfortable with their warm hospitality.

Prof. B. Venkatesh Kumar
Director
National Corporate Social Responsibility Hub
TISS, Mumbai

EXECUTIVE SUMMARY

Bharat Coking Coal Limited is a subsidiary of Coal India Limited, a Maharatna Company. The company is currently operating in 12 administrative areas in Jharia Coalfields encompassing around 226 peripheral villages mainly in the District of Dhanbad, Jharkhand and in some part of West Bengal. The Strategic CSR of BCCL states that the company's main objective is to improve the quality of life of people living in and around its command areas. The key areas of CSR invention are rural development, livelihood generation and skill development. It has a long history of philanthropic activities which were converged to align with the Corporate Social Responsibility mandate of the Companies Act 2013. Rural development, livelihood generation and skill development are thrust areas of the BCCL's CSR interventions. As per the CSR guideline, BCCL has partnered with Tata Institute of Social Sciences to conduct evaluation studies for the completed CSR projects.

For the purpose of this report, impact assessment studies were carried out for four projects, namely, Scheme for Multi-Purpose Utilisation of Mine Water, Mobile Medical Van, Village Adoption and Construction of PCC/Bituminous Road.

The primary data collection for the impact assessment studies was completed in September 2017 by a six member team from TISS. Mixed research methodology was used while In-Depth Interviews, Household Surveys and focused group discussions were the main methods implemented to collect data. 1000 samples were collected from 13 operational areas of BCCL for the impact assessment study.

The objectives of the impact assessment were:

(i) To assess if the objectives of individual projects have been met;

(ii) To understand the continued relevance of the individual projects in their respective contexts; and

(iii) To identify issues in programmatic implementation and provide recommendation to fulfill the objectives efficiently.

Mobile Medical Van has aimed to provide quality health services to the rural poor residing in the operational areas of BCCL. The impact of the project on the community has been remarkable as it provides doorstep medical services to the poor, reduces the medical expenditures, reached the most remote villages and awareness generation. Limited health services, awareness campaigns and limited regularity are the major drawbacks of the project.

In the project Scheme for Multi-Purpose Utilisation of Mine Water, 352 samples were collected, 13 FGDs and 4 Key Informant Interviews (KII) were conducted. There is strong demand for the supply of mine water in the renovated ponds especially during water scarcity periods, which have been stopped for the last couple of months. The mine water is used for household and cattle consumption. Livelihood generation activities have not commenced as yet.

BCCL also adopted Lahbera village, situated in Jharia block of Dhanbad district and committed to the holistic development of the village. Various infrastructural and economic projects were implemented in the village. Although the project has been a huge success, a lapse in monitoring, incomplete projects and limited resources for employment generation have inhibited the successful completion of the project.

BCCL also constructed roads at 7 locations across Dhanbad districts. The roads had led to improved connectivity and enhanced hygienic living conditions, but lack of monitoring, limited connectivity and lack of participatory approach have been some of the shortcomings of the project.

TISS has also provided recommendation such as regular monitoring, creation of employment generation activities, the formation of SHGs etc. for efficient execution of future projects.

LIST OF ABBREVIATIONS

ADC	-	Adult Education Center
BCCL	-	Bharat Coking Coal Limited
CHC	-	Community Healthcare Center
CSR	-	Social Corporate Responsibility
CTP	-	Computer Training Program
FGD	-	Focused Group Discussion
GM	-	General Manager
HHI	-	Household Interviews
IDI	-	In – depth Interviews
IT	-	Information and Technology
KII	-	Key Informant Interviews
LVA	-	Lahbera – Village Adoption
MMV	-	Mobile Medical Van
MUMW	-	Scheme for multipurpose utilization of abandoned mine water
PCC	-	Plain Cement Concrete
PHC	-	Primary Health Care Center
SHG	-	Self Help Group
ST	-	Schedule Tribes
STC	-	Sewing Training Centre
STP	-	Sewing Training Program
EJ	–	Eastern Jharia
WJ	–	Western Jahria
WWD	_	Western Washery Division
CV	–	Chanch Victora

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CHAPTER 1 - INTRODUCTION

Businesses are the most powerful constituents of the society, and they do not operate in isolation; there is an increased realization that not only can companies affect society at large, but they are also in a unique position to influence society and a make positive impact.

> "The Organization for Economic Co-operation and Development[1] (OECD) established a set of guidelines for multinational enterprises in 1976 and was thus a pioneer in developing the concept of CSR. The purpose of these guidelines was to improve the 'investment' climate and encourage the positive contribution multinational enterprises can make to economic and social progress".

An evaluation is 'the systematic and objective assessment of an on-going or completed project, programme or policy, its design, implementation and results. The aim is to determine the relevance and fulfilment of objectives, development efficiency, effectiveness, impact and sustainability. An evaluation should provide information that is credible and useful, enabling the incorporation of lessons learned into the decision-making process of both recipient and donors.' (OECD Publications, 2010)

1.1. About Bharat Coking Coal Limited

Bharat Coking Coal Limited (BCCL) is a subsidiary of Coal India Limited, a Maharatna Company. The company is operating in 12 administrative areas in Jharia Coalfields encompassing around 226 peripheral villages mainly in the District of Dhanbad, Jharkhand and in some part of West Bengal. The Strategic CSR of BCCL states that the company's main objective is to improve the quality of life of people living in and around its command areas. Towards achieving this objective and understand the interest levels of the local community, BCCL has undertaken a departmental baseline survey cum Skill Gap Analysis study at some locations. The recommendations from the study would form the basis for the design and deployment of the various skill development initiatives to be planned.

[1] http://www.oecd.org/about/

1.2 About National Corporate Social Responsibility Hub, TISS

National Corporate Social Responsibility Hub, (NCSR Hub) was established in 2011 by the Department of Public Enterprises to enable the Public Sector Enterprises to design and implement holistic and rights-based CSR initiatives. Tata Institute of Social Sciences (TISS), Mumbai and Department of Public Enterprises (DPE), Government of India had come to realize that there is a need to have a centralized system where core functions of CSR including learning and knowledge dissemination take place. The core activities of the Hub are:

- Vision and strategic direction setting for Policy and Programme
- Advisory role for PSEs on Policy and Programme implementation
- Research and development and 'evidence-based' policy advocacy
- Capacity building of PSEs, partners and civil society institution
- Impact assessment, monitoring and evaluation
- Empanelment and partner management

1.3 Project Backgrounds

Bharat Coking Coal Limited (BCCL) sanctioned impact evaluation studies for four projects in different stages of completion which were carried out by National CSR Hub in August-September 2017. The following report details the evaluation of projects undertaken by Bharat Coking Coal Limited in accordance with their CSR policy laid out in 2014. A cogent CSR policy is a requirement laid out in the Companies (CSR Policy) Rules, 2014 conferred under the Companies Act, 2013.

As stated above, for this report four projects were evaluated namely: *Mobile Medical Van, Scheme for multipurpose utilisation of abandoned mine water, Village adoption program and construction of PCC/Bituminous road.*

a) **Mobile Medical Van (*Swastha Ratha*) -** The service of Mobile Medical Van for villagers under command areas of BCCL started in 2009 with the help of 2 Mobile Medical Vans. Now BCCL has fourteen Medical Mobile Vans (MMVs) equipped with doctors, paramedical staff serving different 203 villages situated in and around the mining areas on working days. The villagers are examined by the experienced clinicians

and medicines are dispensed free of cost to them. This provision has been made by BCCL exclusively under CSR activities for the benefit of villagers by providing them free medical assistance.

Objective: To provide health services in peripheral villages in and around BCCL command area to provide medical facilities with a focused service on identification, screening, diagnosis and treatment to provide free medical; assistance.

Location of implementation: 203 villages in the peripheral areas of BCCL

b) **Scheme for multipurpose utilisation of abandoned mine water -** BCCL since inception has felt the importance of water and endeavoured for effective and gainful utilisation of mine water from abandoned mines which has to be taken out compulsorily in the course of the mining process. For harnessing such water, BCCL has taken upon the task of holding the mine water into the water bodies by restricting them to flow into the natural drainage course like village reservoirs which gets dried during summers by laying out a pipeline network of approximately 45 km.

Objective of the project: Harnessing mine water for its gainful multipurpose utilisation in the peripheral villages of BCCL command area.

Location: Two reservoirs are situated in Khonathi and Behrakudar villages of Baghmara block of Dhanbad district.

c) **Lahbera Village Adoption Program** - In order to develop peripheral villages of BCCL in an integrated manner, including their economic development, infrastructure upliftment, providing opportunities for social empowerment and other aspects of overall human development. i.e. education, health, drinking water supply, providing training and tools for self-employment etc. This would include economic development, infrastructure development and other aspects of human development, i.e. education, health, drinking water supply and credit linkage.

Objective of the project: The objective of Village Adoption Programme is to develop the selected village in an integrated manner ensuring the holistic and integrated development of village through capacity building and participation of local people and institutions.

Location: Lahbera Village in Jharia block of Dhanbad district

d) Construction of PCC/Bituminous road - Understanding the importance of Road BCCL had Constructed PCC Roads in and around eight villages of the BCCL command area. Roads are of vital importance to make a nation grow and develop. In addition, providing access to employment, social, health and education services makes a road network crucial in fighting against poverty. They open up areas of economic and social development.

Objective of the project: Enabling and increasing the connectivity from semi-rural to urban areas by constructing PCC Road.

Location:

SN	Name of Village/Area	Construction in Km/Meters
1	Kacharra Arah Tola , Hatudih Panchayat	400 meters
2	Lahbera Village	1.5 Km
3	Aamtal Village, Aamtal Panchayat (Kusunda)	1.5 km
4	Satitand Village, Bauakala Panchayat (Kusunda)	500 meters
5	Padugora Village, Padugora Panchayat (WJ area)	400 meters
6	Kandra Village, Kandrta Panchayat	500 meters
7	Bakaspura Village, Luti Pahari Panchayat	400 meters

CHAPTER 2 – RESEARCH METHODOLOGY

Research methodology is a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically. In it, one studies the various steps that are adopted by a researcher in studying his research problem along with the logic behind them (Kothari, 2004). This chapter outlines the research methodology and also examines the objectives of the study and the research question. The chapter also includes the research design, methods, and level of engagement for data collection, on and off the field. The stage of data collection has also been explained in the chapter with a subsequently the steps utilized to analyze the data that is already collected from the field.

2.1 Objective of Study

The very purpose of the research is to discover answers to the question through the application of the scientific procedures (Kothari, 2004). The aim of the study was to understand the extent of the impact of projects on the socio-economic conditions of the targeted beneficiaries.

The Impact Assessment was conducted on four major projects namely:

1. Mobile Medical Van (MMV),
2. Scheme for multipurpose utilization of abandoned mine water (MUMW),
3. Road Construction, and
4. Labhera village adoption project (LVA)

Therefore the objective of each project has some variation from the other even though having that the main objectives were as follows:

i. To Analyzed the key impact areas of the project
ii. To Analyzed the extent of impact on the beneficiaries
iii. To suggest recommendation for improvement for the project.

2.2 Research Design

The research design refers to the overall strategy that one choose to integrate the different components of the study in a coherent and logical way, thereby, ensuring one will effectively address the research problem; it constitutes the blueprint for the collection, measurement, and analysis of data (De Vaus, 2001)

This study is an **Evaluation** research study as it is designed to assess the outcomes of an intervention so that the findings will provide insights useful for the organizations that have funded and implemented the project. The study is an end line evaluation study, which implies that the findings would be useful if the Company intent to reintroduce the project.

The project undertaken for impact assessment studies were those which are implemented by the BCCL CSR and which covers a mixed chunk of populate spread across the BCCL Command area. As there were four projects that required studying, the research team had developed two research designs based on the project objectives and population covered. This study employs a mixture of Quantitative and Qualitative research methods to evaluate the key aspects of the two projects namely; MMV and MUMV. If one has to define mixed method research it can be 'In general, mixed methods research represents research that involves collecting, analyzing, and interpreting quantitative and qualitative data in a single study or in a series of studies that investigate the same underlying phenomenon.' (Leech N, Onwuegbuzie A, 2008). The study has attempted not just to generate summary statistics that reveal the overall performance of the projects but has also attempted to delve into the individual stories, histories, life experiences and psyche of the beneficiaries through intensive beneficiary-specific case studies (of selected beneficiaries. While conducting the study of MMV and MUMW the research team used two major tools for data collection mainly: Focused Group Discussion (FGD) and Household Survey (HH). These methods were felt appropriate by the research team as it helped in fulfilling the appropriate size and appropriate response.

Simultaneously a different research design was formed for studying the impact of LVA and Road Construction. The qualitative research design enabled the research team to understand the impact of project in their daily life. Along with it, the project had limited beneficiaries that provided the research team with the opportunity to study and to understand the lived narratives of the beneficiaries and also the impact of LVA and road in their day to day life.

2.3 Tools for Data Collection

The tool is one of the essential components of a research study. It is an instrument that helps the researcher to meet the objectives of the research. There are various kinds of tools that are utilized based on the needs and objectives of the research. In the current study the research team undertook certain sets of tool they are listed below;

Major tools involved in the study were:

i. **i. House Hold Interview (Survey) (HHI)**: As a few projects had greater coverage in terms of area and population the household survey was used to get details from the identified villages and areas/panchayats

ii. **ii. Focused Group Discussion (FGD):** FGDs where conducted in all the four project, and the interviewers for the FGD was the village members, Ward/Gram Panchayat Representative, ASHA, Women Representative, SHGs Group Women's, Youth group member etc.

iii. **iii. In-depth Interviews (IDI):** Similarly IDI was conducted with village members who were directly affected by the project

iv. **iv. Case studies:** Case studies were used to get life narratives of the beneficiaries and to understand the impact of the project on their socio-economic and cultural lives

v.

2.4 Data collection methods

The sampling type used for data collection was stratified random sampling method. **The primary data** was collected using the following methods, selected as per the above-explained research design:

a. Survey of beneficiaries through questionnaire
b. Semi-structured interview (using interview schedule) and In-depth interviews. The in-depth interviews were open-ended with complete scope for probing and getting detailed information from the participants.
c. Participatory research methods such as transect walk
d. Document analysis (review of project reports)
e. Direct observation (home visit, village/town visit and institution visit)

2.5 Participants of Data Collection

This study emphasizes the obtaining of perspectives from multiple stakeholders. Accordingly, the following participants and stakeholders were covered through the data collection done in this study:

i. Beneficiaries, i.e. people impacted by the project

i. ii. Higher authorities of BCCL, Area GM, Medical Officers

ii. iii. Village level stakeholders (Community Leaders):, Sarpanch, ward members and former Sarpanch

iii. iv. Project In-charge appointed by BCCL (CSR officials) – the monitoring authority involved in the project

2.6 Sampling with Location for Data Collection

Table 1 – Showing sampling of Multipurpose Utilization of Mine Water (MUMW) through Household Survey

Sr No	Village Name	Block	District	Sample Achieved
1	Darda	Baghmara	Dhanbad	82
2	Sidhwatand	Baghmara	Dhanbad	65
3	Behrakhurd	Baghmara	Dhanbad	34
4	Nisithpur	Baghmara	Dhanbad	82
5	Konati	Baghmara	Dhanbad	93
			Total	**356**

Table 2 – Showing sampling of Mobile Medical Van (MMV) through Household Survey

Sr No	Village Name	Block	District	Sample Achieved
1	Karma Tand	Chandrapura	Bokaro	13
2	Patra Kuli	Chandrapura	Bokaro	8
3	Uper Devghara	Baghmara	Dhanbad	15
4	Chhatawad Kailudih	Baghmara	Dhanbad	10

5	Power House	Dhanbad	Dhanbad	26
6	Madhuban	Baghmara	Dhanbad	13
7	Rathtand	Baghmara	Dhanbad	10
8	Chanchpotri	Agra Khurd	Dhanbad	12
9	Barora	Kulti	Bangal	25
10	Mohlidih	Katras	Dhanbad	20
11	Khanodih	Baghmara	Dhanbad	6
12	Bhim Kanali	Baghmara	Dhanbad	3
13	Bakaspura	Baghmara	Dhanbad	10
14	Bhagabandh	Dhanbad	Dhanbad	19
15	Manjhla Dih	Dhanbad	Dhanbad	19
16	Bhatdih	Jhariya	Dhanbad	19
17	Manpur	Chandan Kyari	Bokaro	19
18	Amlabad	Chandan Kyari	Bokaro	19
19	Sona Nagar	Baghmara	Dhanbad	14
20	Mandal Kedwari	Baghmara	Dhanbad	9
21	Gudri Bera	Baghmara	Dhanbad	18
22	Southari	Dhanbad	Dhanbad	19
23	Betenga bandh	Dhanbad	Dhanbad	12
24	Kari Tand	Dhanbad	Dhanbad	7
25	Basjoda	Dhanbad	Dhanbad	24
26	Lavera Manjhi Tola	Jhariya	Dhanbad	20
27	Ranguni	Baghmara	Dhanbad	18
28	Bangali Kothi	Baliyapur	Dhanbad	20
29	Aamtalbauritola	Baliyapur	Dhanbad	18
30	Nunudih	Jhariya	Dhanbad	20

31	Idgah Pathar tola	Jhariya	Dhanbad	20
32	Pathaldih(Pandiya Tola)	Jhariya	Dhanbad	18
			Total	**503**

The Data collection for Lebhara and Road construction were through FGD where the research team intend to capture the live narrative of the beneficiaries impacted by the project, therefore in FDG the interviews mostly consisted of Sarpanch, Village members, Women Representative, Senior citizen, Children, youths and BCCL higher authorities

2.7 Data Analysis

As previously mentioned, this study employs a mixture of qualitative and quantitative methods. Accordingly, SPSS was used for the quantitative data analysis of the study (such as the analysis of the responses of closed-ended questions in the questionnaires). The responses from the in-depth interviews and the other qualitative data were subjected to coding for detecting patterns. The data from interviews and discussions were analyzed **thematically,** and the data from all the sources was integrated as per the responses to understand, assess and evaluate the entire process of implementation. Being a qualitative study, there was an emphasis on understanding and analyzing the perceptions, views and experiences of the beneficiaries and other key stakeholders with respect to the scholarship project.

2.8 Challenges of the study

1. Language Barrier: The major hurdle in data collection was the language barriers, few of the villagers were speaking Bengali, and few were oddia.

2. Limited documentation: The Limited documentation of CSR project was another hurdle faced by the research team as it had to completely rely on primary data. Most of the employees working on the projects were mostly retrained and even in a few projects, documentation was not available.

CHAPTER 3 –MOBILE MEDICAL VAN (SWASTHA RATH)

3.1 Introduction

Health is an important aspect of human life; it plays a very vital role in our social, economic and other spheres of our life. The better the health, the better the other factors. Mobile Medical Van or Swastha Rath was one of the popular projects that aimed at treating the general illness in the command area population of BCCL. The project was initiated with only 2 Mobile Medical Van in 2009, had now covered more than 203 villages with 14 Mobile Medical Vans. The staffs in the van consist of the doctor, paramedical staff and a driver to provide free consultancy and medicine for general illness.

3.2 Objectives of the Project

The objective of the project was to provide medical health facilities with a focus on identification, screening, diagnosis and treatment of general illness by providing free consultancy and medicine.

3.3 Locations of project

The project location covers the command area of BCCL. This includes rural, semi-rural and urban areas. Following is the list of villages and town where the Swastha rath facility is being provided.

Table 3 – Showing list of villages covered under Mobile Medical Van services (Swastha Rath)

SN	Name of Area	Name of Village
1	BARORA	1. PatraKulh 2. Karmatand 3. Manpur 4. Amlabad
2	BLOCK-II	1. Rath Tand Basti 2 Bakaspur Basti 3. Mahato Tola Bhim Canali Basti 4. Khanudih Basti
3	GOVINDPUR	1. Chhatawad Kailudih, 2. Uper Devghara
4	EJ	1. Lavera Manjhi Tola 2. Idgah Pathar tola
5	WJ	1. Moonidih Basti 2. Bhawardaha Basti
6	WWD	1. Southari 2. Betenga bandh 3. Kari Tand
7	KATRAS	1. Alakdiha 2. Mohlidih
8	SIJUA	1. Pandeydih Basti
9	KUSUNDA	1. Lahbera Basti 2. Rawani Basti
10	BASTACOLLA	1. Sonar Basti. 2. Amtal Basti 3. Bangali Kothi
11	PB	1. Surguja Basti 2. Kaligarh Basti
12	LODNA	1. Nunudih Basti 2. Bhatdih
13	CV	1. Bhatnidih 2. Dispur Basti

3.4 Impact of the project on community

i. Door to door accessibility of health service

Due to the lack and poor health services most of the people in the command face difficulties in accessing the health services as services in government CHC, PHC are not up to the mark. The people used to do self-diagnosis and just randomly take medicine from the pharmacist without any proper consent from the doctor and which

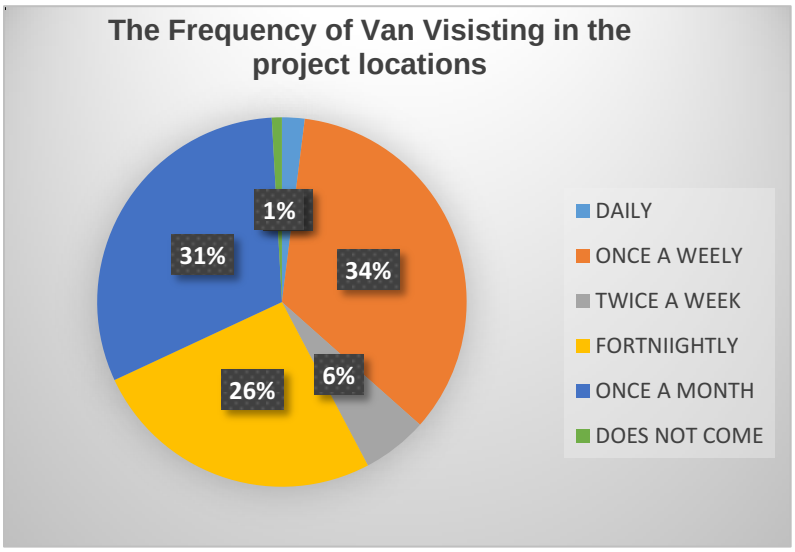

Figure 1 – Frequency of Van Visiting in the project locations

eventually seems to be one of the major cause for the adverse impact on their health. To avoid this and provide basic health care service to the people in the command area of BCCL, Swastha Rath was introduced. The Swastha Rath used to visit at least twice in each village. The respond gathered from the respondent through FGD and HH shows positive impacts of the project on the people in terms of the door to door accessibility of the project.

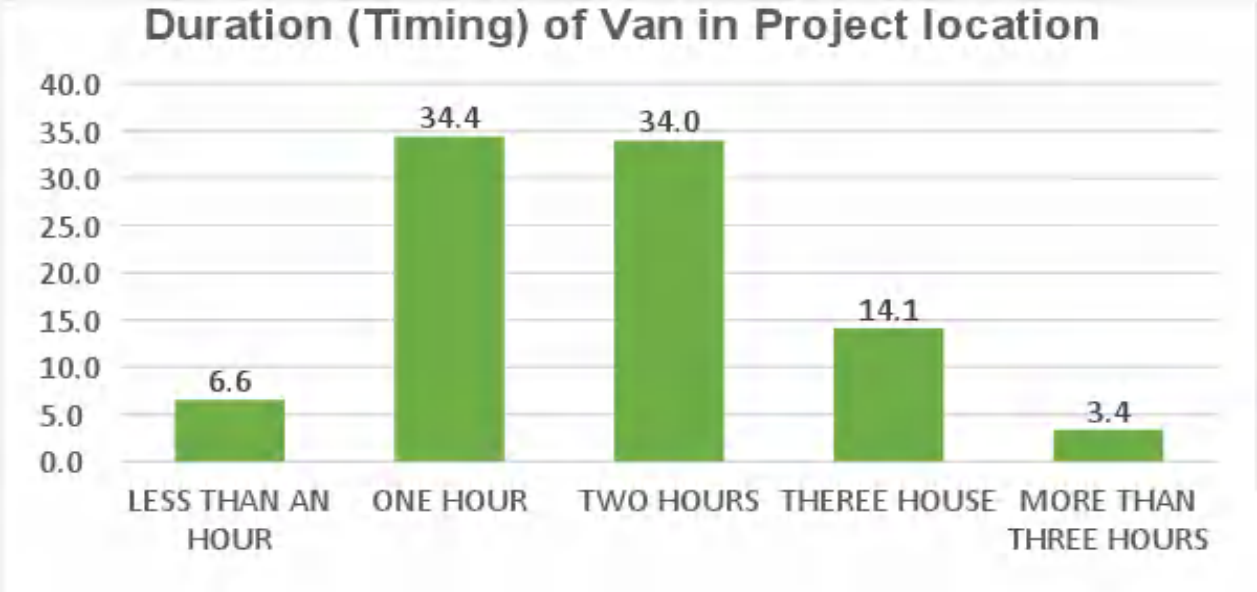

Figure 2 – Duration (Timing) of Van in project location

When interviewed, out of 503 respondents, 93.4 per cent responded that the medical van used to halt on fixed locations. Around 54.9 per cent people reported that the Medical Van had fixed timing and date of visits, which was informed by the Mobile Medical Team prior to its arrival. The locations were selected by keeping in mind the centre point of the villages or near the vital resource area of the villages such as Samaj Mandir, panchayat office etc. 70 % of respondent reported that the Swastha Rath used to wait at least 1 to 2 hours in each village making sure that all the people approaching them are checked and medicines were provided.

When interviewed people regarding the satisfaction of the duration of stay of van in their villages, 47.9 per cent people reported that they are satisfied by the duration (Time) of the van in their villages. Whereas, around 44.1 per cent people responded that they are not satisfied by the timing of the van. Similarly, around 92.8 per cent respondent reported that the location of Swastha rath was easily accessible by them as well as by their family members.

ii. **Filling the gap in health service**

Health is a primary and essential need of human being. It plays an important role in human life. The government hospital lacks in quality health care, infrastructure and accessibility because of which people mostly avoid going to the government-run hospital. To avoid this and provide basic health services, BCCL started Swastha Rath which aims in providing basic health service at the doorstep. Also, the service has enabled people to get access to basic health services at free of cost. Thus the service was a boon to the villagers.

Availability of health services

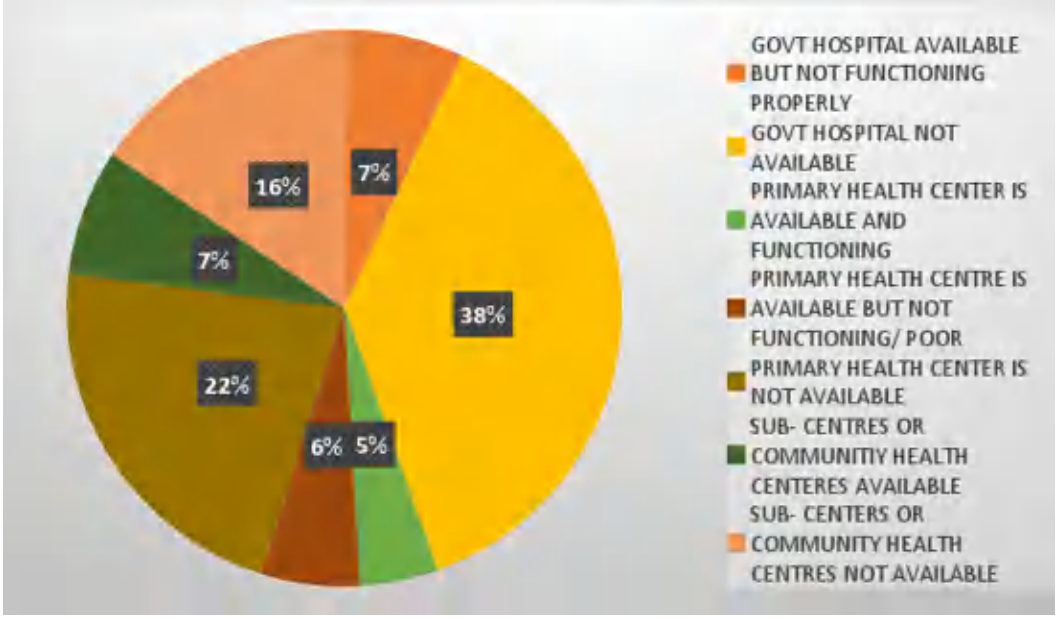

Figure 3 – Availability of health services

The above figure was derived by interviewing 505 households, out of which 38 per cent beneficiaries reported that government hospitals are not available, 22 per cent reported non-availability of primary health center and 16 per cent reported government hospital available but not functioning. Around 90 per cent respondent responded saying the nearest government heath care center is around 6 to 8 km away from their villages. Besides that, one of the major hurdles in reaching the health centre is the non-availability of adequate road infrastructure.

Around 95 per cent of people reported that the roads leading to the PHCs, CHC and Government hospital are mainly kaccha and thus is inaccessible. Therefore by understanding and analyzing the needs of the people regarding health services, BCCL felt the need of starting the Mobile

Medical Van called *Swastha Rathi* that would aim at providing primary health care service to these needy and disadvantaged group on their door step at free of cost.

iii. Awareness about health and hygiene :

Awareness generation was one of the core aspects of Swastha Rath. The MMV team used to provide information regarding healthy surrounding, general cleanness, tuberculosis, maternal and child health care, hygienic water consumption and hygienic sanitation. Many respondent also reported that the team used to practice healthy habits so that people can easily understand. Besides that around 95 per cent people knew that the swastha rath was run by BCCL. And in that around 29 per cent people reported that they came to know about this by seeing the BCCL name on the van.

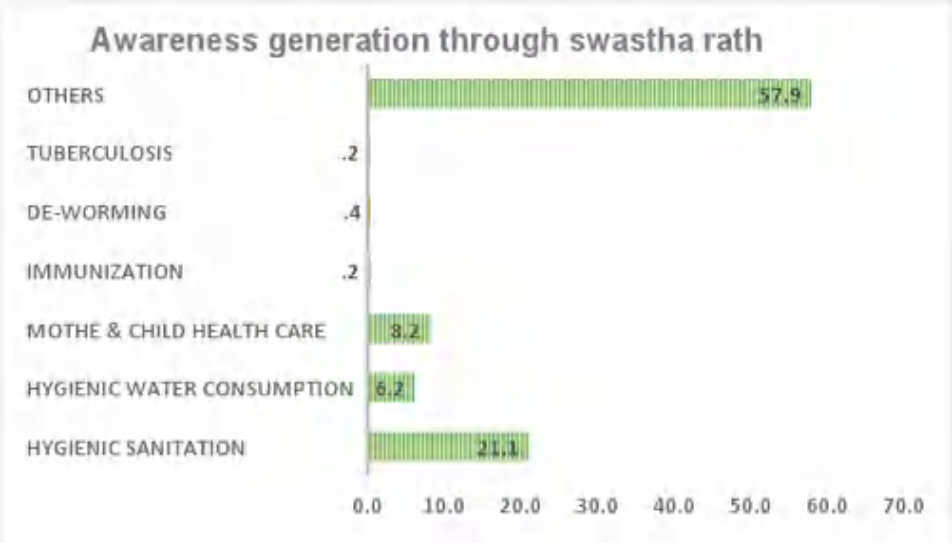

Figure 4 – Awareness generation through swastha Rath

iv. Reduce Economic Burden

Most common disease reported in the region is fever, cough, cold, anaemia, diarrhoea, and skin infection. Since there is no availability of medical services in the entire region, the villagers have to suffer a lot. The average income of the household were not good as the villagers are mainly engaged in agricultural work or work as a labourer. So, their

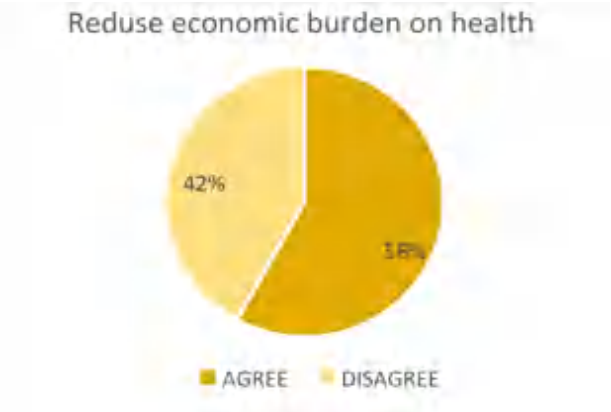

Figure 5 – Reduction in economic burden on health

earning is not sufficient and somehow people manage to survive and fulfil their basic needs. And if someone from family falls ill, then it's a significant economic burden on them to buy medicines because they have to go private hospitals or privately run clinics to purchase medicines even for normal fever or a cough and cold. Therefore, they are thankful to Swastha Rath for providing them medicines and eventually reducing their economic burden.

v. Addressing the health needs of people

Health care services in the entire region are dismal in terms of accessibility, infrastructure and quality. There are only a few Sub Health Centres in the entire area which is functional, but due to lack of such basic medical facilities, people were forced to travel at least 5 to 10 km to avail such medical facilities. Besides that, the transportation system is also very expensive and so accessing the existing health care facilities, which is at a quite long distance, becomes a crucial issue for the villagers. So, Swastha Rath was great hope for them as they are getting services at their doorstep without paying a single penny; in fact, it's saving their money and time as they are getting free services and medicines and also saving their travelling time and transportation cost.

Major ailments in the families

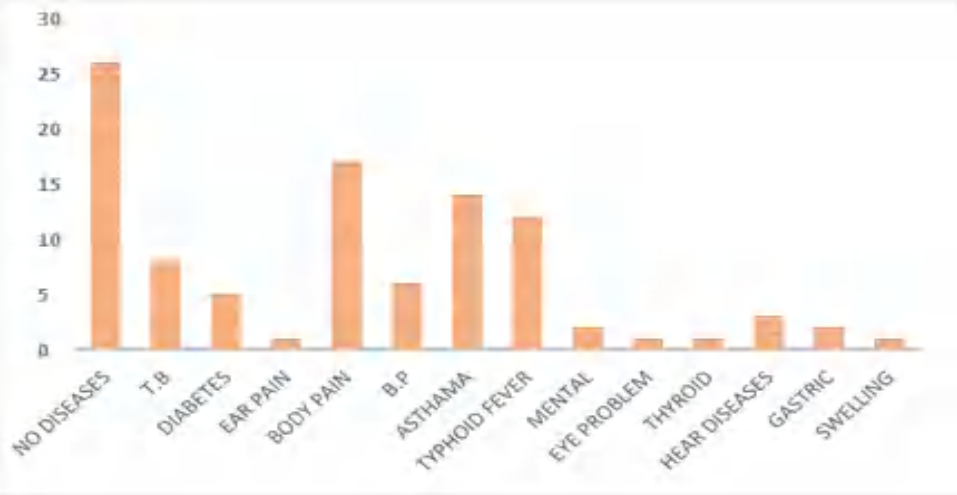

Figure 6 – Major ailments in the families

The major ailments that were reported by the respondent were Body pain, Asthma and Typhoid. When asked further, the respondents replied saying that the working environment and the pollution caused by the open cast mining illness such as respiratory tract infections have had an adverse impact on their health.

vi. Reduction in sickness

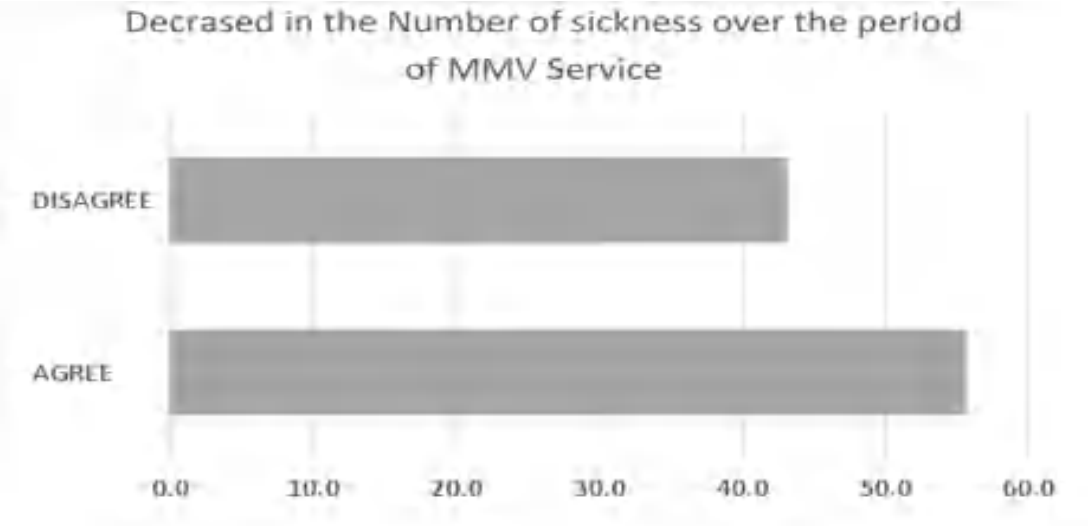

Figure 7 – Decrease in number of sicknesses over the period of MMV service

The above graph shows that 56% of the beneficiaries agreed about the fact that there was decrease in occurrence of sickness over the period of MMV services. While 44% beneficiaries disagreed about this fact.

3.5 Gap identified in the project

a. Limited Regularity of Swastha Rath

Even though the intention of the project was noble, but the regularity was the big hurdle in proper implementation of the project. The Swastha Rath had the target to visit the villages at least twice a month, but during the study it was identified that a few of the places were kept untouched by the project and these areas were mostly near to the colliery areas. As mentioned above around 34 per cent people reported that the Swastha Rath visits once in a week and 31 per cent people reported that it used to report once in a month. The reason for the same reported by medical team of BCCL was availability of limited number of vans. Each BCCL area had only 1 to 2 Swastha Rath. It becomes difficult for the doctors and also to the staffs to reach all the

villages, as each area only gets a van for only 15 days and thus this also limits their accessibility in terms of reaching all the villages.

b. Limited Awareness campaign

In spite of having awareness campaign as the core idea of swastha rath around 93 per cent of people reported that no such awareness campaign has been done by the Swastha Rath. Whereas only 7 per cent of people reported that awareness campaign has been conducted by the Swastha Rath

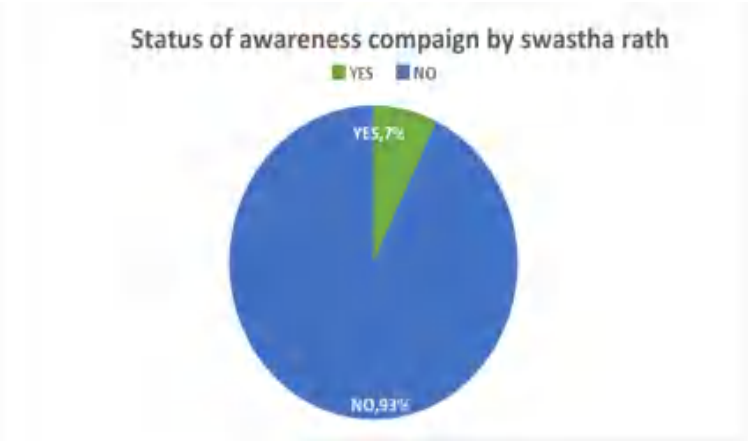

Figure 8 – Status of awareness campaign by Swastha Rath

c. Limited Health Services

The Basic/Primary health services is very limited that is only free health checkup and medicine supply. In some villages, it was also found that the doctor used to visit sometimes and only the pharmacist and the driver use to go and distribute the medicine without any proper diagnosis process being followed. In addition to that blood pressure check and weight checkup were not conducted. At the village level, there was no appointed person who could look after the health services in absences of Swastha Rath. Around 99 per cent people raised the concerns stating that there is scope for improvement and enhancement of the Swastha Rath. 3.6

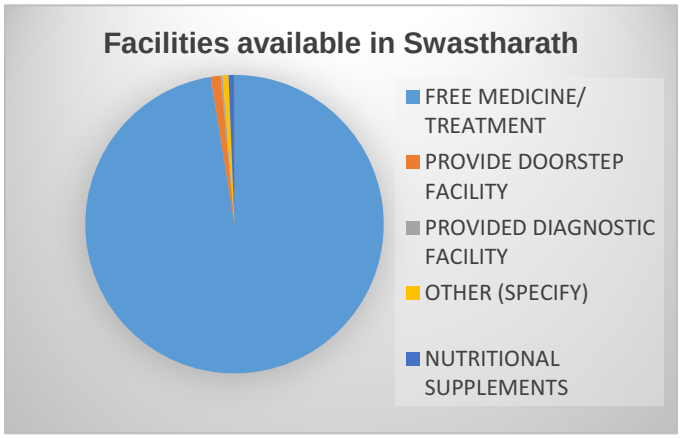

Figure 9 – Facilities available in Swastha Rath

Multi-stakeholder Perspective on Swastha Rath

a. **BCCL Officials:** BCCL being a responsible corporate in Dhanbad region had always been active in providing basic health services to the people of the company's command area since a long time. Therefore BCCL started Swastha Rath with the intention of providing basic health care service in the remote areas for those who are unable to access them or afford them. Besides that, the company aims at creating general awareness about health and hygiene. The Project was run in 206 villages and has targeted more than 2 lakhs people.

b. **Village People:** The Swastha Rath was very useful. It has helped the villagers in many ways. The accessibility of health care has increased as medicines and treatments are being provided free of cost at their doorstep. The economic burden has been reduced. Now people neither travel nor go to the private hospitals and clinics. At the same time, the cost of the travelling is also being saved. Along with this various awareness campaign are conducted wherein the people are being provided with the informations regarding health and hygiene.

3.6 Beneficiaries' point of view on Swastha Rath

3.6.1 Vinay Bhal, 49 year old: a resident of fulwar basti is a laborer in coal mine says "Since the time Swastha Rath had started coming we are very happy because we are staying here for a very long time and health is the major problem that we are facing. The nearest Sub-centre is around 8 km away and that too is not in good condition. It was difficult for us to travel so long, with no other option left, we used to go to local pharmacy and tell them our sickness, and accordingly they use to give us the medicine, and we use to have it. Swastha Rath comes in the village twice a month and provides us medicines free of cost. They treat us all. The doctor behaviour is good. He checks us and also make us aware of the health and hygienic conditions in we should dwell. Since Swastha Rath started coming to our village, our money is being saved and also the medicines are effective".

3.6.2 Meena Rahman 25 year old, resident of Amlabad village says: "Coming from a poor background we are unable to afford to go to private clinics or hospitals. The nearest government Sub-centre is around 7 km away. From where do we bring the money? We work as a wage earner. There is no guarantee of the job. We would get tomorrow or not, we don't know. Thanks to BCCL Swastha Rath! Since the time it has started coming to the village, the economic burden of health has been reduced. We get free treatment and medicines. The van comes twice a month and check all of us. Now we don't get worried so much as the van comes and check us and treat us for free."

3.7 Recommendation of the project

1. **Frequency of the Swasth Rath Should be Increased**

One of the most important demands that came from the public was that the frequency of the Rath should be increased. As it was supposed to visit the targeted villages twice a month, but as mentioned previously that the Rath was unable to visit a few villages. Similarly in many villages, the Rath only visited once in two to three months. Therefore the frequency of the Rath should be increased and should be available in the areas/ villages where it is needed the most and also the availability should be increased.

Frequency of Swastha Rath in Village

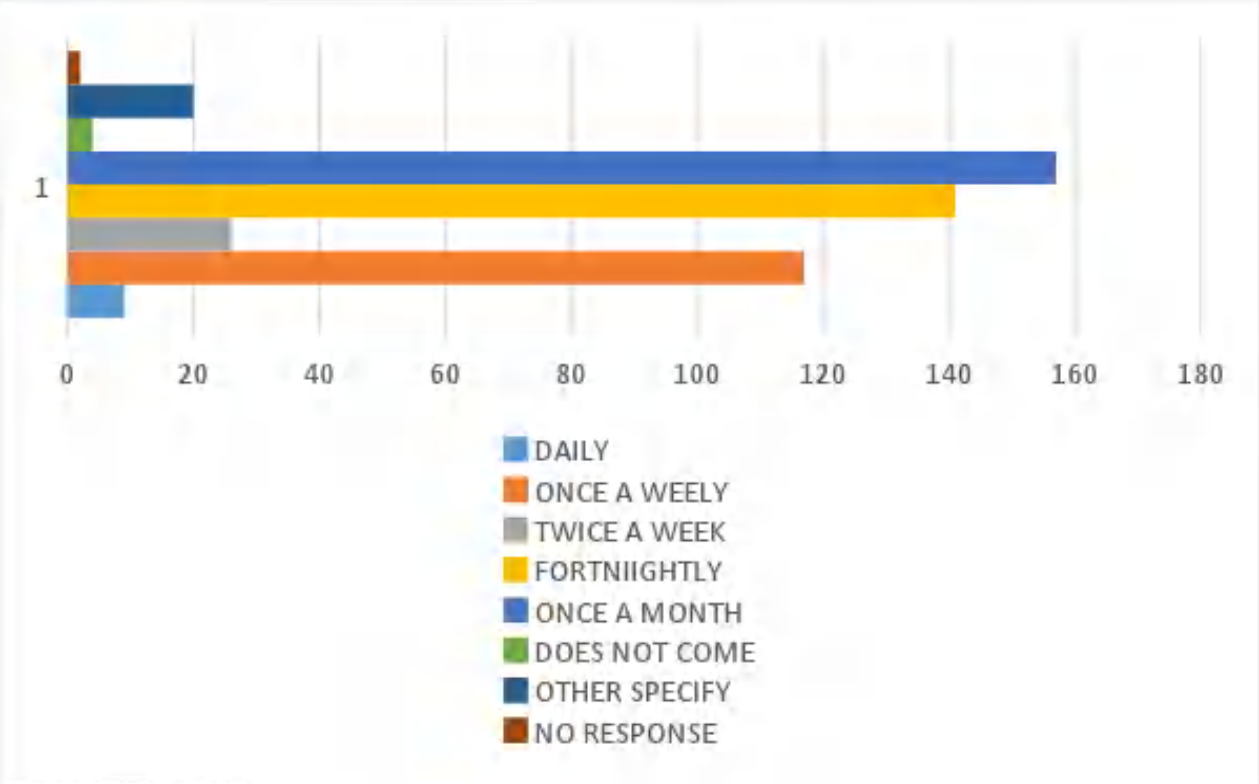

Figure 10 – Frequency of Swastha Rath

The above graph highlights that the frequency of Swastha Rath in the targeted village. Around 157 people responded that the Swastha Rath came once in a month, whereas 141 respondents reported that the Swastha Rath used to come once in fortnight. Again, around 117 people reported that every once a week the Swastha Rath used to come.

2. Need for female doctor and nurse

It was highlighted by the statistical data that out of 500 samples 99.8 per cent reported that there is a need for female doctors and nurses in the Swastha Rath as the women feel uncomfortable to open up their sicknesses in front of male doctors.

3. Need of a health worker at the village level

It is recommended that there should be a health worker appointed at the village level that would look after the health services and status of the village and subsequently could report to the nearest BCCL regional or area hospital. At the same time, medical stock should be provided to this appointed health worker, who in times of emergency could provide necessary medicines as per the need of the villagers.

ii. 4. Necessary Provision for Emergency

Around 98.5 per cent of people responded the need of emergency services in Swastha Rath, and this could be done by printing the emergency helpline number on the van so that during the emergency the people can avail the services.

iii. 5. Need of Additional Services

Additional services such as blood pressure check, BMI, Weight test and malnutrition test should be conducted and if significant issues found in the test results, then further treatment should also be provided to the beneficiaries by referring them to the nearby BCCL area hospitals.

CHAPTER 4 – MULTIPURPOSE UTILIZATION OF MINE WATER

4.1 Background of the project

Since its inception, BCCL has felt the importance of water and endeavoured for effective and gainful utilisation of mine water from abandoned mines which has to be taken out of course of mining process necessarily. For harnessing such water, BCCL has taken upon the task of holding the mine water into the water bodies by restricting them to flow into the natural drainage course like village reservoirs which gets dried during summers, by laying out a pipeline network of approximately 45 km.

With the help of this scheme, approximately 47 million gallon surplus mine water is presently being discharged into natural water courses from the mines of Barora, Block-II & Govindpur areas of BCCL. This water is being stored in two reservoirs situated in Khonathi and Behrakudar villages with storage capacities 16 million gallon & 31 million gallon and with area of about 4.0 ha & 4.5 ha respectively.

Under this scheme of BCCL, the farmers residing nearby and having their cultivation fields in reasonable proximity will benefit in carrying out their agricultural works, in all seasons, which at present is totally dependent on rainwater in monsoon.

This provision will certainly enhance the Socio-Economic status of the area and will also result in more opportunities in secondary & tertiary fields of employment. This water could also be used for drinking purposes after required treatment. In these reservoirs, Pisciculture could also be adopted with the help of self-help groups for their livelihood.

4.2 Objective of the project

To harness mine water for its gainful multipurpose utilisation in the peripheral villages of BCCL command area.

4.3 Location of Implementation

Two reservoirs situated in Khonathi and Behrakudar villages of Baghmara block of Dhanbad district.

4.4 Study sample details

Out of the 352 samples collected by the research team in the villages near the two ponds in Baghmara block, 72 per cent respondents belong to the OBC category while SC makes up 10.5 per cent of the sample studied. Again, 8.2 per cent are Scheduled Tribe and 7.4 per cent belong to the General category. Apart from these categories, a few samples from Nomadic Tribe and Denotified Tribe (around 0.9% each) were also taken into consideration for the study.

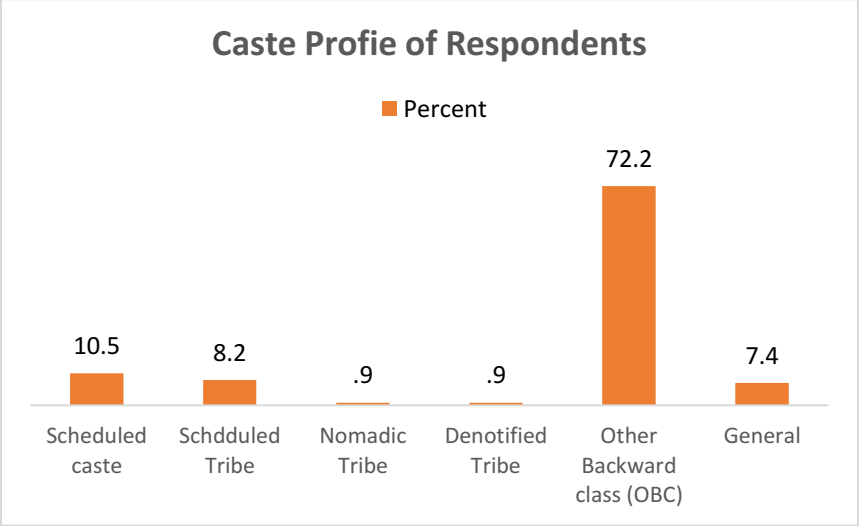

Figure 11 – Caste profile of respondents

42.3 per cent respondents reside in 'pucca' houses while 34.1 per cent resides in semi-pucca houses. 15.3 per cent respondents owned kutcha houses, and 8.2 per cent of the respondents reside in huts. Focused Group Discussions revealed that houses in the villages were not accurate depictions of income and wealth of respondents as the most of the houses were inherited which housed two to three families dwelling together, i.e. 10-15 people in a two bedroom house. Therefore, the respondents staying in houses made of brick and mortar do not necessarily have high-income sources. Electrification of the villages has been a success as 92.9 per cent of the respondents' houses were electrified although the electricity is supplied for 3-4 hours daily. Open defecation is an overarching phenomenon in the villages with 51.7 per cent of respondents opt for this option while 41.5 per cent use their pit toilets.

Private sources of water are scarce as 45.2 per cent of respondents rely on community hand-pump for their potable water needs. While the quality of water could not be ascertained, 38.6 per cent respondents boil the water as a method of water purification, 16.5 per cent respondents sieve the water, and 6.3 per cent do not do anything for water purification.

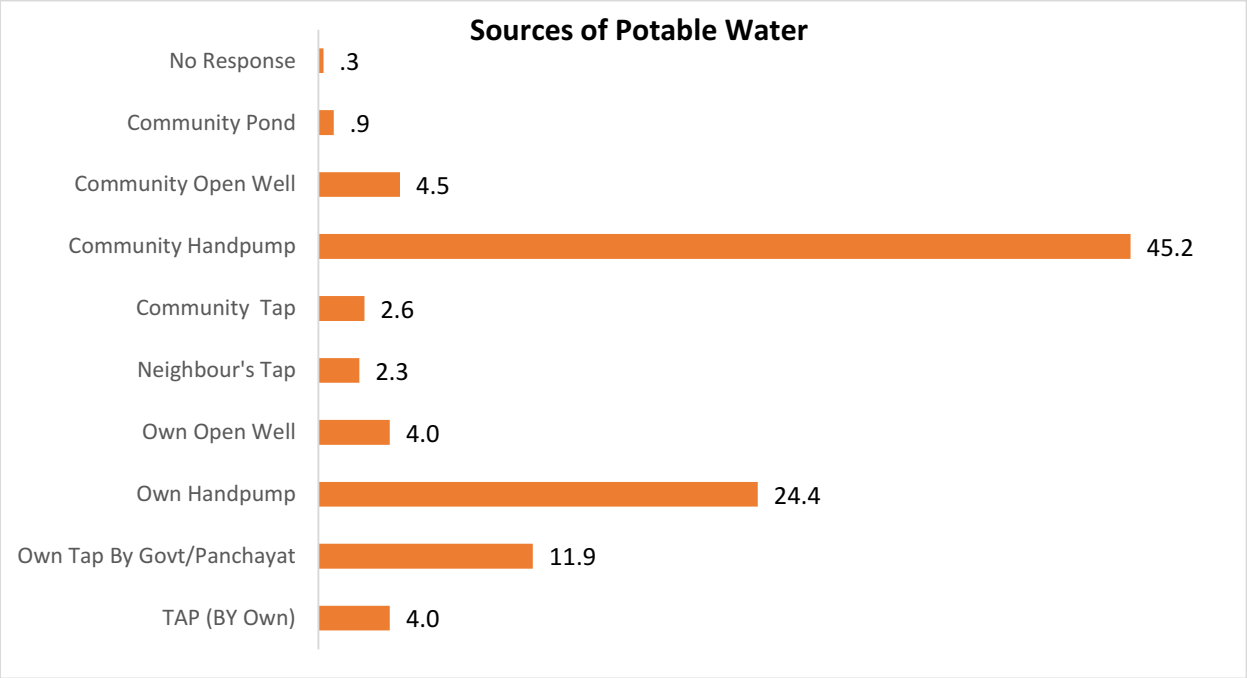

Figure 12 – Sources of potable water

4.5 Impact on the community

i. Use of Mine water supply for filling ponds

The respondents are compelled to use whatever water is available to them for their daily needs. To wash clothes, 49.4 per cent respondents use the mine water ponds while only 0.3 per cent respondents use the ponds for agricultural activities.

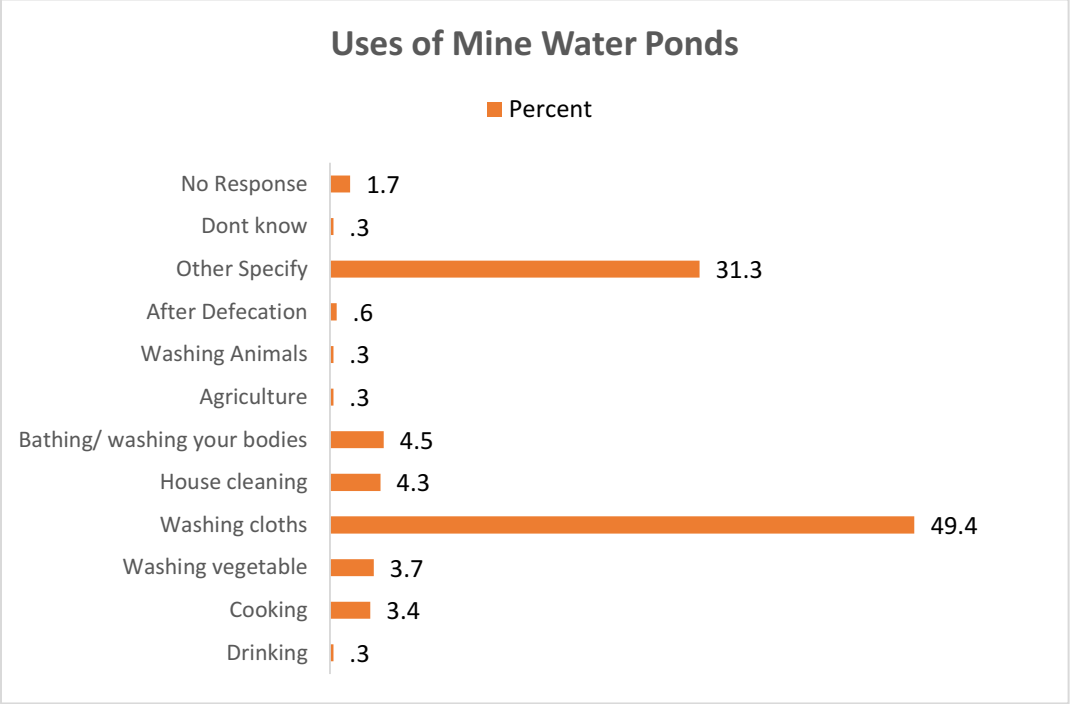

Figure 13 – Uses of mine water ponds

ii. Land holdings and irrigation sources

64.5 per cent respondents claimed they owned agricultural land while 35.5 per cent were found landless. According to the landed respondents, 35.5 per cent of them use the mine water pond for irrigation while 4 per cent have no sources of irrigation. Borewells near the farmland are another source of irrigation which is depicted in the 'other' category in figure no 14. The major crops grown by the respondents are paddy (65.3 per cent), vegetables (21 per cent) and maize (11.3 per cent).

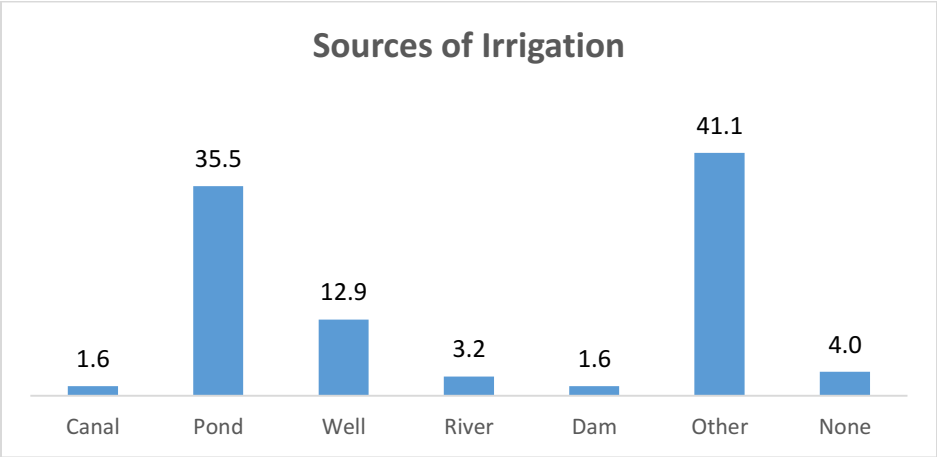

Figure 14 – Sources of irrigation

iii. Renovation activities of the ponds:

For the impact assessment study, it is primarily important to gauge the opinions and perceptions of the beneficiaries about the mine water ponds. BCCL has been operational in the Baghmara block for several years and has created a rapport with the residents of the villages. Therefore 59.1 per cent respondents knew that the mine water was drained into ponds. The respondents were enquired about the activities done by BCCL for the pond. 54.3 per cent of them knew that embankment or stone pitching was done around the bank, while 17 per cent knew that the *ghats*/stairs were constructed. 16.8 per cent respondents did not knew any of these activities, mainly due to the farther distance from the pond or not being present at the time, etc.

Table 4 – Beneficiaries awareness about activities done by BCCL for the pond

Activity	Percentage of respondent responses
Embankment or stone pitching around the bank	54.3
Inlet and Outlets	2.6
Ghats/Stairs	17.0
Repair	8.5
Don't know any of the above	16.2
Don't know	.6
No Response	.9
Total	100.0

Approximately 70 per cent of beneficiaries came to know about the renovation of the pond by physically observing the activities while 9.1 per cent came to know through the display boards put up by BCCL. Only 2.3 per cent were informed in the *gram sabha*.

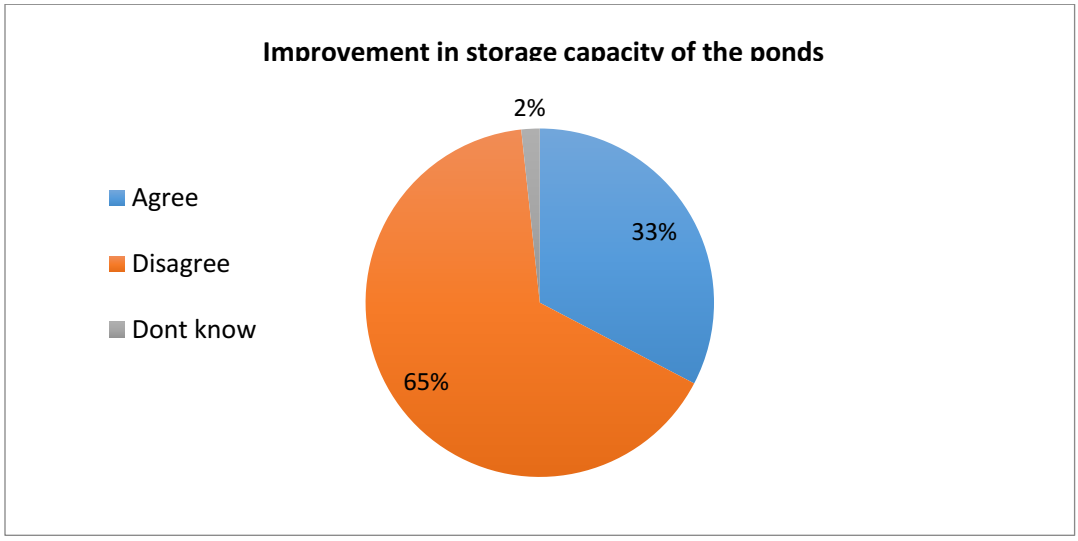

Figure 15 – Improvement in storage capacity of the ponds

It is of great importance that the beneficiaries are being involved in the planning process of a project so that their needs and problems are accounted during the intervention.

During FGDs it was found that heavy machinery such as excavators, loaders and trucks were used to finish the work in less than ten days as manual labour would have extended the time of completion of work to 30-35 days. It was also mentioned that the work in one of the ponds was proposed to be carried out in monsoon. But due to monsoon, the pond was full of water and therefore many areas in the pond was left unexcavated.

4.6 Gaps Identified

i. Minimal improvement in storage capacity

During the discussions, it was discovered that the ponds lie in the natural catchment area of rainwater, therefore, the water in the ponds did not dried up during the summer season before the renovation.

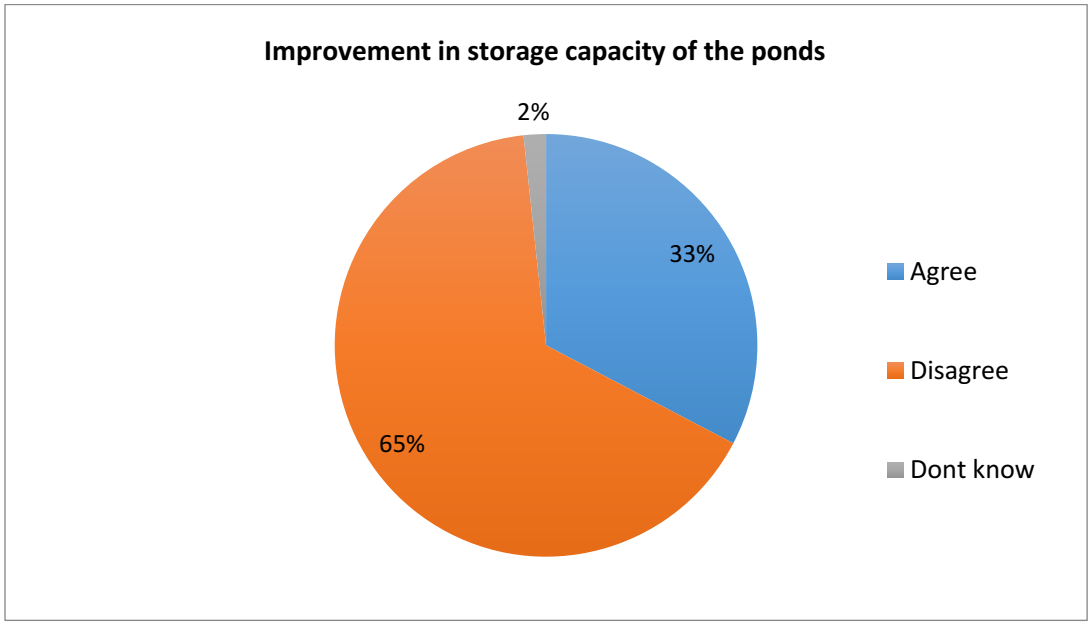

Figure 16 - Improvement in storage capacity of the ponds

Even though the ponds do not dry up, the water is scarce and the population depending on it for routine activities is increasing every year. Respondents also shared that they have to skip bathing for many days so as to preserve water for cooking and drinking. Therefore, 65.6 per cent of the respondents disagreed when asked about the improvement in storage capacity after the renovation of ponds. Also, as evident in Figure 17, 69.3 per cent respondents states that the scarcity of water has not reduced.

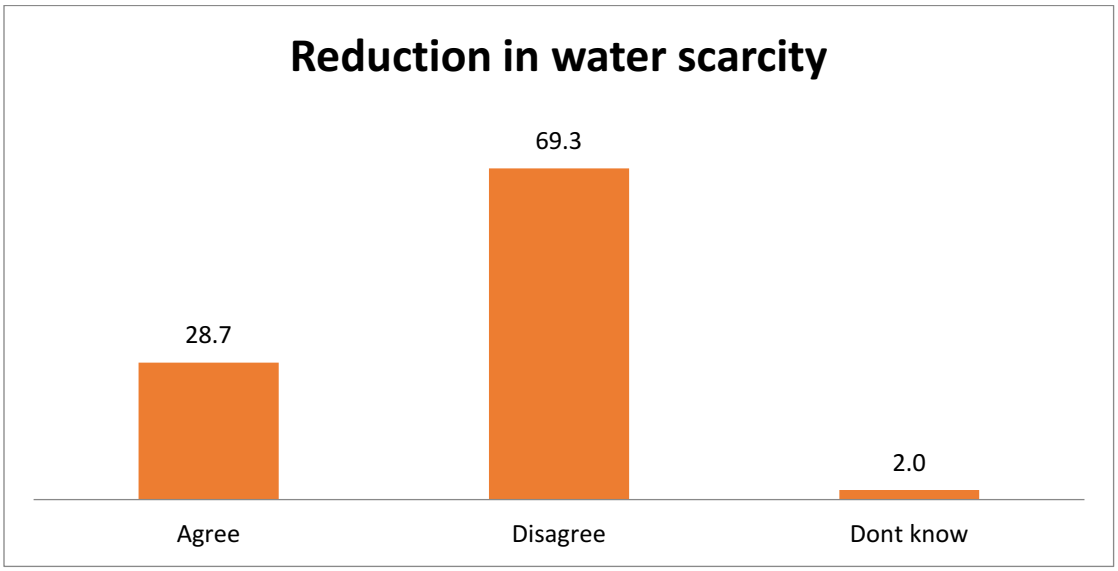

Figure 17 – Reduction in water scarcity

ii. Lack of employment generation activities

Employment generation would have been an important gainful use from the ponds as duckery and fishery activities were proposed in the project. But 92.3 per cent respondents feel that no new job opportunities have been created with the renovation of the ponds.

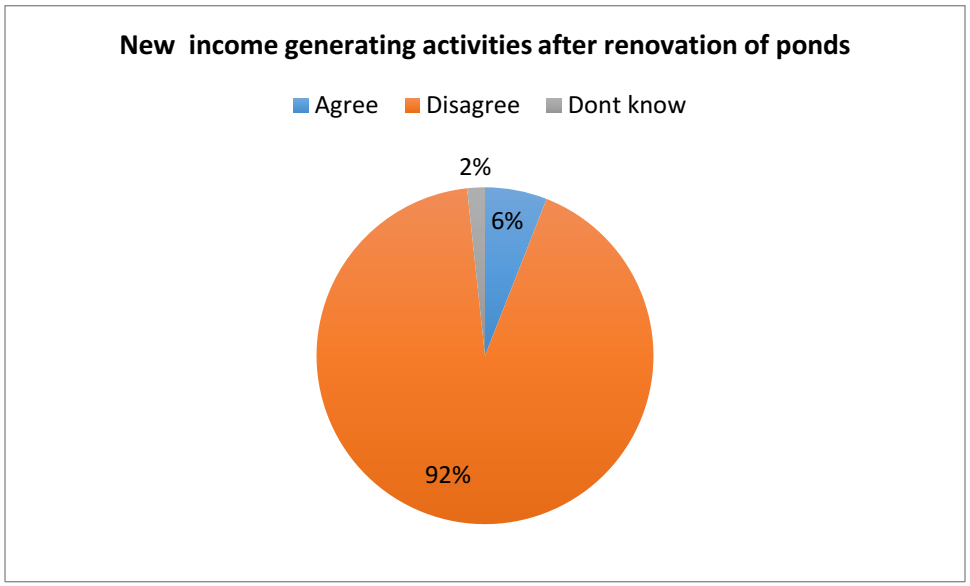

Figure 18 - New income generating activities after renovation of ponds

The respondents also stated their concern to the research team that these gainful activities are being carried out by contractors for their profits, and therefore, the villagers are unofficially banned from carrying out these activities.

iii. Minimal increase in agricultural production

Further, 86.6 per cent respondents believe that the pond has not aided in critical irrigation requirements as there are farmlands of hardly four to five farmers near the pond. Most of th e farmlands are significantly at greater distances. In such cases, the cost of machinery to lift the water to these far away farms is high that residents avoid taking water for irrigation from these ponds. Therefore, the number of crops grown per year by most of the respondents has also remained unchanged after the renovation of ponds.

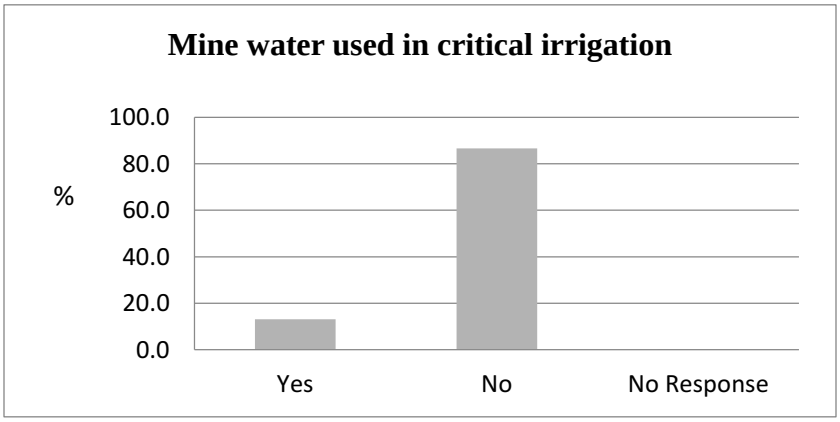

Figure 19 – Mine water used in critical irrigation

As per 90.3 respondents, agricultural production does not happen beyond personal consumption. As a result, the small and marginal farmers go to cities in search of work at least 15 days a month in order to feed their families.

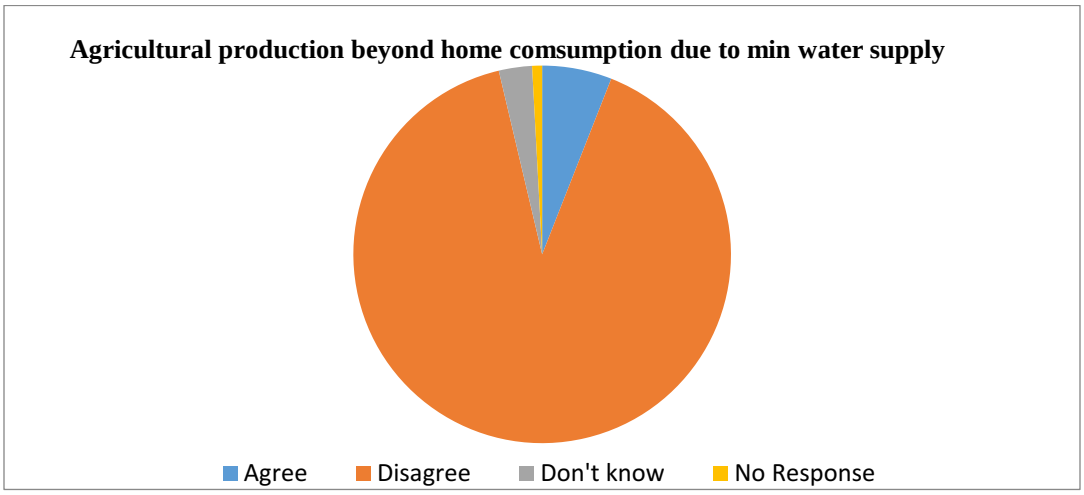

Figure 20 - Agricultural production beyond home consumption due to min water supply

Therefore, when asked if there has been a cumulative increase in the income of the household post- renovation of ponds, 94.9 per cent of the respondents replied negatively.

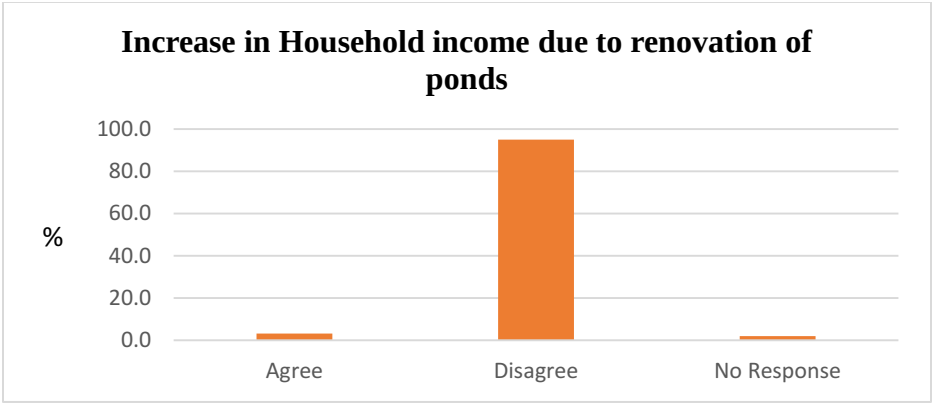

Figure 21 - Increase in Household income due to renovation of ponds

iv. Irregular supply of mine water

Another motive of conducting the impact assessment of this project was to find out from the beneficiaries whether there is any need of improvement in the projects and in which areas. In FGDs, respondents overwhelming suggested that there is an urgent need for improvement in the project in terms of mine water supply. Officially, 70 per cent respondents did not know how often the mine water is being supplied, but 83.2 per cent respondents agreed that there should be a timely supply of mine water.

v. Lack of participatory planning

94.3 per cent respondents claim that no village meeting was conducted before the supply of mine water in the ponds. This highlights the lack of participatory nature of the activity. It can further be showcased when the respondents were asked regarding their participation through *shramdaan* (voluntary labour) and 84.9 per cent responded negatively. Apart from these concerns, 51.1 per cent of the respondents did not know who carries out repair and maintenance of ponds, while 8.8 per cent claimed that BCCL is responsible for the same.

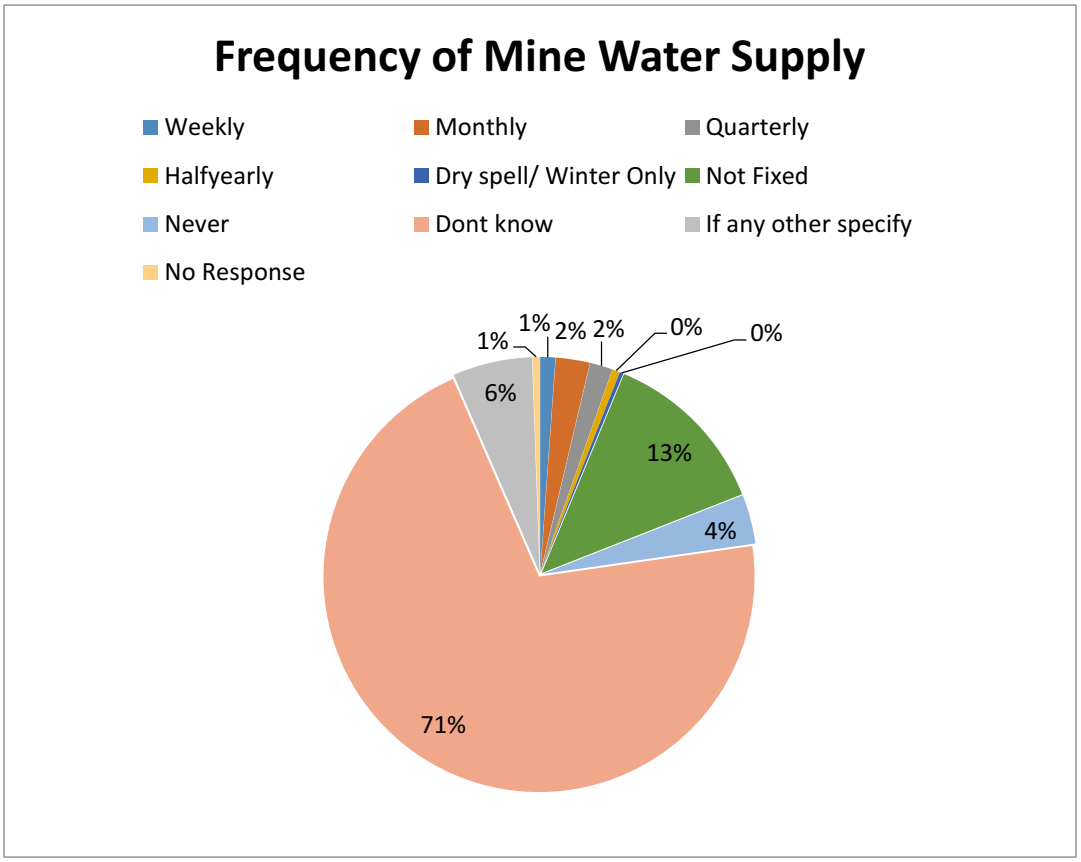

Figure 22 – Frequency of mine water supply

The respondents stated that since the renovation of the pond had taken place, only two or three times the mine water had been supplied. And eventually it was not sufficient for consumption by all the beneficiaries of the ponds.

Table 5 – Beneficiaries response on last supply of mine water.

Last supply of mine water	Percentage
Last three months	.6
Last six months	1.7
Last one year	9.1
More than a Year	47.2
Don't know	40.1
No Response	1.4
Total	100.0

It is of utmost importance to note that 94.3 per cent of the respondents want BCCL to resume supplying mine water to the ponds as they believe that even though there may be no short-term benefits of the project, long-term benefits will help the future generations in leading a better quality of life.

4.7 Recommendations

Due to various reasons, mine water supply to both the ponds has been halted for the past one year. According to the beneficiaries, they have not been able to reap any benefits from the projects. In the project proposal, 25000+ beneficiaries were identified who would be able to avail the benefits of the mine water supply project. However, it was found that only around 1000 families were able to use the ponds. Also, the project proposal had stated further highlighting that the beneficiaries would see a marked improvement in the household income after the pond renovation as they will be able to carry out multiple income generating activities. But as of now, the beneficiaries uses the ponds for only household consumption which was the case prior to the pond renovation as well. Overall, they insist that the mine water project was a fruitful venture but the supply of mine water is insufficient to bring about a change in their income or general quality of life.

Following are the main recommendations for the improvement of the Mine Water supply project:

- Participatory approach: Participatory project development is necessary to gauge the perception and needs of the beneficiarie,s and hence the project needs to be modelled around that.
- Pond upkeep: Repairs and maintenance of the ponds need to be carried out regularly with an immediate attention to Khonati pond as one of the pipes laid near this pond has been damaged.
- Sharing of information: For proper dissemination of the information regarding project cost, project details and maps, boards need to be put up at various locations so that damage to the pipelines could be avoided.
- Focus on employment generation: A plan needs to be developed to ensure effective utilisation of the mine water supplied to the ponds which would subsequently lead to augmentation of household incomes of the beneficiaries.
- BCCL should conduct a cost-benefit analysis as well as Social Return on Investments (SROI) analysis in such large-scale projects.

CHAPTER 5 - VILLAGE ADOPTION PROJECT (LAHBERA)

5.1 Introduction

Lahbera, a village situated in Jharia block of Dhanbad district, Jharkhand is one of the centers attraction of BCCL CSR activities. The village mainly consists of the tribal population of 392 people with 63 households. The charm of this project lies in many facts, one of which is the integrated module of development experimented by the BCCL. The BCCL adopted the village in the year 2009 with an intention of integrated development of tribal for their economic and social development through various schemes and program run by them. As the part of the CSR activities, various infrastructural and economic projects were set up that could help the villagers in their economic development.

5.2 Objectives of the Study

The main objectives of the project is to develop the selected village in an integrated manner ensuring its holistic and integrated development through capacity building and participation of local people and institutions, and this is done through establishing and creating various infrastructures such as:

a. *Construction of Primary School*
b. *Masala Chakki,*
c. *Health Centre*
d. *Sewing Training Centre*
e. *Multipurpose Hall*
f. *Adult Education Centre*
g. *Pipeline for water supplies*
h. *PCC Road and Drainage lines*
i. *Solar lights*
j. *Playground*

5.3 **Projects and their Impacts**

I. Multipurpose Hall

The hall as its name suggest was used for multiple reasons. It was constructed in the year 2009. It is located in the premises of playground and having the area of approx 800 – 1000 sq ft. The amount invested in this infrastructure was Rs.650851/-. The hall is used for various programs such as conducting health camps, adult education centre, village meetings, social gatherings, marriages, family functions and various other programs. The hall was equipped with tube lights, fans and toilet facilities that have impressed the people, utilizing it for various purposes.

Beneficiaries' viewpoint

Meera Marandi, a residence of labhera village says: 'this hall has helped us a lot, especially during our adult education centre; we use to come here daily at 4 pm and study till 6 pm. Not only this, we also used hall for various occasions such as marriages, meetings and other family functions. She also added further admitting that her brother marriage was also fixed here. When we were small, our family used to have functions in our aangana. But after the hall was constructed we are utilizing it for many purposes, and it does not cost us anything as it is free for us. When asked for maintenance, Meera said that usually BCCL looks into it. But she feels it's also her's responsibility to take care of the hall as it is very beneficial for them.

II. Adult Education Centre

The Center started in the year 2009 and was run by the two mentors which were appointed to teach by the BCCL. The aim of the Centre was to provide basic and primary education skill sets to those who were unable to get benefit from the regular education system but were dedicated to learn. The classes were held in the hall where 150 students including young girls and married women were taught in one batch, from 4 pm to 6 pm, for five days a week. The course design was from simple to complex or from known to unknown. The classes include subjects that were related to the daily life of people such as basic mathematics and hindi. Besides that, subject such as English was also encouraged. The session on gender sensitization and human biology were also being taught. Teaching and writing skills to the women was one of the important aspects of the AEC. Girls and women used to like the classes and the mentor's way of teaching.

Beneficiaries' viewpoint

Rani, a construal laborer in a mine and also the residences of lahbera village says: 'from the time the classes had started, I used to come here for studying. Coming from a poor family, I was unable to get school education as I had to assist my parents in coal mines. I wanted to study, but my family condition didn't allow me. Then through BCCL, we got this education centre, where the master used to teach us - how to speak, read and write. In the beginning, I was very shy but then the master always used to motivate me and call me in front and asked me to talk about myself. I used to be very shy and reluctant. But gradually I started speaking and slowly writing and reading too. Now, I also understand basic maths that helps me to calculate the numbers of days my friends and I work and the salary we deserve for it.Earlier we used to be paid less. Because of these classes, I feel empowered and confident now. I can directly speak to my malik

(Boss) and other people.' Rani now feels she is empowered and also has the courage. She also motivates other girls like her to come and join the classes. But it is unfortunate that the classes are not running now as the salary of a few of the mentors has not been paid yet by the BCCL. Hence, the mentors have stopped coming to teach.

III. Health Centre

The Health Centre was also established in the year 2009 and was operation till 2015. The aim of this project was to provide primary health care services to the people of lahbera village. The total cost of construction of health centre was Rs.373096/-. The Health Centre was used to run with the help of the Kusuda Area Medical team. The team consisting of doctors and nurses used to visit the hospital on a regular basis. The health team used to provide services such as consultations and medicine free of cost to all the villagers. Besides that, services such as blood pressure checking and weight measurement were also been provided. In addition to these services, awareness generation on health and hygiene was also provided periodically. The timing of the hospital was mostly 11 am to 2 pm. In case of emergency, the case was transferred to

Kusuma area hospital for further treatment. Health camps were also organized in the village whereby services such as eye checkup and other primary health care treatment were provided. When the research team asked the people about the medical services, a common replay come from all of them was that, 'the health centre must start again'. The impact of this health services was not only limited to the lahbera village, but it was also beneficial for the people from the nearby villages. From the response that the team got from the people states that medicines were mostly provided on general and seasonal illness. And for terminal sickness, the patients were recommended to visit the regional hospitals or the central hospital in Dhanbad.

Beneficiaries' viewpoint

Ravi Mhatto, a residence of lahbera says: 'the health centre was very helpful for us. In the older days we have walk a few kilometres to get access to the health services. Most of the people use to just go to the medical shop and ask for the medicines, and the shopkeeper just used to give them medicines without any knowledge about the sickness. But, when the health centre started, people started coming here. They used to get free treatment and medicines. The doctor's behaviour was also good and kind. But from past few years, the health centre is closed. Since then, it's the same condition as before.' He added: 'we are adopted village and health is the most basic things that we need. We request BCCL that they should start the health centre once again'.

IV. Masala Chakki

Masala Chakki was one of the economic empowerment projects of BCCL. BCCL had provided the Masala Chakki to the villages. The total cost spend on the masala chakki project was Rs.394918/-, and it was run by the group formed by the villagers itself, consisting both male and female members of villages. The aim of Masala Chakki project was to provide self-employment and develop entrepreneurship at the village level. The Masala Chakki was operational only for a few weeks after which the group stopped it. The reasons highlighted for the same was that there was no market linkages, no proper monitoring and no guidance to run the Chakki and even no proper financial management. Hence, it was nonfunctional project as said by the people.

V. Sewing Training Centre

The Sewing Training Centre was another economic empowerment activity of BCCL which intended to provide sewing skills sets to young girls and women through practical teaching. The course was started in the year 2009. The investment made by the BCCL CSR was Rs.378459/-.

The centre was run in collaboration with BCCL CSR and Nari Shakti Samiti, a branch of women development of BCCL. The training was provided to girls and women from the lahbera village which was free of cost but for other participants from nearby villagers was Rs.50/- for admission and Rs.25/- as monthly fees. The training was taught by the two mentors appointed by the BCCL and Nari Shakti Samiti. The training consisted of sewing training of various types such as dress, fall biding, bed sheets and a few others. The total batches run till now were two with the targeted beneficiaries of 156. After the completion of course, a certificate was also issued to the participants. The duration of the first batch was for nine months and for the second batch was six months. The training program also had the practical exam whereby the participants were told to demonstrate the skills that they had learned during the sewing classes.

Beneficiaries' viewpoint

'I did not know what is called sewing', says Nelam Marandi, a girl of 18 years coming from a poor family. She only got a chance to educate herself till STD 4 after which she was told to assist her family by working with them in coal mines. Nelam was very much fond of clothes, especially designing and sewing. But due to no proper skill sets she used to get disappointed. Since the sewing course had started, she joined in. She was the student of the first batch. Over a period of months she started enjoying the training program as it was something that she liked. She learned about different type of fabric cloth, stitching, dress designs and much more. Over the period, she was empowered. Her skills in sewing was improved considerably, along with that her confidence too! After completing the course, she got a job of the assistant tailor in a tailor shop where she experimented her skills and also gathered enough money to buy a new sewing machine for her'. She says, 'I was working hard, saved the money which I got from my job and bought a machine for me. Now, I work from home and I earn around Rs.2000/- a month from this'. She was very thankful to the training centre and also motivated many others like her.

VI. Solar Lights

As on paper, 20 stands of solar lights were to be installed in and around village. But on field, it was observed that only 6 solar lights were present and that too around the corner of the park. Also, the batteries of these 6 solar lights stands were stolen and thus it was not functioning.

VII. Primary School Building

One of the major infrastructural developments in Lahbera was the primary school building. As per the information obtained from the residents, the school was constructed in 2014 but not yet inaugurated. The school intended in providing primary education to the children of lahbera village and other nearby villages. Since the construction had been completed, the school building is not being inaugurated and thus left abandoned.

VIII. Computer Training Center

The centre was started in collaboration with Nari Shakti Samiti and BCCL CSR. Around eight computers were provided to Lehbera CTP. The purpose of the project was to develope IT skills among the youths of Lahbera. The project was functional only for a few months, without any expected outcome.

IX. Drainage line and PCC Road

The Construction of Drainage line and PCC Road in Lahbera covered only a particular region of the whole village. The drainage line physically observed was less than 400 metres, and half the work of the drainage system had been left incomplete. Same was the case with the PCC road construction. A few areas of the village had incomplete road construction as well as unrepaired kaccha roads. The amount of money spent on drainage line and PCC road was Rs.7, 27,949/-.

X. Water supply

Before the village had been adopted, it was facing water scarcity issues. The villagers had to walk a few kilometres to fetch water. The situation didn't change even after the adoption. BCCL installed only three water pipelines that were observed on the field against the population of 392 peoples. As observed on the field, the water flow was very slow and also the water supply was only for 3 hours a day. In place of taps, BCCL had just provided a pipe with no proper measures to control the flow of water and to avoid the wastage of water. The total cost spent on the project seems to be more considering the negligible impact caused by it.

5.4 Multi-stakeholder Perspectives on village Adoption project

Table 6 – Multi – stakeholder perspectives on village adoption project

Projects	Villagers	BCCL
Multipurpose Hall	The Hall was very useful for them as it is easily accessible and can be used for both, personal and community functions purposes.	The BCCL was aware of the need of community hall as it was used for important purpose, both at personal and community level.
Health Center	The Health centre was useful as it was providing medical treatment free of cost. But now disappointed as the centre is closed from past two years and even the MMV project has been stopped. So people now depend upon the privately run clinics.	As a part of adoption project, health was seen as an important aspect. Thus the Health Centre was constructed.
School Building	The school building is constructed. However, it has not yet started and thus need to start.	BCCL was aware of the educational problem of villagers and so they constructed the school. But the school has not started yet as the procurement is under process.
Masala Chakki	The people were upset as it had provided employment only for a few weeks.	Intention was to generate employment opportunity by providing the required infrastructure.
AEC	The centre was very useful as it had helped many girls and women to learn basic reading and writing skills and hence villagers demanded to start it once again.	Intention was to provide basic skills of writing and learning.
STC	The Training was useful, but at times there was discrimination among the girls as the girls from Lahbera were	The intention was to provide entrepreneur skills to the girls and women by providing them sewing

	given preferences, and girls from other villages were not allowed to use the machine in spite of paying the fees.	training skillsets.
Drainage line and PCC Road	The project was good as it had reduced the mosquito breeding spots and has made the communication with main road easy. But the construction is left incomplete and only a few lanes have PCC road and drainage system.	The intention was to increase the communication and reduce the unhygienic condition in Lahbera
Water Connection	The scarcity of water prevailed before, and even now the villagers bring water from outskirts. Only three pipelines are being installed for the whole village which is not sufficient.	Intended to provide water for the entire village by providing pipeline supply system.
CTP	It was useful but was shut down after some time. reason was not to know	Intended to develop IT skills among the student of Lahbera village.
Solar Lights	It was not useful for people, as it is only limited to a few spots. The villagers get electricity connection through state supply electricity connection.	The intention was to provide electrification to the village.

5.5 Gaps and Scope for Improvement

i. **Lack Monitoring:** The proposed project intented towards the integrated development of Lahbera village. But since past few years, no monitoring has been done by the BCCL and that had led to the ineffectiveness of the projects. Some of the projects have been unsuccessful, namely Health Center, STP, CTP, and AEC, due to lack of monitoring.

ii. **Unfinished projects: A** Few of the projects/infrastructures such as school building, road and drainage lines, solar light stands and water connection is partially done and that had created a negative image of the company in the eyes of villagers.

iii. **Lack of Execution:** Among nine projects that were aimed at developing the village four projects have been unsuccessful, namely Water pipeline connection, Solar Stand Lights, School and Masala chakki**.**

iv. **Limited Resources in training centre:** The resource supply in training centre especially STP was very limited. The number of students in a batch was more than 50 but the sewing machines available were only 4. A few batchmates even complaint for not allowing them to use the machines.

v. **No Scope for employment generation:** One of the common gaps found among the STP and the Computer centre was that there was no scope for the students, neither for future training nor employment generation, as this centre only provided basic training. In case of masala chakki, no market linkages were made for the production and sale of masala.

vi. **Limited growth through training program:** The training programs such as STP, AEC, and CTP had very limited growth outcome as teachers/mentors teaching the courses were not upgraded, and also the salaries of the mentors were not paid. Thus, it was reflected in their teaching. In case of STP and CTP, no linkages were created.

5.6 Recommendations

i. **Creating a local sustainable mechanism to look over the monitoring of the projects:** It is essential that a village development committee consisting of BCCL officials, village members and the panchayat representative should be formed. This committee must be autonomous and should monitor and recommend projects that are essential for the developing Lehbera as an ideal village. At the same time, periodic training should be provided to the villagers for increasing their skills sets and capability.

ii. **Formation of SHGs:** Self Help Groups have played an important role in development of individual and as well as the community. Therefore, SHGs especially of women and youth should be formed, and they should be provided training on capacity building and entrepreneur skills rather than just providing infrastructure.

iii. **Need Base Assessment should be done:** The demand for a particular project or infrastructure should come from the voices of people rather than from the BCCL. Therefore, proper need base assessment should be done.

iv. **Creating Jobs and Market linkages:** Linkages should be created for jobs so that after the training the students can get jobs. At the same time, market linkages such as textile and spice market should be created, might be within BCCL, where the product produced by the villagers could be sold.

v. **Rejuvenating the existing project:** The projects such as CTP, ADC, STP, and Health Centre should be rejuvenated, as these projects had created good impacts on the villagers. At the same time, it is essential that required resources and periodic upgradation should be done. Emergency medical vans should be made available. A female doctor should be available in the health centre.

vi. **Linking the villages with existing government schemes:** It was evident during the field visit that most of the villagers belong to the ST community. Hence, they could be linked with various government schemes and services that are available for them by creating awareness generation for the same.

CHAPTER 6 - CONSTRUCTION OF PCC ROAD

6.1 Introduction

Roads are primary mean of transportation. These provide human access to different places. Roads make a crucial contribution to economic development and growth and bring important social benefits. They are of vital importance in order to make a nation grow and develop. In addition, providing access to employment, social, health and education services makes a road network crucial in fighting against poverty. Roads open up more areas and stimulate economic and social development. Hence understanding the importance of Road BCCL had Constructed PCC Roads in and around eight villages of the BCCL command area.

6.2 Objective of the project

Enabling and increasing the connectivity from semi-rural to urban areas by constructing PCC Road.

6.3 Location of implementation

Table 7 – Location of implementation of road projects in various areas

SN	Name of Village/Area	Construction in Km/Meters
1	Kacharra Arah Tola , Hatudih Panchayat	400 meters
2	Lahbera Village	1.5 Km
3	Aamtal Village, Aamtal Panchayat (Kusunda)	1.5 km
4	Satitand Village, Bauakala Panchayat (Kusunda)	500 meters
5	Padugora Village, Padugora Panchayat (WJ area)	400 meters
6	Kandra Village, Kandrta Panchayat	500 meters
7	Bakaspura Village, Luti Pahari Panchayat	400 meters

6.4 Impact of Road on Community

1. Improved Connectivity

The most important aspect of this project is improved connectivity of people from both rural and urban area to the main town or urban world. The road has helped these communities by increasing their accessibility and communication to various vital resources centres such as health, market, schools and employment places. Hence people have now been easily accessing this place without any difficulty.

Beneficiaries' viewpoint

Sunil Mahato Resident of Kahcharra arah Tola, Hadudih Panchayat says: 'the road has helped us. The connectivity has increased. Health centre, schools and marketplaces are now easily accessible. Besides that, there is increase in the rate of vehicles after completion of the road.'

2. Enhanced Hygienic Living Condition

The Construction of Road has enhanced hygienic living condition. PCC road had reduced the risk of getting malaria and other vector-borne diseases. Besides that, there is also improvement in communication from one part to another part of village and also to the other vital resources centres

Beneficiaries' viewpoint

'The road has improved our living condition. We had Kaccha road in rainy season. There was always water logging and slushy pathways that made all of us difficult to walk, Children use to fall on the road. Besides that, due to the slushy pathways we also faced health issues such as malaria. Mosquitos were all around, especially in rainy season. But, since the PCC road has been constructed, it has prevented water logging and slushy pathways and even had reduced the mosquito breeding spots. Thus our health issues are also being reduced'; says Krishna Singh, Resident of Amtal Village.

6.5 Gaps identified in the project

i. Inferior Quality of Road Construction

Almost all the road constructed under the CSR project was of inferior quality. The quality of the road had started diminishing after a few months from its construction. In many places, potholes and cracks were found by the research team. It was reported by the community that the construction of the road involved several unscrupulous means.

ii. Limited Connectivity

Most of the road constructed had limited connectivity. The road which was constructed was the internal road, which at some places was not even connecting to the main road. For example, the road constructed in lahbera was mostly internal and no connection was made with the main road. Thus, the people highlighted regarding its limited social value. A few of the road constructions were left incomplete. Besides that, lack of maintenance was also reported by the people.

iii. Participatory Approach

It was reported by the people that the participatory approach was neither utilized before nor during the construction of the road. Opinion and views of the people should be taken into consideration. The people reported that consent during infrastructure development such as in road was mostly avoided.

iv. Lack of monitoring from the BCCL

All the villages and areas where the road had been constructed, people reported that no monitoring or follow-up was done after the construction of the road. It was also told to the research team that after the construction of the road that is after two to three years, it is only now that the BCCL officials have come to inspect the road, along with the research team. People reported that they were highly unsatisfied for the negligence of BCCL officials in terms of monitoring and inspection.

6.6 Multi-stakeholder Perspective

i. BCCL officials - The aim of the project was to provide connectivity, connecting the small villages to the main town or main road that would subsequently enhance the productivity of the people and also the standard of living.

ii. **Villagers -** The road is useful to villagers in many ways. For example, it has increased the accessibility of vital resource centres such as schools, market, hospitals, etc. It has also increased the communication from one village to another and also from the village to the main town.

6.7 Recommendations

i. **Periodic monitoring** should be conducted by the BCCL. This would enable the company to identify the gaps in implementation of project, and at the same time while doing this; the creditability of the organization will also increase among the people/community.

ii. **Considering People's opinion and view** will enable the BCCL to implement the project in more effectively. Besides that good rapport will develope between both the parties.

iii. **Regular Maintenances** should be done by the BCCL. Similarly expansion should be done based on the needs and demands of the people/community.

iv. **Improvisation of road quality** by tendering the project to a contractor with better credibility and good quality work record in the past.

v. Participation of community should be encouraged before as well as during the construction of road as it would provide an opportunity to the villagers to monitor and supervise the construction process in terms of higher transparency, accountability and sustainability.

ANNEXURE

Confidential (for research purpose only- property of TISS)

HOUSEHOLD QUESTIONNAIRE

Project - Mobile Medical Van (*Swasth Rath*)

(As this questionnaire requires input from male and female members of household, it should be administered to head of household in the presence of other responsible adult male and female members.)

IDENTIFICATION PARTICULARS

Before Starting Interview

Name of District _____Code:_____
Name of Taluka _____Code:_____
Name of Block _____Code:_____
Gram Panchayat _____Code:_____
Name of the village_____Code:_____

Name of the Mining Area _____

Date of Interview (DD/MM/YY): _____/_____/_____
Time of starting Interview (HH.MM): _____. _____ AM/PM

After Ending Interview

Time of ending interview (HH.MM): _____. _____ AM/PM
Names of Respondents 1: _____ MID: _____
2: _____ MID: _____
3: _____ MID: _____
Name of Interviewer: _____ Code: _____

After Checking/Editing Questionnaire

Name of Supervisor: _____Code: _____
Name of Editor: _____Code:
_____

A: HOUSEHOLD PROFILE AND HEALTH SEEKING BEHAVIOR

Qn.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
A01	What is your religion?	HINDU….....1 MUSLIM….....2 CHRISTIAN….....3 SIKH….....4 BUDHHIST….....5 JAIN….....6 OTHER _____7 NO RELIGION….....8	
A02	Do you come under scheduled caste, scheduled tribe, nomadic tribe, or other backward class? Which one?	SCHEDULED CASTE….....1 SCHEDULED TRIBE….....2 NOMADIC TRIBE….....3 DENOTIFIED TRIBE….....4 OTHER BACKWARD CLASS (OBC)……..5 GENERAL….....6 DON'T KNOW….....7	
A03	From where do you fetch water for your household? (ask for all sources)	TAP (BY OWN).....1 OWN TAP BY GOVT/PANCHAYAT .....2 OWN HANDPUMP.....3 OWN OPEN WELL.....4 NEIGHBOUR'S TAP.....5 COMMUNITY TAP.....6 COMMUNITY HANDPUMP.....7 COMMUNITY OPEN WELL.....8 OTHER(SPECIFY)_____9	
A04	If household members fall sick, where do you go or whom do you consult first?	TRADITIONAL HEALER/DAI.....1 LOCAL DOCTOR/RMP.....2 CHEMIST SHOP.....3 MOBILE CLINIC OF JHARKHAND GOVERNMENT.....4 SHC/ASHA/ANGANWADI.....5 PHC/CHC.....6 GOVT HOSPITAL.....7 PRIVATE CLINIC.....8 PRIVATE HOSPITAL.....9 COMPANY/AIDED HOSPITAL.....10 SEEK NO TREATMENT.....11 DEPENDS ON AILMENT.....12 MOBILE MEDICAL VAN OF BCCL....13	

		OTHER_____14	
A05	During the last 12 months, which are the agencies did you/your household members visit for consultation and/or treatment? (ASK FOR ALL SOURCES)	TRADITIONAL HEALER/DAI.....1 LOCAL DOCTOR/RMP.....2 CHEMIST SHOP.....3 MOBILE CLINIC.....4 SHC/ASHA/ANGANWADI.....5 PHC/CHC.....6 GOVT HOSPITAL.....7 PRIVATE CLINIC.....8 PRIVATE HOSPITAL.....9 COMPANY/AIDED HOSPITAL.....10 MOBILE MEDICAL VAN OF BCCL.....11 MOBILE CLINIC OF JHARKHAND GOVERNMENT.....12 OTHER_____13 NO TREATMENT.....14 NOBODY FELL SICK.....15	
A06	How the purification techniques followed at household level?	BOIL THE WATER.....1 ADD BLEACH/CHLORINE.....2 SIEVE IT THROUGH CLOTH.....3 WATER FILTER (CERAMIC, SAND, COMPOSITE, ETC.).....4 LET IT STAND AND SETTLE.....5 OTHER _____6 DON'T KNOW.....7	
A07	What type of toilet facility do you have?	FLUSH TOILET (OWN).....1 PIT TOILET(OWN).....2 FLUSH TOILET(COMMUNITY).....3 PIT TOILET(COMMUNITY).....4 OTHER _____5 GO FOR OPEN DEFECATION.....6	
A08	Do you wash hand properly after defecation?	YES.....1 NO.....2	
A09	What is the status of health infrastructures availability in the villages or nearest location in terms of government services?	GOVT HOSPITAL AVAILABLE BUT NOT FUNCTIONING PROPERLY.....1 GOVT HOSPITAL NOT AVAILABLE…..2 PRIMARY HEALTH CENTER IS AVAILABLE AND FUNCTIONING.....3 PRIMARY HEALTH CENTER IS AVAILABLE BUT NOT	

		FUNCTIONING/POOR.....4 PRIMARY HEALTH CENTER IS NOT AVAILABLE.....5 SUB-CENTRES OR COMMUNITY HEALTH CENTRES AVAILABLE .....6 SUB-CENTRES OR COMMUNITY HEALTH CENTRES NOT AVAILABLE.....7	
A10	How is the access to health facilities in terms of connectivity to/from villages, type of approach road?	KUCCHA ROAD.....1 PACCA ROAD IN GOOD CONDITION....2 PACCA ROAD IN BAD CONDITION.....3 ROAD INSIE THE VILLAGE IS GOOD..4 ROAD INSIDE THE VILLAGE IS NOT GOOD.....5	
A11	What are the major Ailments in your family?	COUGH & COLD.....1 SKIN DISEASES (ITCHING ETC.)....2 WATER BORNE DISEASE .....3 MALARIA/ DENGUE.....4 OTHER (SPECIFY)_____5	
A12	What is the mode of transport used for referral cases?	AMBULANCE.....1 HIRED VAN/TRAKER/TAXI/AUTO RICKSHAW.....2 JUTE COT (KHATIA).....3 MAN DRIVEN RIKSHAW.....4 OTHER(SPECIFY) _____5	

B. SERVICES OF MOBILE MEDICAL VAN (*Swastha Rath*)

Qn.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
B01	Are you aware that Mobile Medical Van (Swastha Rath) is sponsored by BCCL?	YES.....1 NO.....2	
B02	How long back the van been coming?	MORE THAN FIVE YEARS.....1 FIVE YEARS.....2 FOUR YEARS.....3 THREE YEARS.....4 TWO YEARS.....5 ONE YEARS.....6 DON'T KNOW/REMEMBER.....7	
B03	How does the BCCL plan to publicize and make the communities in the village aware of their visits as they have a set a time for their visits	ANNOUNCEMENT BY MUKHIYA IN GRAM SABHA.....1 ANNOUNCEMENT THOUGH LOUDSPEAKER BY BCCL.....2 BY ASHA WORKER/VILLAGE VOLUNTEERS.....3 BCCL REPRESENTATIVES CALL FOR VILLAGE MEETING.....4	

		OTHER MEANS(SPECIFY)_____5	
B04	Do you think the van comes frequently enough?	DAILY.....1 ONCE A WEEKLY.....2 TWICE A WEEK.....3 FORTNIIGHTLY.....4 ONCE A MONTH.....5 DOES NOT COME.....6 OTHER SPECIFY.....7	
B05	Is there a fixed point where the van comes and waits?	YES.....1 NO.....2 DON'T KNOW.....3	
B06	If yes, specify:		
B07	Does fixed date and time of visit is maintained by the Mobile Medical Van?	YES.....1 NO.....2 DON'T KNOW.....3	
B08	How long does the van wait in the village?	LESS THAN AN HOUR.....1 ONE HOUR.....2 TWO HOURS.....3 THREE HOURS.....4 MORE THAN THREE HOURS.....5 DON'T KNOW.....6	
B09	Do you think this time is enough?	YES.....1 NO.....2 CAN'T SAY.....3	
B10	If no, how much longer should it wait? (Write as it is)		
B11	How is the priority in beneficiary selection governed?	FIRST COME FIRST SERVE.....1 AGED PERSONS.....2 INFANTS/CHILDREN.....3 DIFFERENTLY ABLED.....4 PREGNANT WOMEN.....5 RANDOM, NO PRIORITY AS SUCH....6 VISIBLY VERY UNWELL PERSON.....7	

B12	Facilities available in the van	FREE MEDICINE/ TREATMENT.....1 PROVIDE DOORSTEP FACILITIES....2 PROVIDE DIAGNOSTIC FACILITY....3 PROVIDE ALL THE FACILITIES THAT ARE PROVIDED IN A HOSPITAL.....4 OTHER(SPECIFY)_____5	
B13	Does the medical team give awareness about the followings?	HYGIENIC SANITATION.....1 HYGIENIC WATER CONSUMPTION.....2 MOTHER & CHILD HEALTH CARE.....3 IMMUNIZATION.....4 ANAEMIA.....5 DE-WORMING.....6 VECTOR BORNE DISEASES.....7 HEPATITIS.....8 TYPHOID.....9 COMMON CARDIAC PROBLEMS.....10 HIV.....11 DIABETES.....12 SNAKE BITE.....13 TUBERCULOSIS.....14 OTHERS_____15	
B14	Does the medical team diagnose the following?	BLOOD PRESSURE.....1 HEMOGLOBIN LEVELS.....2 OXYGEN SATURATION.....3 MALARIA.....4 HEPATITIS.....5 DENGUE.....6 TYPHOID.....7 DIABETES.....8 OTHERS_____9	
B15	What kind of services do you get from the van as far as cure is concern?	MEDICINES.....1 NUTRITIONAL SUPPLEMENTS.....2 DE-WORMING.....3 TONICS.....4 OTHERS_____5	
B16	Is it convenient for your family to reach the MMV point? (Ask specific to women, children, senior citizen, and differently abled if any in the family).	WOMEN.....YES(1) NO(2) CHILDREN.....YES(1) NO(2) SENIOR CITIZEN.....YES(1) NO(2)	

		PWD.....YES(1) NO(2)	
B17	If no, then what is the difficulty?	LONG DISTANCE.....1 NO INTERNAL ROAD.....2 NO APPROACH ROAD.....3 NO CONNECTING BRIDGE.....4 KUTTCHA ROAD.....5 NO MODE OF TRANSPORTATION.....6 INCONVINIENT TIMING OF THE MMV.7 OTHERS SPECIFY_____8	
B18	Who are present in the Mobile Medical Van of BCCL?	DOCTOR.....1 COMPOUNDER/PHARMACIST.....2 NURSE/ANM.....3 DRIVER.....4 ALL THE ABOVE.....5 OTHER(SPECIFY)_____6	
B19	What is the availability of doctor in the Van?	ALWAYS PRESENT .....1 SOMETIMES PRESENT.....2 NEVER PRESENT.....3	
B20	If no, then who facilitate the service? (Write as it is)		
B21	Do you able to convey your problems to the Doctor/pharmacist? (probe behavior of the medical team)	YES.....1 NO.....2	
B22	What if a person falls ill in the period when Van is not visiting? (Write as it is)	VISIT PRIVATE PRACTIONER.....1 VISIT RMP.....2 NEAREST HEALTH GOVERNMENT HEALTH CENTER.....3 NEAREST PRIVATE CLINIC/HOSPITAL..4 WAIT FOR MMV FOR NEXT VISIT.....5 OTHERS(SPECIFY)_____6	
B23	Does the medical team provide awareness campaign?	YES.....1 NO.....2 CAN'T SAY.....3	
B24	If yes, what are they?	HIV/AIDS/SMOKING/ALCHOLISM.....1 PUBLICITY AND SENSITIZATION CAMPAIGN.....2 CLEANINESS AND HYGIEN.....3	

		MATERNITY CARE.....4 OTHER(SPECIFY)_____5	

C. BENEFICIARIES' FEEDBACK ON MMV SERVICE

Qn.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
C01	Do you think the frequency of doctor's visit to private clinic/hospital or government health center has been reduced due to service of MMV provided by BCCL?	AGREE.....1 DISAGREE.....2 CAN'T SAY.....3	
C02	Do you think monthly expenditure on health checkups /medicine has been reduced due to the service of MMV provided by BCCL?	AGREE.....1 DISAGREE.....2 CAN'T SAY.....3	
C03	Do you think that your time has been saved due to the service of MMV provided by BCCL?	AGREE.....1 DISAGREE.....2 CAN'T SAY.....3	
C04	Do you think travelling cost has been saved due to service provided by MMV of BCCL?	AGREE.....1 DISAGREE.....2 CAN'T SAY.....3	
C05	Do you think you get free advice by a qualified trained/ qualified doctors at your door step?	AGREE.....1 DISAGREE.....2 CAN'T SAY.....3	
C06	Do you think major ailments in your family have been reduced due to awareness given by the medical team of BCCL through MMV? OR your family is healthier than before?	AGREE.....1 DISAGREE.....2 CAN'T SAY.....3	
C07	Is there any scope of improvement in MMV? If yes, answer the question from **C08 to C12**	YES.....1 NO.....2 CAN'T SAY.....3	
C08	MMV should reach on time/ time should be fixed	YES.....1 NO.....2 CAN'T SAY.....3	
C09	There should be fixed/ convenient time of reaching the MMV (any)	YES.....1 NO.....2 CAN'T SAY.....3	
C10	Quantity/ variety of medicines should be increased (any)	YES.....1 NO.....2 CAN'T SAY.....3	

C11	Frequency/coverage of MMV should be increased (any)	YES.....1 NO.....2 CAN'T SAY.....3	
C12	Requirement of a lady doctor/nurse	YES.....1 NO.....2 CAN'T SAY.....3	
C13	How would you rate (out of 5) the service of Mobile Medical Van provide by BCCL.	POOR(1/5).....1 BELOW AVERAGE(2/5).....2 AVERAGE(3/5).....3 GOOD(4/5).....4 EXCELLENT(5/5).....5	
C14	Do you think this service by BCCL should be continued?	AGREE.....1 DISAGREE.....2 CAN'T SAY.....3	

HOUSEHOLD QUESTIONNAIRE

Project - Scheme for multipurpose utilization of abandoned mine water

(As this questionnaire requires input from male and female members of household, it should be administered to head of household in the presence of other responsible adult male and female members.)

IDENTIFICATION PARTICULARS

Before Starting Interview

Name of District

_____Code:_____

Name of Taluka

_____Code:_____

Name of Block

_____Code:_____

Gram Panchayat

_____Code:_____

Name of the

village_____Code:_____

Pond Name_____

Date of Interview (DD/MM/YY): _____/_____/_____

Time of starting Interview (HH.MM): _____. _____

AM/PM

After Ending Interview

Time of ending interview (HH.MM): _____. _____

AM/PM

A: HOUSEHOLD PROFILE AND AGRICULTURE AND WATER AVAILABILITY

Qn.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
A01	What is your religion?	HINDU….....1 MUSLIM….....2 CHRISTIAN….....3 SIKH….....4 BUDHHIST….....5 JAIN….....6 OTHER _____7 NO RELIGION….....8	
A02	Do you come under scheduled caste, scheduled tribe, nomadic tribe, or other backward class? Which one?	SCHEDULED CASTE….....1 SCHEDULED TRIBE….....2 NOMADIC TRIBE….....3 DENOTIFIED TRIBE….....4 OTHER BACKWARD CLASS (OBC)……..5 GENERAL….....6 DON'T KNOW….....7	
A03	Type of house (record as per guidelines based on type of wall, roof and floor)	RCC .....1 PUCCA .....2 SEMI-PUCCA .....3 KUCHCHA .....4 HUT .....5 TENT (MAKESHIFT).....6	
A04	House electrified?	YES.....1 NO.....2	
A05	From where do you fetch potable water for your household? (ask for all sources)	TAP (BY OWN).....1 OWN TAP BY GOVT/PANCHAYAT .....2 OWN HANDPUMP.....3 OWN OPEN WELL.....4 NEIGHBOUR'S TAP.....5 COMMUNITY TAP.....6 COMMUNITY HANDPUMP.....7 COMMUNITY OPEN WELL.....8 COMMUNITY POND.....9 OTHER(SPECIFY)_____10	
A06	How far is the water source from your household?	JUST OUTSIDE.....1 WITHIN 1/2 KM.....2 WITHIN 1 KM.....3 MORE THAN 1 KM.....4	

A07	If it is used for drinking, what is purification techniques followed at household level?	BOIL THE WATER.....1 ADD BLEACH/CHLORINE.....2 SIEVE IT THROUGH CLOTH.....3 WATER FILTER (CERAMIC, SAND, COMPOSITE, ETC).....4 LET IT STAND AND SETTLE .....5 OTHER (SPECIFY).....6 DON'T KNOW.....7	
A08	What is the purpose of mine water utilization through pond?	DRINKING.....1 COOKING.....2 WASHING VEGETABLES .....3 WASHING CLOTHES.....4 HOUSE CLEANING.....5 BATHING/WASHING YOUR BODIES....6 AGRICULTURE.....7 WASHING ANIAMLS.....8 AFTER DEFECATION.....9 OTHER(SPECIFY) 10	
A09	What type of toilet facility do you have?	FLUSH TOILET (OWN).....1 PIT TOILET(OWN).....2 FLUSH TOILET(COMMUNITY).....3 PIT TOILET(COMMUNITY).....4 OTHER _____5 GO FOR OPEN DEFECATION.....6	
A10	Do you use pond water after open defecation?	YES.....1 NO.....2	
A11	Does your household own any agricultural land including any plantation land?	YES.....1 NO.....2	
A12	How much agriculture land do you own?	_____ACRS _____(LOCALE MEASUREMENT SCALE)	
A13	How much of the land cultivated by you is irrigated?	NIL..... 0 _____ACRS _____(LOCALE MEASUREMENT SCALE)	
A14	What are the sources of irrigation? Do not record rain as a method of irrigation (ASK FOR ALL SOURCES)	CANAL.....1 POND.....2 WELL.....3 RIVER.....4 MOTOR PUMP.....5 TUBE WELL.....6	

		BORE WELL.....7 DAM.....8 OTHER_____9 NONE.....10	
C15	What is the lift irrigation equipment used by you to draw water from pond to agriculture field?	DIESEL ENGINE/PUMP.....1 ELECRIC MOTOR..... .....2 SUBMERGIBLE PUMP.....3 OTHER (SPECILFY)_____4	
A16	Major crops grown	1) _____ 2) _____ 3) _____ 4) _____ 5) _____	

B. AWARENESS ABOUT MINE WATER SUPPY, REPAIRS, RENOVATION & RESTORATION OF THE PONDS AT KHONATHI AND BEHRAKUDAR BY BCCL

Qn.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
B01	Do you know that BCCL is supplying mine water to the pond?	YES.....1 NO.....2	
B02	Do you know about the activities done by BCCL for the pond?	EMBANKMENT OR STONE PITCHNG AROUND THE BANK .....1 INLET AND OUTLETS.....2 GHATS/STAIRS .....3 REPAIRE.....4 INCREASED THE CATCHMENT/RESTORATION.....5 DON'T KNOW ANY OF THE ABOVE.....6	
B03	How you come to know that BCCL has renovated the pond?	DISPLAY BOARD BY BCCL.....1 GRAM SABHA.....2 OBSERVED RENOVATION WAS GOING.....3 OTHER SOURCE (PLEASE MENTION)..4 _____	
B04	Whether BCCL conducted any village meeting along with Mukhiya before supplying mine water to the pond?	YES.....1 NO.....2 DON'T KNOW.....3	

B05	When and how many meetings were held? (Specify the number with month and year)		
B06	Does the pond dry up initially during summer?	YES.....1 NO.....2 DON'T KNOW.....3	
B07	How often the mine water is supplied to the village pond by BCCL?	WEEKLY.....1 MONTHLY.....2 QUARTERLY.....3 HALFYEARLY.....4 DRY SPELL/WINTER ONLY.....5 NOT FIXED.....6 NEVER..... .....7 DON'T KNOW.....8 IF ANY OTHER, SPECIFY.....9	
B08	How many hours/day is water supplied?	30 MINUTES.....1 45 MINUTES.....2 ONE HOUR.....3 TWO HOURS.....4 MORE THAN TWO HOURS.....5	
B09	Is the quantity of water supplied sufficient for your village?	YES.....1 NO.....2 DON'T KNOW.....3	
B10	Has there been any case of illness die to poor water quality? If yes, please specify	NO YES (SPECIFY) _____ _____	
B11	What is alternative source of water in case the existing facility is damaged? (Specify)		
B12	When was the last mine water supplied by BCCL?	LAST MONTH….....1 LAST THREE MONTHS….....2 LAST SIX MONTHS….....3 LAST ONE YEAR.....4 MORE THAN A YEAR(HOW LONG,SPECIFY) _____5	

B13	When was the last monitoring done by BCCL regarding utilization of mine water?	LAST MONTH….....1 LAST THREE MONTHS….....2 LAST SIX MONTHS….....3 LAST ONE YEAR….....4 MORE THAN A YEAR(HOW LONG,SPECIFY) _____5 NEVER.....6 DON'T KNOW.....7	

C. IMPACT AFTER THE INTERVENTION ON UTILIZATION OF MINE WATER FOR DOMENSTIC AND AGRICULTURAL USE

Qn.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
C01	Is water available throughout the year?	YES.....1 NO.....2	
C02	What you think, the availability of water in the pond throughout the year is due to?	MINE WATER SUPPLIED BY BCCL...1 NATURALLY DUE TO RAIN WATER...2 GROUND WATER REGENERATION.....3 DON'T KNOW.....4 OTHER REASONS(SPECIFY)_____ _____5	
C03	Is there any improvement in water storage capacity or catchment areas of tank seen after the renovation of pond by BCCL?	AGREE.....1 DISAGREE.....2 DON'T KNOW.....4	
C04	Do you think that water scarcity has reduced during dry spell/winter due to mine water supply provided by BCCL?	AGREE.....1 DISAGREE.....2 DON'T KNOW.....4	
C05	Do you find adequate quantity of water during summer/winter due to mine water supply provided by BCCL?	AGREE.....1 DISAGREE.....2 DON'T KNOW.....4	
C06	Do you think the impact of flood has been reduced during monsoon due to renovation of pond by BCCL?	AGREE.....1 DISAGREE.....2 DON'T KNOW.....4	
C07	Do you think the distance of water availability has been reduced for animals especially for those who can't go long distance to drink water due to mine water supply of BCCL?	AGREE.....1 DISAGREE.....2 DON'T KNOW.....4	

C08	Do you think you get water for household easily and timely due to mine water supply of BCCL?	AGREE.....1 DISAGREE.....2 DON'T KNOW.....4	
C09	Do you think that villages has developed new job opportunity like duckery and fishery in dry season and use their time better than before?	AGREE.....1 DISAGREE.....2 DON'T KNOW.....4	
C10	Do you utilize pond water for critical irrigation?	YES.....1 NO.....2	
C11	Do you think you are able to produce two crops (Winter crops) in a year due to mine water supply of BCCL	AGREE.....1 DISAGREE.....2 DON'T KNOW.....4	
C12	Do you think you produce beyond your home consumption and get money to be used for different purposes due to mine water supply of BCCL?	AGREE.....1 DISAGREE.....2 DON'T KNOW.....4	
C13	Are any new crops grown due to this intervention, which were not sown before due to unavailability of water during winter/dry spell?	YES.....1 NO.....2	
C14	The new crops grown are	1)_____ 2)_____ 3)_____ 4)_____ 5)_____	
C15	Was any increase in land under irrigation seen?	YES.....1 NO.....2	
C16	How much land under irrigation increased?	_____ACRS _____(LOCALE MEASUREMENT SCALE)	
C17	Do you think your income has been increased due to pond renovation and mine water supply?	AGREE.....1 DISAGREE.....2 DON'T KNOW.....4	
C18	Do you think your agricultural production has been increased due to pond renovation and mine water supply?	AGREE.....1 DISAGREE.....2 DON'T KNOW.....4	
C19	Have you used pond for fishery or duckery	YES.....1 NO.....2	
C20	How much income have you gained?	RS._____/MONTH	

C21	Do you think there is scope for improvement with regards to mine water supply? If yes, answer **C22 to C24**	YES.....1 NO.....2	
C22	Mine water should be reached on time/ time should be fixed	YES.....1 NO.....2 CAN'T SAY.....3	
C23	Frequency of mine water supply should be increased	YES.....1 NO.....2 CAN'T SAY.....3	
C24	Quantity and quantity of water should be improved	YES.....1 NO.....2 CAN'T SAY.....3	
C25	How would you rate (out of 5) the quantity of water service provide by BCCL.	POOR(1/5).....1 BELOW AVERAGE(2/5).....2 AVERAGE(3/5).....3 GOOD(4/5).....4 EXCELLENT(5/5).....5	
C26	How would you rate (out of 5) the quality of water service provide by BCCL.	POOR(1/5).....1 BELOW AVERAGE(2/5).....2 AVERAGE(3/5).....3 GOOD(4/5).....4 EXCELLENT(5/5).....5	
C27	Do you think BCCL should continue supplying Mine water?	YES.....1 NO.....2	

D. MANAGEMENT OF POND

Qn.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
D01	Have community participated during pond renovation through*"shramdaan"*?	YES.....1 NO.....2 DON'T KNOW.....3	
D02	Is there any evidence that the pond has been recently undergone maintenance/ de-silting?	YES.....1 NO.....2 DON'T KNOW.....3	
D03	Does community also participate in maintenance/ de-silting?	YES.....1 NO.....2 DON'T KNOW.....3	

D04	If the BCCL water supply facility gets damaged, who repair it? (write as it is)		
D05	Maintenance is carried out?	FUND RAISED BY COMMUNITY(*CHANDA*) .....1 MUKHIYA DEVELOPMENT FUND.....2 BCCL CSR FUND.....3 MP/MLA FUND.....4 OTHER(SPECIFY)_____5	
D06	Constraint in O & M	**INEFFECTIVE COORDINATION AMONG USERS**.....1 **LACK OF FUND REHABILITAION**....2 NEGELGENCE OF LOCAL AUTHORITY.3 OTHER(SPECIFY)_____4	

QUESTIONNAIRE
VILLAGE ADOPTION PROGRAMME (Lahbera, Dhanbad)

1. Date Time

2. Village:
   Panchayat:
   Block:
   District:
   State:

3. Mukhiya/Sarpanch/Ward member/Participant:
   Name:
   Contact No.:

4. Population:

Multipurpose hall

Questions

1.	When was the hall built? How much time did the construction take?
2.	Who built it? (Mention implementing agency). Who provided the land for the same.
3.	Why was the need felt to build this hall?
4.	Were the villagers consulted before constructing the hall?
5.	What is the cost of the building? (How many respondents know?)
6.	Was there any board displayed during/after the construction of the hall providing information related to it?
7.	Is the hall useful?
8.	What is the hall used for? • SHG Meetings • Wage Payments • Bank related details • Gram Sabha • Awareness Campaigns • Meetings with BCCL • Trainings • Functions (community) • Functions (individuals) • Livelihood activities • Fairs • Lodging • Others (Please specify)
9.	Is the access to multi-purpose hall affected by any factor? • Caste • Religion • PRI Members • Gender • Gram Sachiv • Other govt. employee • Others (Please specify)
10.	Who has the control over or authority related to the multi-purpose hall? • Gram Sabha • Sarpanch • Specific committee/group • Individual (Please specify) • BCCL • Others
11.	What is the procedure to use the hall for any purpose? Is there a system devised? If yes, please specify.
12.	How can this hall be better utilized?

Masala Chakki:

Questions for Beneficiaries

1.	When was the Masala Chakki made operational? How much time did the process of operationalization take?
2.	Who installed it? (Mention implementing agency). Who provided the land/building for the same?
3.	Why was the need felt to start this initiative?

4. Were the villagers consulted before starting this initiative?
5. What is the cost of the initiative? (How many respondents know?)
6. Was there any board displayed during/after the installation and operationalization of the Masala Chakki providing information related to it?
7. Is the Masala Chakki useful?
   - Enhancing livelihood
   - Making grinding easier
   - Others (Mention)
8. What is the impact of this initiative for participants?
- Tangible (income)
   - Earnings of individual workers
   - Collective income of the community
   - Profit by owners
   - Others

- Intangible
   - Services/sales/production increase or decrease
   - Empowerment
   - Drudgery Reduction
   - Negative impacts if any (pollution/disputes/others)
   - Are they now able to make Investment in areas like:
      - Health
      - Education
      - Malnutrition
      - Transportation
      - Other (Specify)
   - Others (Mention)
9. What is the mechanism of selling the products? Where are the masalas sold? How is the demand in market?
10. What is the technical support provided for production as well as marketing? What more is expected?
11. How can we make this initiative better?
- To enhance positive impacts
- To reduce negative impact
12. Are impacts overall positive or negative? For whom?
13. What are the most important impacts? According to whom?
14. How significant are they? In what way?
15. Do changes alter livelihood strategies and security, or do they just add one element (a coping strategy) within existing approaches? Can impacts be summarised in terms of changes in livelihood security or robustness?

***Health Centre*:**

Questions

1. What was the scenario before the Health Centre was started?
   - Doctors
   - Health workers
   - Nearest Health Centre
   - Access to medicines
   - Access to screening tests
   - Others (Mention)
2. Why was the health centre set up in the village?
3. Were people of the village involved in the decision making?
- Need Assessment
- Location of Health Centre
- Others (Specify)
4. What is the basic infrastructure available?
   - Electricity
   - Water
   - Drinking water
   - Ambulance
   - Others (Mention)
5. What is the human resource deployed at the health Centre?
   - Doctor (qualification)
   - Nurse/ANM
   - Pharmacist
   - Lab-technician
   - Others (Specify)
6. How is the behaviour of the staff?

7. Population Coverage by the Health Centre
8. How is the utilization of the medical services at the Health centre?
9. Institutional Deliveries • Vaccination • First Aid • General Check ups • Ante natal services • Others
10. What diseases do people generally suffer from?
11. Name the diseases/symptoms. Also mention if they receive treatment for the mentioned diseases at the health centre
12. Are referral services provided?
13. What are the timings of the Health Centre?
14. How are emergencies handled?
15. Are people satisfied with the health Centre? If yes provide reasons.
16. What are people dissatisfied about? • Staff unavailable • Non-examination by staff • Improper attention • Centre not clean • Medicines not available • Others (Mention)
17. Are the services provided for free? If not, how much do they pay for treatment/medicines?
18. Is education/awareness provided at the health centre?
19. Complaints/Improvement suggestion for health centre.

Sewing Training Centre

Question

1. Why was the Sewing Machine initiative started?

2. Who use the Sewing Machine Initiative? Name the stakeholders.
• Direct Participants
  ○ Owners
  ○ Workers
  ○ Customers
• Non-participants (local residents)
• Others
  ○ Government
  ○ NGO
  ○ CBO
  ○ PRI
  ○ Co-operatives

3. What is the criterion to be a part of this initiative?
4. Who is not a part of it or stays out of it?
5. Specify who and the reason. Following maybe the reasons: • Gender • Power Dynamics • Education • Poverty • Disability • Other
6. How can participation be encouraged?
7. How is it beneficial?

8. What is the impact of livelihoods for participants?
• Tangible (income)
  ○ Earnings of individual workers
  ○ Collective income of the community
  ○ Profit by owners
• Intangible (empowerment)
• Direct (services/sales/production)
• Positive
• Negative
• Intended
• Unintended

9. What impact does it have on the quality of life?
10. How has the investment pattern changed? • Health • Education • Malnutrition • Transportation • Other (Specify)
11. What is sown or stitched? Where are the clothes sold? How is the demand in market?
12. What is the technical support provided for production as well as marketing? What more is expected?
13. How can we make this initiative better? • To enhance positive impacts • To reduce negative impact
14. What are the most important impacts? According to whom?
15. How significant are they? In what way?
16. Why did only 6 women start earning? How can that be improved?

Adult Education Centre:

Questions:

1. What is the literacy percentage of the village? Male and female both.
2. Why did the need to have arisen to have the adult education centre?
3. How long has it been functional?
4. What subjects are taught?
5. How many students are enrolled? How many attend
6. How is the attendance of the students? Do they enjoy coming?
7. Anyone who has dropped out from the Adult Education centre? If yes, Why?
8. Why are only women studying? What is the selection criterion?
9. What is the impact of the initiative on the following? • Employment • Basic Reading Skills • Health • Personal Goals • Further Education • Skill Development • Other outcomes
10. How can we encourage participation of enrolling illiterate people irrespective of barriers? What are the barriers? How can we overcome them?
11. Who is the teacher? How does he/she evaluate the progress?
12. Any complaints
13. Any success story

Primary School building:

Questions

1. When was the school constructed? Since when is it functional?
2. How many students study in school? Male/Female
3. What is the human resource and the respective strength in the school?
4. What is the average number of students in a class?
5. What is the infrastructure at the primary school? • Classrooms • Benches • Electricity • Lights • Fans • Toilets and water supply • Drinking Water • Other (mention)
6. Are teachers good? What is the learning level of children? • Good 4-5 • Average 2-3 • Bad-0-1
7. Do children enjoy going to school?
8. Are children benefitting from the school? In what ways (Mention)?
9. Any complaints?

Water supply

Questions

1. What difficulties were faced by the villagers before the intervention?
2. How far are the other water sources from the village?
3. Why did the need of laying down pipelines arise?
4. Who all were involved in the decision making process?
5. Where is the water supplied (individual households/common storage)? If it is a common storage how do people take it home for use?
6. How many people benefit from this?
7. What do the people use the water for?
8. How does it affect their life? • Education • Livelihood • Sanitation • Commercial • Domestic affairs • Others
9. What are the areas with water deficit? How does this initiative benefit those areas?
10. Any complaints?
11. How can this be improved?

Drainage:

Questions
1. How was the drainage managed before the initiative?
2. What is the drainage for?
3. What are benefits that are reaped by the people after the initiative?
4. Where is the waste water directed to?
5. Does it have an impact on health? • Positives • Negatives
6. Were people of the village provided information before implementing the project?

Solar Lights:

Questions

1. How is the supply of electricity in the village?
2. What were the issues faced by the villagers before the solar light intervention?
3. What is the use of the installed solar lights?
4. Why are the provided for public usage and not for individual usage?
5. Success stories
6. Complaints

QUESTIONNAIRE

CONSTRUCTION OF PCC/ BITUMINOUS ROAD FOR THE COMMUNITY

5. Date Time

6. Village:
   Panchayat:
   Block:
   District:
   State:

7. Mukhiya/Sarpanch/Ward member/Participant:
   Name:
   Contact No.:

8. Population:

1.	When was this road constructed?
2.	Do you know the agency who created this road? a. BCCL b. State Government c. Local MLA d. MP e. Others -
3.	If BCCL, How you know about this fact? a. Display board by BCCL b. Gram Sabha/Village Meeting c. Witnessed/passing while construction was going d. Villages e. Others
4.	What is the length of the road? (In kms.)
5.	What was the condition before the construction of the road? a. Pucca b. PCC but damaged
6.	What is the condition after the construction of the road?
7.	How far is the road from your place? (in kms)
8.	How many villages or towns does this road connect? (The geographical scale, names of the villages)
9.	Has this road been benefitted or affected your situation? Please elaborate.
10.	Please state <u>your</u> uses of this road.
11.	Did the community contribute in any way during the construction? If yes, how?
12.	Do you know anyone who was directly involved in the construction of road? a. Yes, who? b. No
13.	How has this road improved the quality of the life in this particular area? the following questions mark YES or NO. If yes, kindly elaborate.
	a. Has there been an increase in amount (volume/proportion) of the commercial profit agricultural production in the area?

	b. Has it become easier to reach the markets with the produce of the area?
	c. Have you noticed an increase employment of people in this area?
	d. Are more people engaging in the non-agricultural employment like businesses,eg. groceries, artisans, labourers,etc.?
14.	Has this road improved the connectivity of this area to other places, causing decrease in transportation cost and time to reach places? If yes, how?
	For the following questions mark YES or NO. If yes, kindly elaborate.
	Education:
	a. Has it helped to access the educational institutes more easily? Does it take less time to reach them? b. Has there been an increase in attendance in primary and high schools of the area after the construction?
	c. How far are the high schools from here?
	d. Has it become more convenient to reach them now?
	e. Are more children from this area going to school now?
	f. Can you use transports like cycles or rickshaws to reach these places now?
	Health:
	a. Is there any health care facility in your area? i. Primary Health Centre ii. Community Health Centre iii. Referral Hospital iv. Private Nursing home/Dispensary v. Others
	b. How far is the closest healthcarefacility or hospital? i. Less than half Km ii. Less than 1 Km iii. More than 1 Km iv. More than 5 Kms. v. Others
	c. Has road made it more convenient to access these centres now?
	d. Are you provided with MMV services here?
	e. How often? i. Weekly: ii. Monthly:
	f. Have you seen an overall improvement of health because of this?
	g. Has there been an increase in the utilization of hospitals or healthcare centres after the construction of road?
	h. Has the maternal health improved since the construction of the road?
	i. Do you see any improvement in rates institutional delivery of infants in this area?
15.	Has there been any repairs or upkeep after the construction of the road? If yes, who is responsible for the upkeep? a. Fund raising in the villages b. Mukhiya Fund c. Others:
16.	How does this road serve you during rains?

17.	Have you faced any problems after the construction? If yes, what? Please elaborate.
18.	How the village does contributes to the upkeeping of the road?
19.	How would rate the quality and viability of this road on a scale a. Very poor b. Poor c. Average d. Good e. Excellent
20.	Kindly provide any additional comments, concerns and/or observations/suggestions to improve this project?

Mid- term Evaluation of Project *Swablamban* - Reeling and Spinning Training Projecr under CSR (Sustainable Development Department), Bharat Coking Coal Limited, Dhanbad FY(2015-16)

By

National CSR Hub

Tata Institute of Social Sciences, Mumbai

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Prof. B. Venkatesh Kumar
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EXECUTIVE SUMMARY

The purpose of this report, mid-term evaluation study was conducted for Reeling and Spinning training as a skill development project. The locations of the study were Alakdiha and Mukunda training centres, in Dhanbad. The primary data collection for the mid-term evaluation was completed in September 2017 by a 6 member team from TISS. Qualitative research methodology was used while in-depth interviews and focused group discussions were the main methods employed.

The Reeling and Spinning training project was conducted in association with Jharkhand Silk Textile and Handicraft Development Corporation (JHARCRAFT), a Government of Jharkhand undertaking under Industry Department, registered under section 26 Companies Act. 1956.

While BCCL provided monetary support and infrastructure, JHARCRAFT provided skilled trainers, handlooms and raw material for the training. The Primary beneficiaries of the project were 150 underprivileged women across locations. Five training centres were proposed in the project proposal out of which two centres were selected as pilot initiatives of the project.

After successful completion of two month long training course at both the centres, beneficiaries were given access to handloom machinery to hone their skills and earn an income in the process. Currently, only one centre is functional with 20-25 beneficiaries regularly coming to the training centre. The project in the mid-implementation phase faces certain challenges such as minimal increase in household income and lack of orders from JHARCRAFT, these if overcome, can result in effective and efficient implementation of the reeling and spinning training project.

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CHAPTER 1- INTRODUCTION

Businesses are the most powerful constituents of the society and they do not operate in isolation; there is an increased realization that not only can companies affect society at large, but they are also in a unique position to influence society and make positive impact.

> "The Organization for Economic Co-operation and Development[1] (OECD) established a set of guidelines for multinational enterprises in 1976, and was thus a pioneer in developing the concept of CSR. The purpose of these guidelines was to improve the 'investment' climate and encourage the positive contribution multinational enterprises can make to economic and social progress".

An evaluation is 'the systematic and objective assessment of an on-going or completed project, programme or policy, its design, implementation and results. The aim is to determine the relevance and fulfillment of objectives, development efficiency, effectiveness, impact and sustainability. An evaluation should provide information that is credible and useful, enabling the incorporation of lessons learned into the decision-making process of both recipient and donors.' (OECD Publications, 2010)

1.1. About Bharat Coking Coal Limited

Bharat Coking Coal Limited (BCCL) is a subsidiary of Coal India Limited, a Maharatna Company. The company is operating in 12 administrative areas in Jharia Coalfields encompassing around 226 peripheral villages mainly in the District of Dhanbad, Jharkhand and in some part of West Bengal. The CSR strategy of BCCL states that the company's main objective is to improve the quality of life of people living in and around its command areas. Towards achieving this objective and to understand the interest levels of the local community, BCCL undertook a departmental baseline survey cum Skill Gap Analysis study at some locations. The recommendations from the study formed the basis for the design and deployment of the skill development initiatives.

[1] http://www.oecd.org/about/

1.2. About National Corporate Social Responsibility Hub, TISS

National Corporate Social Responsibility Hub, (NCSR Hub) was established in 2011 by the Department of Public Enterprises to enable the Public Sector Enterprises to design and implement holistic and rights-based CSR initiatives. Tata Institute of Social Sciences (TISS), Mumbai and Department of Public Enterprises (DPE), Government of India had come to realize that there is a need to have centralized system where core functions of CSR including learning and knowledge dissemination take place. The core activities of the Hub are:

- Vision and strategic direction setting for Policy and Programme
- Advisory role for PSEs on Policy and Programme implementation
- Research and development and 'evidence-based' policy advocacy
- Capacity building of PSEs, partners and civil society institution
- Impact assessment, monitoring and evaluation
- Empanelment and partner management

1.3. Project Background

REELING AND SPINNING TRAINING PROJECT: This is a skill Development cum employment generation project under "*Swaavlambee* Project" of BCCL targeting groups of unemployed and willing to work women from *Mukunda, Alakdiha, Gareia , Panchmohali* and *Nootangram* villages belonging to Dhanbad District. These villages were chosen because they are located in the command area of BCCL, a project was estimated to generate employment for a group of thirty women from a village. For this purpose, BCCL and JHARCRAFT entered into an agreement for implementation of the project.

1.4. Objectives of the project

1. Skill enhancement through Training and shortening the learning curve of skilled and semi-skilled women.
2. Self-Employment generation and enhancing employability of women groups in the villages.

3. To help improve overall quality of life by providing employment to women especially the weaker section of the society.

1.5. Mid Term Evaluation study for Reeling And Spinning project of BCCL

Bharat Coking Coal Limited (BCCL) sanctioned mid-term evaluation of the reeling and spinning skill development project to National CSR Hub in August-September 2017. The following report details the evaluation of projects undertaken by Bharat Coking Coal Limited in accordance to their CSR policy laid out in 2014.

As per the agreement with CIL, TISS was entrusted the responsibility to undertake the work of generating data through a baseline survey in the peripheral villages of BCCL. Accordingly TISS conducted a sample survey in 42 villages in and around BCCL in the year 2013 to assess community needs that could be addressed through CSR initiatives. .

Based on the results of the baseline survey, a skilled development and employment generation project was envisioned for unemployed women of these villages. In order to facilitate the identified groups of women of these villages with employment opportunities, initiatives have been taken to take the help of JHARCRAFT, a Government of Jharkhand undertaking. Five groups of women each group comprising of thirty (30) women were identified at Mukunda, Alakdiha, Gareria, Panchmohali and Nootangram village.

CHAPTER 2– RESEARCH METHODOLOGY

Research methodology is a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically. In it, one studies the various steps that are generally adopted by a researcher in studying his research problem along with the logic behind them (Kothari, 2004). This chapter outlines the research methodology and also examines the objectives of the study and the research question. The chapter also includes the research design, methods, and level of engagement for data collection, on and off the field as well as the ethics of research and the limitations that the researcher has kept in consideration.

2.1 Objective of Study

The very purpose of the research is to discover answers to the question through the application of the scientific procedures (Kothari, 2004). These objectives help in exploring answers and understanding the behaviour, condition or phenomenon prevalent in the population under study. The aim of the study was to understand the extent of the impact of the project on the socio-economic conditions of the targeted beneficiaries. Further, following are the main objectives of the study:

i. To assess if the objectives of individual projects are being met/have been met;
ii. To understand the continued relevance of the individual projects in their respective contexts;
iii. To identify issues in programmatic implementation and provide recommendation to fulfil the objectives efficiently.

2.2 Key issues addressed

- Implementation mechanisms used by the Implementation Agencies;
- Monitoring mechanisms undertaken by the IAs;
- Scope of improvement as articulated by various stakeholders;
- Efforts towards ensuring sustainability of the project
- Documentation of the project design, outcomes and achievements.

2.3 Research Design

The research design refers to the overall strategy that one chooses to integrate the different components of the study in a coherent and logical way, thereby, ensuring one will effectively address the research problem; it constitutes the blueprint for the collection, measurement, and analysis of data (De Vaus, 2001)

This study is an **Evaluation** research study as it is designed to assess the outcomes of an intervention, so that the findings will provide insights useful for the organizations that have funded and implemented the project. For the purpose of the mid-term evaluation of reeling and spinning training project, qualitative research design was developed.

2.4 Research Methods

Tools for Data Collection

The tool is one of the essential components of a research study. It is an instrument that helps the researcher to meet the objectives of the research. There are various kinds of tools that are utilized based on the needs and objectives of the research. In the current study the research team made use of certain sets of tools which are as follows:

- **Focused Group Discussion (FGD):** FGDs where conducted in all the 4 project, and those interviewed for the FGD were the village members, Ward/Gram Panchayat Representative, ASHA workers, Women Representatives, SHGs Youth group members etc.
- **In-depth Interviews (IDI):** Similarly IDI was conducted with village members who were directly affected by the project
- **Case studies:** Case studies were used to get life narratives of the beneficiaries and to understand the impact of the project on their socio-economic and cultural lives

2.5 Data collection methods

The sampling type used for Data collection was Random Stratified sampling. **Primary data** was collected using the following methods, selected as per the above-explained research design:

a. Survey of beneficiaries through questionnaire

b. Semi-structured interview (using interview schedule) and In-depth interviews. The in-depth interviews were open-ended with complete scope for probing and getting detailed information from the participants.
c. Participatory research methods such as transect walk
d. Document analysis (review of project reports)
e. Direct observation (home visit, village/town visit and institution visit)

Secondary data: Secondary data, wherever made available by the implementing agencies, consisted of Annual reports, Project Proposals, Baseline studies and project blue prints

2.6 Participants of Data Collection

This study aims to capture perspectives from multiple stakeholders. Accordingly the following participants and stakeholders were covered through the data collection done in this study:

- Beneficiaries i.e. people (here SHG/Women's group) impacted by the project
- Officials of BCCL (Sustainable Development Department)
- Village level stakeholders (Community Leaders):, Sarpanch, ward members and former Sarpanch

2.7 Data Analysis

As previously mentioned, this study employs qualitative methods. The responses from the in-depth interviews and the other qualitative data were subjected to coding for detecting patterns. The data from interviews and discussions was analyzed **thematically** and the data from all the sources was integrated as per the responses to understand, assess and evaluate the entire process of implementation. This being a qualitative study, there is an emphasis on understanding and analyzing the perceptions, views and experiences of the beneficiaries and other key stakeholders with respect to the skilled development project.

2.8 Challenges of the study

1. **Language Barrier:** The major hurdle in data collection was the language barriers, few of the villagers were speaking Bengali and few were Oriya/Odia.

2. **Limited documentation:** The Limited documentation of the CSR project was another hurdle faced by the research team. It rendered primary data as the only source of information

CHAPTER 3–FINDINGS FROM THE FIELD

3.1 Introduction

"Swaavlambi Project" is a Skill Development initiative of BCCL and JHARCRAFT, an undertaking of Government of Jharkhand. They have mutually agreed to develop skills in weaving and reeling to assure sustainable livelihoods to underprivileged and unemployed women of Dhanbad District of Jharkhand. Mukunda, Alakdiha, Gareia, Panchmohali and Nootangram are the chosen villages to implement this employment generation program. The purpose of the intervention is to develop an infrastructure to train women, employ them in the centres and assure a market linkage for sustainability. The aim is to ensure maximum possible monetary benefits to these women.

3.2 Background

"Swaavlambi Project" is a Skill Development initiative of BCCL and JHARCRAFT, an undertaking of Government of Jharkhand. They have mutually agreed to develop skills in weaving and reeling to assure sustainable livelihoods to underprivileged and unemployed women of Dhanbad District of Jharkhand. Mukunda, Alakdiha, Gareia, Panchmohali and Nootangram are the chosen villages to implement this employment generation program. The purpose of the intervention is to develop an infrastructure to train women, employ them in the centres and assure a market linkage for sustainability. The aim is to ensure minimum monetary benefits to these women, BCCL and JHARCRAFT have entered into an agreement to share the responsibilities of the Weaving and Reeling Training Program. JHARCRAFT imparted skill development training to a group of thirty women on Reeling and Spinning of cotton and silk thread in two locations for a period of one month. After having received training, the women were found to be skilled enough, to produce the cotton and silk handlooms. The training centre was the production centre and guidance was provided by the trainers and officials of JHARCRAFT. Apart from training, JHARCRAFT was responsible for generating a market for the produce. The Emporiums across the country were the platforms to exhibit and sale the finished products. The money earned from the sale was to be transferred to the bank accounts of women.

Reeling and spinning training project is a CSR initiative which is a skill development and employment generation project under "*Swaavlambee* Project" of BCCL. Itis focussed on willing unemployed groups of women of the villages *Mukunda, Alakdiha, Gareia, Panchmohali* and *Nootangram* belonging to Dhanbad District. To generate employment opportunities for the women, BCCL and Jharkhand Silk Textile and Handicraft Development Corporation Ltd. (JHARCRAFT) have entered into an agreement for implementation of the project. JHARCRAFT is a Government of Jharkhand undertaking under Industry Department and is registered under section 26 under Companies Act. 1956. It is operating such projects successfully at Khraswan in Jameshdpur, Nagri in Ranchi and Bhagahiya in Sahebganj. Besides this, their projects are also being implemented as CSR activities of Gua Ore Mines, Megahatburu, Kirkburn, Durgapur plant of SAIL and NTPC Hazaribagh, THIESS Minaces, JINDAL Power Patratuas organisations.

In the first phase, for one month, JHARCRAFT imparted skill development training to a group of thirty women on Reeling and Spinning of cotton and silk thread in two locations, Mukunda and Alakdiha. Once trained, these women started production of cotton and silk fabrics under the guidance of JHARCRAFT trainers and officials for the remaining project period. According to the agreement, JHARCRAFT also managed production of the silk products produced by the trained women and promoted marketing of the products through their emporiums spread over various locations of the country. Money earned from the sale of the silk products is being transferred to bank accounts of the women.

This project, therefore, intended to provide a sustainable employment generation for the women of the target communities

3.3 Objectives of the reeling and spinning training project

a) Skill enhancement through Training and shortening the learning curve of skilled and semi-skilled women.
b) Self-Employment generation and enhancing employability of women groups in the villages.
c) To help improve overall quality of life by providing employment to women especially the weaker section of the society.

3.4 Implementation of the Project

BCCL is the donor partner and JHARCRAFT the Implementing Agency for the Reeling and Spinning Training Program. JHARCRAFT is responsible to train the women and guide the production of cotton and silk handloom for the period of two years. The Agency is also liable for promoting and marketing the produce with sales. Both parties are accountable to each other for the period of mutual agreement as per the MoU. In the documents presented and official's accounts collected, it was found that there was no clear exit strategy after the completion of the project. The officials reported that bimonthly monitoring visits were made to ensure the efficient implementation of the project.

The primary beneficiaries of the project were thirty women pre centre. The beneficiaries were selected on the basis of their vulnerable background and willingness to acquire skills and participate in production post training. These women belonged to socio-economically vulnerability groups. The indirect beneficiaries were, thus, the families of these women.

Out of five proposed locations, centres have been started at Mukunda and Alakdiha. The other centres will be gradually started after analyzing the results of the pilot
Proposed Location of Implementation:

Table No. 1 – Proposed Location of implementation

Sl.No.	Name of Village	Name of *panchayat*	Name of police Station	District	State
1	Mukunda	Mukunda	Tisra	Dhanbad	Jharkhand
2	Alakdiha	Alakdiha	Tisra	Dhanbad	Jharkhand
3	Gareria	Gareria	Kenduadih	Dhanbad	Jharkhand
4	Panchmohali	Panchmohali	Chirkunda	Dhanbad	Jharkhand
5	Nootangram	Nootangram	Chirkunda	Dhanbad	Jharkhand

3.5 Observations of the Mid Term Evaluation

Focused Group Discussions with the beneficiaries and Key Informant Interviews with the officials of BCCL were conducted to gain insights on the ongoing projects. BCCL provided financial support to JHARCRAFT so as to develop an infrastructural facility to conduct trainings and manufacture the handlooms. Whereas, JHARCRAFT provided training and guidance for the duration of two years. They also arranged for required resources like raw materials, reeling and spinning equipment, technical support and a network for promotion of sale of the produce from these centres.

During the study, it was observed that out of two, only one centre at Mukunda is functional with only twenty to twenty-five women working for five days a week. The other centre at Alakdiha is non-operational. However, thirty women were provided training at the location. A negotiation is on-going between BCCL, JHARCRAFT and group of women to re-initiate the centre and start the production.

3.6 Mukunda Training Centre

The centre was inaugurated in the month of January, 2016 and training started from the month of March, 2016. The facility was provided in the adjoining centre of Mukunda Hospital operated by BCCL. The centre is spacious to facilitate trainings and store needful logistics like raw material, equipment & finished products.

Twenty-five women have been trained and are participating in the process of manufacturing at the Mukunda Centre. They reside in the radius of five kilometers from the centre and are between twenty-five to thirty-five years old. Most are either illiterate or barely educated, only one was reported to be a graduate. The women largely belong to Other Backward Classes, Scheduled Caste and Scheduled Tribe and monthly average income ranges from Rs. 15000 to Rs. 30000 per month. According to the beneficiaries, they are currently not employed anywhere else other than the training centre. None of them have started a self-employment venture as a result of the reeling and spinning training because according to the beneficiaries, the handlooms are unaffordable for them.

Beneficiaries with a finished handloom product and reeling *charkha*

The beneficiaries explained that they were uninitiated to the workings of the handloom craft and thus were hesitant to join the training and commit two years for the same. Since the beneficiaries had not contributed to the household income prior to this initiative, their family members were uncertain about the viability of the project as well. It was only after the detailed information dissemination by the '*mukhiya*' and the BCCL personnel that the women decided to join the training. The beneficiaries were also assured an increase in income as a consequence of the training program. The beneficiaries noted that their main motivation for engaging with this program was to gain a unique skill which could be used for income generation at any time in the future.

The training was conducted in a facility adjoining the Mukunda hospital operated by BCCL. The centre was found to be spacious enough to facilitate trainings and store resources. The facility houses 20 large handlooms along with a storage room for raw materials such as thread, needles, parts of the handlooms and also the finished materials. The women spent approximately five to six hours a day at the facility weaving fabrics. Even though the agreement between BCCL and

Government of Jharkhand states that JHARCRAFT will be solely responsible for the purchase of the finished products and will also bring business for the beneficiaries evidence from secondary research conducted and perspectives from KIIs on the field, indicate that JHARCRAFT has been unable to uphold this aspect of the agreement in its totality. Nevertheless, JHARCRAFT has been instrumental in providing training to the beneficiaries and the trainer is still involved with the production of fabric so that he can provide assistance to the beneficiaries when required.

According to secondary research, JHARCRAFT is, however, not able to provide the optimum market for the produce of the centre. Handloom is learnt over many years whereas these women had spent only two years practicing the craft. Consequently the quality of the product was not at par with market standards On the other hand, the women expected get gainful employment after the completion of the project. Resulting in uncertainty due to the lack of it. This is also breach of contract as they agreed to sale the output of the centre.

The beneficiaries unanimously noted that the trainer was a highly skilled professional trainer who had been integral in the growth of their artisan skills. They were well aware of the procedures of the agreement and the roles of JHARCRAFT and BCCL officials. In addition, they were found to have successfully grasped intricate concepts from their syllabus. They also mentioned that post the initial training period, they practiced the nuances of handloom reeling and spinning and are still in the process of honing their craft. They express their gratitude to the involved parties to help them work on the handloom machines post the training.

Apart from facilitation in acquiring a new skill, the reeling and spinning training project has also helped in self-esteem boost, development of entrepreneurship and enhancement in quality of life. The beneficiaries shared that they had never gone out of their house without a male companion but now are able to access the banking services without any assistance post the training program. They also shared instances of realizing the importance of quality education after exposure to myriad of delegates and officials from the well renowned organisations such as BCCL and their partners. The beneficiaries have now tried to chart out a plan to provide quality education to their children and hope this training program will aid them in contributing to the increase in their household income.

As regards to achievement of stated milestones, disappointment was expressed by beneficiaries, as there have been no financial gains to the women in spite of working for more than five hours a day for twenty days in the month. They earn a bare minimum income of INR 350- INR 600 per month which is less than minimum wages and far less than the benefit promised to them. Conclusively, there is a marginal increase in the household incomes as reported by the beneficiaries. Corrective measures for the same are yet to be taken from the all the stakeholders.

3.7 Alakdiha Training Centre

The Research Investigators were unable to interact with any of the respondents from this centre as it was not functional at the time of the study.

The training centre at Alakdiha is non-operational due to many unfortunate constraints accumulated over a period of time. Thirty women were successfully trained and were about to initiate the process of production but everything halted at the demand of mechanized reeling machines. These machines reduce the human labour and time required to weave the handlooms.

At present, all stakeholders are discussing and negotiating in order to reach a mutual consent to re-initiate the centre and avoid further delays loses losses to any of the shareholders.

The BCCL officials explained that the beneficiaries belong to the highly marginalised communities and their villages are located amidst the mining activities of BCCL. Public and private transport rarely plies to these villages making them cut-off from the nearest towns and cities. In these situations, the beneficiaries expected an avenue of income generation located in their vicinity but they feel that this training program has been unsuccessful in providing the same.

Further, there is a strong demand of a mechanised machine for reeling the threads which will reduce their manual labour on reeling on a manual charkha and focus the remaining time on weaving the thread. This matter has been escalated at the level of BCCL and JHARCRAFT and both the organisations are amidst negotiations with the beneficiaries and among themselves to come to a fruitful conclusion.

Table no. 2 – Summary of concerns in Alakdiha Centre

Sr.No	Stakeholder	Concerns in regard to mechanised reeling machine	Recommendation
1	Beneficiaries	Decreases the reeling time by at least 60%.	Demand for mechanised reeling machine.
2	BCCL	No budgetary allowances for the same in the MoU	Negotiation meeting to be scheduled with JHARCRAFT
3	JHARCRAFT	No budgetary allowances for the same in the MoU	

Secondly, the travelling is another major area of concern of these women. There are no public or private transport services bridging the distances between the centre and habitat of the women. These women hail from highly marginalized communities and reside at the sites amidst of the mining activities of BCCL. They remain disconnected with the main cities as there is no consistent and assured mode of transport which is 15-20 kms away. The beneficiaries have also demanded for the production near their vicinity. They expressed that their expectations were not fulfilled and the project was not considerate enough to support these women from the far places.
In spite of extreme difficulties, the recipients of training acknowledged the quality of training, the skills of the trainer, infrastructural facilities, tools & techniques and other necessary resources of the training program.

BCCL and JHARCRAFT are interacting with the women to find best possible solution to terminate the conflicts and re-start the process of manufacturing at the centre.

3.8 Concerns regarding the project

When asked about the challenges being faced by the beneficiaries from both training facilities in the past two years of the reeling and spinning training program, following are the main responses:

- Minimal increase in household income: even though the beneficiaries received Rs. 3000 per month for the period of the training, the beneficiaries' state that the income posts that has dwindled. In Mukunda, the women have persevered in the hope of learning new skill as they hail from economically stable families while in Alakdiha, lack of income is of primary concern as they are situated in geographically and economically remote areas. Therefore, lack of income coupled with spending a full working day at the loom is not feasible for the beneficiaries of Alakdiha centre.

- Lack of mechanised tools: the beneficiaries expressed concern about the time manual reeling machines take as compared to ones that have a motor attached. According to the beneficiaries, the mechanised reeling machine can save up to 60% of their time spent in the reeling activities in preparation of fabric production. They note that the time spent on the production of fabric can be increased if the time on reeling the thread is reduced. Currently, they spend at least 10 days on reeling the threads on a manual *charkha* which is then used in the handlooms. They claim that on a mechanised *charkha*, the same reeling process will take 4 days instead of 10 days.

- Lack of orders from JHARCRAFT: the beneficiaries have expressed that there has been a decrease in orders from the aforementioned organisation and they are not provided a variety of threads to work with. They were hoping to be working on bigger orders by now but according to their trainer some of the beneficiaries are still learning and once their skills are further developed they will be able to work with other thread varieties to produce fabric on the handloom.

CHAPTER 4 - RECOMMENDATIONS

Table no. 3 – Summary of recommendations

Sr.No	Recommendation	Purpose
1	The internal conflicts can be mutually resolved by discussions and provisions of viable demands.	To revive the existing centres (operational & non-operational) with increased productivity and enhanced quality.
2	Market Linkages can be multiplied by creating avenues like online sale, participation in exhibitions, display in retail chains and B2B contracts	To assure consistent sale for sustainability.
3	Branding, product innovation, design development, technical training and technological support can be imparted for better quality product and higher goodwill.	To compete with the changing trends of fashion and offer products at affordable prices.
4	Training in Entrepreneurship can be conducted as part of the training program.	To motivate the trainees to own the responsibility of sustaining the centres of production.
5	Trainees can be educated on forming SHGs and availing micro-finance from the financial intuitions.	To make the collective self-reliable and self-sufficient.
6	Introduce and link with State and Government schemes in Handloom Sector, Women Entrepreneurship, Micro-Finance, Market Linkages, Procurement of raw material & other technical support,	To assure support and sustainability of the enterprise.
7	A website can be launched with Brand Name	To reach to the new

	and portal for online payments to promote the produce and increase the sale. Social Media can be used as a platform for publicity and awareness.	community of online purchasers and increase the sale multi-fold.
8	Training on data management, financial management, logistics management, etc can be imparted to the beneficiaries.	To educate beneficiaries on aspects of managerial skills for analysing the state of the enterprise to plan the line of action.
9	Backward and forward linkages can be identified and specialised services can be exchanged.	To withstand the uncertainties of the market and minimise the risks by sharing it with multiple stakeholders.
10	Exposure to interact with established cluster collectives.	To learn the process of formation of an enterprise from a small no.of beneficiaries,and extending the participation for more benefits.

ANNEXURE

.

QUESTIONNAIRE FOR BENEFICIARIES

SKILL DEVELOPMENT ON REELING AND SPINNING TRAINING UNDER CSR OF BCCL

Date:

Time:

Village:

1.	Details of the beneficiary:
a)	Name:
b)	Age:
c)	Educational Qualification:
d)	Income:
2.	Are you currently employed? If yes, with whom?
3.	Are you working as a skill artisan?
4.	Or are there initiatives taken to make you self-sufficient entrepreneurs?
5.	What do you know of this training? (Objectives)
6.	When did this training start?
7.	How did you know about this training?
8.	What made you join this training?
9.	What were you trained for?
10.	How were you trained?
11.	What was the duration of the training?
12.	Were you satisfied with the trainer?
13.	How has this training benefitted you?

14.	Has there been an increase in the household income?
15.	What personal skills did you develop?
16.	Has it brought about any perceptional change in your family?
17.	What did you like about the training?
18.	What did you not like about the training?
19.	What were the immediate effects after training? Social: Familial: Economic:
20.	Did you earn from the products made during the training? How much did you earn?
21.	Was it more or less according to your expectations?
22.	Were you given any stipend during the training?
23.	Can you teach others what you have learnt?
24.	Who do you sell your products to?
25.	Do they give you a target to achieve in a month?
26.	What are the transactions terms by the buyer?
27.	Were the beneficiaries given the final assessment at the end of the training? If yes, what was it?
28.	Are the beneficiaries' parts of a Self Help Group?
29.	What other skills were imparted to them?
30.	Was the community involved? If yes, in what ways?
31.	How has this project shown improvement in the quality of the life in the beneficiaries? Please elaborate (medical insurances, bank accounts, etc.)
32.	What has been the response/feedback from the beneficiaries to Jharcraft on this project?
33.	Did Jharcraft face any challenges while engaging with the community?
34.	To your knowledge, are there any other organizations working with a similar programme in this geographical area? If yes, could you provide the names of those organizations?
35.	Budget of running the particular project:

36.	What was the cost decided upon?
37.	Was there any deviance?
38.	Please provide details about the team who were assigned the project: *What was their role? What was the input and the output?*
39.	What are the strengths and weaknesses of this project?
40.	Has Jharcraft faced any challenges in engaging with BCCL? What were the key challenges faced during this project?
41.	What are the key achievements of this project?
42.	According to you should there be additional measures taken to improve this project?
43.	Kindly provide any additional comments, concerns and/or observations/suggestions to improve this project?

INTERVIEW SCHEDULE FOR BHARAT COKING COAL LIMITED

DATE:

TIME:

44.	Details of the Company:	
e)	Name:	
f)	Designation:	
g)	Contact No.:	
h)	Address:	
45.	Name of project:	
46.	Date of Implementation:	
47.	Objectives of the project:	
48.	List which of these objectives were achieved and which were not achieved?	
49.	Please explain the process of collaboration with Jharcraft. The rationale is stated in the proposal, was that idea accomplished?	
50.	Why and how did BCCL choose Jharcraft to implement this project?	
51.	As per the MoU, did Jharcraft do any baseline study before commencing the program?	
52.	State the geographical areas the project is being implemented in.	
53.	No. of villages:	Names of villages:
54.	What is the total number of beneficiaries? (please attach scanned copy of total number of beneficiaries mentioning their phone numbers)	

55.	Is there a deviance from the numbers decided upon initially? If yes, why?
56.	How did you decide upon the beneficiaries?
57.	Since when has BCCL been funding this project?
58.	What resources did BCCL contribute? E.g.: Infrastructure, monetary contribution, etc.
59.	Was the community involved? If yes, in what ways?
60.	Are the beneficiaries aware of the role of BCCL in this project? Has a display board used to make them aware?
61.	How has this project shown improvement in the quality of the life in the beneficiaries? What has been the response/feedback from the beneficiaries to BCCL on this project?
62.	Did BCCL face any challenges while engaging with the community?
63.	Did the community know that BCCL is the funder agency of this project?
64.	To your knowledge, are there any other organizations working with a similar programme in this geographical area? If yes, could you provide the names of those organizations?
65.	Budget of running the particular project:
	What was the cost decided upon? Was there any deviance?
66.	Please provide details about the team who were assigned the project: What was their role? What was the input and the output?
67.	What are the strengths and weakness of this project?
	Strengths:
	Weakness:
68.	Has BCCL undertaken monitoring of the said project? How many times? Kindly provide documents if any.
69.	Has Jharcraft conducted any evaluation of the project?
70.	Has BCCL received any monthly reports from Jharcraft? If yes, how many? Please provide with the documents.
71.	Has BCCL faced any challenges in engaging with Jharcraft? What were the key challenges faced during this project?
72.	What are the key achievements of this project?
73.	According to you should there be additional measures taken to improve this project?
74.	Would you replicate this model in future as your CSR project in more villages? Has this model been already replicated?
75.	What changes would you include in the replication of the project?
76.	Kindly provide any additional comments, concerns and/or observations/ suggestions to improve this project?

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GROUNDWATER LEVEL & QUALITY REPORT

FOR CLUSTERS OF MINES, BCCL

(Assessment year – 2024-25)

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

JHARIA COALFIELD AND RANIGANJ COALFIELD (PART)

For
(BHARAT COKING COAL LIMITED)

(A Subsidiary of Coal India Limited)

KOYLA BHAWAN (DHANBAD)

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Annexure – I

DETAILS OF THE REPORT

Sl No.	ITEMS	INFORMATIONS
1	Geographical Area	Jharia Coalfield (JCF): 453.0 sq. km. Raniganj Coalfield (BCCL area): 19.64 sq. km.
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 part
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: 1185.40 mm (year 2024) 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 50 m upto 650 m
7	Hydrogeological properties (Aquifer Pump Test)	Unconfined Aquifer: Hydraulic Conductivity – 0.50 - 0.90 m/day Transmissivity – 10 - 42 m^2/day
		Semi-confined to confined Aquifer: Hydraulic Conductivity – 0.0006-1.44 (0.05 avg.) m/day Transmissivity – 0.06 – 15.0 m^2/day
8	Groundwater Level Monitoring Network	Out of total 139 nos. of monitoring stations 73 nos. located within core mining area and rest comes within Buffers zone. 55 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 18 Nos. of Groundwater monitoring well (Dug Wells) in RCF (CV Area).
9	Groundwater Levels Below Ground Level (bgl)	JCF area: Pre-monsoon – 1.70 to 11.38 m (Avg. 6.33 m bgl) in '2023-24 Post-monsoon – 0.60 to 8.03 m (Avg. 3.77 m bgl) in '2023-24 RCF area (part): Pre-monsoon – 2.10 to 9.50 m (Avg. 5.22 m bgl) in '2023-24 Post-monsoon – 1.50 to 5.18 m (Avg. 3.06 m bgl) in '2023-24
10	Groundwater Quality	Potable as per BIS (**Annexure- VIII**)
11	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 (GWRE:2023-24)

GROUNDWATER LEVEL & QUALITY REPORT FOR CLUSTER OF MINES OF BCCL

1.0 INTRODUCTION

1.1 LOCATION DETAILS AND BRIEF ABOUT THE PROJECT

The 16 nos. Cluster of mines (Cluster-I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XIII, XIV, XV XVI and XVII) 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. (CV area). 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 16 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/e HEAD OF BUSINESS DEVELOPMENT, CMPDI HQ

भारत कोकिंग कोल लिमिटेड
एक मिनी रत्न कंपनी
(कोल इंडिया लिमिटेड का एक अंग)
कोयलाभवन, कोयलानगर,धनबाद –826005

Bharat Coking Coal Limited
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-/18/1086-1088/H) दिनांक : 14.06.2018

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^{o} C and falls between 10^{o} C to 5^{o} 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:

Coefficient of variation (CV) = [Standard Deviation / Mean] × 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).

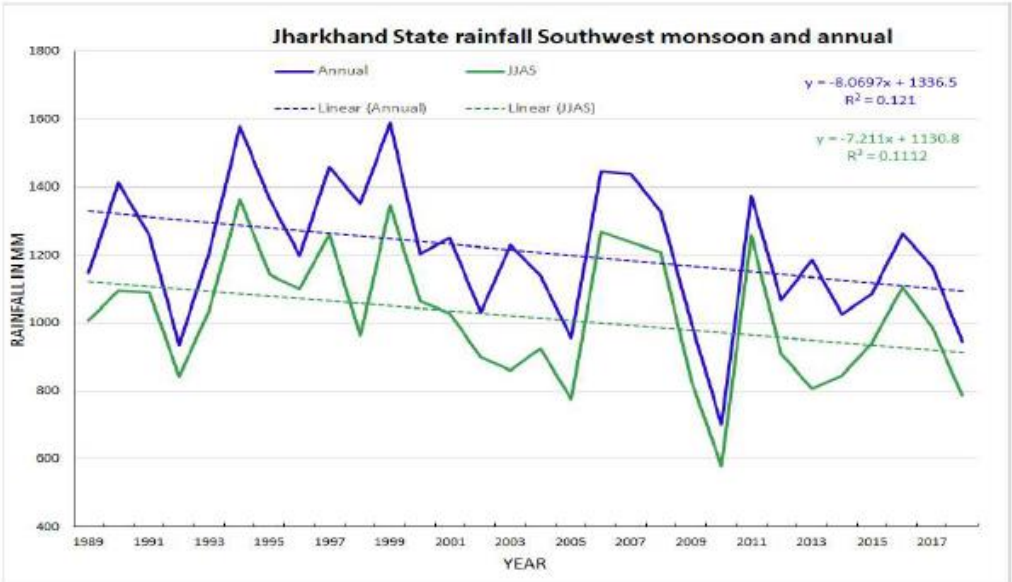


Fig-1.

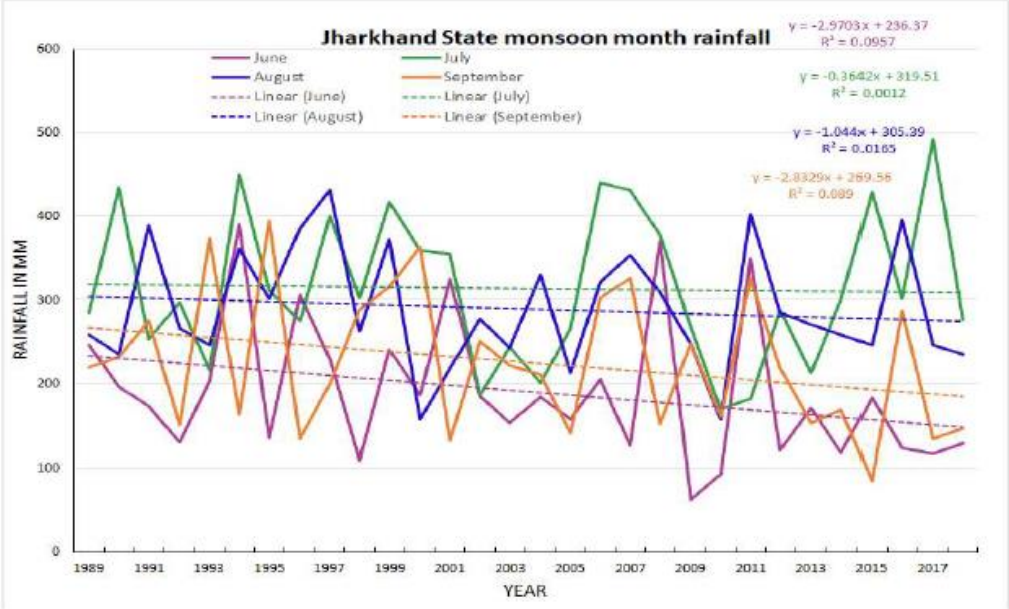


Fig-2.

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 Formaton	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	50 to 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 to 0.90 m/day as computed from pumping tests on the wells. The transmissivity of the unconfined aquifer ranges from 10.68 m^2 /day to 41.48 m^2 /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) and also various piezometers within Cluster of mines BCCL during 2022-23. 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 determined from piezometers constructed in BCCL

Sl no.	Piezometer No.	Aquifer / Formation	Depth of the well (Meters)	Aquifer thickness (Meters)	Static Water Level (Meters)	Discharge (LPS)	Test duration (Minutes)	**K** (m/day)	**T** (m^2/day)
1	PZ-1A	Phreatic Aquifer	40	15	12.15	4.70	275	9.71×10^{-1}	14.6
2	PZ-1B	Barakar Formation (JCF)	115	30	27	2.85	275	6.33×10^{-2}	1.9
3	PZ-2A		87	15	28.1	1.5	960	5.88×10^{-2}	0.88
4	PZ-3A		172	42	17.55	3.0	157	4.04×10^{-2}	1.70
5	PZ-4A		70	18	15.55	1.65	167	5.00×10^{-2}	0.89
6	PZ-8A		140	24	68.72	1.05	275	6.53×10^{-2}	1.57
7	PZ-9B		100	30	34.68	2.45	390	6.68×10^{-2}	2.00
8	PZ-10A		135	30	5	4.7	865	1.52×10^{-1}	4.55
9	PZ-11A	Barren Measure Formation (JCF)	300	66	60.60	3.05	300	3.9×10^{-2}	2.57
10	PZ-13A	Ranigunj Formation (JCF)	80	24	30.9	1.75	400	6.37×10^{-2}	1.53
11	PZ-14B		162	24	12.15	2.75	475	7.48×10^{-2}	1.80
12	PZ-16A	Barakar Formation (part of RCF)	90	18	31.5	2.0	385	5.59×10^{-2}	1.01

3.0 GROUND WATER LEVEL MONITORING

To collect the representative groundwater levels in the study area, CMPDI has established a monitoring network of total 139 monitoring stations out of which 73 located within core zone and rest falls in Buffer zone. Total 105 nos. dug well within JCF and 34 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 on quarterly basis (May'24, Aug'24, Nov'24 and Jan'25).

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 2024 (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
	2023	1.70	11.38	6.33	0.60	8.03	3.77	0.10	6.55	2.56
	2024	1.95	12.50	6.73	0.65	8.22	3.80	1.30	4.28	2.93
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
	2023	2.10	9.50	5.22	1.50	5.18	3.06	0.60	4.32	2.16
	2024	2.14	10.26	5.17	1.14	7.34	3.10	1.00	2.92	2.07

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: Avg. Depth to water table

Formation	*Area*	*DTW (bgl, m) [Year-2024-25]*	
		Pre-monsoon (May'24)	*Post-monsoon (Nov'24)*
Sedimentary (Gondwana Formation / Core Zone)	Non-mining	1.95-11.90	0.65-8.22
	Mining	1.95-10.6	0.65-7.34
Metamorphics (Hard rock)	Peripheral part of the Coalfield	3.17-12.5	1.14-7.77

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 2×10^{-3}
		Mining	1.0×10^{-2} to 1.5×10^{-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.

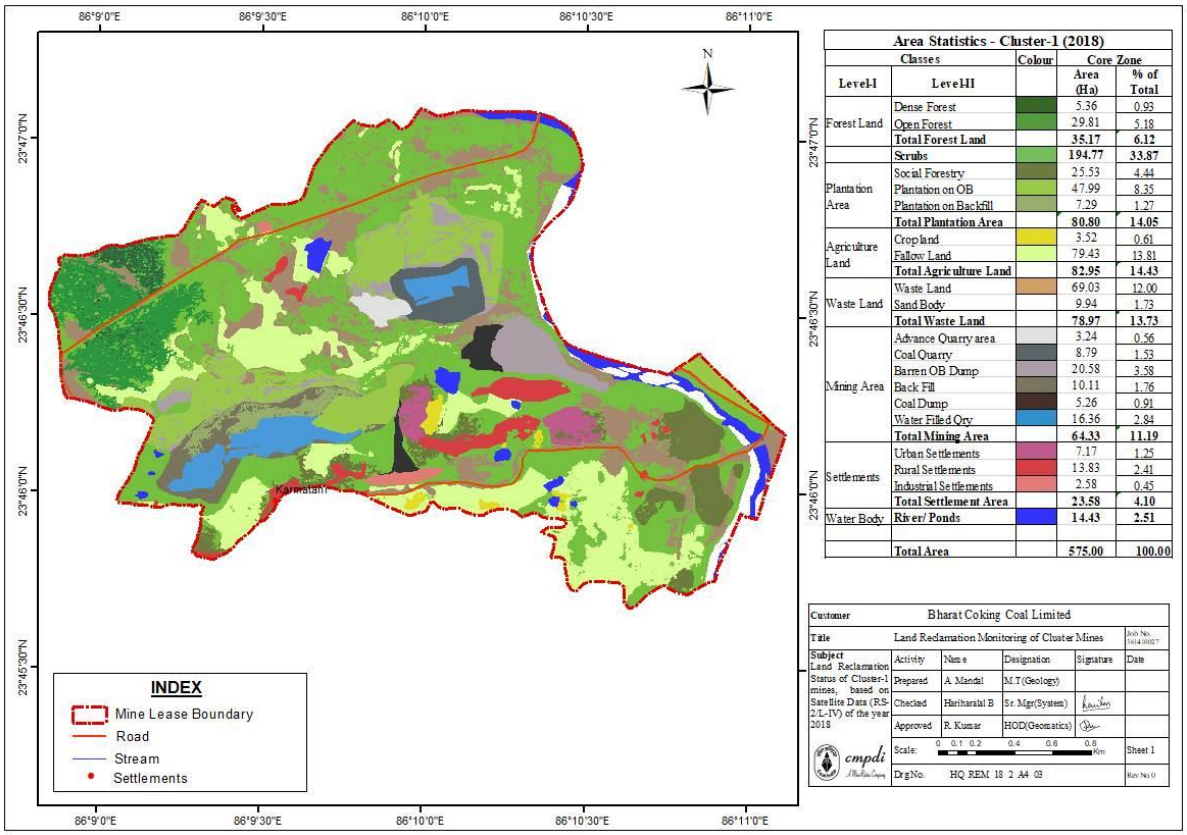
Monitoring stations (**B015, B051 and B053**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl	Well	Location	Water level (bgl in meters)											
No.	No.		2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	B015	Bera Basti	3.35	0.70	0.91	1.54	3.20	0.80	1.00	2.72	3.67	0.45	1.02	2.30
2	B051	Taranga	6.40	2.66	4.47	5.05	5.20	2.51	4.45	4.95	5.06	0.00	4.57	2.87
3	B053	Karmatanr	3.10	1.02	1.21	1.45	2.62	1.33	1.13	1.66	4.42	1.78	3.54	1.68
Average WL (bgl)			4.28	1.46	2.20	2.68	3.67	1.55	2.19	3.11	4.38	0.74	3.04	2.28

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.62 m Max –6.40 m
Post-monsoon GW Level (m): Min – 0.91 m Max – 4.57 m

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



Area Statistics - Cluster-1 (2018)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest Land	Dense Forest		5.36	0.93
	Open Forest		29.81	5.18
	Total Forest Land		**35.17**	**6.12**
	Scrubs		**194.77**	**33.87**
Plantation Area	Social Forestry		25.53	4.44
	Plantation on OB		47.99	8.35
	Plantation on Backfill		7.29	1.27
	Total Plantation Area		**80.80**	**14.05**
Agriculture Land	Cropland		3.52	0.61
	Fallow Land		79.43	13.81
	Total Agriculture Land		**82.95**	**14.43**
Waste Land	Waste Land		69.03	12.00
	Sand Body		9.94	1.73
	Total Waste Land		**78.97**	**13.73**
Mining Area	Advance Quarry area		3.24	0.56
	Coal Quarry		8.79	1.53
	Barren OB Dump		20.58	3.58
	Back Fill		10.11	1.76
	Coal Dump		5.26	0.91
	Water Filled Qry		16.36	2.84
	Total Mining Area		**64.33**	**11.19**
Settlements	Urban Settlements		7.17	1.25
	Rural Settlements		13.83	2.41
	Industrial Settlements		2.58	0.45
	Total Settlement Area		**23.58**	**4.10**
Water Body	River/ Ponds		14.43	2.51
	Total Area		**575.00**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 5614.0002
Subject	Activity	Name	Designation	Signature	Date
Land Reclamation Status of Cluster-I mines, based on Satellite Data (RS-2/L-IV) of the year 2018	Prepared	A. Mandal	M.T(Geology)		
	Checked	Hariharalal B	Sr. Mgr(System)		
	Approved	R. Kumar	HOD(Geomatics)		
cmpdi	Scale: 0 0.1 0.2 0.4 0.6 0.8 Km				Sheet 1
	Drg No. HQ REM 18 2 A4 03				Rev No 0

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.

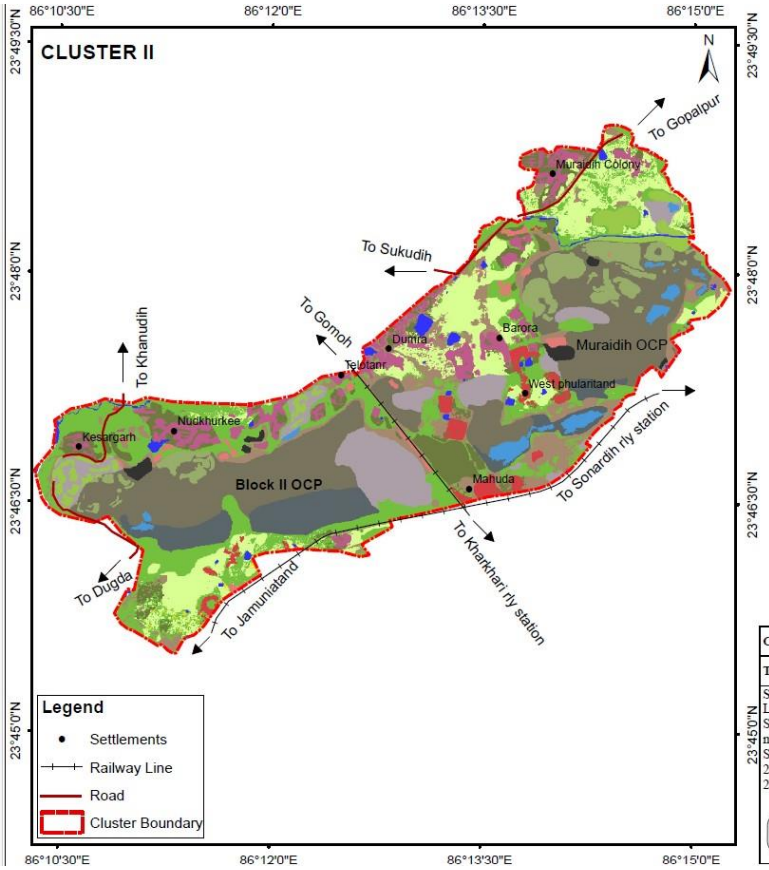
Monitoring stations (**B001, B059, B060 and B062**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl	Well	Location	Water level (bgl in meters)											
No.	No.		2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	B001	Muraidih	4.12	1.82	2.58	2.83	3.22	1.25	2.45	2.7	2.1	1.65	1.81	2.73
2	B059	Khodovaly	2.98	0.50	0.65	1.12	1.88	0.5	0.7	1.12	4.5	0.44	1.14	1.04
3	B060	Bahiyardih	9.10	2.70	5.77	9.04	10.73	5.31	5.73	9.51	10.53	1.08	5.8	9.38
4	B062	Sadiyardih	4.97	3.01	3.19	3.80	4.8	2.35	3.1	4	6.45	1.77	4.91	5.15
Average WL (bgl)			5.29	2.01	3.05	4.20	5.16	2.35	3	4.33	5.9	1.24	3.42	4.58

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.88m Max – 10.73 m
Post-monsoon GW Level (m): Min – 0.65 m Max – 5.80 m

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



Area Statistics - Cluster-II (2022)				
Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**381.65**	**18.84**
Plantation Area	Social Forestry		128.03	6.32
	Plantation on OB		47.29	2.33
	Plantation on Backfill		87.42	4.32
	Total Plantation (C)		**262.74**	**12.97**
	Total Vegetation (A+B+C)		**644.39**	**31.81**
Agriculture Land	Crop land		2.51	0.12
	Fallow Land		254.68	12.57
	Total Agriculture Land		**257.19**	**12.70**
Waste Land	Waste Land		191.19	9.44
	Sand Body		2.01	0.10
	Total Waste Land		**193.20**	**9.54**
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		116.08	5.73
	Barren OB Dump		146.93	7.25
	Back Fill		422.00	20.83
	Coal Dump		15.58	0.77
	Water Filled Qry		32.77	1.62
	Total Mining Area		**733.36**	**36.20**
Settlements	Urban Settlements		111.11	5.48
	Rural Settlements		41.15	2.03
	Industrial Settlements		19.35	0.96
	Total Settlement Area		**171.61**	**8.47**
Water Body	**River/ Ponds**		**25.96**	**1.28**
	Total Area		**2025.71**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 564922120
Subject: Land Reclamation Status of Cluster-II mines, based on Satellite Data (RS-2A/L-IV) of the year 2022	Activity	Name	Designation	Signature	Date
	Prepared	A. Parida	Dy. Mgr(Geol)		
	Checked	Hariharalal B	Ch. Mgr(System)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi	Scale: 0 0.5 1 2 Km				Sheet 1
	Drg No. HQ REM 22 2 A4 02				RevNo 0

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

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.

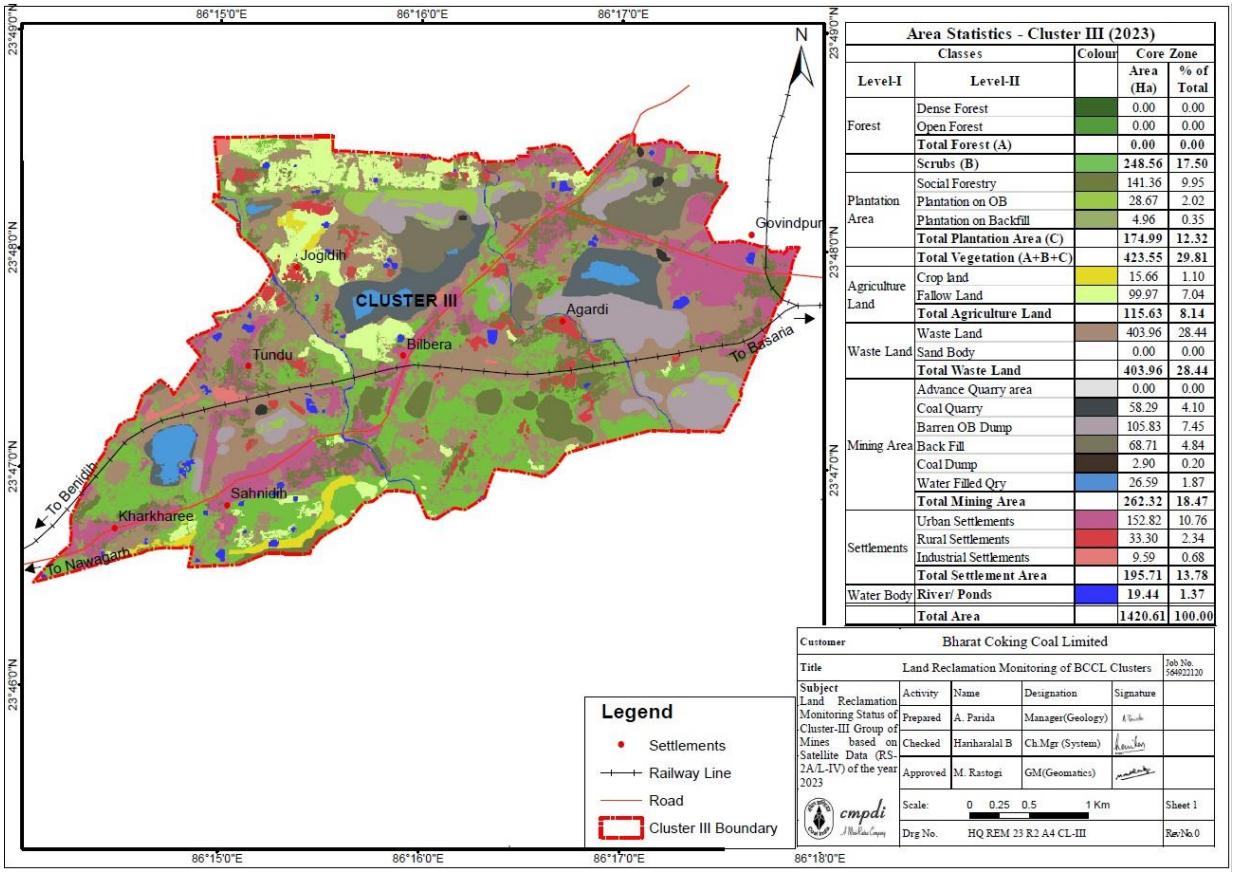
Monitoring stations (**A025, A029, B014 and B060**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2024-25				2023-24				2022-23			
							May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A025	Sinidih	4.85	1.39	2.65	2.98	2.93	1.09	2.6	2.7	3.31	1.33	2.08	2.51
2	A029	Dharmaband	3.06	1.01	2.80	2.88	5.6	2.1	3.2	4.08	4.6	1.2	1.15	1.12
3	B014	Mathadih	3.40	0.93	2.27	2.45	2.84	1.12	2.34	2.42	3.24	0.09	2.6	2.55
4	B060	Sonardih	9.10	2.70	5.77	9.04	10.73	5.31	5.73	9.51	10.53	1.08	5.8	9.38
Average WL (bgl)			5.10	1.51	3.37	4.34	5.53	2.41	3.47	4.68	5.42	0.93	2.91	3.89

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.84 m Max – 10.73 m
Post-monsoon GW Level (m): Min – 1.15 m Max – 5.80 m

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



Area Statistics - Cluster III (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
Plantation Area	**Scrubs (B)**		**248.56**	**17.50**
	Social Forestry		141.36	9.95
	Plantation on OB		28.67	2.02
	Plantation on Backfill		4.96	0.35
	Total Plantation Area (C)		**174.99**	**12.32**
	Total Vegetation (A+B+C)		**423.55**	**29.81**
Agriculture Land	Crop land		15.66	1.10
	Fallow Land		99.97	7.04
	Total Agriculture Land		**115.63**	**8.14**
Waste Land	Waste Land		403.96	28.44
	Sand Body		0.00	0.00
	Total Waste Land		**403.96**	**28.44**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		58.29	4.10
	Barren OB Dump		105.83	7.45
	Back Fill		68.71	4.84
	Coal Dump		2.90	0.20
	Water Filled Qry		26.59	1.87
	Total Mining Area		**262.32**	**18.47**
Settlements	Urban Settlements		152.82	10.76
	Rural Settlements		33.30	2.34
	Industrial Settlements		9.59	0.68
	Total Settlement Area		**195.71**	**13.78**
Water Body	**River/ Ponds**		**19.44**	**1.37**
	Total Area		**1420.61**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 564922120
Subject: Land Reclamation Monitoring Status of Cluster-III Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
cmpdi	Scale:	0 0.25 0.5 1 Km			Sheet 1
	Drg No.	HQ REM 23 R2 A4 CL-III			Rev No 0

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.

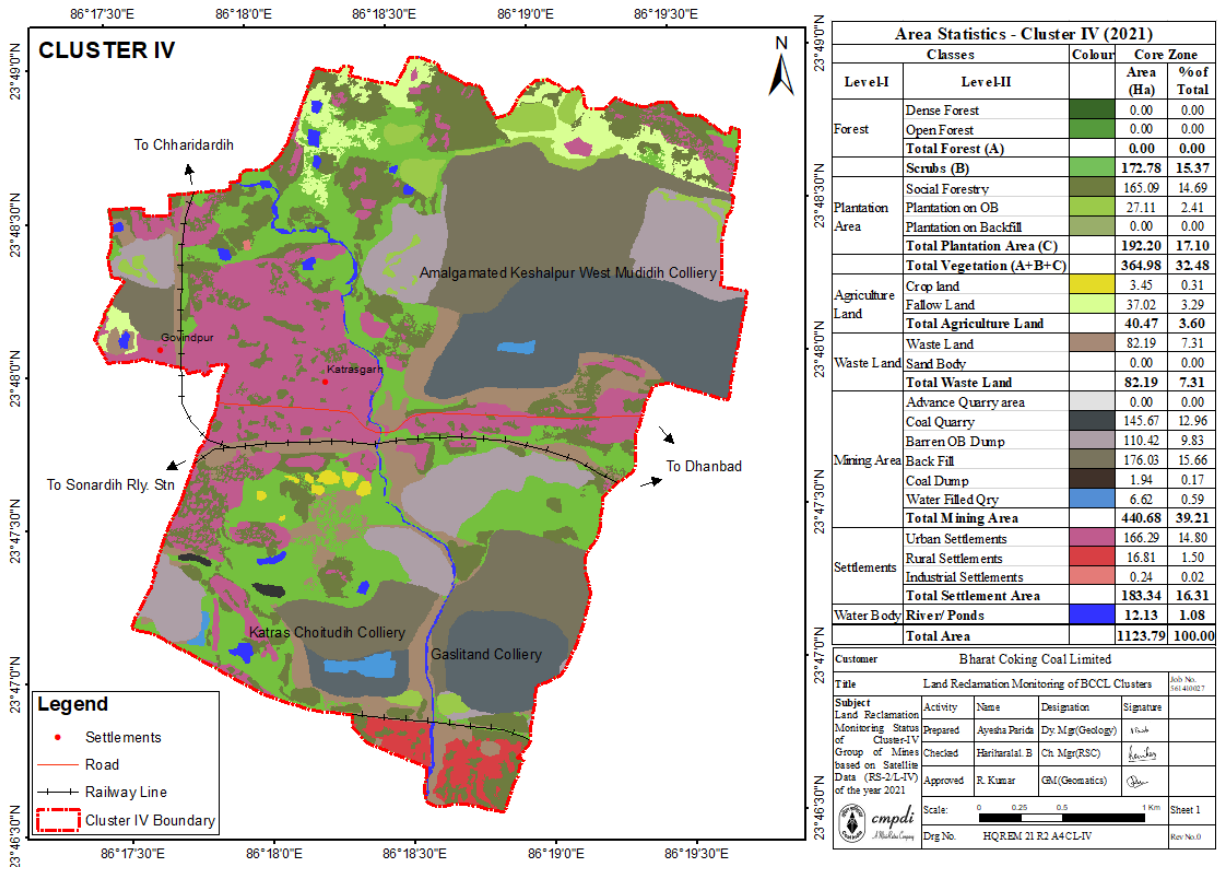
Monitoring stations (**A026, A028 and B065**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A026	Malkhera	7.00	3.18	3.72	4.35	8.4	3.87	3.83	5.5	6.42	2.83	4.31	3.62
2	A028	Lakarka	4.30	3.30	3.49	3.78	3.45	3.13	3.35	3.4	4.23	2.85	3.3	3.57
3	B065	Jhinjipahari	10.60	2.22	2.45	4.01	8.45	1.95	2.35	4.93	7.45	0.5	2.27	3.45
Average WL (bgl)			7.30	2.90	3.22	4.05	6.77	2.98	3.18	4.61	6.03	2.06	3.29	3.55

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.45 m Max – 10.60 m
Post-monsoon GW Level (m): Min – 2.27 m Max – 4.31 m

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



Area Statistics - Cluster IV (2021)

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)		**172.78**	**15.37**
Plantation Area	Social Forestry		165.09	14.69
	Plantation on OB		27.11	2.41
	Plantation on Backfill		0.00	0.00
	Total Plantation Area (C)		**192.20**	**17.10**
	Total Vegetation (A+B+C)		**364.98**	**32.48**
Agriculture Land	Crop land		3.45	0.31
	Fallow Land		37.02	3.29
	Total Agriculture Land		**40.47**	**3.60**
Waste Land	Waste Land		82.19	7.31
	Sand Body		0.00	0.00
	Total Waste Land		**82.19**	**7.31**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		145.67	12.96
	Barren OB Dump		110.42	9.83
	Back Fill		176.03	15.66
	Coal Dump		1.94	0.17
	Water Filled Qry		6.62	0.59
	Total Mining Area		**440.68**	**39.21**
Settlements	Urban Settlements		166.29	14.80
	Rural Settlements		16.81	1.50
	Industrial Settlements		0.24	0.02
	Total Settlement Area		**183.34**	**16.31**
Water Body	**River/ Ponds**		**12.13**	**1.08**
	Total Area		**1123.79**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 541400027
Subject	Activity	Name	Designation	Signature	
Land Reclamation Monitoring Status of Cluster-IV Group of Mines based on Satellite Data (RS-2/L-IV) of the year 2021	Prepared	Ayesha Parida	Dy. Mgr(Geology)		
	Checked	Hariharalal. B	Ch. Mgr(RSC)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ/REM/21/R2/A4/CL-IV				Rev No.0

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.

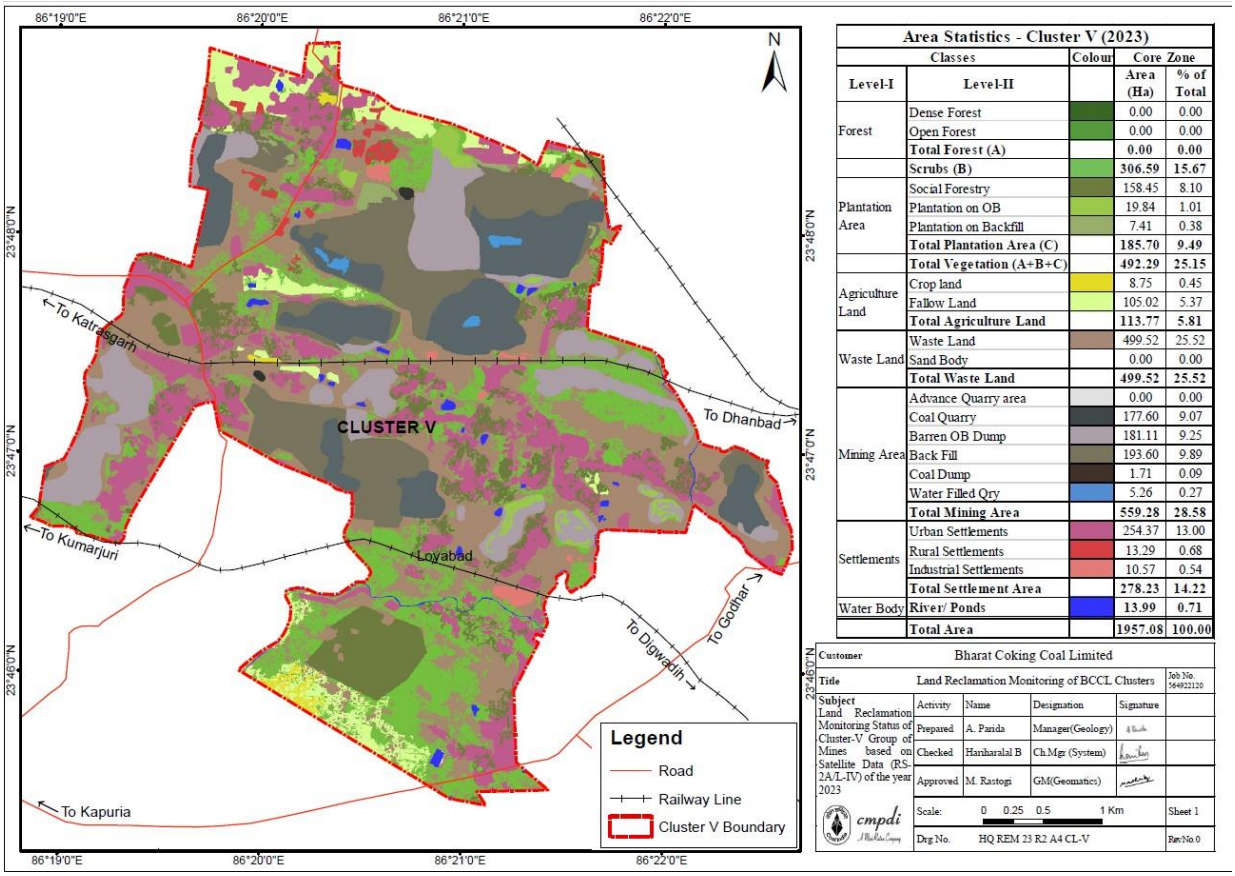
Monitoring stations (**A016 and A027**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A016	Ekra	4.56	3.29	3.49	3.81	5.55	1.35	3.52	4.3	5.8	1.35	3.08	2.99
2	A027	Tetulmari	7.00	3.18	3.72	4.35	1.7	0.55	1.6	1.8	1.9	0.1	1.33	1.5
Average WL (bgl)			5.78	3.24	3.61	4.08	3.63	0.95	2.56	3.05	3.85	0.73	2.21	2.25

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.70 m Max – 7.00 m
Post-monsoon GW Level (m): Min – 1.33 m Max – 3.72 m

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



Area Statistics - Cluster V (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**306.59**	**15.67**
Plantation Area	Social Forestry		158.45	8.10
	Plantation on OB		19.84	1.01
	Plantation on Backfill		7.41	0.38
	Total Plantation Area (C)		**185.70**	**9.49**
	Total Vegetation (A+B+C)		**492.29**	**25.15**
Agriculture Land	Crop land		8.75	0.45
	Fallow Land		105.02	5.37
	Total Agriculture Land		**113.77**	**5.81**
Waste Land	Waste Land		499.52	25.52
	Sand Body		0.00	0.00
	Total Waste Land		**499.52**	**25.52**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		177.60	9.07
	Barren OB Dump		181.11	9.25
	Back Fill		193.60	9.89
	Coal Dump		1.71	0.09
	Water Filled Qry		5.26	0.27
	Total Mining Area		**559.28**	**28.58**
Settlements	Urban Settlements		254.37	13.00
	Rural Settlements		13.29	0.68
	Industrial Settlements		10.57	0.54
	Total Settlement Area		**278.23**	**14.22**
Water Body	**River/ Ponds**		**13.99**	**0.71**
	Total Area		**1957.08**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 564922120
Subject: Land Reclamation Monitoring Status of Cluster-V Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
cmpdi	Scale:	0 0.25 0.5 1 Km			Sheet 1
	Drg No.	HQ REM 23 R2 A4 CL-V			Rev No 0

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

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.

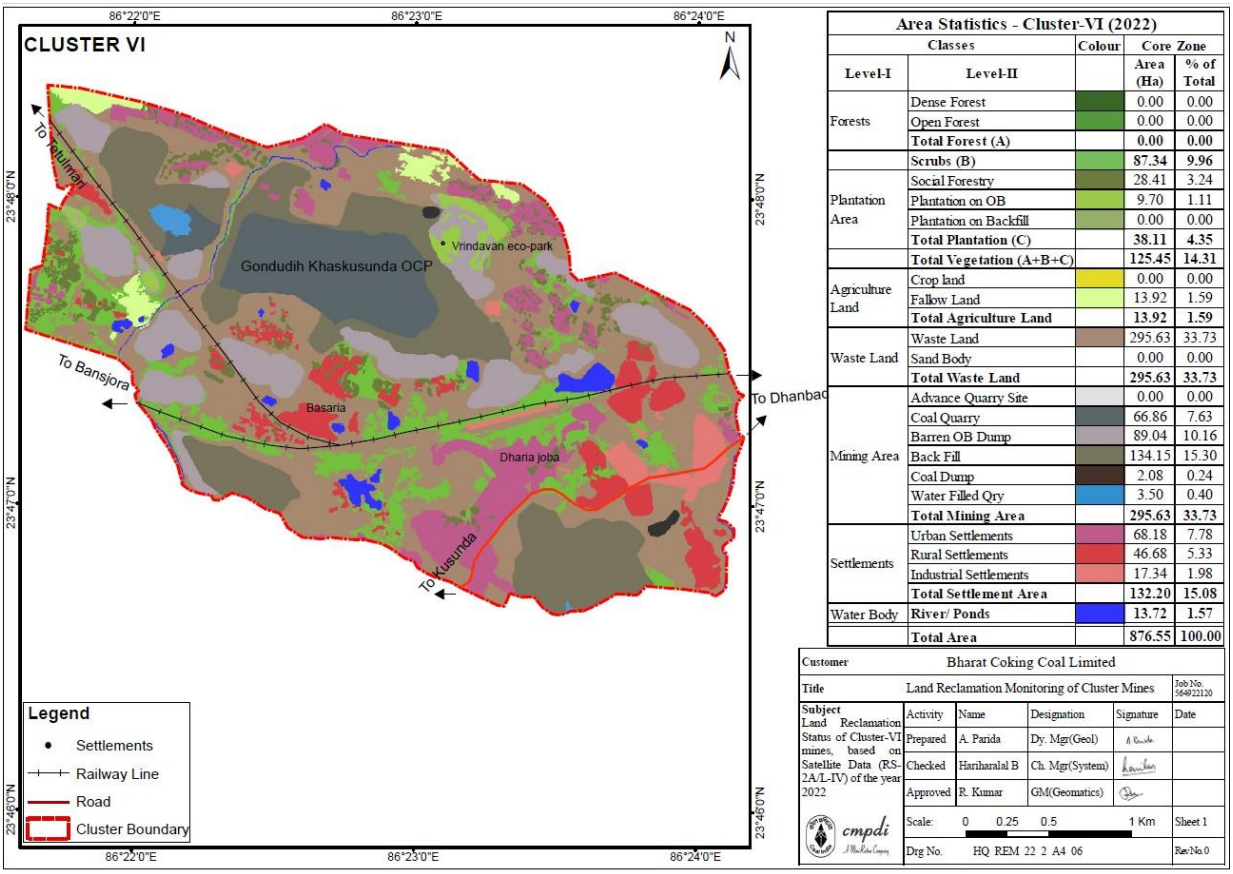
Monitoring stations (**D025, D030 and D034**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D025	Godhur	6.33	3.24	3.47	5.20	4.40	1.80	3.40	4.20	11.90	2.58	4.70	5.30
2	D030	Borkiboa	4.12	1.39	2.28	2.88	4.08	2.10	2.20	3.44	4.37	1.80	2.29	4.15
3	D034	Kusunda	4.30	2.12	2.63	2.99	3.80	1.80	2.50	2.89	5.00	2.15	3.15	3.22
Average WL (bgl)			4.92	2.25	2.79	3.69	4.09	1.90	2.70	3.51	7.09	2.18	3.38	4.22

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.80 m Max – 11.90 m
Post-monsoon GW Level (m): Min – 2.20 m Max – 4.70 m

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



Area Statistics - Cluster-VI (2022)				
Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
Plantation Area	Scrubs (B)		87.34	9.96
	Social Forestry		28.41	3.24
	Plantation on OB		9.70	1.11
	Plantation on Backfill		0.00	0.00
	Total Plantation (C)		**38.11**	**4.35**
	Total Vegetation (A+B+C)		**125.45**	**14.31**
Agriculture Land	Crop land		0.00	0.00
	Fallow Land		13.92	1.59
	Total Agriculture Land		**13.92**	**1.59**
Waste Land	Waste Land		295.63	33.73
	Sand Body		0.00	0.00
	Total Waste Land		**295.63**	**33.73**
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		66.86	7.63
	Barren OB Dump		89.04	10.16
	Back Fill		134.15	15.30
	Coal Dump		2.08	0.24
	Water Filled Qry		3.50	0.40
	Total Mining Area		**295.63**	**33.73**
Settlements	Urban Settlements		68.18	7.78
	Rural Settlements		46.68	5.33
	Industrial Settlements		17.34	1.98
	Total Settlement Area		**132.20**	**15.08**
Water Body	**River/ Ponds**		**13.72**	**1.57**
	Total Area		**876.55**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 5640/22120
Subject: Land Reclamation Status of Cluster-VI mines, based on Satellite Data (RS-2A/L-IV) of the year 2022	Activity	Name	Designation	Signature	Date
	Prepared	A. Parida	Dy. Mgr(Geol)		
	Checked	Hariharalal B	Ch. Mgr(System)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 22 2 A4 06				Rev/No.0

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, Hurriladih 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.

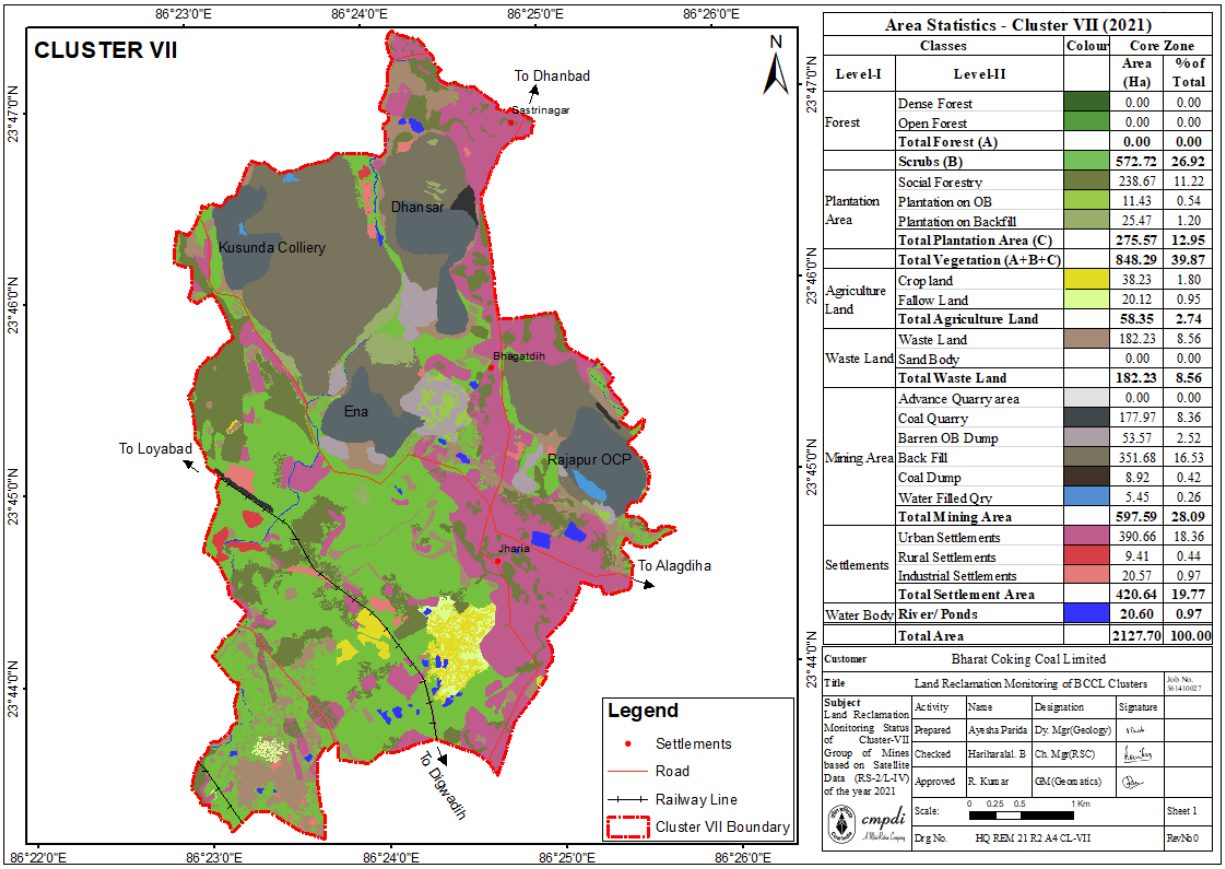
Monitoring stations (**D003, D034, D047 and D080**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D003	Dhansar	1.95	0.87	1.71	1.88	3.15	1.22	1.85	2.28	5.96	0.55	1.32	1.34
2	D034	Kusunda	4.30	2.12	2.63	2.99	3.8	1.8	2.5	2.89	5	2.15	3.15	3.22
3	D047	Parastanr	4.32	2.14	3.38	3.65	4.45	2.57	3.27	3.85	6.55	5.32	5.85	11.4
4	D080	Bastacolla	3.66	2.14	2.55	2.71	4.75	1.75	2.6	3.42	3.3	2.4	3.08	1.8
Average WL (bgl)			3.56	1.82	2.57	2.81	4.04	1.84	2.56	3.11	5.2	2.61	3.35	4.44

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.95 m Max – 6.55 m
Post-monsoon GW Level (m): Min – 1.32 m Max – 5.85 m

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



Area Statistics - Cluster VII (2021)

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)		**572.72**	**26.92**
Plantation Area	Social Forestry		238.67	11.22
	Plantation on OB		11.43	0.54
	Plantation on Backfill		25.47	1.20
	Total Plantation Area (C)		**275.57**	**12.95**
	Total Vegetation (A+B+C)		**848.29**	**39.87**
Agriculture Land	Crop land		38.23	1.80
	Fallow Land		20.12	0.95
	Total Agriculture Land		**58.35**	**2.74**
Waste Land	Waste Land		182.23	8.56
	Sand Body		0.00	0.00
	Total Waste Land		**182.23**	**8.56**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		177.97	8.36
	Barren OB Dump		53.57	2.52
	Back Fill		351.68	16.53
	Coal Dump		8.92	0.42
	Water Filled Qry		5.45	0.26
	Total Mining Area		**597.59**	**28.09**
Settlements	Urban Settlements		390.66	18.36
	Rural Settlements		9.41	0.44
	Industrial Settlements		20.57	0.97
	Total Settlement Area		**420.64**	**19.77**
Water Body	**River/ Ponds**		**20.60**	**0.97**
	Total Area		**2127.70**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 36/14/0027
Subject: Land Reclamation Monitoring Status of Cluster-VII Group of Mines based on Satellite Data (RS-2/L-IV) of the year 2021	Activity	Name	Designation	Signature	
	Prepared	Ayesha Parida	Dy. Mgr(Geology)		
	Checked	Hariharalal. B	Ch. Mgr(RSC)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 21 R2 A4 CL-VII				Rev No 0

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.

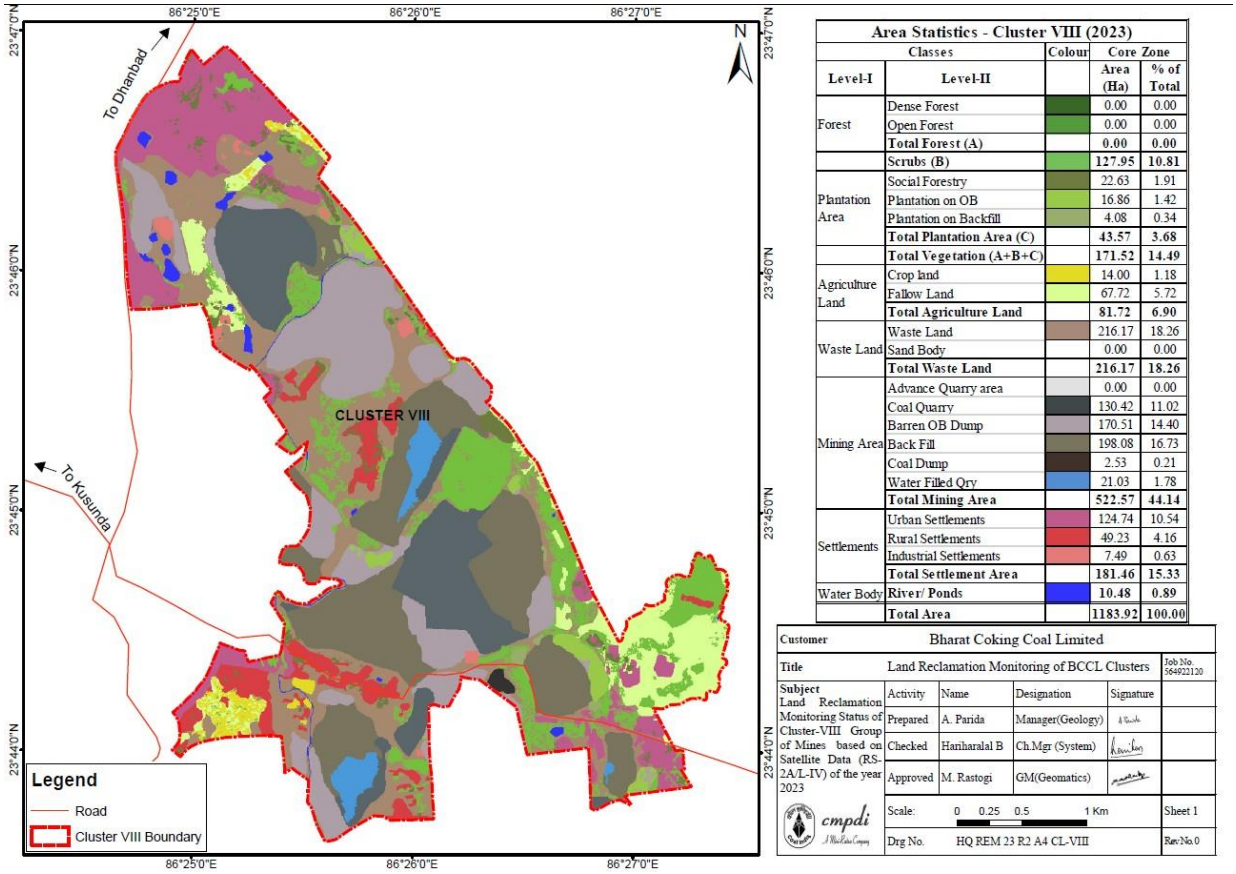
Monitoring stations (**D008 and D039**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D008	Alokdiha	8.90	2.74	4.82	5.47	7.70	4.42	4.82	6.75	6.32	4.25	5.42	6.34
2	D039	Tilaboni	3.20	2.51	2.77	2.87	8.52	2.52	3.28	5.75	7.50	1.85	3.05	1.75
Average WL (bgl)			6.05	2.63	3.80	4.17	8.11	3.47	4.05	6.25	6.91	3.05	4.24	4.05

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.20 m Max – 8.90 m
Post-monsoon GW Level (m): Min – 2.77 m Max – 5.42 m

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



Area Statistics - Cluster VIII (2023)				
Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**127.95**	**10.81**
Plantation Area	Social Forestry		22.63	1.91
	Plantation on OB		16.86	1.42
	Plantation on Backfill		4.08	0.34
	Total Plantation Area (C)		**43.57**	**3.68**
	Total Vegetation (A+B+C)		**171.52**	**14.49**
Agriculture Land	Crop land		14.00	1.18
	Fallow Land		67.72	5.72
	Total Agriculture Land		**81.72**	**6.90**
Waste Land	Waste Land		216.17	18.26
	Sand Body		0.00	0.00
	Total Waste Land		**216.17**	**18.26**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		130.42	11.02
	Barren OB Dump		170.51	14.40
	Back Fill		198.08	16.73
	Coal Dump		2.53	0.21
	Water Filled Qry		21.03	1.78
	Total Mining Area		**522.57**	**44.14**
Settlements	Urban Settlements		124.74	10.54
	Rural Settlements		49.23	4.16
	Industrial Settlements		7.49	0.63
	Total Settlement Area		**181.46**	**15.33**
Water Body	**River/ Ponds**		**10.48**	**0.89**
	Total Area		**1183.92**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 564922120
Subject: Land Reclamation Monitoring Status of Cluster-VIII Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
cmpdi	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 23 R2 A4 CL-VIII				Rev No.0

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.

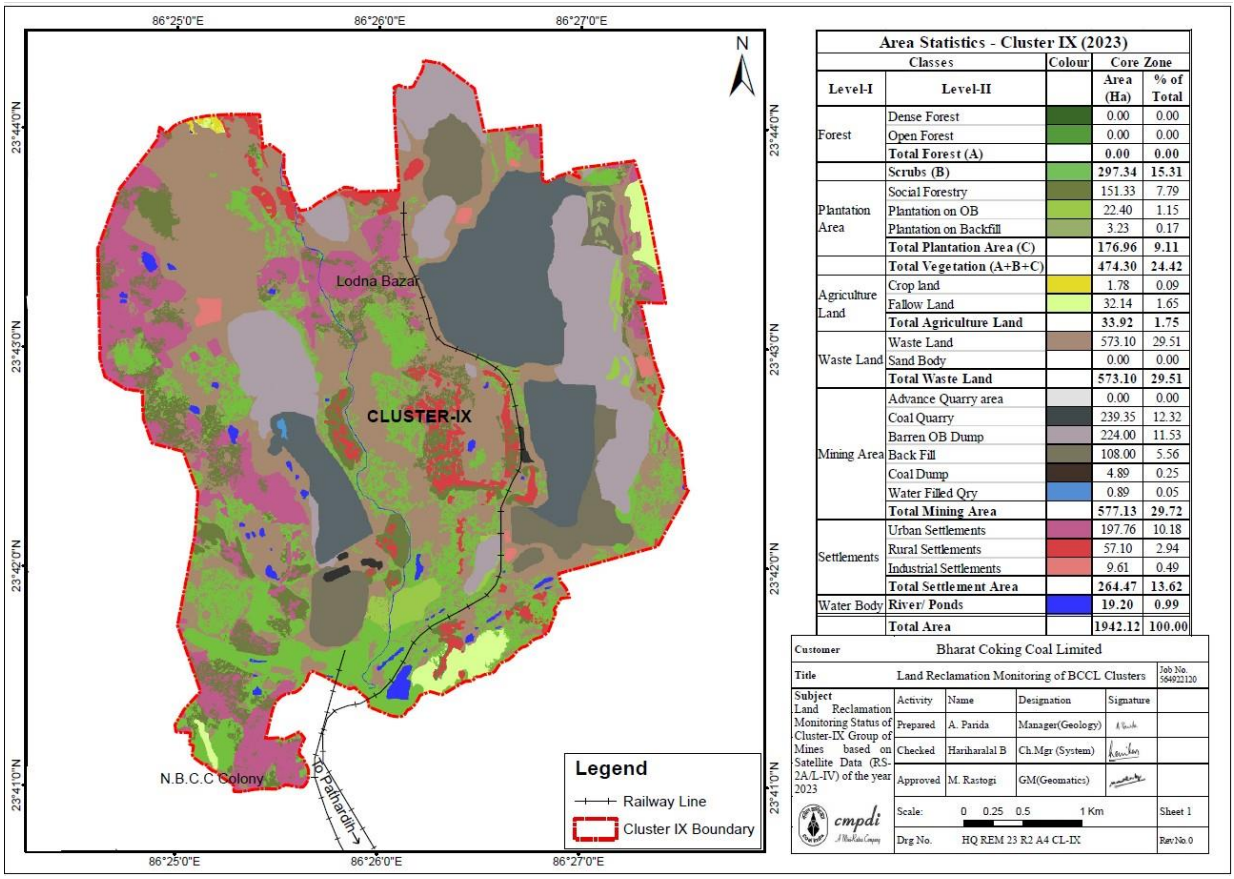
Monitoring stations (**D005, D007, D039 and D074**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D005	Jiyalgora	8.70	4.53	6.02	7.35	8.20	4.08	5.90	6.54	8.40	3.36	7.01	8.95
2	D007	Golden Pahari	9.82	2.70	3.52	5.67	9.03	1.88	3.64	5.18	9.03	2.17	5.67	6.57
3	D039	Tilaboni	3.20	2.51	2.77	2.87	8.52	2.52	3.28	5.75	7.50	1.85	3.05	1.75
4	D074	BhulanBararee	4.74	2.65	3.73	3.89	4.57	3.10	3.54	4.09	6.17	3.20	5.77	7.90
Average WL (bgl)			6.62	3.10	4.01	4.95	7.58	2.90	4.09	5.39	7.78	2.65	5.38	6.29

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.20 m Max – 9.82 m
Post-monsoon GW Level (m): Min – 2.77 m Max – 7.01 m

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



Area Statistics - Cluster IX (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**297.34**	**15.31**
Plantation Area	Social Forestry		151.33	7.79
	Plantation on OB		22.40	1.15
	Plantation on Backfill		3.23	0.17
	Total Plantation Area (C)		**176.96**	**9.11**
	Total Vegetation (A+B+C)		**474.30**	**24.42**
Agriculture Land	Crop land		1.78	0.09
	Fallow Land		32.14	1.65
	Total Agriculture Land		**33.92**	**1.75**
Waste Land	Waste Land		573.10	29.51
	Sand Body		0.00	0.00
	Total Waste Land		**573.10**	**29.51**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		239.35	12.32
	Barren OB Dump		224.00	11.53
	Back Fill		108.00	5.56
	Coal Dump		4.89	0.25
	Water Filled Qry		0.89	0.05
	Total Mining Area		**577.13**	**29.72**
Settlements	Urban Settlements		197.76	10.18
	Rural Settlements		57.10	2.94
	Industrial Settlements		9.61	0.49
	Total Settlement Area		**264.47**	**13.62**
Water Body	**River/ Ponds**		**19.20**	**0.99**
	Total Area		**1942.12**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 584922120
Subject: Land Reclamation Monitoring Status of Cluster-IX Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 23 R2 A4 CL-IX				Rev No.0

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.

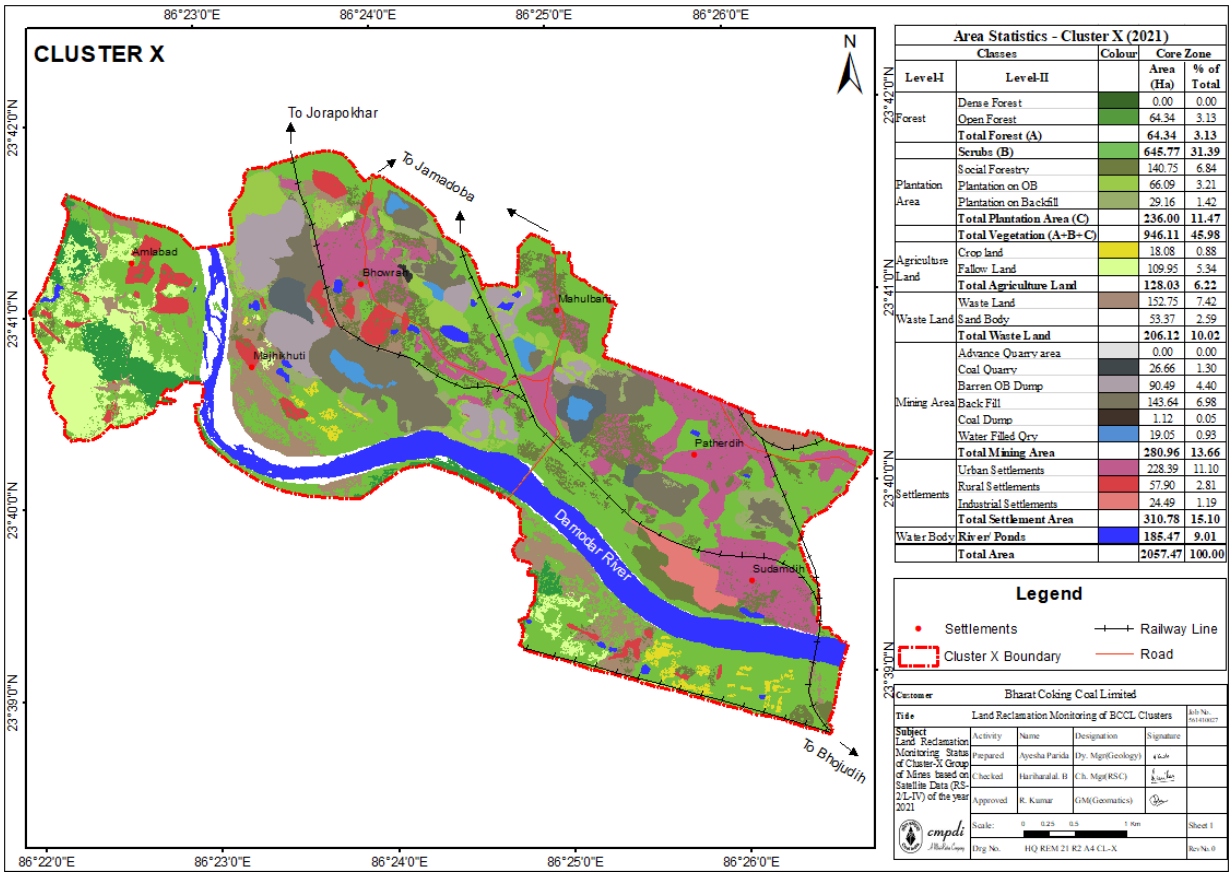
Monitoring stations (**A019, D035, D036 and D077**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24, the Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A019	Bhowrah	3.12	2.49	2.51	2.77	2.90	2.10	2.60	2.73	4.10	1.82	2.54	1.79
2	D035	Patherdih	5.16	3.28	4.10	4.70	5.23	3.45	3.90	4.10	6.10	3.70	4.68	5.50
3	D036	Sudamdih	2.64	0.45	0.74	1.13	1.85	0.50	0.60	1.00	3.25	0.15	0.60	1.44
4	D077	Amlabad	6.15	3.80	4.01	4.76	5.98	3.90	3.93	5.07	6.50	3.40	4.70	6.00
Average WL (bgl)			4.27	2.51	2.84	3.34	3.99	2.49	2.76	3.23	4.99	2.27	3.13	3.68

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.85 m Max – 6.50 m
Post-monsoon GW Level (m): Min – 0.60 m Max – 4.70 m

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



Area Statistics - Cluster X (2021)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		64.34	3.13
	Total Forest (A)		**64.34**	**3.13**
	Scrubs (B)		**648.77**	**31.39**
Plantation Area	Social Forestry		140.75	6.84
	Plantation on OB		66.09	3.21
	Plantation on Backfill		29.16	1.42
	Total Plantation Area (C)		**236.00**	**11.47**
	Total Vegetation (A+B+C)		**946.11**	**45.98**
Agriculture Land	Crop land		18.08	0.88
	Fallow Land		109.95	5.34
	Total Agriculture Land		**128.03**	**6.22**
Waste Land	Waste Land		152.75	7.42
	Sand Body		53.37	2.59
	Total Waste Land		**206.12**	**10.02**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		26.66	1.30
	Barren OB Dump		90.49	4.40
	Back Fill		143.64	6.98
	Coal Dump		1.12	0.05
	Water Filled Qry		19.05	0.93
	Total Mining Area		**280.96**	**13.66**
Settlements	Urban Settlements		228.39	11.10
	Rural Settlements		57.90	2.81
	Industrial Settlements		24.49	1.19
	Total Settlement Area		**310.78**	**15.10**
Water Body	**River/ Ponds**		**185.47**	**9.01**
	Total Area		**2057.47**	**100.00**

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

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.

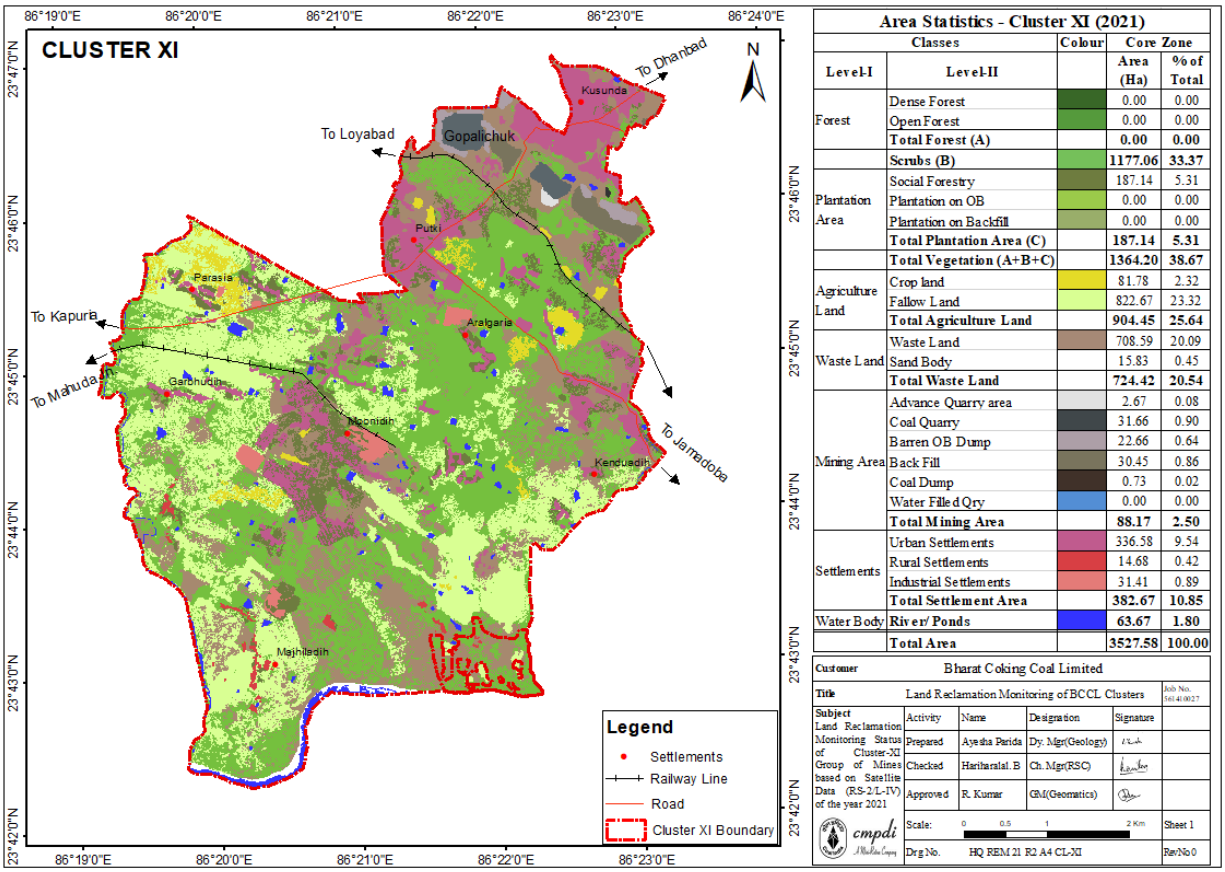
Monitoring stations (**A017, A020 and A032**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A017	Kachi Balihari	3.18	2.11	2.26	2.51	2.41	1.78	2.19	2.57	2.62	2.06	2.59	2.64
2	A020	Gorbudih	7.90	4.15	4.30	5.10	8.02	4.05	4.20	7.27	5.59	3.18	3.54	5.27
3	A032	Baludih	3.51	1.59	1.72	2.15	3.83	0.95	1.60	2.09	2.25	0.65	1.75	2.79
Average WL (bgl)			4.86	2.62	2.76	3.25	4.75	2.26	2.66	3.98	3.49	1.96	2.63	3.57

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.25 m Max – 8.02 m
Post-monsoon GW Level (m): Min – 1.60 m Max – 4.30 m

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



Area Statistics - Cluster XI (2021)

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)		**1177.06**	**33.37**
Plantation Area	Social Forestry		187.14	5.31
	Plantation on OB		0.00	0.00
	Plantation on Backfill		0.00	0.00
	Total Plantation Area (C)		**187.14**	**5.31**
	Total Vegetation (A+B+C)		**1364.20**	**38.67**
Agriculture Land	Crop land		81.78	2.32
	Fallow Land		822.67	23.32
	Total Agriculture Land		**904.45**	**25.64**
Waste Land	Waste Land		708.59	20.09
	Sand Body		15.83	0.45
	Total Waste Land		**724.42**	**20.54**
Mining Area	Advance Quarry area		2.67	0.08
	Coal Quarry		31.66	0.90
	Barren OB Dump		22.66	0.64
	Back Fill		30.45	0.86
	Coal Dump		0.73	0.02
	Water Filled Qry		0.00	0.00
	Total Mining Area		**88.17**	**2.50**
Settlements	Urban Settlements		336.58	9.54
	Rural Settlements		14.68	0.42
	Industrial Settlements		31.41	0.89
	Total Settlement Area		**382.67**	**10.85**
Water Body	**River/ Ponds**		**63.67**	**1.80**
	Total Area		**3527.58**	**100.00**

Customer	Bharat Coking Coal Limited			
Title	Land Reclamation Monitoring of BCCL Clusters			Job No. 561410027
Subject: Land Reclamation Monitoring Status of Cluster-XI Group of Mines based on Satellite Data (RS-2/L-IV) of the year 2021	Activity	Name	Designation	Signature
	Prepared	Ayesha Parida	Dy. Mgr(Geology)	
	Checked	Hariharalal. B	Ch. Mgr(RSC)	
	Approved	R. Kumar	GM(Geomatics)	
cmpdi	Scale: 0 0.5 1 2 Km			Sheet 1
	Drg No. HQ REM 21 R2 A4 CL-XI			Rev No 0

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.

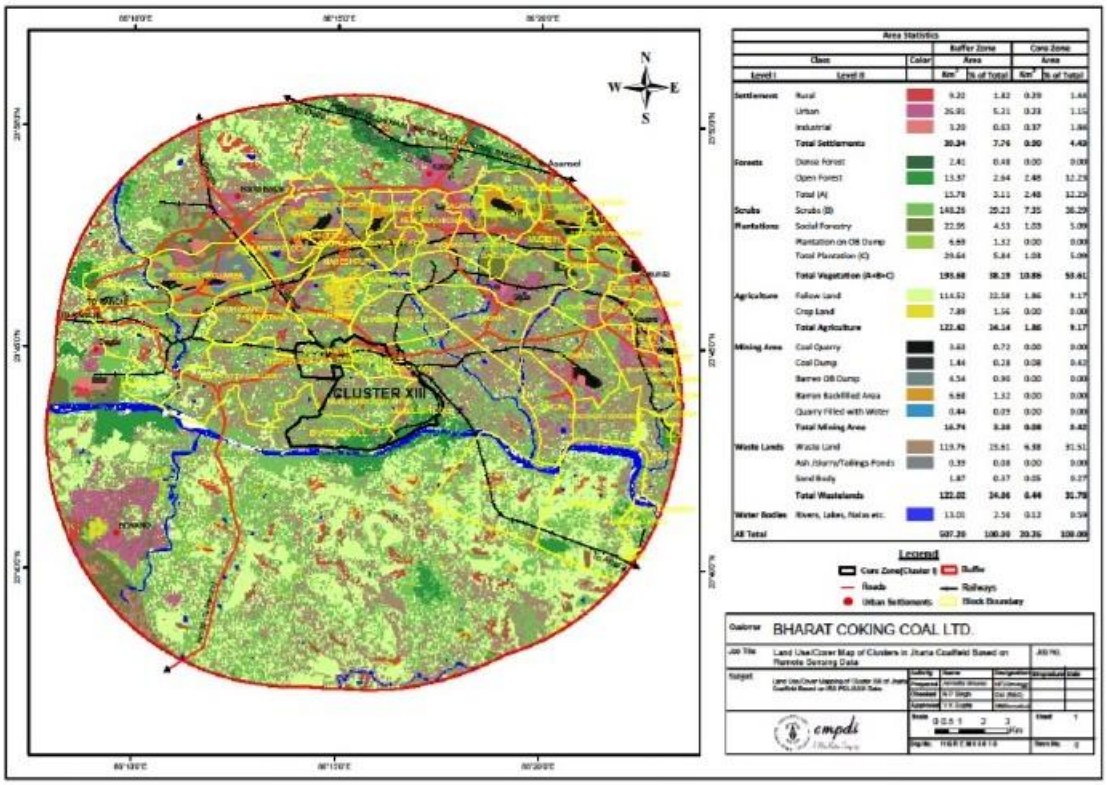
Monitoring stations (**A023, A034 and B048**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A023	Machhayara	10.44	2.72	5.72	6.95	9.00	5.10	5.71	7.90	7.97	1.14	4.79	6.67
2	A034	Mahuda vil.	6.54	1.82	3.90	4.92	6.54	2.98	4.01	4.85	8.20	3.65	6.35	6.95
3	B048	Mahuda	5.99	4.58	4.95	5.23	6.13	4.55	5.05	5.57	6.85	0.65	6.25	5.80
Average WL (bgl)			7.66	3.04	4.86	5.70	7.22	4.21	4.92	6.11	7.67	1.81	5.80	6.47

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 5.99 m Max – 10.44 m
Post-monsoon GW Level (m): Min – 3.90 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	1484.41×10^4	0.0	1570.48×10^4
2	Open Land	183.28×10^4	0.0	97.22×10^4
3	Road/ Paved Area	71.84×10^4	0.0	71.83×10^4
4	Rooftop area of building/ sheds	159.09×10^4	0.0	159.09×10^4
5	Total	1898.62×10^4	0.0	1898.62×10^4

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.

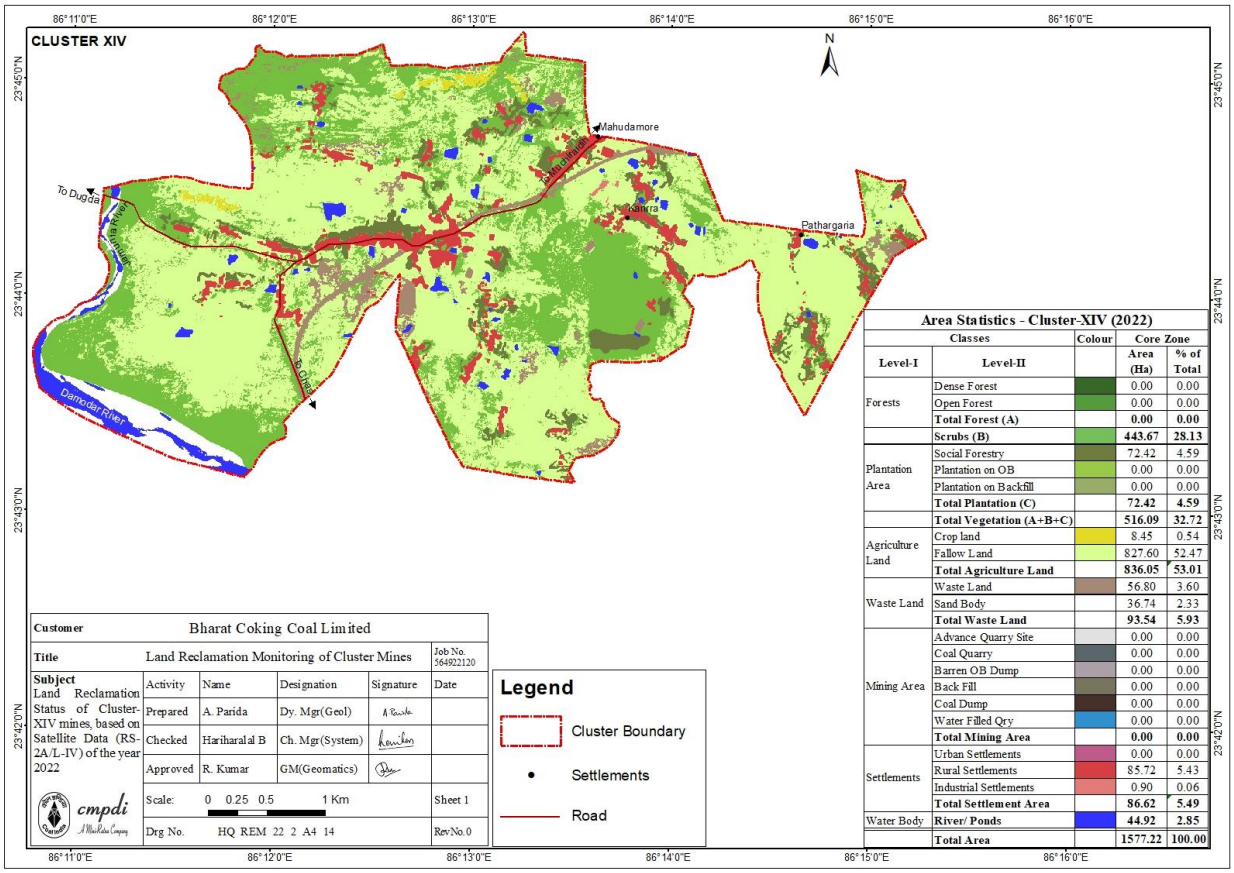
Monitoring stations (**B024 and B067**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2023-24				2022-23				2021-22			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	B024	Telmuchu	4.63	3.13	3.24	3.93	5.53	1.34	3.46	4.23	5.68	1.55	2.08	3.07
2	B067	Simatanr	8.05	3.85	5.32	6.27	8.50	3.55	6.30	7.35	8.95	2.45	2.95	3.65
Average WL (bgl)			6.34	3.49	4.28	5.1	7.02	2.45	4.88	5.79	7.32	2.00	2.52	3.36

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 4.63 m Max – 8.50 m
Post-monsoon GW Level (m): Min – 3.22 m Max – 6.30 m

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



Area Statistics - Cluster-XIV (2022)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**443.67**	**28.13**
Plantation Area	Social Forestry		72.42	4.59
	Plantation on OB		0.00	0.00
	Plantation on Backfill		0.00	0.00
	Total Plantation (C)		**72.42**	**4.59**
	Total Vegetation (A+B+C)		**516.09**	**32.72**
Agriculture Land	Crop land		8.45	0.54
	Fallow Land		827.60	52.47
	Total Agriculture Land		**836.05**	**53.01**
Waste Land	Waste Land		56.80	3.60
	Sand Body		36.74	2.33
	Total Waste Land		**93.54**	**5.93**
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		0.00	0.00
	Barren OB Dump		0.00	0.00
	Back Fill		0.00	0.00
	Coal Dump		0.00	0.00
	Water Filled Qry		0.00	0.00
	Total Mining Area		**0.00**	**0.00**
Settlements	Urban Settlements		0.00	0.00
	Rural Settlements		85.72	5.43
	Industrial Settlements		0.90	0.06
	Total Settlement Area		**86.62**	**5.49**
Water Body	**River/ Ponds**		**44.92**	**2.85**
	Total Area		**1577.22**	**100.00**

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

N. GROUND WATER LEVEL OF CLUSTER-XV

Mines o 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.

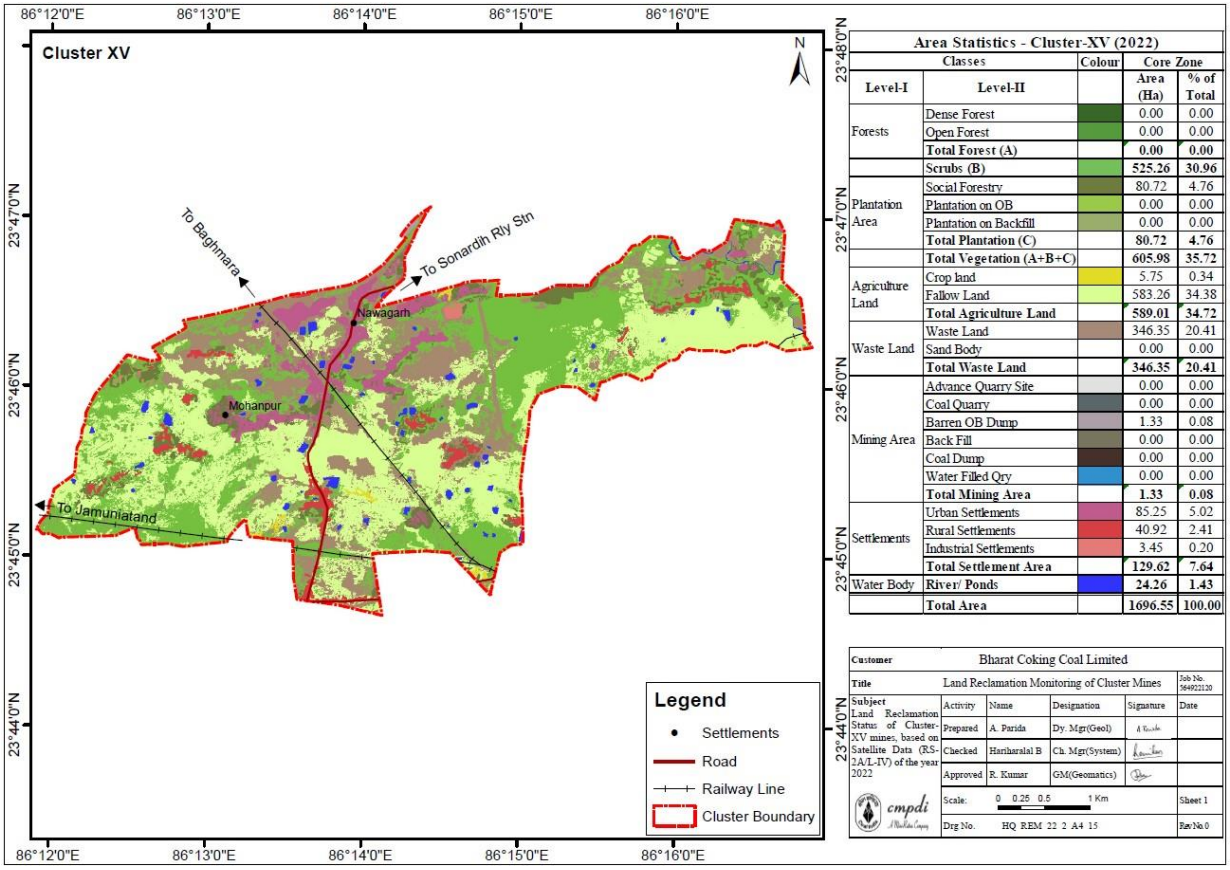
Monitoring stations (**A024, B032 and B062**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A024	Pipratanr	5.43	3.71	3.96	4.12	5.38	3.60	3.90	5.00	7.28	2.55	4.33	5.32
2	B032	Madhuband	6.60	2.10	3.60	4.82	5.35	3.93	3.60	5.42	4.15	0.70	2.56	4.15
3	B062	Sadiyardih	4.97	3.01	3.19	3.80	4.80	2.35	3.10	4.00	6.45	1.77	4.91	5.15
Average WL (bgl)			5.67	2.94	3.58	4.25	5.18	3.29	3.53	4.81	5.96	1.67	3.93	4.87

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 4.15 m Max – 7.28 m
Post-monsoon GW Level (m): Min – 2.56 m Max – 4.91 m

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



Area Statistics - Cluster-XV (2022)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**525.26**	**30.96**
Plantation Area	Social Forestry		80.72	4.76
	Plantation on OB		0.00	0.00
	Plantation on Backfill		0.00	0.00
	Total Plantation (C)		**80.72**	**4.76**
	Total Vegetation (A+B+C)		**605.98**	**35.72**
Agriculture Land	Crop land		5.75	0.34
	Fallow Land		583.26	34.38
	Total Agriculture Land		**589.01**	**34.72**
Waste Land	Waste Land		346.35	20.41
	Sand Body		0.00	0.00
	Total Waste Land		**346.35**	**20.41**
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		0.00	0.00
	Barren OB Dump		1.33	0.08
	Back Fill		0.00	0.00
	Coal Dump		0.00	0.00
	Water Filled Qry		0.00	0.00
	Total Mining Area		**1.33**	**0.08**
Settlements	Urban Settlements		85.25	5.02
	Rural Settlements		40.92	2.41
	Industrial Settlements		3.45	0.20
	Total Settlement Area		**129.62**	**7.64**
Water Body	**River/ Ponds**		**24.26**	**1.43**
	Total Area		**1696.55**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 564922120
Subject	Activity	Name	Designation	Signature	Date
Land Reclamation Status of Cluster-XV mines, based on Satellite Data (RS-2A/L-IV) of the year 2022	Prepared	A. Parida	Dy. Mgr(Geol)		
	Checked	Hariharalal B	Ch. Mgr(System)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 22 2 A4 15				Rev No 0

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	957.34 x 10^4
2	Open Land	1130.53 x 10^4	0.0	538.37 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.

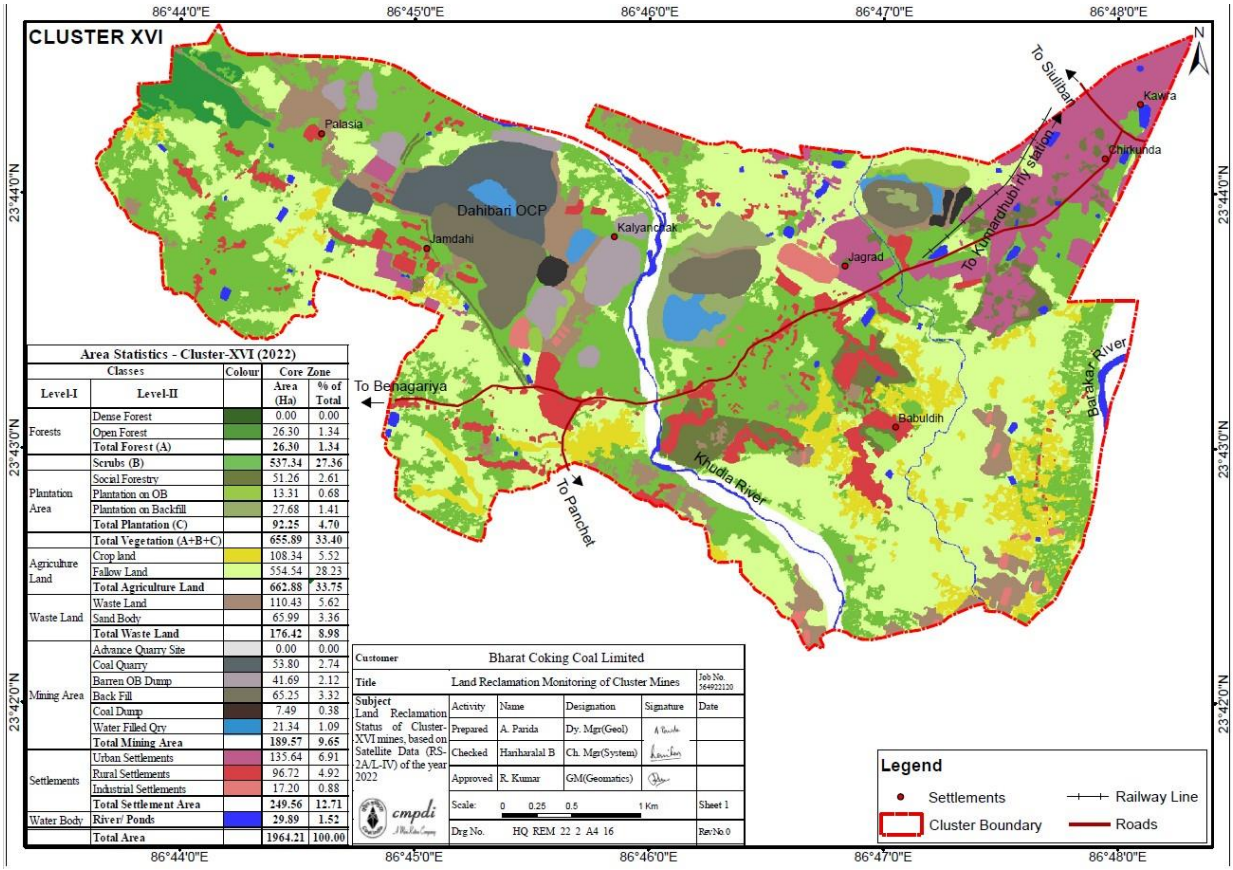
Monitoring stations (**DB022, DB023, DB024 & DB025**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	DB022	Dahibari, Basti	4.08	1.63	2.33	3.07	4.25	2.07	2.43	3.31	3.72	1.47	1.99	1.58
2	DB023	Dahibari OC	4.56	1.24	2.79	3.07	4.80	2.61	2.94	4.24	3.56	1.71	2.60	2.40
3	DB024	Dahibari	7.84	3.73	6.92	6.98	8.25	3.50	4.18	6.87	7.08		3.91	
Average WL (bgl)			5.49	2.20	4.02	4.37	5.77	2.73	3.18	4.81	4.79	1.59	2.83	1.99

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.56 m Max – 8.25 m
Post-monsoon GW Level (m): Min – 1.99 m Max – 6.92 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

P. GROUND WATER LEVEL OF CLUSTER-XVII

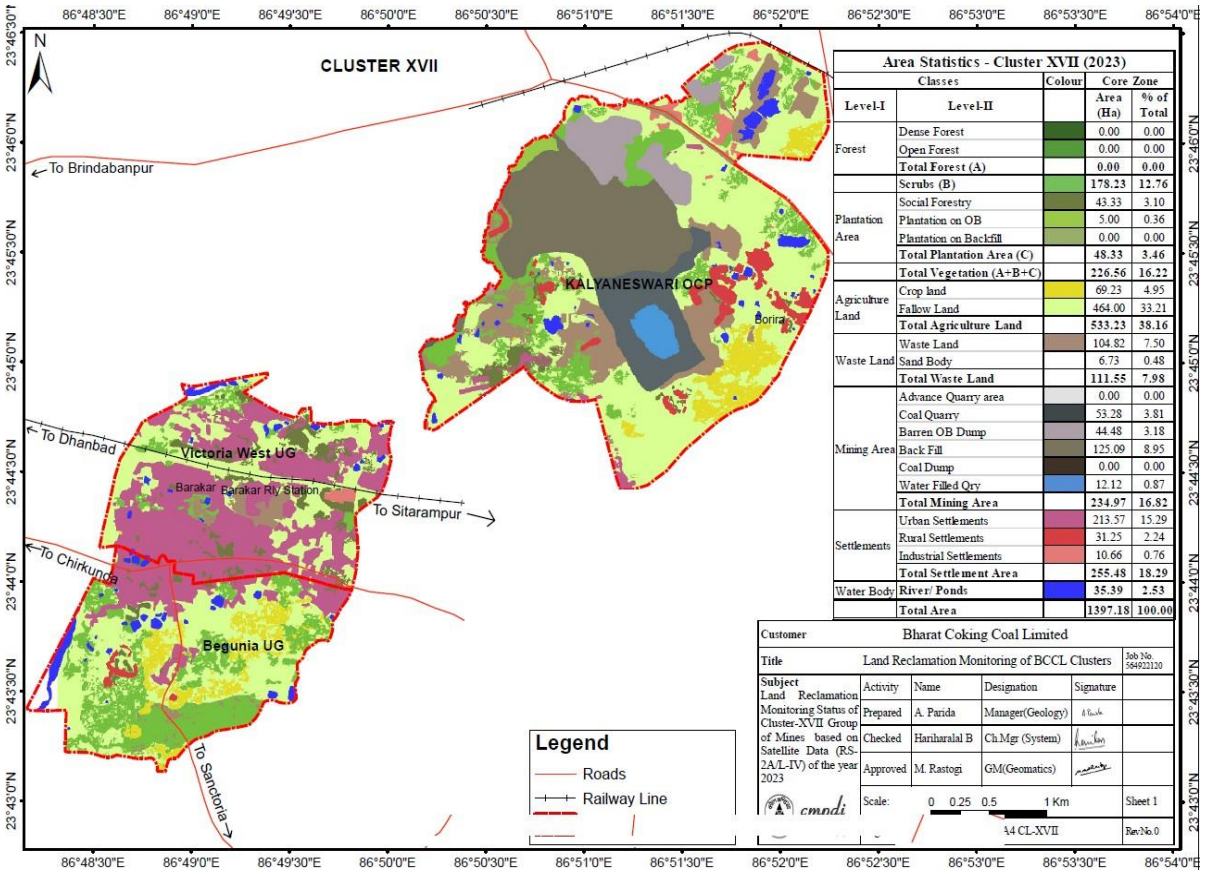
Cluster-XVII mines are under administrative control of Chanch Victoria Area, BCCL, located in western part of Raniganj coalfield in Dhanbad district of Jharkhand. Cluster–XVII consists of two closed Underground (UG) coal mines (Begunia Colliery and Victoria-West Colliery) and one opencast mines [Kalyaneshwari OCP]. The Leasehold area of the Cluster is located between latitude 23^0 43' 08" to 23^0 46' 26" N and longitude 86^0 47' 46" to 85^0 52' 11" E. All the above mines are contiguous in nature and the environmental impact is overlapping in the ambient due to cumulative effect of the mining activities. Leasehold area of the Cluster is 1397.18 ha and the capacity of the project is 4.0 MTPA using opencast method. Cluster-XVII mines is covered in Survey of India toposheet no. 73 I/13. The cluster is approachable both by rail and road. Salanpur and Kulti railway stations of Eastern Railways are at a distance of about 0.6 km from the eastern and southwestern boundary of the cluster respectively. The National Highway No.19 (NH-19) passes through the north eastern part of the cluster and the National Highway No.419 (NH-419) passes along the eastern boundary of the cluster while the Kulti and Barakar townships are about 2 km by road to the south east of the area.The study area has an undulating topography with gentle slope towards south and south west. The buffer zone is predominantly characterized by plain land, with highlands located in parts of the northwest, northeast, and southwest. The area comes under the watershed area of Barakar River.

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2024-25				2023-24				2022-23			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	DB8	Chungei	5.40	3.06	4.10	4.76	4.50	2.55	3.42	3.97	4.67		2.86	
2	DB9	Barakar	10.26	6.42	7.34	8.93	9.50	4.17	5.18	6.47	9.68		4.85	
3	DB12	Sabanpur	5.60	2.07	2.37	3.27	5.44	2.01	2.30	3.17	4.56		1.89	
4	K26		2.14	1.36	1.53	1.58	2.10	1.33	1.50	1.55	1.93		1.29	
Average WL (bgl)			5.85	3.23	3.84	4.64	5.39	2.52	3.10	3.79	5.21		2.72	

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.93 m Max – 10.26 m
Post-monsoon GW Level (m): Min – 1.29 m Max – 7.34 m

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



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	336.55 x 10^4	0.0	336.5 x 10^4
2	Open Land	1008.81 x 10^4	0.0	1008.81 x 10^4
3	Road/ Paved Area	26.81 x 10^4	0.0	26.81 x 10^4
4	Rooftop area of building/ sheds	25.06 x 10^4	0.0	25.06 x 10^4
5	Total	1397.23 x 10^4	0.0	1397.23 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'24 & Jan'25)	Avg. Fluctuation (in meters) during 2024	Geological Formation
1	I	3 nos.	0.80 to 5.20 m	1.48 m	Barakar
2	II	4 nos.	0.50 to 10.73 m	2.16 m	Barakar
3	III	4 nos.	1.09 to 10.73 m	2.06m	Barakar
4	IV	3 nos.	1.95 to 8.45 m	3.59 m	Barakar
5	V	2 nos.	0.55 to 5.55 m	1.07 m	Barakar
6	VI	3 nos.	1.80 to 4.40 m	1.39 m	Barakar
7	VII	4 nos.	1.22 to 4.75 m	1.48 m	Barakar
8	VIII	2 nos.	2.52 to 8.52 m	4.06 m	Barakar
9	IX	4 nos.	1.88 to 9.03 m	3.49 m	Barakar
10	X	4 nos.	0.50 to 5.98 m	1.23 m	Barakar
11	XI	3 nos.	0.95 to 8.02 m	2.09 m	Barakar & Barren Measure
12	XIII	3 nos.	2.98 to 9.00 m	2.30 m	Raniganj
13	XIV	2 nos.	3.13 to 8.05 m	2.06 m	Raniganj
14	XV	3 nos.	2.35 to 5.42 m	1.64 m	Barakar & Barren Measure
15	XVI	3 nos.	2.07 to 8.25 m	2.50 m	Barakar

Depth to water level (in bgl) values describe that water level goes down to maximum 10.73 m during summer season and minimum up to 0.50 m during monsoon season of 2023. 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, Cluster-VIII and Cluster-XIII 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 DETAILS OF PIEZOMETERS

A piezometer network is useful for monitoring the impact of mining activity on groundwater regime. Total 23 nos. of Piezometers were constructed during 2022-23 within JCF and RCF to monitor GW level (**Plate-III**). The depth of piezometers varies from 30m to 300m below ground level.

Water level in the piezometers from May23 to Jan24 are furnished below in **Table-8** and the hydrographs (May22 to Jan24) are given in the Annexure VIB.

Table –8: Groundwater level data in Piezometers (Cluster-wise)

PZ ID	Cluster	Lat.	Long.	Depth (m)	May 23	June23	July23	Aug23	Sept 23	Oct 23	Nov 23	Dec 23	Jan24
PZ1A	I	23.7692	86.1754	40	12.26	13.20	8.80	6.75	6.50	7.50	8.65	9.90	11.98
PZ1B	I	23.7692	86.1753	115	30.20	29.10	24.04	19.00	19.90	21.90	24.05	26.90	30.40
PZ2A	II	23.7672	86.1890	87	30.90	31.60	22.50	17.50	16.50	18.90	22.50	25.50	28.33
PZ2B	II	23.7908	86.2470	77	8.02	7.30	5.10	3.50	3.90	4.30	4.50	4.40	4.6
PZ3A	III	23.8015	86.2824	172	89.5	89.1	83.73	76.50	78.85	81.00	82.64	84.00	86.42
PZ3B	III	23.7798	86.2418	30	24.72	23.72	18.0	14.1	13.2	15.12	18.3	20.4	23.23
PZ3C	III	23.8016	86.2824	124	-	-	-	-	-	-	-	-	-
PZ4A	IV	23.7764	86.3123	70	38.1	37.5	32.2	26.5	27.39	29.5	31.3	33.5	34.9
PZ4B	IV	23.7765	86.3125	240	100.9	98.2	94.6	89.9	90.8	91.3	91.6	92.1	92.7
PZ5A	V	23.7817	86.3569	35	8.5	7.8	5.8	2.5	3.5	4.4	4.8	5	5.31
PZ5B	V	23.7999	86.3619	94	90.94	85.5	80.1	75.08	73.2	78.04	82.0	86.1	90.32
PZ7A	VII	23.7701	86.4110	159	109.9	110.1	105.02	98.5	92.9	96.8	98.1	101.8	104.86

PZ7B	VII	23.7400	86.3997	35	29.36	30.02	21.38	16.63	15.68	17.96	21.38	24.23	26.18
PZ7C	VII	23.7342	86.4433	105	92.27	90.88	85.40	78.03	80.43	82.62	84.29	85.68	85.2
PZ8A	VIII	23.7556	86.4271	140	49.23	49.01	46.05	40.08	38.37	42.55	43.45	44.20	46
PZ9A	IX	23.7305	86.4464	84	43.85	44.55	41.87	38.25	39.43	40.50	41.32	42.00	40.32
PZ9B	IX	23.6962	86.4159	100	72.6	71.05	67.5	57.2	58.9	59.8	61.3	63.35	63.7
PZ10A	X	23.6880	86.4051	134	6.9	6.2	4.01	3.1	3.6	4.05	4.6	5.1	6.35
PZ11A	XI	23.7264	86.3419	300	52.7	47.5	37.2	28.09	34.6	37.1	39.05	40.9	53.15
PZ13A	XII	23.7138	86.2516	80	39.9	36.3	32.1	23.6	25.8	26.5	28.1	30.1	31.81
PZ14A	XIV	23.7415	86.2139	30	12.8	10.1	7.9	4.6	5.5	6.1	7.3	7.9	8.39
PZ14B	XIV	23.7415	86.2139	162	14.6	13.5	9.8	5.05	6.3	7.5	9.1	10.5	12.56
PZ16A	XVI	23.7308	86.7605	90	35.58	35.64	32.49	29.60	28.54	30.40	31.06	32.0	32.24

6.0 GROUND WATER QUALITY

The ground water samples of the study area (16 nos. of Cluster of mines, BCCL) were collected from dug wells and analyzed. Thirty-five ground water samples were analyzed during the month of May'2024 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:

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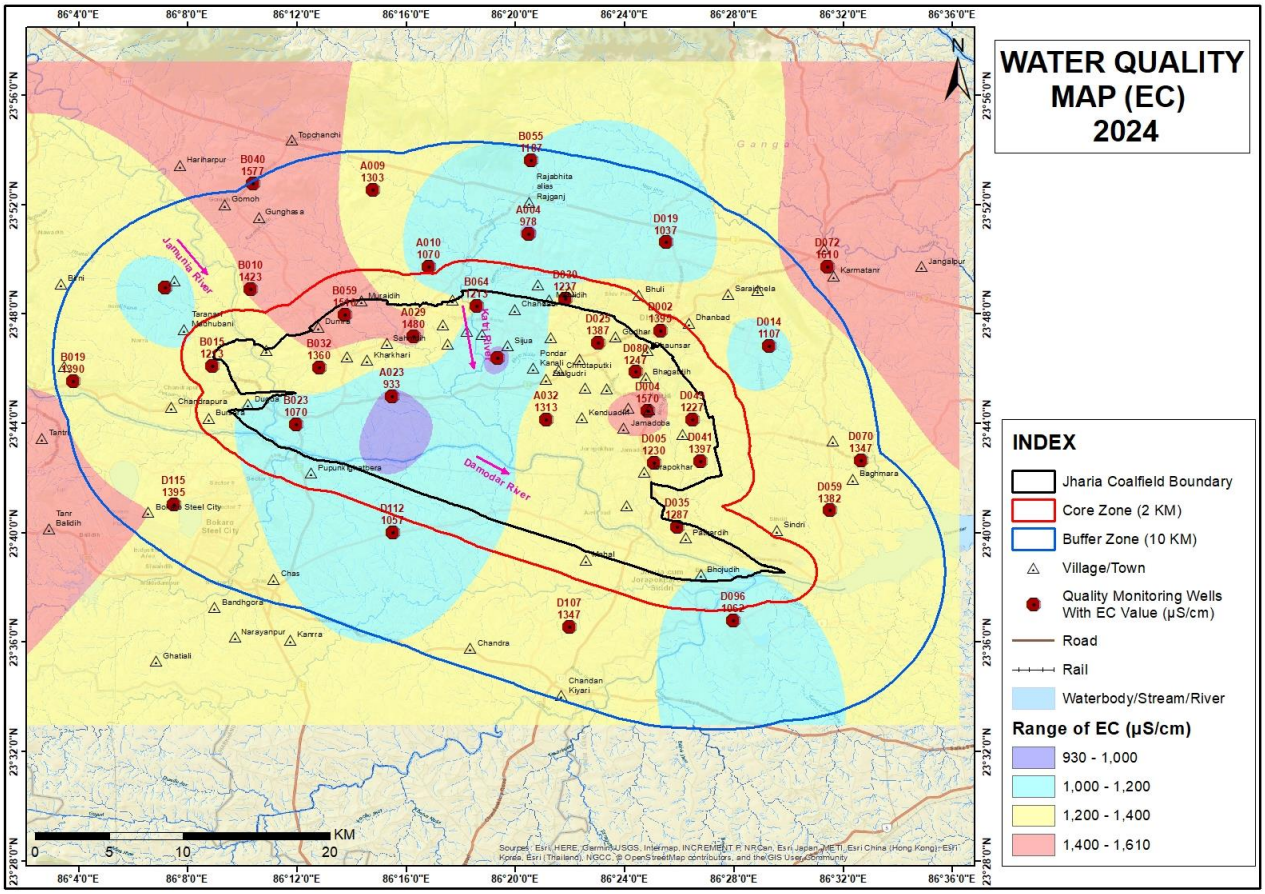
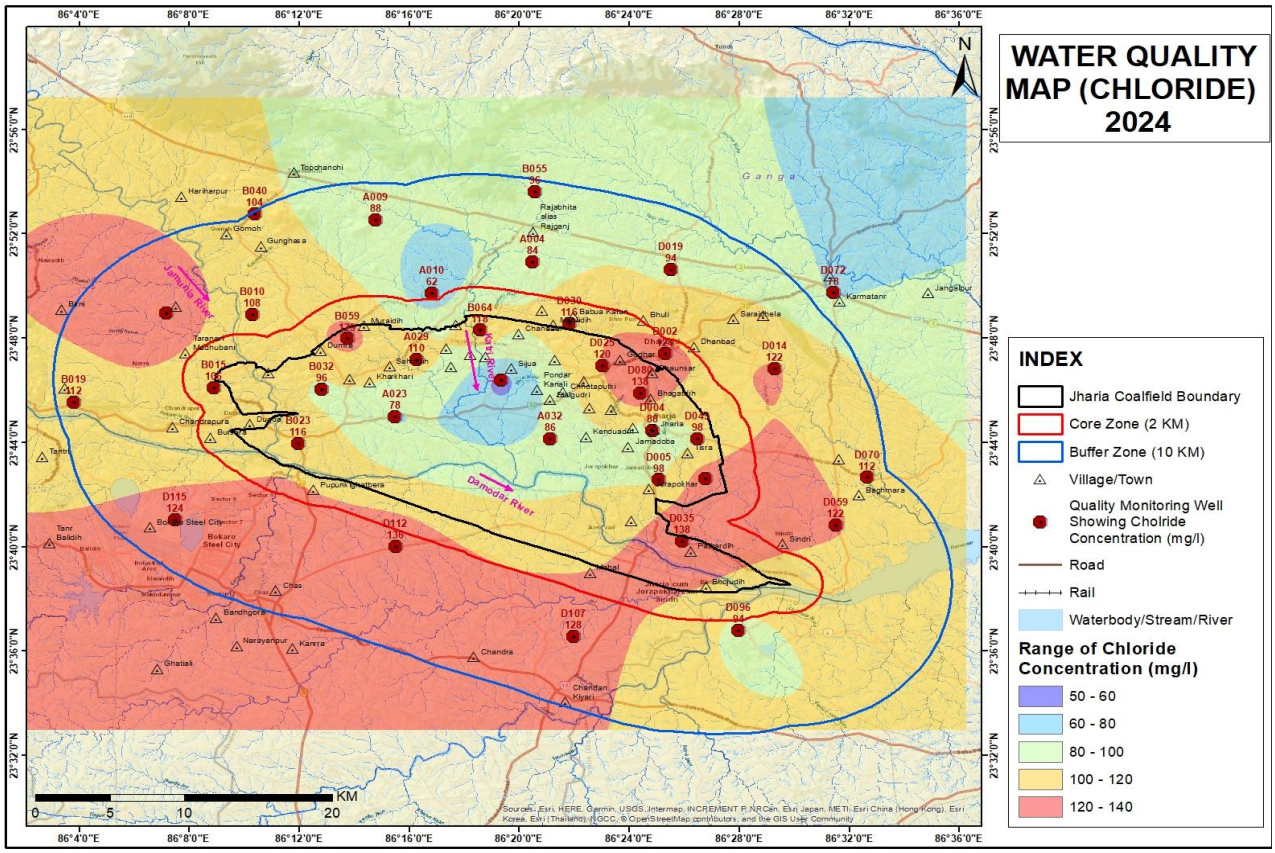
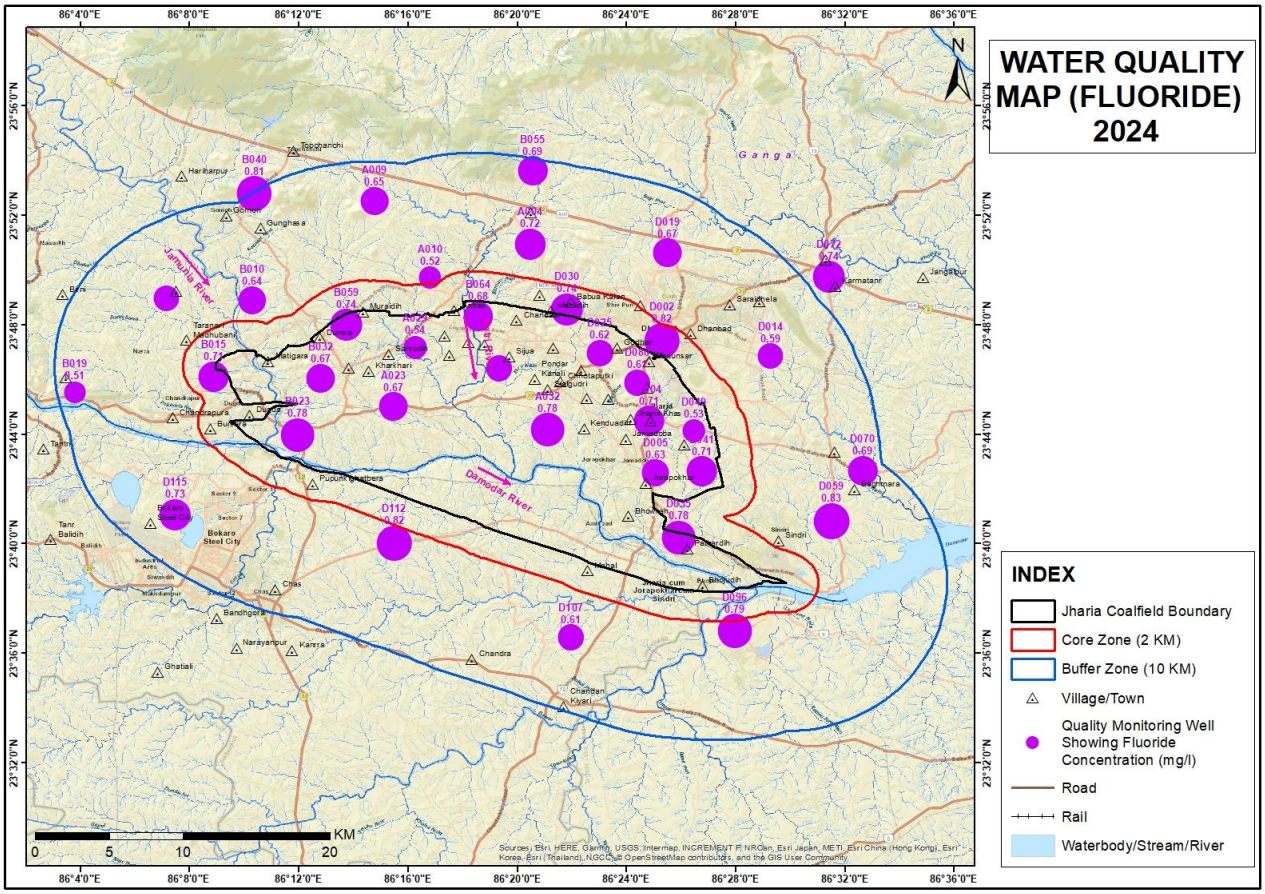
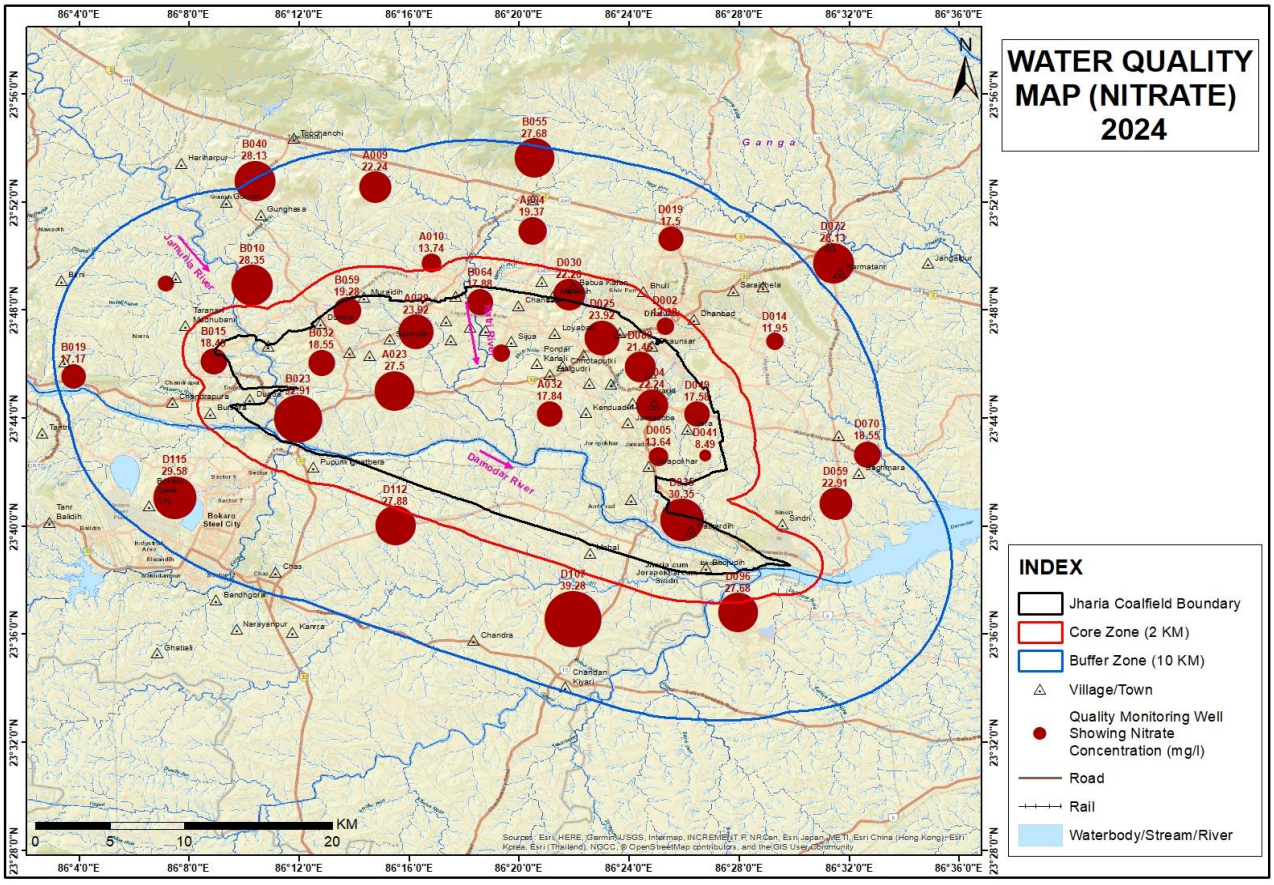
In wells of JCF concentration of magnesium in the water samples varies 103 (D-70) to 125 mg/l (D-4) and is above the permissible limit (100 mg/l) of drinking water standards. The total hardness mg/l ranges from 614 (A-09) to 824 mg/L (D-72) and is above the permissible limit of (600 mg/L) of drinking water standards The Iron, Manganese, Zinc and Chromium concentration in the water samples found to be below the upper IS 10500:2012 limits for drinking water.

In RCF part of BCCL Command area At a few locations, the total hardness value of the analyzed samples exceeds the permissible limit of 600 mg/L, specifically at DB2A (650 mg/L), DB4 (680 mg/L), DB30 (648 mg/L), DB38 (705 mg/L), and DB39 (602 mg/L). The rest of the groundwater quality data indicates that the values are well within the permissible limits as per the IS 10500:2012 drinking water standards.


WATER QUALITY MAP (EC) 2024
INDEX
Jharia Coalfield Boundary
Core Zone (2 KM)
Buffer Zone (10 KM)
Village/Town
Quality Monitoring Wells With EC Value (µS/cm)
Road
Rail
Waterbody/Stream/River
Range of EC (µS/cm)
930 - 1,000
1,000 - 1,200
1,200 - 1,400
1,400 - 1,610
Jamunia River
Damodar River
Barakar River
KM
0 5 10 20


WATER QUALITY MAP (CHLORIDE) 2024
INDEX
Jharia Coalfield Boundary
Core Zone (2 KM)
Buffer Zone (10 KM)
Village/Town
Quality Monitoring Well Showing Cholride Concentration (mg/l)
Road
Rail
Waterbody/Stream/River
Range of Chloride Concentration (mg/l)
50 - 60
60 - 80
80 - 100
100 - 120
120 - 140
Jamunia River
Damodar River
Barakar River
KM
0 5 10 20


WATER QUALITY MAP (FLUORIDE) 2024
INDEX
Jharia Coalfield Boundary
Core Zone (2 KM)
Buffer Zone (10 KM)
Village/Town
Quality Monitoring Well Showing Fluoride Concentration (mg/l)
Road
Rail
Waterbody/Stream/River
Damodar River
Jamunia River
Ganga
Bokaro Steel City
KM


WATER QUALITY MAP (NITRATE) 2024
INDEX
Jharia Coalfield Boundary
Core Zone (2 KM)
Buffer Zone (10 KM)
Village/Town
Quality Monitoring Well Showing Nitrate Concentration (mg/l)
Road
Rail
Waterbody/Stream/River
Damodar River
Jamunia River
Ganga
Bokaro Steel City
KM

7.0 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 74.34% (as per GWRE 2023-24, INGRES Portal). The highest stage of development is in Baliapur Block (110.03%) & Dhanbad Urban Block (95.65%) and lowest stage of development is in Purbi Tundi Block (26.15%) and Chirkunda Block (34.53%) as per GWRA-2023-24 (Source: Ingres Portal). 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. Block wise data of Dhanbad District given below:

Table–9A: Block wise Stage of Groundwater development

Sl No.	Administrative Unit			Category (GWRA-2017)	Category (GWRA-2022)	Category (GWRA-2023-24)
	State	District	Block			
1	Jharkhand	DHANBAD	BAGHMARA	**Over-exploited**	**Over-exploited**	Semi-Critical
2	Jharkhand	DHANBAD	BALIAPUR	Critical	Safe	**Over Exploited**
3	Jharkhand	DHANBAD	DHANBAD	Semi-Critical	**Over-exploited**	Semi-Critical
4	Jharkhand	DHANBAD	DHANBAD URBAN	**Over-exploited**	Semi-critical	Critical
5	Jharkhand	DHANBAD	JHARIA	**Over-exploited**	Critical	Hilly Area
6	Jharkhand	BOKARO	CHANDRAPURA	Critical	Critical	Safe
7	West Bengal	PASCHIM BARDHAMAN	SALANPUR	Safe	Safe	Safe

- **Dynamic Groundwater Resource Assessment, CGWB as per 2017, 2022 and 2023-24.**

Table–9B: 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) 2024-25		GW level declining trend 2005-2023		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	Chandrapura (SOD: Safe)	2173 (2065+108)	NIL	2112 (1698+414)	61	4.28	2.20	YES	YES	Recharge structure needed
Cluster-II	Baghmara (SOD: Semi Critical)	8350	Jamunia river	6737 (2755+3982)	1613	5.29	3.05	NO	NO	Excess mine water needed to be utilized
Cluster-III		12760 (10960+1800)	NIL	8946 (7849+1097)	3814	5.10	3.37	YES	NO	
Cluster-IV		5900	MADA	5100 (3605+1495)	800	7.30	3.22	YES	NO	
Cluster-V		12690 (11025+1665)	MADA	11063 (5710+5353)	1897	5.78	3.61	YES	YES	
Cluster-VI	Dhanbad (SOD: Critical)	4150	MADA	4150 (1664+2486)	0.0	4.92	2.79	YES	NO	--
Cluster-VII		21565	MADA	20826 (17596+3230)	739	3.56	2.57	YES	YES	Excess mine water needed to be utilized
Cluster-VIII		9320	MADA	5294 (3730+1564)	4026	6.05	3.80	YES	NO	
Cluster-IX		12980	MADA	9358 (4549+4809)	3622	6.62	4.01	NO	NO	
Cluster-X		11825	Damodar river	6201 (4255+1946)	5624	4.27	2.84	NO	NO	
Cluster-XI	Dhanbad (SOD: Critical)	24960	MADA & DVC	19425 (14015+5410)	5535	4.86	2.76	YES	NO	
Cluster-XIII	Baghmara (SOD: Critical)	750	Damodar river	692	58.0	7.66	4.86	NO	NO	--
Cluster-XIV		943	NA	668	275	6.34	4.28	NO	NO	--
Cluster-XV		6200	NA	5941 (4600+1341)	259	5.67	3.58	NO	NO	--
Cluster-XVI	Chirkunda (SOD: Safe)	1910	DVC (Barakar river)	1730 (1380+350)	180	5.49	4.02	NO	NO	--
Cluster-XVII	Salanpur (SOD: Safe)	5091 *	DVC (Barakar river)	5091 (1470+1405)	2216	5.85	3.84	NO	NO	-

*EAC awaited

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

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

8.0 IMPACT OF MINING ON GROUND WATER REGIME

8.1 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.

8.2 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 steep 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.

8.3 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.

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

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, laying 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.

9.0 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).
- 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).

10.0 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 / ABANDONDED IN THE JCF MINE AREA

Fig-9 to 10.

RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

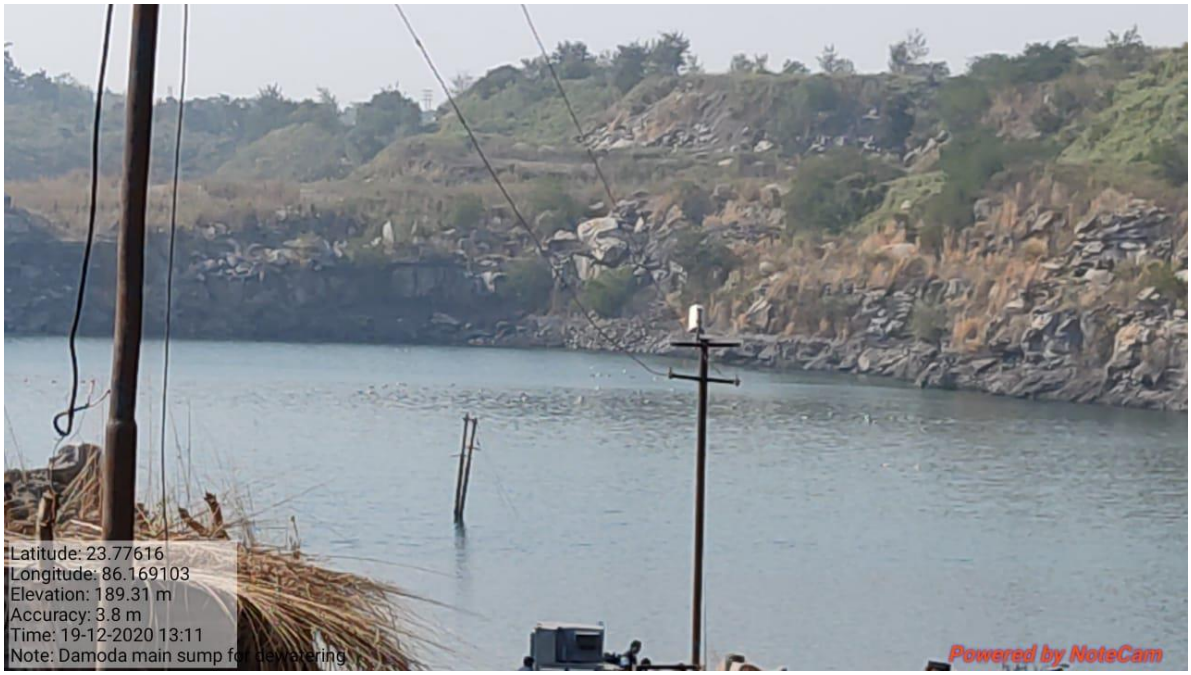
FILTER PLANT IN THE MINE AREA

Fig-11 to 12.

RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

Fig-13 to 14.



RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

Annexure – IV

25 Year Normal Rainfall Data (in mm) for Dhanbad District (Source: WRIS Grided Data)

Yearly Rainfall (25 Years Normal: 1998-2022)	
Year	**Rainfall (in mm)**
1998	1578
1999	1903
2000	1481
2001	1648
2002	1584
2003	1546
2004	1401
2005	1149
2006	1390
2007	1773
2008	1173
2009	1303
2010	1027
2011	1296
2012	1152
2013	1203
2014	1002
2015	996
2016	1398
2017	1385
2018	1144
2019	1357
2020	1116
2021	1745
2022	982

Monthly Rainfall (25 Years Normal: 1998-2022)	
Month	**Rainfall (in mm)**
January	8.2
February	15.1
March	19.8
April	32.1
May	77.6
June	204.6
July	329.6
August	285.8
September	259.9
October	105.5
November	6.4
December	4.5
Total	1349.1

Monthly Rainfall (16 Years Normal: 2008-2023) Bardhaman District, RCF	
Month	**Rainfall (in mm)**
January	7.55
February	16.06
March	17.69
April	37.68
May	131.88
June	198.95
July	254.46
August	240.09
September	180.82
October	92.15
November	9.44
December	14.95
Total	1201.72

Annexure – IV

Block wise Rainfall Data as per GWRE 2023-24 (Source: INGRES Portal)

State	District	Block	Category (GWRE 2023-24)	Rainfall in mm
Jharkhand	DHANBAD	BAGHMARA	SEMI-CRITICAL	1393.60
Jharkhand	DHANBAD	BALIAPUR	OVER EXPLOITED	1393.60
Jharkhand	DHANBAD	DHANBAD	SEMI-CRITICAL	1393.60
Jharkhand	DHANBAD	DHANBAD URBAN	CRITICAL	1393.60
Jharkhand	DHANBAD	JHARIA	HILLY AREA	0.00
Jharkhand	BOKARO	CHANDRAPURA	SAFE	1211.50
West Bengal	PASCHIM BARDHAMAN	SALANPUR	SAFE	1348.20

Annexure – IV

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
2023	0.00	0.00	19.40	47.20	128.00	61.20	128.50	424.20	289.80	211.20	0.00	49.20	1358.7
2024	6.60	11.00	90.00	0.00	80.20	80.60	284.00	678.20	404.60	105.60	0.00	0.00	1740.8

Annexure – V

Location of Hydrograph Stations (Dug Wells)

Well No	Latitude	Longitude	Well No	Latitude	Longitude
A002	86.2586	23.8181	D029	86.3742	23.8208
A004	86.3417	23.8492	D030	86.3640	23.8096
A006	86.3149	23.8498	D034	86.3837	23.7733
A007	86.2982	23.8287	D035	86.4321	23.6705
A008	86.2635	23.8527	D036	86.4360	23.6564
A009	86.2462	23.8758	D039	86.4371	23.7195
A010	86.2805	23.8290	D046	86.5211	23.7377
A013	86.3226	23.7735	D047	86.4076	23.7539
A015	86.3425	23.8249	D052	86.4473	23.7538
A016	86.3598	23.7807	D054	86.3751	23.7222
A017	86.3672	23.7520	D056	86.4600	23.6590
A019	86.4004	23.6847	D057	86.4999	23.6467
A020	86.3272	23.7481	D059	86.5253	23.6806
A023	86.2581	23.7502	D062	86.4805	23.7029
A024	86.2275	23.7535	D063	86.4636	23.6760
A025	86.2540	23.7830	D065	86.4929	23.7442
A026	86.3005	23.7787	D068	86.4623	23.7054
A027	86.3402	23.8090	D070	86.5443	23.7112
A028	86.2979	23.7900	D071	86.5248	23.7922
A029	86.2713	23.7865	D072	86.5238	23.8293
A032	86.3521	23.7360	D074	86.4255	23.7015
A034	86.2537	23.7136	D075	86.3985	23.6509
B001	86.2402	23.8164	D077	86.3707	23.6802
B002	86.2091	23.7950	D080	86.4067	23.7650
B009	86.1797	23.8387	D088	86.3950	23.6230
B010	86.1718	23.8153	D089	86.3872	23.5968
B011	86.2063	23.8256	D090	86.4209	23.6058
B012	86.2049	23.8094	D091	86.4378	23.5621
B014	86.2704	23.8008	D096	86.4663	23.6135
B015	86.1484	23.7685	D105	86.3295	23.6436
B017	86.1194	23.7514	D109	86.1983	23.6554
B018	86.0918	23.7459	D112	```86.2586	23.6670
B024	86.2161	23.7410	D113	86.2785	23.6948
B027	86.3418	23.7562	D115	86.1250	23.6843
B029	86.2076	23.6992	D117	86.1787	23.7136
B032	86.2135	23.7676	DB001	86.7902	23.7303
B033	86.2053	23.8552	DB002	86.7794	23.75
B038	86.2135	23.8834	DB003	86.7638	23.6555
B040	86.1731	23.8799	DB004	86.8062	23.6541
B041	86.1611	23.9121	DB005	86.8216	23.6785
B043	86.2420	23.8949	DB008	86.81519	23.73067
B044	86.1276	23.8735	DB009	86.8135	23.7354
B046	86.1195	23.8163	DB010	86.8561	23.7085
B047	86.1233	23.7702	DB012	86.8713	23.7638
B048	86.2783	23.7259	DB013	86.8687	23.7814

B051	86.1521	23.7941	DB018	86.7915	23.7394
B053	86.1636	23.7683	DB019	86.7483	23.7194
B054	86.3639	23.8660	DB022	86.7571	23.7237
B055	86.3427	23.8940	DB023	86.7514	23.7291
B057	86.2860	23.8738	DB024	86.7509	23.7309
B059	86.2293	23.8000	DB025	86.7399	23.7337
B060	86.2541	23.8059	DB026	86.75	23.7194
B062	86.1929	23.7628	DB027	86.7232	23.7298
B065	86.3076	23.8083	DB028	86.6836	23.7472
B067	86.2325	23.7233	DB029	86.6548	23.7462
B068	86.0873	23.7225	DB030	86.6654	23.795
B071	86.0799	23.8088	DB033	86.8126	23.7645
D003	86.4149	23.7804	DB034	86.7877	23.7785
D005	86.4180	23.7098	DB036	86.7546	23.798
D007	86.4574	23.7220	DB038	86.7361	23.8346
D008	86.1915	23.8340	DB039	86.715	23.7996
D010	86.4947	23.7252	DB047	86.7509	23.7557
D012	86.4484	23.7771	K010	86.9157	23.7059
D014	86.4884	23.7808	K012	86.9277	23.7267
D018	86.4317	23.8189	K015	86.9103	23.8177
D019	86.4253	23.8440	K020	86.8824	23.8514
D020	86.4023	23.8527	K021	86.9277	23.7267
D022	86.4021	23.8015	K026	86.8808	23.7414
D025	86.3837	23.7828	K030	86.8472	23.7396
D028	86.4016	23.8223			

Annexure – VA

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
A002	Beharekudur	0.63	3.00	12.93	Metamorphic	Nona Das	Domestic
A004	Daldoli	0.52	3.12	6.00	Metamorphic	Govt.	Domestic
A006	Barwadi,Kanko	0.75	3.15	9.10	Metamorphic	Govt.	Domestic
A007	Chaddriderdih	0.45	1.80	9.95	Metamorphic	Hazi	Domestic
A008	Siskari	0.60	1.95	12.50	Metamorphic	Govt.	Domestic
A009	Srirampur	0.43	2.10	9.80	Metamorphic	Mosque	Domestic
A010	Phulwar	0.63	1.90	10.90	Metamorphic	Govt.	Domestic
A013	Sijua	0.40	2.35	6.90	Barakar	Rajen	Domestic
A015	Tetulmari	0.90	1.85	9.00	Metamorphic	Dharmendar	Domestic
A016	Ekra, Kalali	0.45	3.10	6.50	Barakar	Govt.	Domestic
A017	Kachi Balihari	0.56	1.60	5.30	Barakar	Govt.	Domestic
A019	Bhaura	0.54	3.15	11.65	Barakar	Govt.	Domestic
A020	Gorbhudih	0.43	3.30	8.30	BM	Govt.	Domestic
A023	Machhyara	0.43	1.85	12.40	Raniganj	Govt	Domestic
A024	Pipra Tanr	0.22	1.80	19.55	Raniganj	Govt	Domestic
A025	Sinidih	0.22	2.00	11.30	Barakar	Govt	Domestic
A026	Pasitanr	0.32	1.80	9.65	Barakar	Govt	Domestic
A027	Chandor	0.60	2.50	5.50	Barakar	Govt	Domestic
A028	Lakarka 6 no.	0.65	1.30	5.25	Barakar	BCCL	Domestic
A029	Aambagan	0.10	2.60	9.15	Barakar	Govt	Domestic
A032	Baludih	0.55	2.30	6.85	BM	Govt	Domestic
A034	Bhatdih	0.55	3.50	24.50	Raniganj	BCCL	Domestic
B001	Muraidih	0.47	1.80	5.35	Talchir	Govt	Domestic
B002	Baghmara Tola	0.32	1.85	11.25	Metamorphic	Govt	Domestic
B009	Jari Tanr	0.60	2.57	9.00	Metamorphic	Hariram Majhi	Domestic
B010	Narayanpur	0.23	4.57	8.60	Metamorphic	Mukteswar	Domestic
B011	Nischitpur	0.60	2.08	11.30	Metamorphic	Babulal Das	Domestic
B012	Harina	0.37	2.20	10.87	Metamorphic	Ramayan	Domestic
B014	Mathadih	0.76	2.15	3.75	Barakar	Govt	Domestic
B015	Bera Basti	0.55	1.60	2.50	Talchir	Dhanu Roy	Domestic
B017	Chandrapura	0.40	1.85	11.40	Barakar	Govt	Domestic
B018	Khanoodih	0.66	2.30	13.25	Metamorphic	Govt	Domestic
B024	Telmuchu	0.67	4.35	10.83	Raniganj	Govt	Domestic
B027	Chirudih Basti	0.08	1.40	11.00	BM	Govt	Domestic
B029	Popanki	0.50	1.70	6.50	Metamorphic	Govt	Domestic
B032	Madhuband	0.80	4.30	8.60	Barakar	BCCL	Domestic
B033	Ramakunda	0.75	3.20	9.65	Metamorphic	Liluram Mahato	Domestic

B038	Tantri	0.4	1.80	11.3	Metamorphic	Panchayat	Domestic
B040	BhuiwarChita	0.4	1.80	9.15	Metamorphic	Govt	Domestic
B041	Pawapur	0.45	3.00	6.7	Metamorphic	Govt	Domestic
B043	Chatatanr	0.5	1.50	9.2	Metamorphic	Govt	Domestic
B044	Lachmipur	0.35	3.35	10.1	Metamorphic	Govt	Irrigation
B046	Telo	0.2	1.50	8.1	Metamorphic	Govt	Domestic
B047	Madanpur	0.7	1.80	10.8	Metamorphic	DVC	Domestic
B048	Mahuda	0.65	2.10	11.50	Raniganj	Mosque	Domestic
B051	Taranga	0.00	2.50	5.75	Metamorphic	Bisun	Irrigation
B053	Karmatanr	0.58	2.70	13.25	Barakar	Govt	Domestic
B054	Domanpur	0.45	3.30	9.55	Metamorphic	Govt	Domestic
B055	Rantanr	0.50	3.40	5.25	Metamorphic	Govt	Domestic
B057	Kotaldih	0.60	3.20	7.5	Metamorphic	Govt	Domestic
B059	Khodovaly	0.60	2.40	9.30	Barakar	BCCL	Domestic
B060	Bahiyardih	0.77	3.00	15.60	Barakar	BCCL	Domestic
B062	Sadariyadih	0.15	3.10	9.50	Barakar	Govt	Domestic
B065	Jhinjipahari	0.95	2.20	12.4	Metamorphic	Private	Domestic
B067	Simatanr	0.55	2.20	11.8	Raniganj	Govt	Domestic
B068	Sibutanr	0.4	2.20	6	Metamorphic	DVC	Domestic
B071	Bandiyo	0.55	3.50	7.1	Metamorphic	Govt	Irrigation
D003	Dhansar	0.6	1.70	8.7	Barakar	Govt	Domestic
D005	Jiyalgora PO	0.7	2.80	10.55	Metamorphic	Govt	Domestic
D007	Golden Pahari	0.67	2.85	10.05	Barakar	BCCL	Domestic
D008	Alokdiha	0.35	1.75	8.15	Metamorphic	Govt	Domestic
D010	Rakhisitpur	0.55	1.65	4.6	Metamorphic	Govt	Domestic
D012	Dhowatanr	0.75	1.85	13.2	Metamorphic	Govt	Domestic
D014	Karmatanr	0.48	1.90	11.55	Metamorphic	Nepal	Domestic
D018	Dhaiya	0.44	2.00	8.1	Metamorphic	Govt	Domestic
D019	Memko More	0.42	3.80	7.57	Metamorphic	Govt	Domestic
D020	Dhanbad	0.22	3.10	11.45	Metamorphic		Domestic
D022	Shyamnagar	0.35	1.70	6.3	Metamorphic	Govt	Domestic
D025	Godhar More	0.6	2.75	5.8	Barakar	Govt	Domestic
D028	Nawadih	0.46	2.00	10.6	Metamorphic	Gitarani Paul	Domestic
D029	Karamara	0.5	3.10	10.5	Metamorphic	Govt	Domestic
D030	Borkiboa	0.7	2.00	5.6	Metamorphic	Haru	Domestic
D034	Kusunda	0.6	1.50	3.45	Barakar	BCCL	Domestic
D035	Patherdih	0.4	2.00	11.2	Metamorphic	Govt	Domestic
D036	Sudamdih	0.9	2.00	6.2	Metamorphic	BCCL	Domestic
D039	Tilabani	0.85	2.00	20	Barakar	BCCL	Domestic
D046	Sindupur	0.74	3.00	8.75	Metamorphic	Govt	Domestic
D047	Ena colliery	0.45	3.20	23.8	Barakar	BCCL	Domestic
D052	Goluckdih	0.47	3.10	5	Metamorphic	Govt	Domestic
D054	Amtal	0.65	6.40	10.8	Barakar	Govt	Domestic
D056	Bhutgoria	0.5	1.80	12.75	Metamorphic	Govt	Domestic
D057	Kandra	0.37	2.10	6.55	Metamorphic	Govt	Domestic

D059	Belghutu Tola	0.5	3.60	9.3	Metamorphic	Govt	Domestic
D062	Bendachuna	0.65	2.80	12.1	Metamorphic	Saheb Ram	Domestic
D063	Chatabad	0.2	1.90	10.7	Metamorphic	Govt	Domestic
D065	Nischitpur	0.15	3.15	10.6	Metamorphic	Govt	Domestic
D068	Surunga	0.53	3.00	10.25	Metamorphic	Govt	Domestic
D070	Jaladih	0.7	1.80	9.5	Metamorphic	Govt	Domestic
D071	Domandih	0.65	2.00	13.5	Metamorphic	Govt	Domestic
D072	Gobindpur	0.4	1.70	6.7	Metamorphic	Govt	Domestic
D074	Bhulan-Barari	0.1	1.60	12.8	Barakar	Govt	Domestic
D075	Manpur	0.6	2.90	10.2	BM	Govt	Domestic
D077	Rohoniatanr	0.4	3.15	6.9	BM	Govt	Domestic
D080	Bastacolla	0.7	2.50	24.95	Barakar	Govt	Domestic
D088	Laghla more	0.35	2.00	7.75	Metamorphic	Govt	Domestic
D089	Machatanr	0.6	1.60	9.15	Metamorphic	Govt	Domestic
D090	Marradih	0.42	3.10	8.8	Metamorphic	Govt	Domestic
D091	Asurbandh	0.65	1.80	8.1	Metamorphic	Govt	Domestic
D096	Paradih	0.85	1.30	9.2	BM	Private	Domestic
D105	Bandhwatanr	0.55	3.00	9.15	Metamorphic	Dasarath Mahato	Domestic
D109	Domatanr	0.65	9.15	9	Metamorphic	Shiv Charan Mahato	Domestic
D112	Bansra	0.45	1.38	7.75	Metamorphic		Domestic
D113	Dumarda	0.7	3.00	11	Metamorphic	Govt	Domestic
D115	Mahuar	0.15	2.00	6.45	Metamorphic	Private	Domestic
D117	Bhatua	0.23	2.70	10	Metamorphic	Govt	Domestic
DB001	Laikadih	1	2.55	14.96	Barakar	BCCL	Domestic
DB010	Kulti College	0.6	1.8	13.88	BM	Govt	Domestic
DB012	Sabanpur	0.85	1.8	9.6	Barakar	Govt	Domestic
DB013	Dendua More	0.5	2	7.85	-	Govt	Domestic
DB018	Sarsapahari	0.75	1.6	7	Barakar	Govt	Domestic
DB019	Luchibad	0.73	1.8	6.45	Talchir	Govt	Domestic
DB002	Sulibari	0.42	1.8	9.63	Barakar	Govt	Domestic
DB022	Dahibari Majhi Basti	0.9	1.85	16.25	Barakar	Govt	Domestic
DB023	BCCL Substation,Dahibari	0.67	1.42	5.75	Barakar	Govt	Domestic
DB-24	Dahibari,LHS	0.58	2	12.8	Barakar	Govt	Domestic
DB026	Patlabari	0.7	4	9.8	Metamorphic	DVC	Domestic
DB027	Ledaharia Village	0.67	2.4	10.65	Metamorphic	Govt	Domestic
DB028	Patharkua	0.7	2.3	8	Barakar	BCCL	Domestic
DB029	Kelyasol	0.6	3.6	13.7	Barakar	BCCL	Domestic
DB003	Puapur	0.37	1.55	5.25	Raniganj	Govt	Domestic

DB030	Ramkanali Village	0.6	3.1	10.55	Metamorphic	Govt	Domestic
DB033	Barajor/Amkura	0.7	2	9.2	Talchir	Kajal Chatterjee	Domestic
DB034	Tetuldanga	0.6	3.6	11.6	Talchir	Govt	Domestic
DB036	Madanpur	0.55	2.4	8	Talchir	Chhotka Marandi	Domestic
DB038	Lukuidih	0.55	3.8	7.8	Metamorphic	Govt	Domestic
DB039	Pandra	0.65	3	6.9	Talchir	Forest Dept.	Domestic
DB004	Sarbari	0.62	2.22	8.98	Raniganj	DVC	Domestic
DB047	Mugma	0.65	3.2	8.3	Barakar	Govt	Irrigation
DB005	Parbelia	0.48	3.2	7.8	Raniganj	Govt	Domestic
DB008	Chungei	0.8	2.2	5.75	BM	Govt	Domestic
DB009	Begunia Temple	0.68	3	19.25	Barakar	Govt	Domestic
K010	Phatepur	0.8	2.02	28.3	Raniganj	Govt	Domestic
K012	Ethora	0.81	2	15.9	Raniganj	Govt	Domestic
K015	Kankurkunda	0.55	2.1	12.5	-	Govt	Domestic
K020	Majhladih	0.79	1.22	11.77	-	Govt	Domestic
K021	Pratappur	0.6	1.4	10.94	-	Govt	Domestic
K026	Bodra	0.9	2.1	10	BM	Govt	Domestic
K030	Kulti Station	0.31	0.75	4.25	BM	Govt	Domestic

MP: Measuring Point **R.L.: Reduced Level** **W.L.: Water Level m: Meter**
Abn.: Abandoned **b.g.l.: Below Ground Level** **a.g.l.: Above Ground Level**
G.L.: Ground Level **bmp: Below Measuring Point** **BM: Barren Measure**

Annexure – VB

Historical Water Level data of Hydrograph Stations

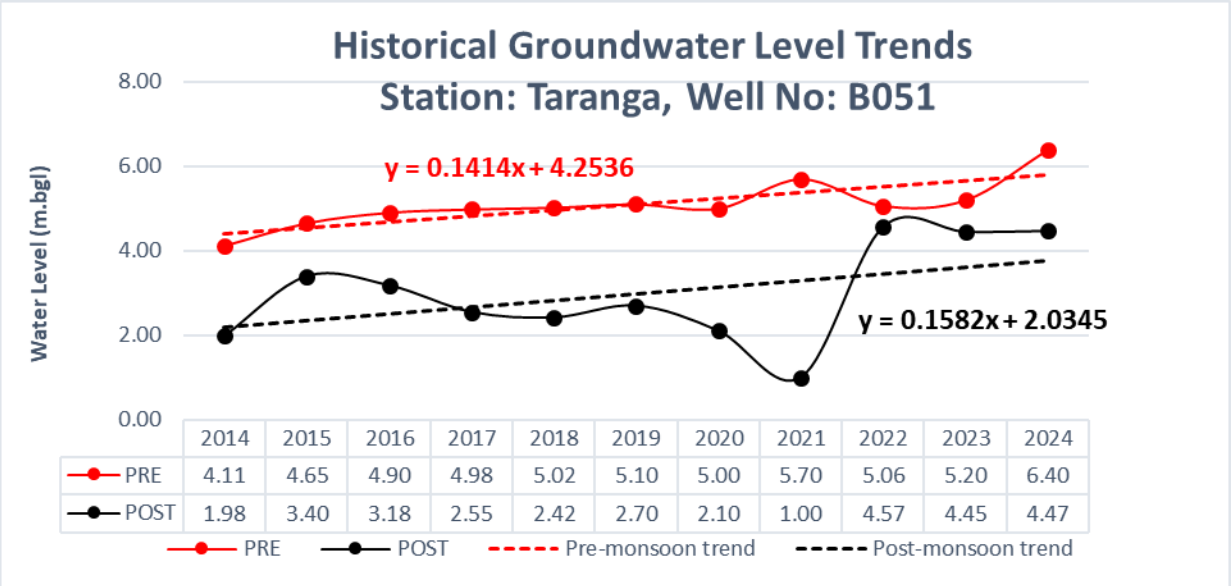
Well No	Water level below ground level (bgl) in meters																	
	May 15	Nov 15	May 16	Nov 16	May 17	Nov 17	May 18	Nov 18	May 19	Nov 19	May 20	Nov 20	May 21	Nov 21	May 22	Nov 22	May 23	Nov 23
JCF																		
A002	9.10	5.21	9.30	4.95	8.15	4.35	8.27	4.78	7.55	3.25	6.95	3.00	6.87	4.50	6.45	4.91	4.80	3.10
A004	4.56	1.78	5.20	1.48	3.48	0.91	4.48	1.73	3.38	1.78	4.63	2.28	3.51	1.83	4.40	1.80	3.51	1.90
A006	8.25	6.25	8.25	3.95	6.95	3.35	8.40	5.35	4.90	4.25	7.75	5.30	7.00	4.07	8.40	5.30	7.35	4.72
A007	7.79	4.57	9.45	5.27	7.55	2.55	7.40	3.75	9.45	4.10	7.35	3.70	6.63	3.66	7.40	3.75	8.15	5.65
A008		9.73	11.85	3.20	9.90	1.38			11.30				8.99	4.30	8.80	4.20	10.70	5.03
A009	6.70	5.47	7.23	4.44	7.77	2.42	6.42	5.22	8.87	5.07	6.12	4.62	7.42	4.55	6.30	5.05	7.42	4.76
A010	9.61	8.37		2.42	7.47	2.27	7.72	5.47	8.17	5.57	7.57	5.29	8.92	5.60	7.70	5.40	8.92	5.05
A013	3.60	5.30	5.20	3.85	4.40				5.10				4.63	2.60	4.60	2.50	4.63	2.31
A015	7.15	7.00	7.95	5.20	6.50	3.95			7.00				6.93	3.76	6.70	3.50	6.93	3.62
A016	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	5.80	3.08	5.55	3.52
A017	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	2.41	2.19
A019			7.81	4.11	6.38	2.46	5.55	2.45	4.86	3.44	6.06	3.26	3.31	1.91	4.10	2.54	2.90	2.60
A020	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	8.02	4.20
A023	11.37	9.37	11.87	8.13	11.87	6.97	11.15	7.17	11.97	3.77	8.92	5.62	9.52	2.82	7.97	4.79	9.00	5.71
A024	17.20	14.58	16.62	12.43	16.28	4.18	14.58	6.88	15.88	2.48	4.88	4.28	10.13	2.78	7.28	4.33	5.38	3.90
A025	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	2.93	2.60
A026	7.33	3.18	8.93	4.48	5.28	2.53	6.23	3.88	6.58	3.33	6.98	3.18	5.66	2.73	6.42	4.31	8.40	3.83
A027	4.40	3.99	4.85	1.80	2.90	1.25	2.90	1.00	2.40	0.92	2.40	1.10	1.67	0.90	1.90	1.33	1.70	1.60
A028	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	3.45	3.35
A029	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	5.60	3.20
A032	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	3.83	1.60
A034	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	6.54	4.01
B001	3.28	2.75	3.58	1.93	2.33	1.63	2.88	2.08	3.18	1.73	3.28	1.63	2.58	1.91	2.10	1.81	3.22	2.45
B002	-	-	10.93	6.99	10.9	6.8	-	-	10.88	6.58	-	-	10.13	6.5	9.8	6.4	10.55	4.47
B009	8.82	3.50	8.90	3.90	7.80	2.30	8.40	3.40	6.56	3.25	8.51	3.27	7.61	3.16	7.40	4.60	6.75	3.20
B010	7.12	3.63	6.77	4.69	7.97	4.42	6.97	2.79	8.02	2.77	6.92	2.80	7.12	3.35	6.80	2.70	7.47	4.42
B011	9.49	3.45	9.20	4.55	10.60	2.80	9.90	4.68	9.38	4.65	10.05	4.90	8.24	4.02	9.50	4.60	10.30	3.75
B012	8.78	7.31	7.17	8.63	9.03	5.33	8.37	4.83	8.98	8.63	8.63	5.66	8.68	6.99	6.4	4.7	8.88	5.63
B014	2.94	2.29	2.44	0.47	2.94	1.84	3.64	2.84	2.24	2.74	2.44	1.04	2.84	2.04	3.24	2.6	2.84	2.34
B015	1.5	0.45	1.85	0.55	1.85		1.85	0.85	1.9	0.95	3.7	1.47	1.46	0.35	3.67	1.02	3.2	1
B017	6.65	2.9	4.8	3.15	3	2.65	6.61	4.4	7.4	4.6	6.69	4.15	6.5	4.25	6.5	4.2	7.95	4.33
B018	9.01	6.16	6.39	5.19	6.24	1.99	8.56	3.39	8.34	3.34	8.54	3.52	7.84	3.62	8.5	3.2	7.36	3.9
B024	10.05	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	4.63	3.24
B027	9.87	5.47	6.07	4.22	8.12	3.87	9.97	5.67	7.52	5.42	8.87	5.47	8.89	4.73	10.1	4.8	8.89	4.16
B029	5.58	5.15	5.95	3.05	5.5				4.8	2.65			5.26	2.48	5.5	2.15	3.6	1.9
B032	7.55	3.32	6.95	3.07	6.95	2.8	6.75	3.9	5.55	1.7	3.3	2	5.6	1.7	4.15	2.56	7.3	3.54
B033	6.53	4.13	5.45	4.05	5.3	4.15	6.5	3.45	6.65	3.3	6.29	3.3	6.38	3.43	4.75	3.1	7.3	3.54
B038	10.65	7.95	10.82	4.2	7.6	4.5	10.3	5.1	10.8	4.85	9.17	4.85	9.34	4.18	8.1	5.2	8.17	5.2
B040	5.63	4.45	7.05	3.45	4.7	3.4	6.1	4.6	8.7	4.9	5.68	4.15	5.58	3.24	5.3	3.1	3.5	1.96
B041	5.9	2.85	5.25	3.75	5.35	2.9	5.25	2.05		1.95	5.37	2.25	5.36	2.4	5.05	3.6	6.45	4.02
B043	7.65	5.5	7.75	3.82	7.6	2.4	7.5	4.2		4.55	7.35	3.7	7.26	3.78	6.5	4.6	7.26	3.93
B044	9.15	5.54	7.7	4.79	6.6	2.75	9.68	5.05		4.6	8.58	4.73	7.51	3.83	9.1	6.3	9.35	7.63
B046	6.85	4.62	5.05	4.82	5.6	3.8	5.6	3.6			5.55	3.35	5.5	3.65	6.05	3.75	7.25	3.9
B047	9.33	8.6	8.85	6.7	10	4.37	8.2	5.3		5.1	8.02	4.66	7.15	4.73	8.75	5.6	7.8	4.95
B048	7.9	5.42	9.35	4.6	7.7	4.15	7.33	3.97	7.05	4.35	8.2	3.85	7.23	6.05	6.85	6.25	6.13	5.05
B051	4.65	3.4	4.9	3.18	4.98	2.55	5.02	2.42	5.1	2.7	5	2.1	5.7	1	5.06	4.57	5.2	4.45
B053	5.58	2.82		2.07	4.02	1.92	3.92	1.42	3.22	1.42	3.12	1.4	4.85	1.87	4.42	3.54	2.62	1.13

B054	7.62	4.56	9.25	5.55	7.2	4.1	7.55	3.65	9.05	3.55	7.7	3.87	7.4	3.43	7.3	4.75	7.65	5.8
B055	3.46	2.25	4.45	2.2	4.6	5.52	3.6	2.48		2.5	4.15	2.58	3.73	2.52	3.3	2	3.73	2.2
B057	6.18	3.35	6.9	3.45	5.9	3.6	6.2	3.1		2.95	6.4	3.05	5.36	2.92	6.1	3.5	5.36	3.26
B059	4.12	1.6	4.4	0.5	5.4	0.6	3.9	0.9	6.2	0.9	5.25	1.4	5.49	0.9	4.5	1.14	1.88	0.7
B060	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	5.8	10.73	5.73
B062	9.1	5.21	9.3	4.95	8.15	4.35	8.27	4.78	7.55	3.25	6.95	3	6.87	4.5	6.45	4.91	4.8	3.1
B065	7.82	5.87	7.15	2.68	9.05	1.25	10.03	2.4	11.05	0.95	9.25	2.3	9.03	1.42	7.45	2.27	8.45	2.35
B067	9.23	5.53	9.53	4.3	10	2.15	9.55	4	8.57	4.35	7.55	3.95	8.95	2.95	8.5	6.3	8.05	5.32
B068	5.05	3.42	5.25	2.8	4.35		5.2	3.85		3.65	5.1	3.44	4.18	3.76	5.5	4.6	7.92	4.6
B071	5.48	3.2	6.15				5.5	3.47		3.45			5.43	3.25	5.3	2.5	10.28	5.64
D003	4.25	2.25	2.35	1.9	2.15	2.3	3.43	2.45	1.75	1.3	5.4	1.38	3.41	0.85	5.96	1.32	3.15	1.85
D005	9.37	8.33	9.4	6.4	7.9	5.2	7.8	5.3	8.25	4.85	8.6	7.7	7.28	4	8.4	7.01	8.4	7.01
D007	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	9.03	3.64
D008	6.24	4.38	8	3.43	5.15	1.85	5.65	1.85	4.8	2.85	5.83	2.75	4.55	2.27	5.8	3.5	7.7	4.82
D010	3.77	2.9	3.77	1.6	3.65	1.6	3.95	2.6	3.5	2.73	3.78	2.45	3.55	1.47	3.5	1.9	5.4	2
D012	12.25	7.9	12.25	8.8	12.45	8.55	11.25	7.7	12.25	7.2	10.82	8.07	11.38	7.28	12	9.9	11.38	7.76
D014	11.02	9.47	10.77	8.12	10.22	7.47	10.52	7.42	10.32	7.07	9.47	5.65	9.57	7.02	10.3	7.1	9.57	6.18
D018	7.01	4.45	3.36	1.56	3.56	3.76	7.06	3.06		3.06			3.66	3.11	4.5	2.3	3.66	2.35
D019	8.43	5.12	8.33	5.5	7.76	4.65	7.53	4.83	7.45	4.85	7.21	4.25	7.47	4.4	7.05	4.4	7.68	5.48
D020	7.42	6.58	8.02	5.88	7.88	4.43	7.38	3.88	8.18	4.33	7.29	3.81	7.66	3.88	6.4	5.5	6.48	4.28
D022	5.78	2.67	5.45	4.75	4.15	1.15	5.8	1.75		2.5	5.75	1.7	3.8	0.5	4.6	1.7	3.8	1.36
D025	4.48	2.45	2.4	1.9	2.4	1.2	2.6	2.4	3.9	5.38	6.5	3.38	8.68	3.8	10.5	4.7	4.4	3.4
D028	9.38	7.22	9.27	3.57	8.64	2.79	9.04	5.74	8.52	5.59	7.44	4.62	8.75	5.51	7.9	5.6	8.75	4.87
D029	9.62	4.35	8.35	4.2	6.3	3.45	9.6	5.2	9.35	5	8.69	5	9.55	5.1	9.75	7.1	9.55	5.87
D030	4.55	3.15	4.45	3.2	4.4	1.25	4.58	1.1	4.6	0.75	4.5	1.35	4.23	0.84	4.37	2.29	4.08	2.2
D034	2.55	1.45	2.3	0.3	0.8	0.55	2.8	0.45	2.4	2	2.9	2.4	3.38	2.5	5	3.15	3.8	2.5
D035	9.8	7.9	9.52	6.45	8.8	3.6	8.4	4.45	8	3.8	8.2	5.4	6.6	2.9	6.1	4.68	5.23	3.9
D036	1.66	1.13	0.78	0.95	1.3	0.7	1.2	0.6	1.2	0.55	2.1	1	2.02	0.55	3.25	0.6	1.85	0.6
D039	5	2.61	2.18	2.65	5.05	4.75	4.95	4.35	4.95	5.6	9.05	5.7	10.35	4.75	7.5	3.05	8.52	3.28
D046	6.14	3.31	7.46	3.26	7.16	3.01	6.06	3.24	7.61	3.36	6.01	3.21			7.05	4.6	7.66	4.18
D047	9.6	3.6	3.18	2.95	3.15	2.85	5.33	2.55	4.55	4.35	9.45	5.45	4.05	2.45	2.2	1.5	4.45	3.27
D052			4.23	1.63	3.53	1.56	4.63	3.33	2.08	3.54	4.58	3.28			3.6	2	3.2	1.95
D054	8.78	6.7	9.5	3.55	8.65	5.35	8.85	3.45	9.35	3.15	7.33	2.88			9.5	6.9	8.03	6.3
D056	10.6	6.9	8.46	5.25	7.1	5	10.48	5.8	6.2	5.55	10	5.75	6.85	4.86	9.4	5.9	5.6	3.73
D057	5.94	5.33	6.1	5.41	5.23	3.43	6.03	4.63	5.23	4.43	6.13	3.98	5.42	3.5	5.2	4.05	5.18	3.65
D059	6.98	3.32	7.7	4.88	7.35	3.55			7.3				7.3	3.6	7.38	3.95	7.3	4.02
D062	7.43	4.12	6.33	3.5	7.76	3.65	7.35	4	7.45	3.85	7.21	3.85	7.47	3.4	7.75	4.4	7.47	3.74
D063	8.41	4.9	9.8	3.74	7.85	3.15	8.3	5.3	7.58	5.3	8.43	5.17	7.75	3.14	9.8	5.7	7.75	4.55
D065	7.48	4.36	8.85	2.35	6.95	4.95	7.45	3.9	8.35	3.85	7.68	3.85	7.41	4.83	7.9	5.7	6.4	4.65
D068	8.49	4.9	6.45	3.54	8.42	4.27	7.27	3.27		2.97	6.97	3.03	7.92	4.22	8.2	5.2	7.92	4.6
D070	7.1	4.25	7.55	3.08	6.5	4.28	7.2	5.1	5.1	4.8	7.12	4.8	6.13	3.78	7.5	5.05	8.6	4.63
D071	10.85	6.55	11.35	5.45	10.35	4.05	10.55	6.89	10.93	6.85	10.6	7	10.28	3.35	10.15	7.5	10.28	5.64
D072	4.62	2.6	3.41	2.3	2.5		5.65	3.6		3.75	6.92	3.86	4.36	2.69	3.3	2.2	5	2.9
D074	10.05	7.2	7.73	5	9.25	3.85	8.6	4.8	5.8	3.57	4.3	3.93	6.93	2.9	6.17	5.77	4.57	3.54
D075	7.42	4.5	5.75	1.4	3.2	1.3	7.4	3.4	5.25	4	7.45	3.27			5.8	2.3	5.75	2.8
D077	6.44	5.6	4.6	2.9	6.5	4.9	6.3	5.2	6.5	3.2	6.4	3.5	5.98	4.69	6.5	4.7	5.98	3.93
D080	10.97	3.35	6.55	4.15	8.65	3.7	9.35	4.2	5	3.05	4.3	4.9	7.1	2.55	6	3.3	4.75	2.6
D088	5.93	3.65		4.2	6.55	2.75	6.15	3.66		3.45	6.12	4.03	6.55	2.52	5.6	2.8	6.55	3.1
D089	5.2	3.22		4.7	6	2.7	5.3	3.7		3.6	5.45	3.63	4.41	2.55	5.7	4.2	4.41	3.55
D090	6.66	3.88		3.68	4.03	2.58	6.63	3.83		3.68	5.82	3.46	5.63	2.66	7	4.5	5.63	3.68
D091	6.85	4.95		4.15	5.65	2.65	6.85	3.15		3.4	6.4	3.4	5.18	3.02	5.2	3.1	5.18	3.2
D096	6.9	3.13		3.15	6		6.85	3.05					5.97	2.71	7.75	4.05	6.1	3.2
D105	7.57	3.1	8.15		7.95	4.3	4.1	4.2	7.7	4.48	6.7		8.2	6	7.05	4.92		
D109	8.15	6.55	5.8	4.15	7.51		7.78	3.5	6.35	3.85	7.9	3.22	7.33	3.1	5.2	3	7.33	2.88
D112	6.4	3.75	5.95	3.4	7.05	2.5	6.63	4.11	7.25	4.57	6.74	4.63	6.9	4.05	7.15	3.35	6.9	3.35

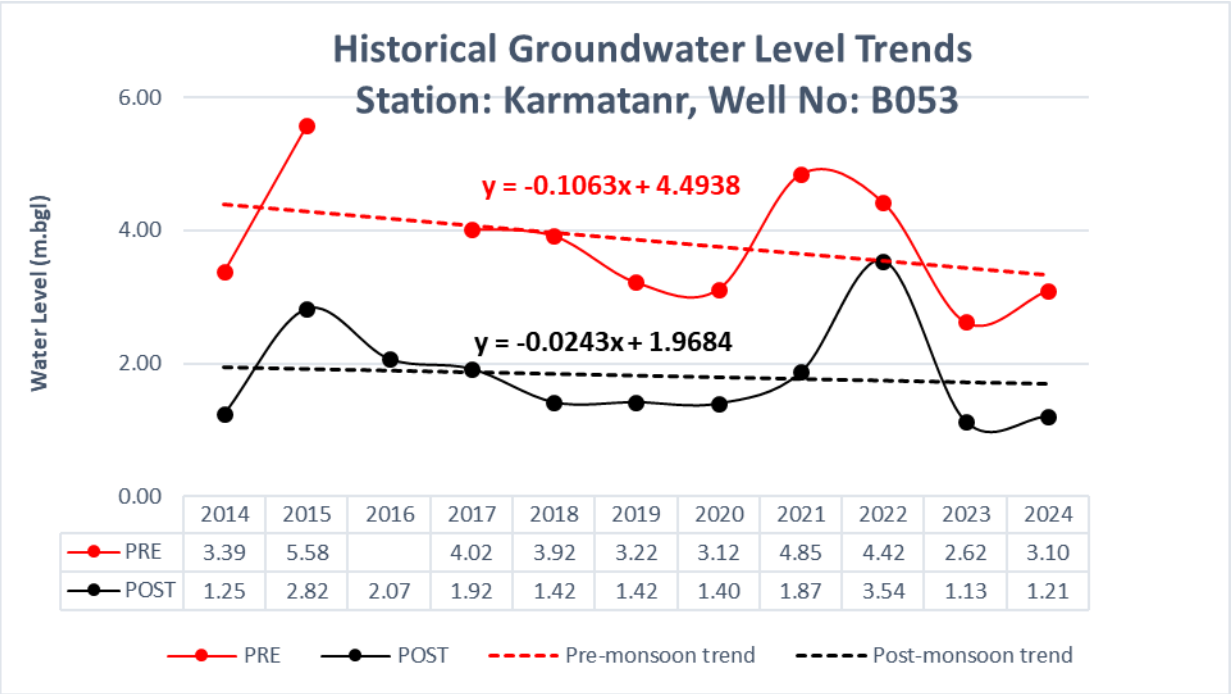
D113	6.6	3.85		3.95	7.28	2.35	6.85	3.3		3.5	6.1	3.45	6.8	2.99	7.3	4.3	5.75	3.48
D115		4.85		5.22	6.05	2.7	7.1	3.05		2.95	7.45	2.4	7.65	3.43	5.5	4.6	6.38	3.83
D117	7.86	5.34		5.67	8.8	4.37	7.92	5.02		5.02	7.52	4.79	7.87	5.11	8.7	5.5	7.27	5.25
RCF (Part)																		
DB001	5.4	4.08	4.17	3.7	4.5	3.8	4.35	4.2	4.85	4.3	5.08	4.08	4.88	3.88	4.73	3.76	3.94	2.77
DB002	3	1.8	3.2	1.98	3.42	2	3.19	2.02	3.6	2.62	3.97	2.43	3.30	2.31	3.20	2.24	2.9	2.25
DB003	4.8	3	5.3	3.22	5.32	2.42	5.6	3.1	5.67	3.12	4.72	3.37	4.53	3.20	4.40	3.11	4.55	2.98
DB004	7.5	4	7.32	3.12	6.59	3.42	6.8	4.1	5.8	3.55	5.17	3.01	4.96	2.98	4.81	2.89	6.1	4.80
DB005	6.88	3.26	6.48	3.8	5.48	3.8	4.98	3.13	5.08	2.78	5.1	3.26	4.90	3.10	4.75	3.00	5.52	3.50
DB008	4.6	2.8	4.57	3.02	4.17	2.13	4.17	2.89	4.27	3.07	5.01	3.1	4.81	2.95	4.67	2.86	4.5	3.42
DB009	9.45	4.5	10.5	5.26	11.5	6.26	9.26	5.22	11.01	6.26	10.4	6.44	9.98	5.00	9.68	4.85	9.5	5.18
DB010	5.68	4.07	4.75	3.75	4.4	2.5	4.8	2.9	4.55	2.95	5.28	3.07	5.07	2.92	4.92	2.83	4.6	3.12
DB012	6.5	2.05	6.76	2.78	6.3	2.73	5.18	2.55	5.08	2.73	4.9	2.05	4.70	1.95	4.56	1.89	5.44	2.30
DB013	3.55	6.5	3.25	5.8	3.72	5.5	3.1	5.3	2.92	5.4	3	4.5	4.88	2.98	4.73	2.89	4.5	2.70
DB018	5.48	3.65	4.6	3.2	4.2	3.3	4.2	2.99	4.6	2.55	3.8	2.9	3.65	2.76	3.54	2.67	4.25	2.61
DB019	5.26	3.02	5.5	3.93	5.53	3.18	4.98	3.03	5.33	3.98	4.9	3.02	4.70	2.87	4.56	2.78	4.8	2.96
DB022	4.87	3.1	4.63	2.23	4.83	2.53	3.16	1.83	3.8	2	3.99	2.16	3.83	2.05	3.72	1.99	4.25	2.43
DB023	4.05	2.82	4.17	2.97	3.9	2.57	4.4	2.17	4.67	2.27	3.82	2.82	3.67	2.68	3.56	2.60	4.8	2.94
DB024	9.47	6.3	9.48	4.08	7.38	4.3	8.88	4.98	8.93	4.46	7.6	3	7.30	2.85	7.08	3.91	8.25	4.18
DB025	8.1	3.5	7.73	3.63	6.88	3.23	6.68	2.65	6.4	2.78	5.25	3.05	5.04	2.90	4.89	2.81	5.15	2.90
DB026	5.9	3.77	6.14	3.53	6.6	3.52	7.3	4.86	7.6	4.6	6.93	3.77	6.65	3.58	6.45	3.47	6.9	3.66
DB027	6.26	3.2	5.77	2.92	6.02	3.35	5.97	3.69	5.57	3.37	6	3.59	5.76	3.41	5.59	3.31	6.85	3.63
DB028	3.08	3.74	1.9	4.1	2.1	3.9	1.88	4.3	2.6	3.8	1.9	3.35	3.80	2.03	3.69	1.97	4.2	2.39
DB029	9.1	4.8	8.6	4.6	8.1	3.98	7.6	4.1	7.1	4.25	6.9	4.3	6.62	4.09	6.43	3.96	8.5	4.67
DB030	7.02	3.6	7.6	3.8	6.8	3.98	7.1	3.8	6.85	3.5	6.01	4.25	5.77	4.04	5.60	3.92	7.5	3.89
DB031	7.84	3.78	7.44	3.6	6.8	3.8	5.45	3.8	5.55	3.55	4.91	3.78	4.71	3.59	4.57	3.48	5.7	2.98
DB033	6.05	4	6.85	3.95	5.07	3.65	5.55	2.9	5.6	3.15	4.69	3	4.50	2.85	4.37	2.76	5.6	3.10
DB034	9.2	4.02	7.93	3.3	6.95	3.88	6.4	3.3	5.9	3.18	5.33	3.8	6.12	3.61	5.94	3.50	5.5	3.08
DB036	6.48	4.15	8.1	4.8	6.75	3.98	7.85	3.9	8.4	4.25	6.46	3.8	6.20	3.61	6.02	3.50	5.04	3.24
DB038	4	2.95	4.2	2.05	3.8	2.8	3.95	2.43	3.55	2.31	3.68	2.95	3.53	2.80	3.43	2.72	3.73	2.66
DB039	5.45	3.31	6	3.6	5.8	3.8	5.62	3.47	5.1	3.5	5.74	3.31	5.51	3.14	5.35	3.05	6.67	3.90
DB047	7.62	4.8	8.77	3.27	6.77	3.62	8.97	3.63	9.07	3.77	6.56	3.8	6.30	3.61	6.11	3.50	7.02	4.30
K010	3.1	1.9	3.05	1.85	3	1.8	2.95	1.86	3.01	2.01	3.11	1.98	2.99	1.88	2.90	1.82	3.5	1.98
K012	4.16	1.98	4.8	2.5	3.9	1.75	4.05	1.9	3.75	1.8	3.65	1.95	3.50	1.85	3.40	1.80	3.7	2.00
K015	4.75	2.46	4.32	2.3	4	2.1	4.5	2.35	4.3	2.22	4.1	2.2	3.94	2.09	3.82	2.03	4.8	2.10
K020	7.25	2.85	7.1	2.7	6.5	2.8	6.75	2.98	6.3	2.5	6.2	2.4	5.95	2.28	5.77	2.21	5.44	2.50
K021	5.45	2.98	5.3	2.8	5.4	3.09	5.1	3	4.88	2.8	4.9	2.7	4.70	2.57	4.56	2.49	4.6	3.00
K026	2.2	1.46	2.7	1.8	2.1	1.6	2.08	1.65	2.1	1.55	2.07	1.4	1.99	1.33	1.93	1.29	2.1	1.50
K030	2.5	1.4	2.4	1.4	2.22	1.53	2.4	1.63	2.6	1.1	2.22	1.3	2.13	1.24	2.07	1.20	2.4	1.50

Annexure – VI

HYDROGRAPHS OF CLUSTER-I



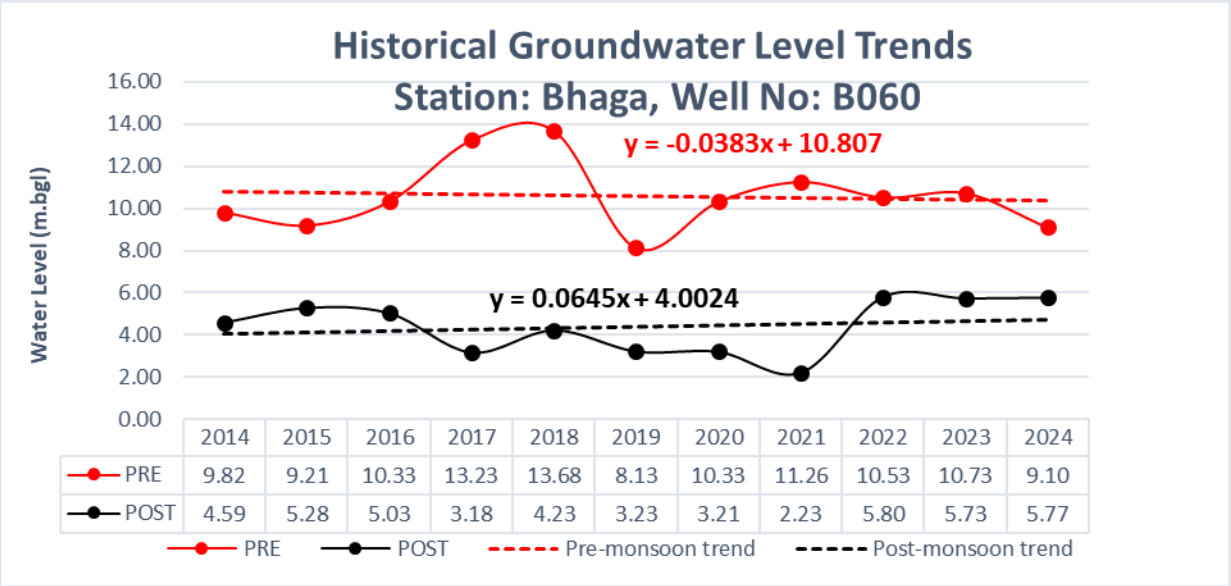
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	4.11	4.65	4.90	4.98	5.02	5.10	5.00	5.70	5.06	5.20	6.40
POST	1.98	3.40	3.18	2.55	2.42	2.70	2.10	1.00	4.57	4.45	4.47



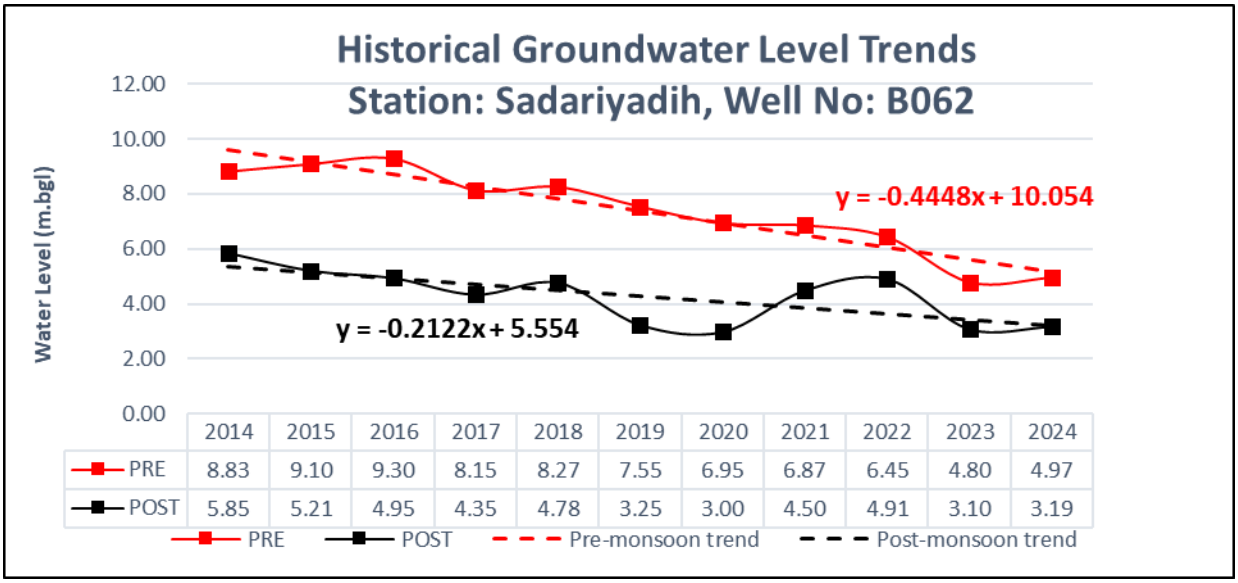
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	3.39	5.58		4.02	3.92	3.22	3.12	4.85	4.42	2.62	3.10
POST	1.25	2.82	2.07	1.92	1.42	1.42	1.40	1.87	3.54	1.13	1.21

Annexure – VI

HYDROGRAPHS OF CLUSTER-II



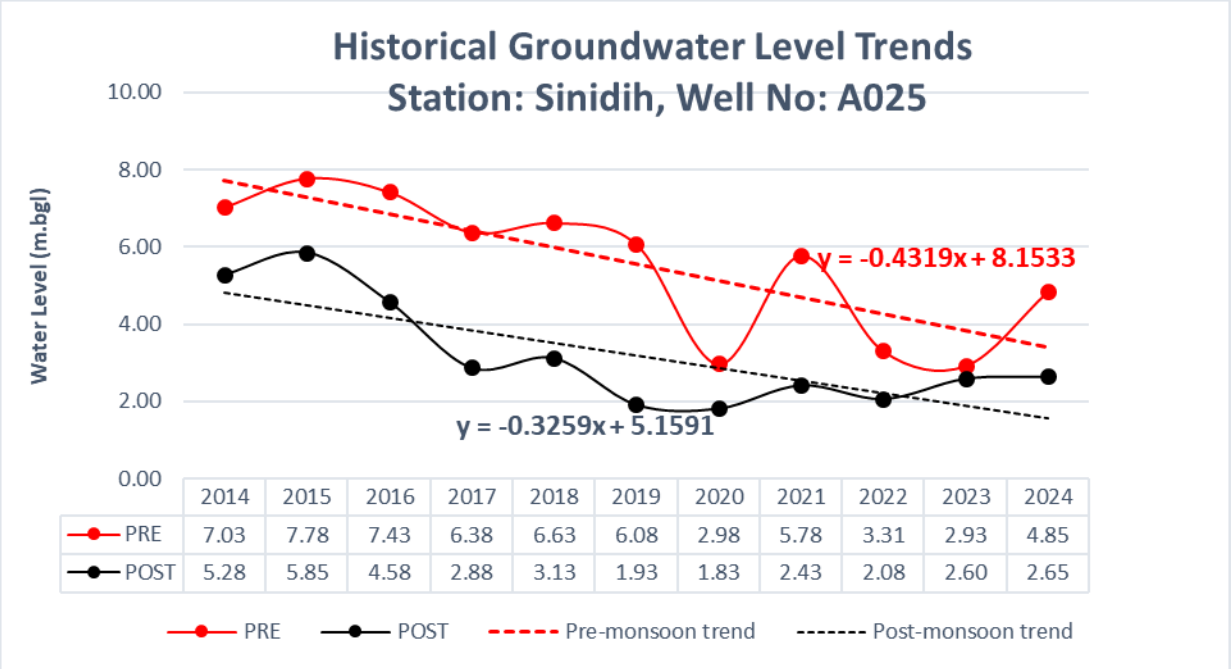
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	9.82	9.21	10.33	13.23	13.68	8.13	10.33	11.26	10.53	10.73	9.10
POST	4.59	5.28	5.03	3.18	4.23	3.23	3.21	2.23	5.80	5.73	5.77



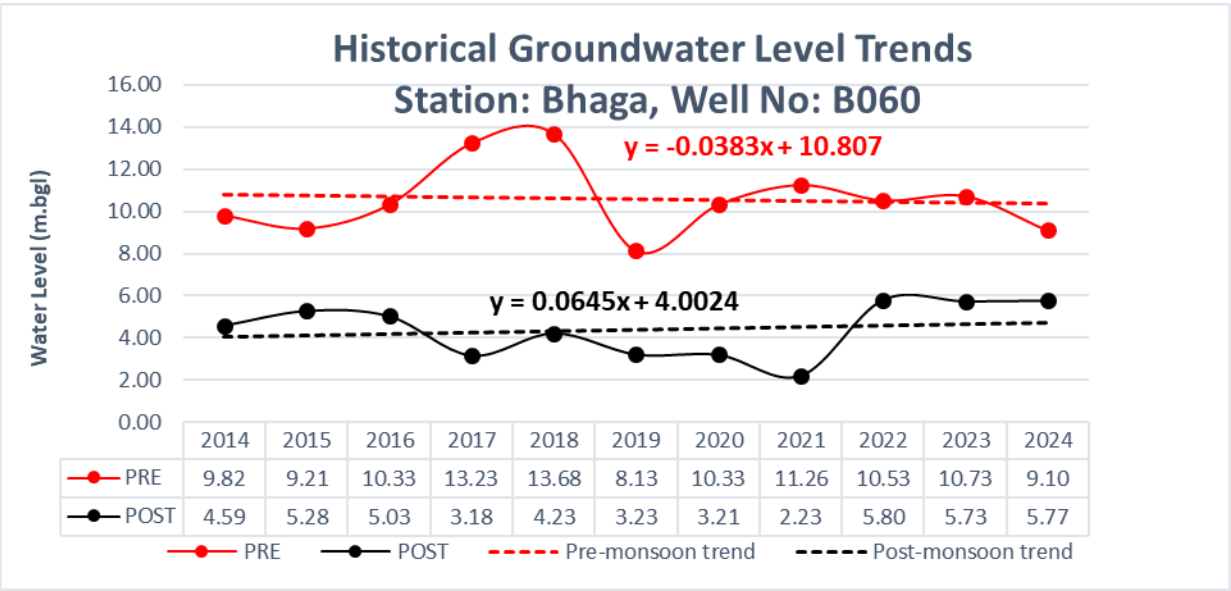
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	8.83	9.10	9.30	8.15	8.27	7.55	6.95	6.87	6.45	4.80	4.97
POST	5.85	5.21	4.95	4.35	4.78	3.25	3.00	4.50	4.91	3.10	3.19

Annexure – VI

HYDROGRAPHS OF CLUSTER-III



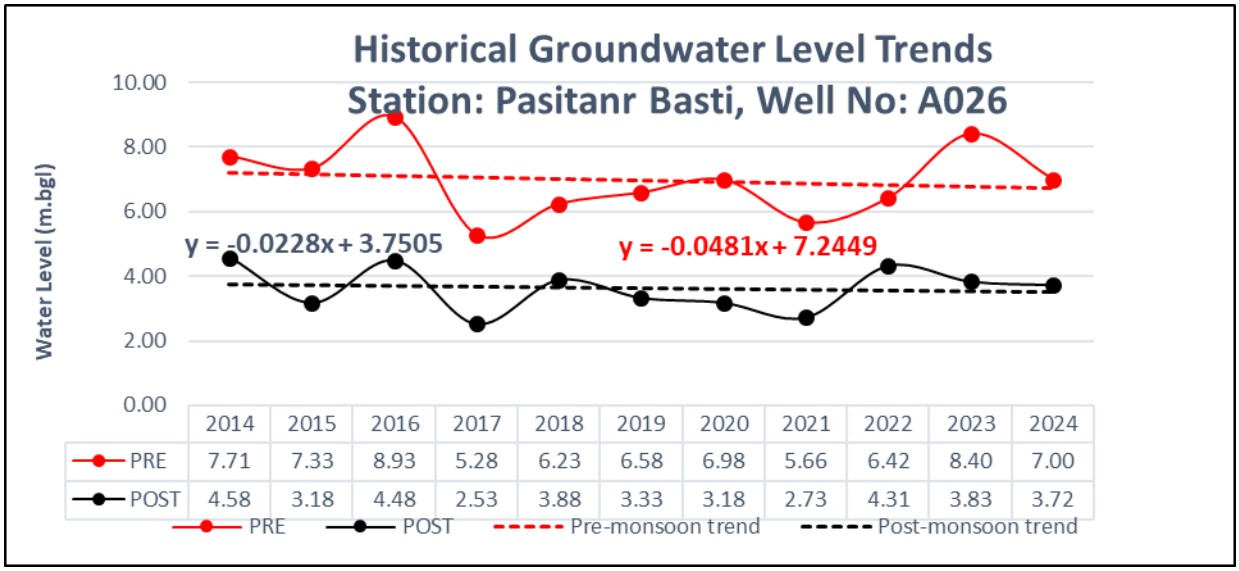
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	7.03	7.78	7.43	6.38	6.63	6.08	2.98	5.78	3.31	2.93	4.85
POST	5.28	5.85	4.58	2.88	3.13	1.93	1.83	2.43	2.08	2.60	2.65

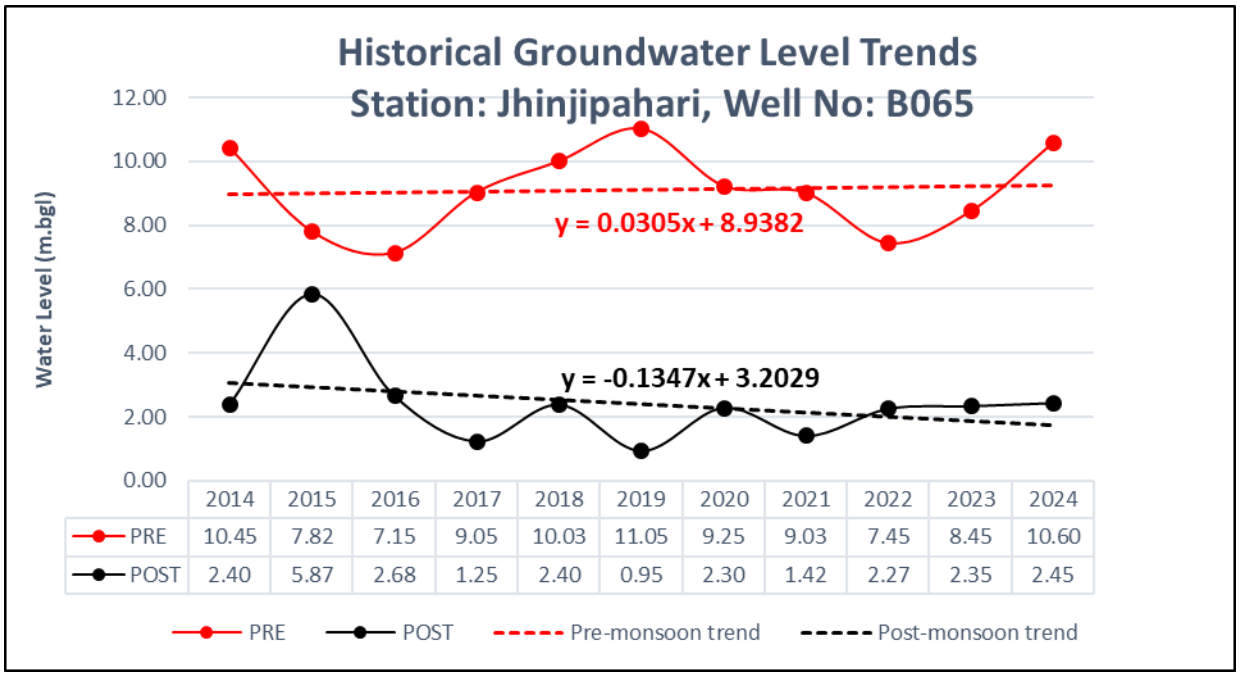


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	9.82	9.21	10.33	13.23	13.68	8.13	10.33	11.26	10.53	10.73	9.10
POST	4.59	5.28	5.03	3.18	4.23	3.23	3.21	2.23	5.80	5.73	5.77

Annexure – VI

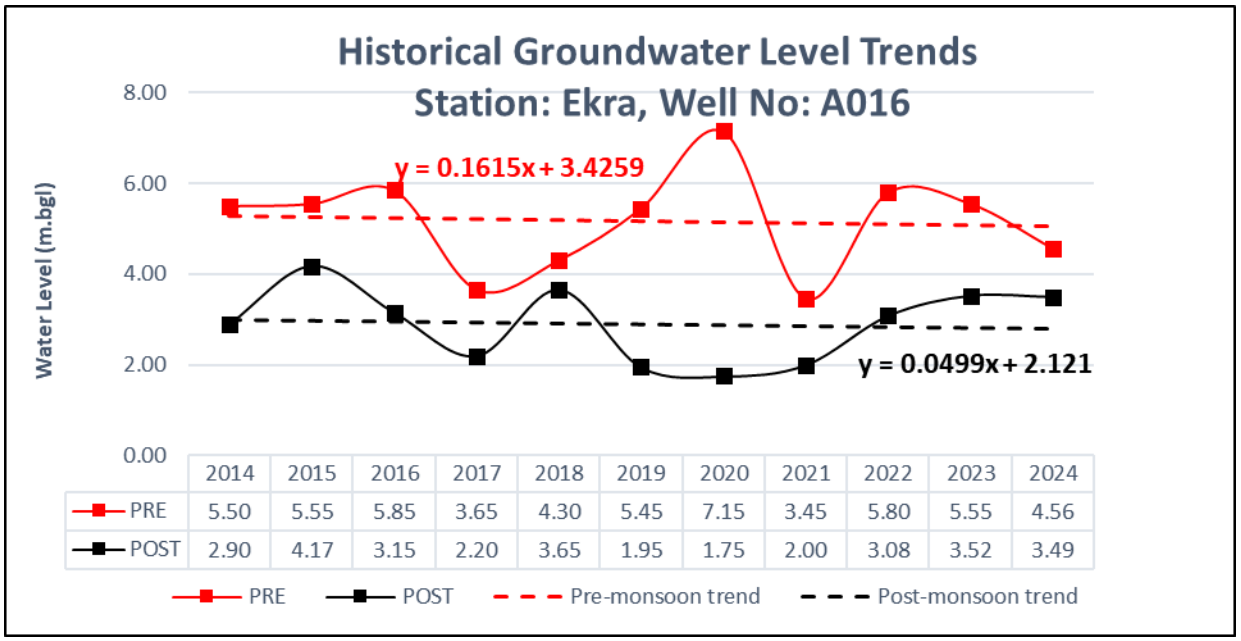
HYDROGRAPHS OF CLUSTER-IV

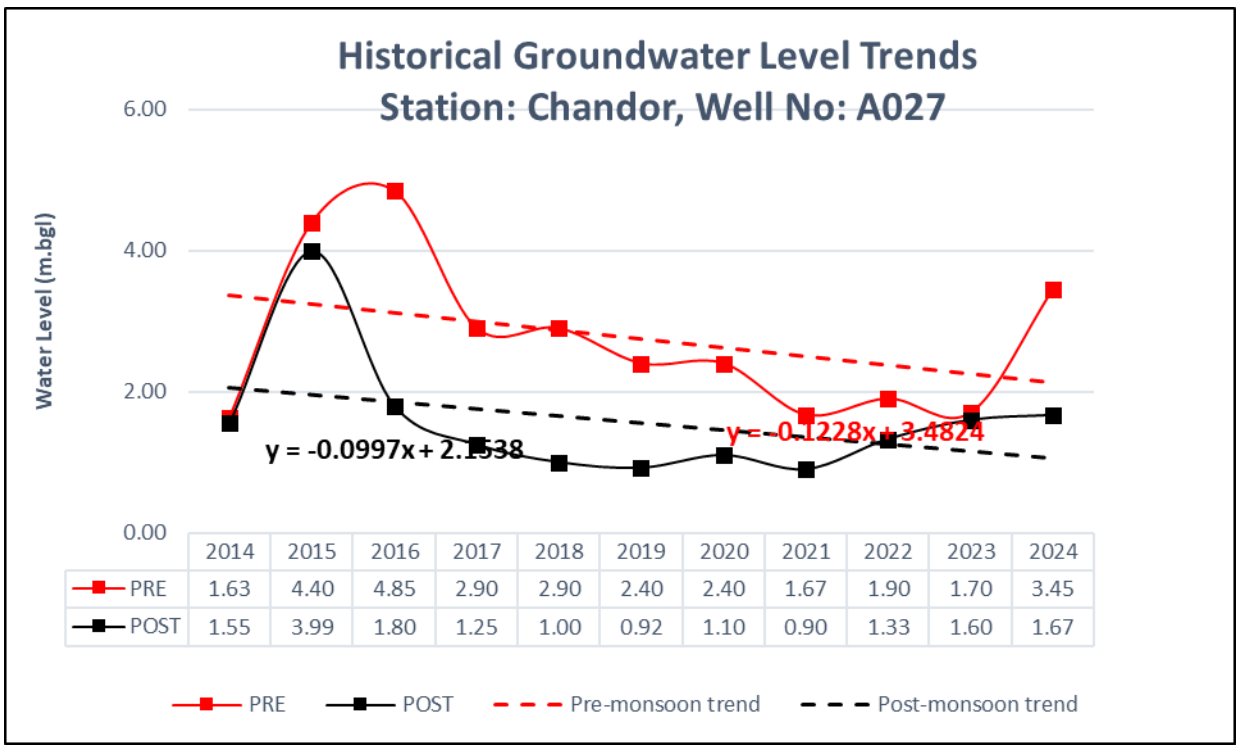




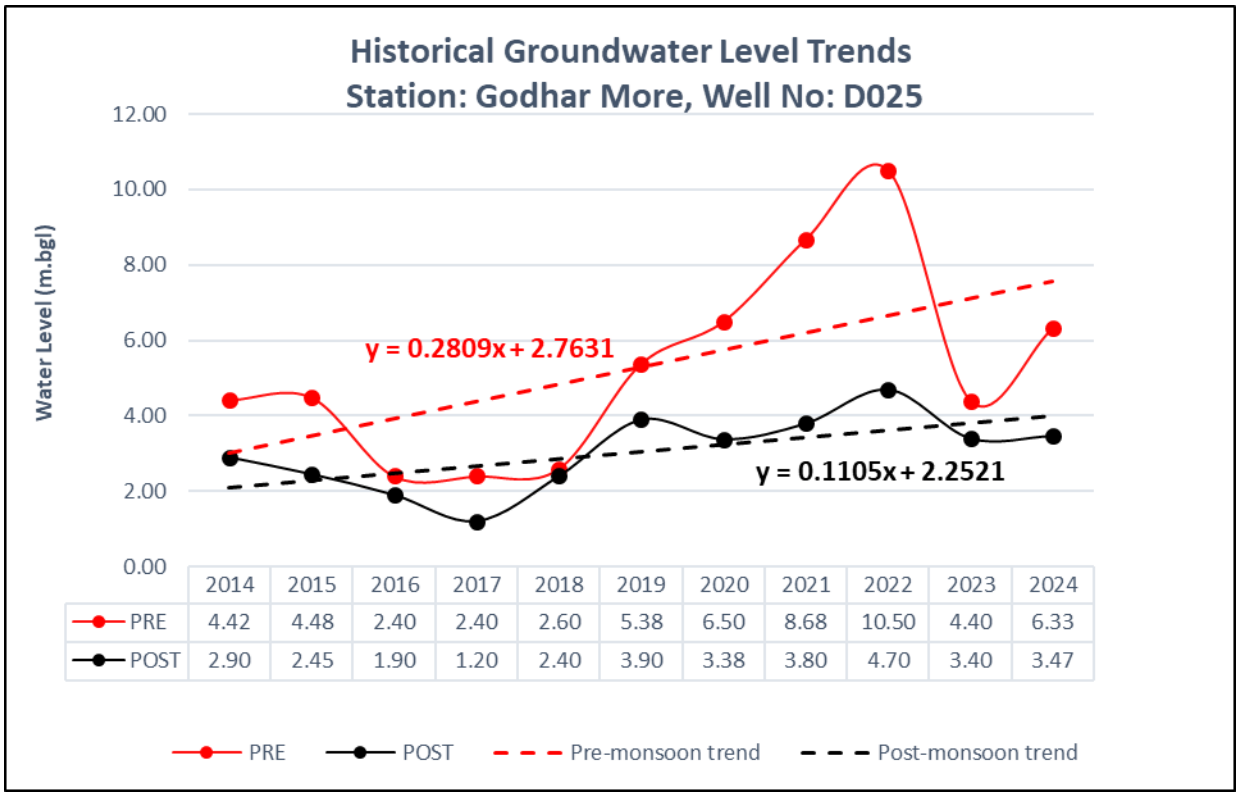
Annexure – VI

HYDROGRAPHS OF CLUSTER-V

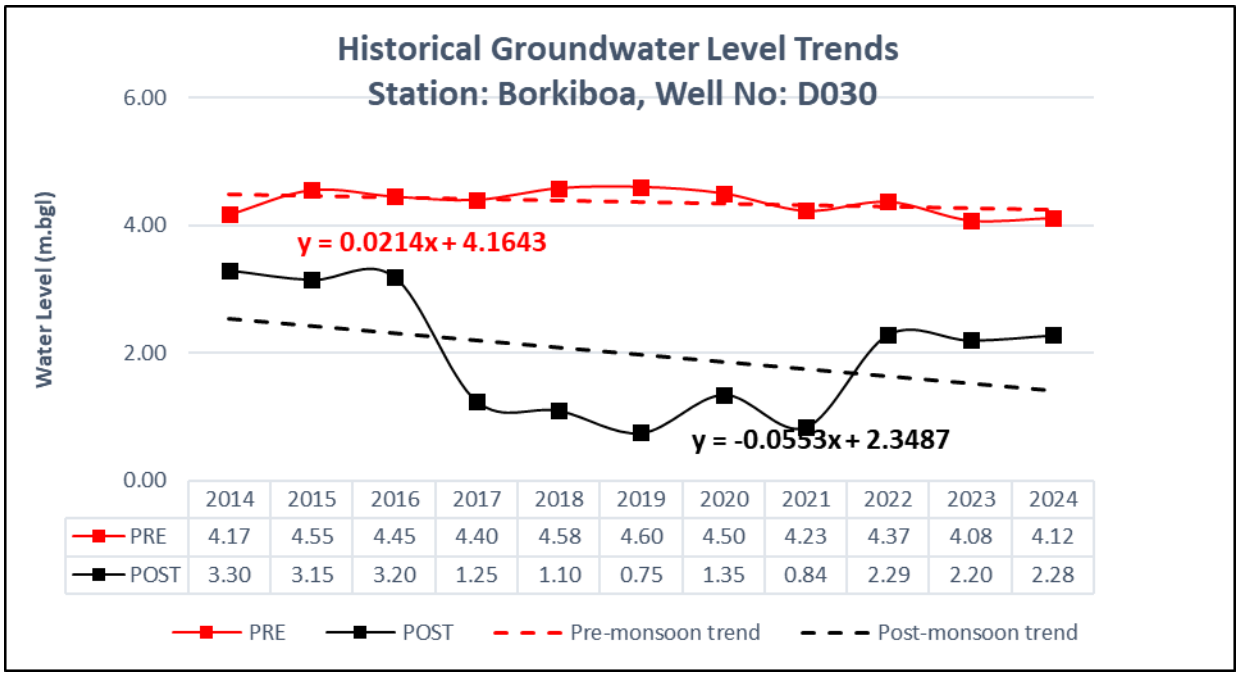




HYDROGRAPHS OF CLUSTER-VI



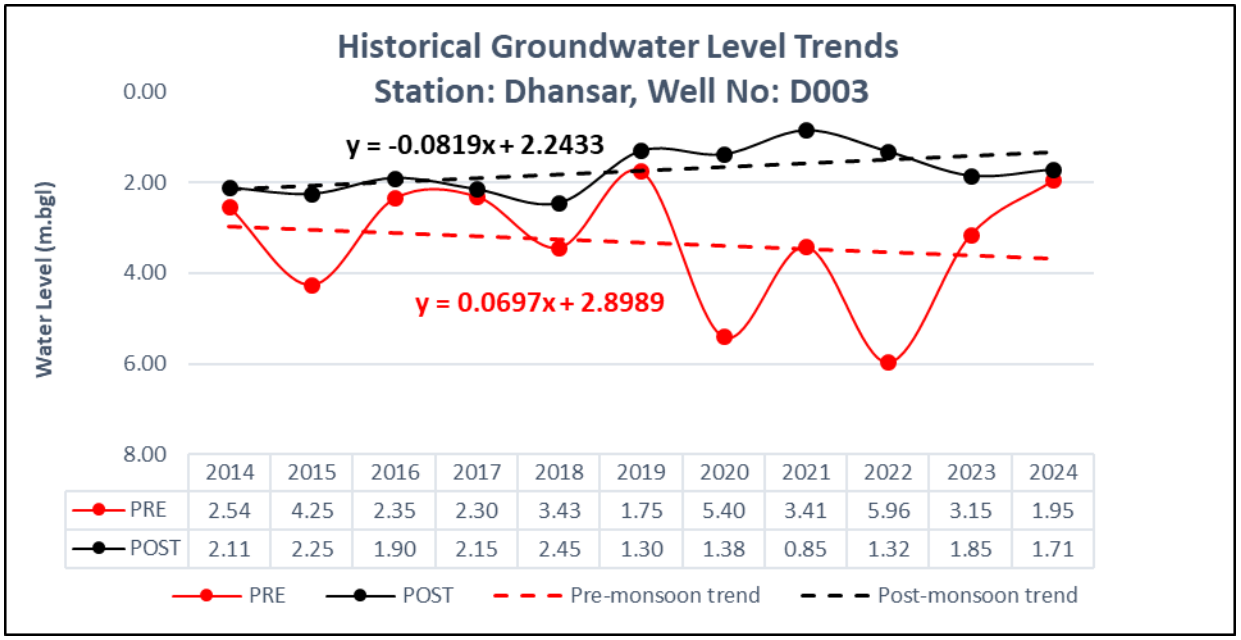
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	4.42	4.48	2.40	2.40	2.60	5.38	6.50	8.68	10.50	4.40	6.33
POST	2.90	2.45	1.90	1.20	2.40	3.90	3.38	3.80	4.70	3.40	3.47



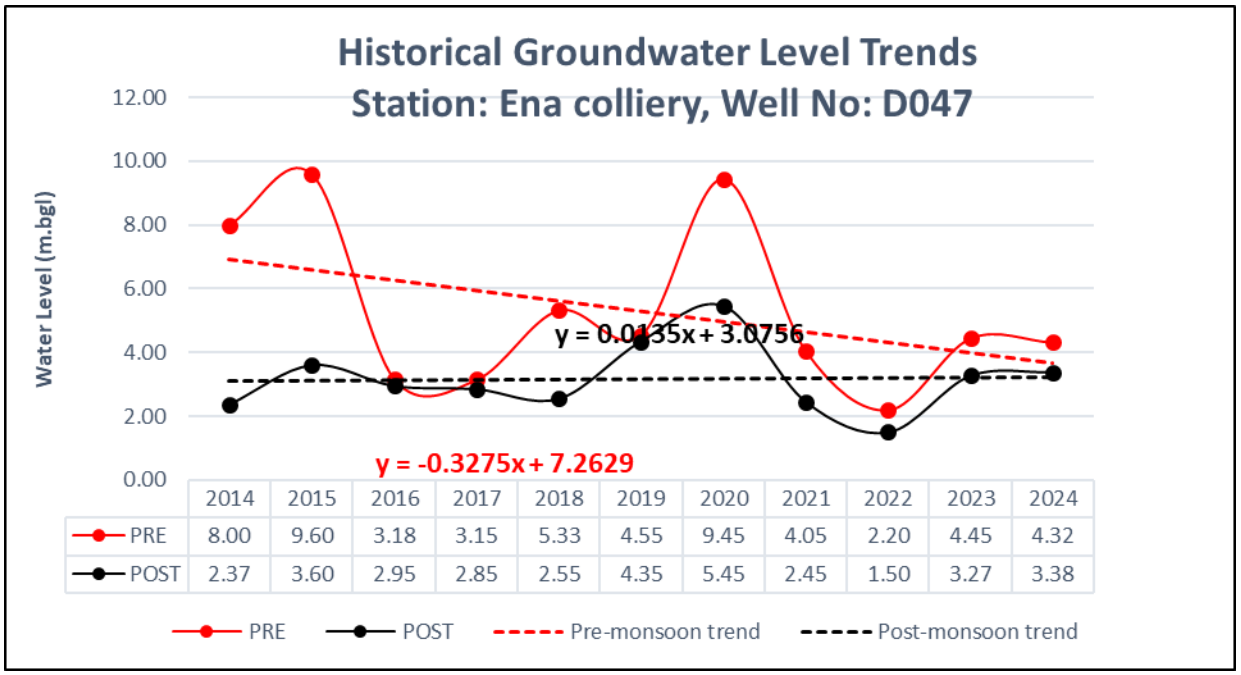
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	4.17	4.55	4.45	4.40	4.58	4.60	4.50	4.23	4.37	4.08	4.12
POST	3.30	3.15	3.20	1.25	1.10	0.75	1.35	0.84	2.29	2.20	2.28

Annexure – VI

HYDROGRAPHS OF CLUSTER-VII



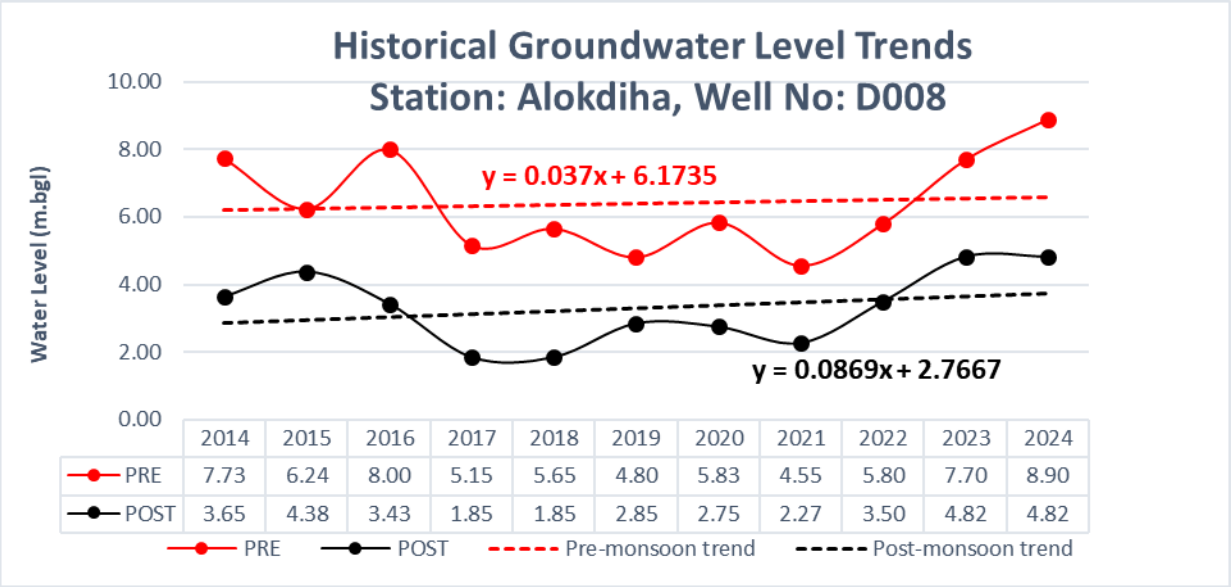
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	2.54	4.25	2.35	2.30	3.43	1.75	5.40	3.41	5.96	3.15	1.95
POST	2.11	2.25	1.90	2.15	2.45	1.30	1.38	0.85	1.32	1.85	1.71



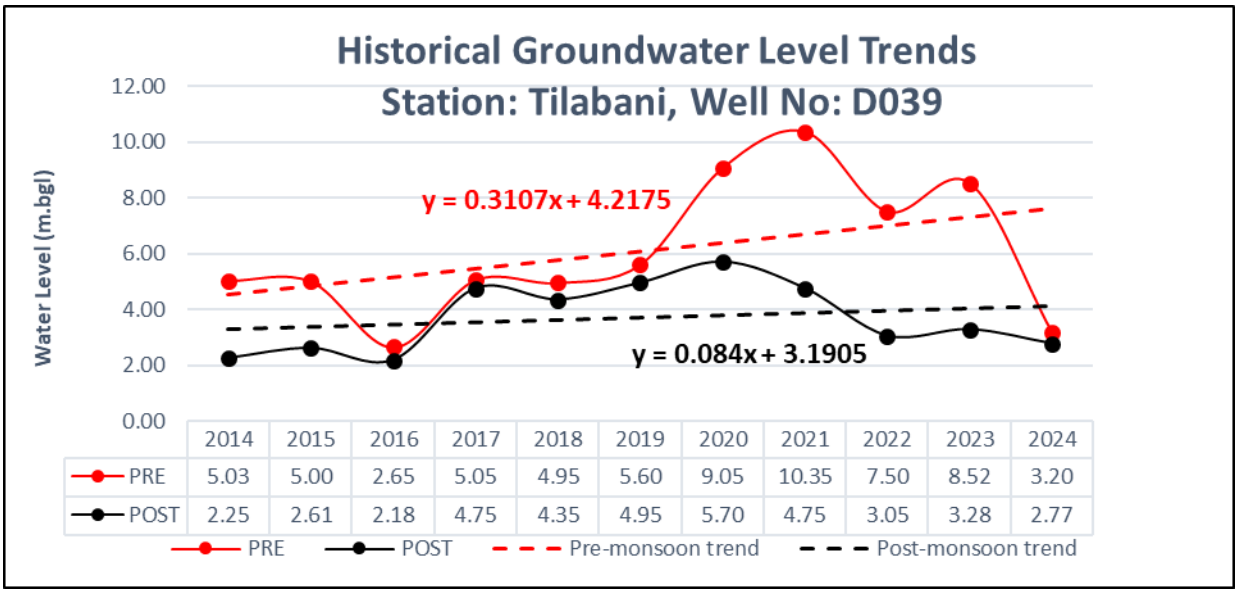
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	8.00	9.60	3.18	3.15	5.33	4.55	9.45	4.05	2.20	4.45	4.32
POST	2.37	3.60	2.95	2.85	2.55	4.35	5.45	2.45	1.50	3.27	3.38

Annexure – VI

HYDROGRAPHS OF CLUSTER-VIII



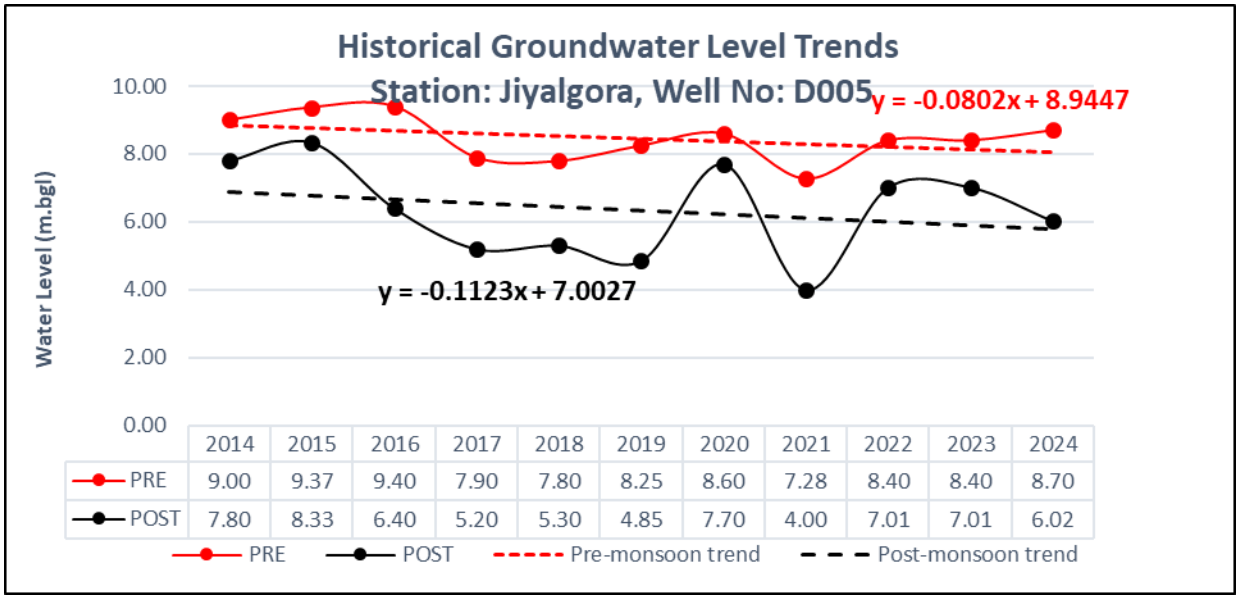
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	7.73	6.24	8.00	5.15	5.65	4.80	5.83	4.55	5.80	7.70	8.90
POST	3.65	4.38	3.43	1.85	1.85	2.85	2.75	2.27	3.50	4.82	4.82



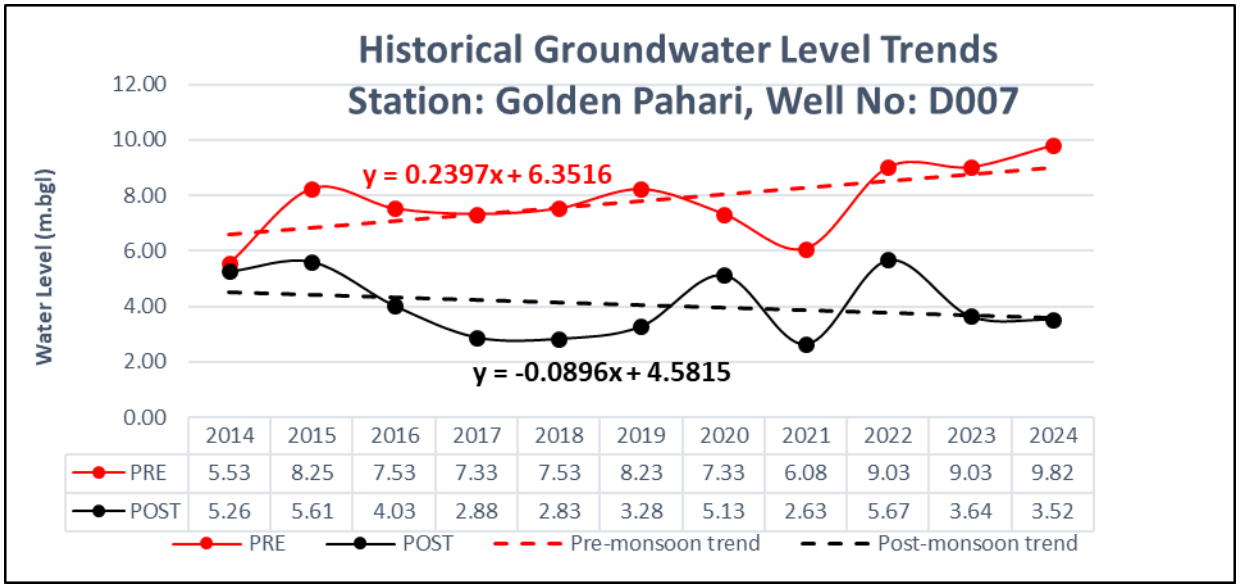
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	5.03	5.00	2.65	5.05	4.95	5.60	9.05	10.35	7.50	8.52	3.20
POST	2.25	2.61	2.18	4.75	4.35	4.95	5.70	4.75	3.05	3.28	2.77

Annexure – VI

HYDROGRAPHS OF CLUSTER-IX



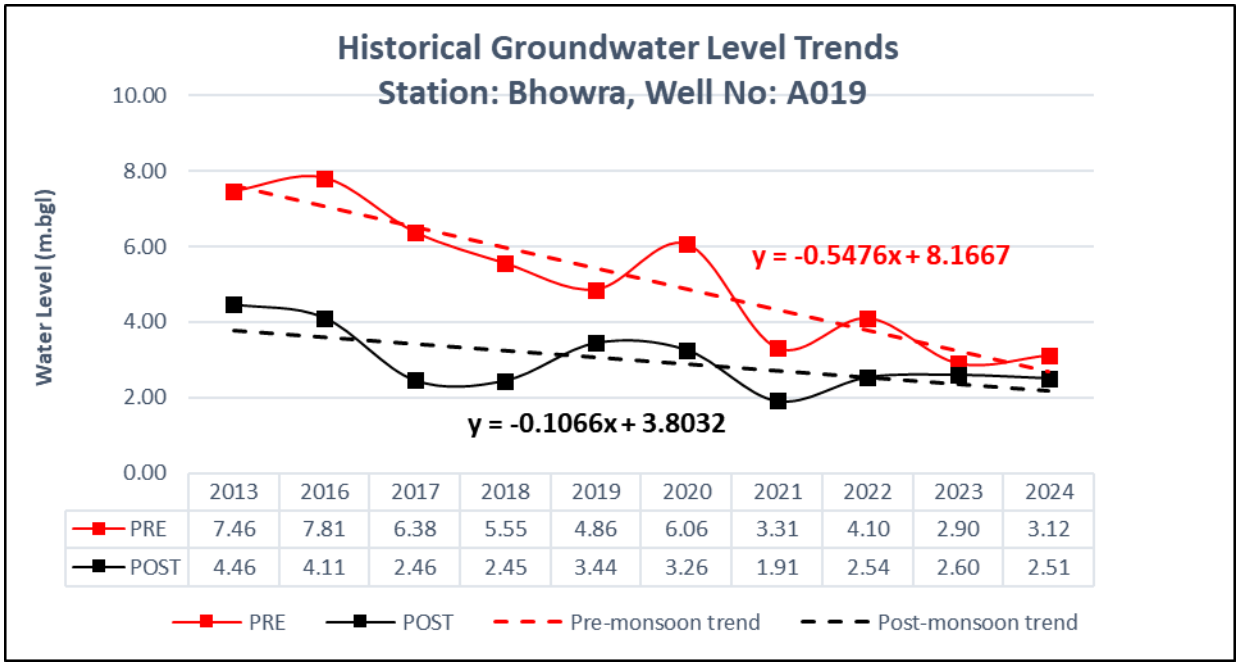
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	9.00	9.37	9.40	7.90	7.80	8.25	8.60	7.28	8.40	8.40	8.70
POST	7.80	8.33	6.40	5.20	5.30	4.85	7.70	4.00	7.01	7.01	6.02



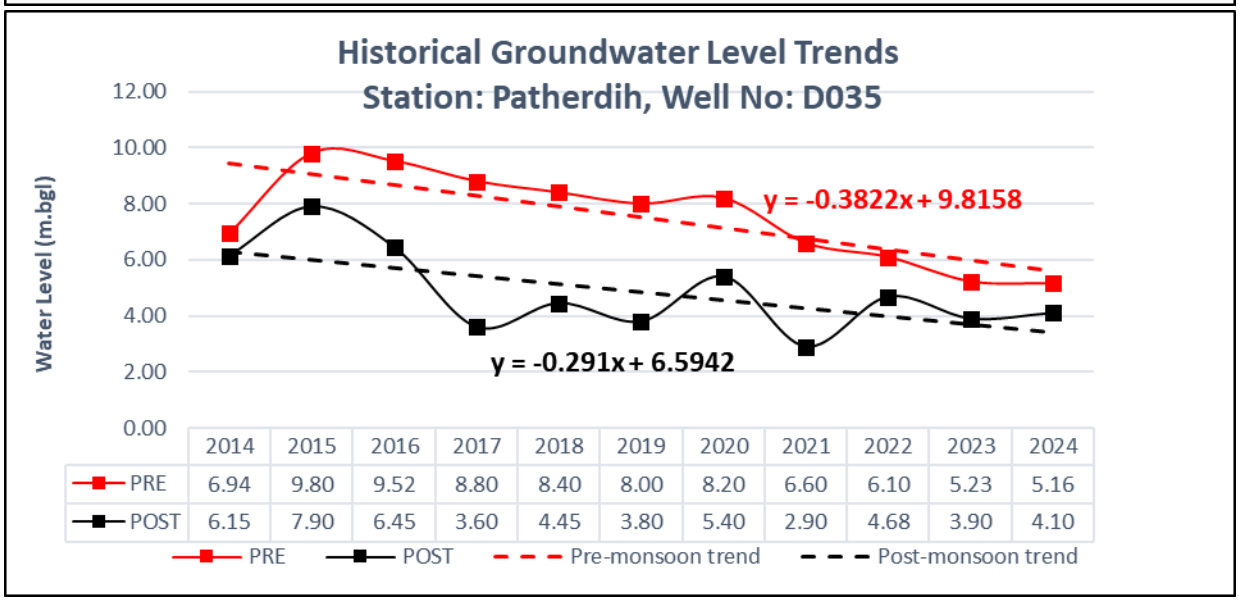
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	5.53	8.25	7.53	7.33	7.53	8.23	7.33	6.08	9.03	9.03	9.82
POST	5.26	5.61	4.03	2.88	2.83	3.28	5.13	2.63	5.67	3.64	3.52

Annexure – VI

HYDROGRAPHS OF CLUSTER-X



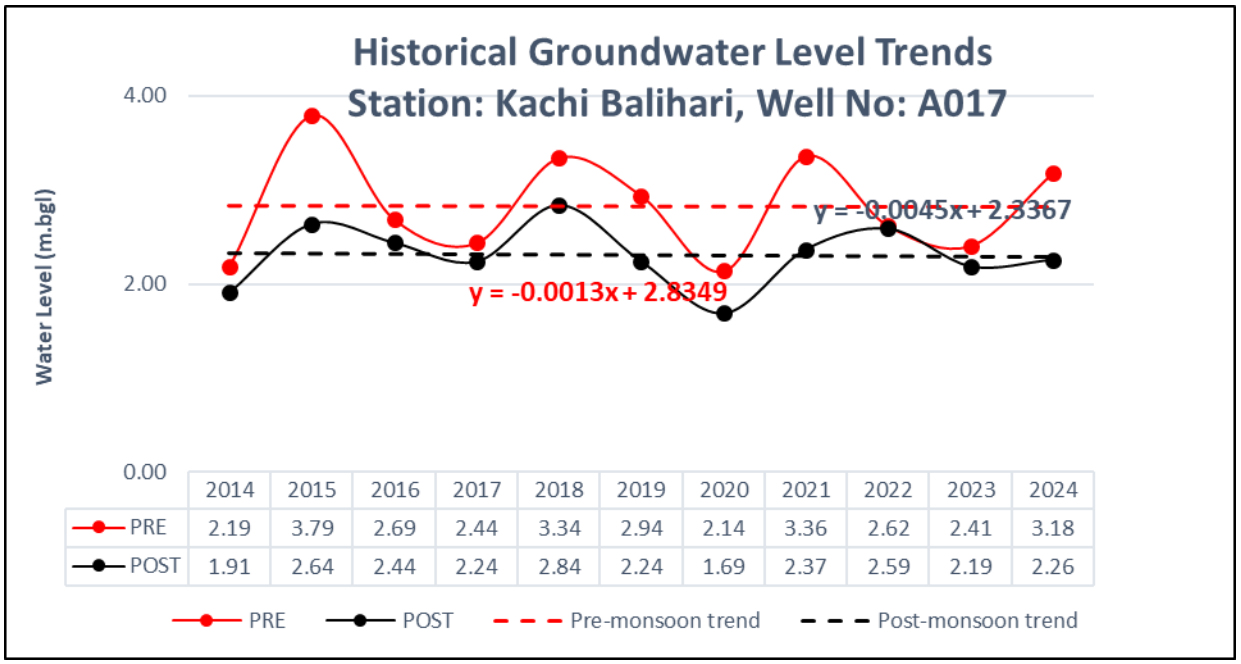
	2013	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	7.46	7.81	6.38	5.55	4.86	6.06	3.31	4.10	2.90	3.12
POST	4.46	4.11	2.46	2.45	3.44	3.26	1.91	2.54	2.60	2.51



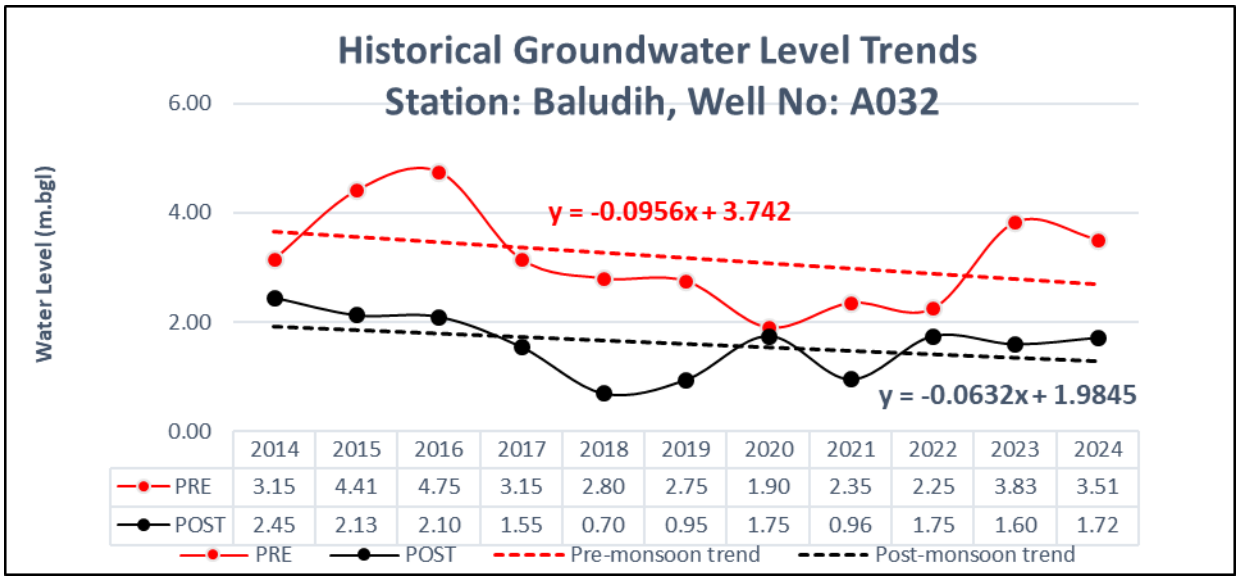
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	6.94	9.80	9.52	8.80	8.40	8.00	8.20	6.60	6.10	5.23	5.16
POST	6.15	7.90	6.45	3.60	4.45	3.80	5.40	2.90	4.68	3.90	4.10

Annexure – VI

HYDROGRAPHS OF CLUSTER-XI



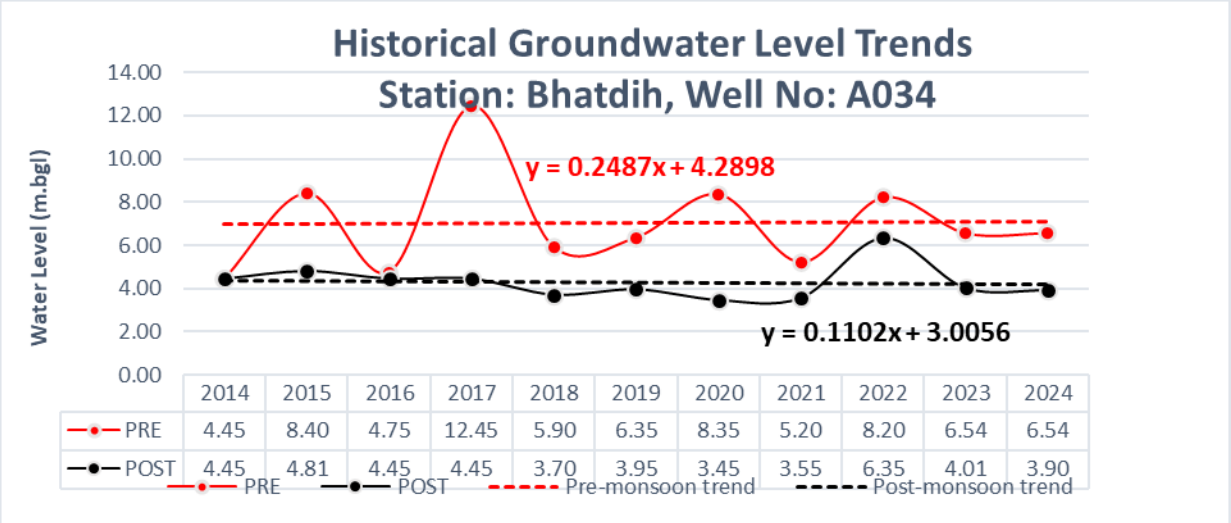
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	2.19	3.79	2.69	2.44	3.34	2.94	2.14	3.36	2.62	2.41	3.18
POST	1.91	2.64	2.44	2.24	2.84	2.24	1.69	2.37	2.59	2.19	2.26

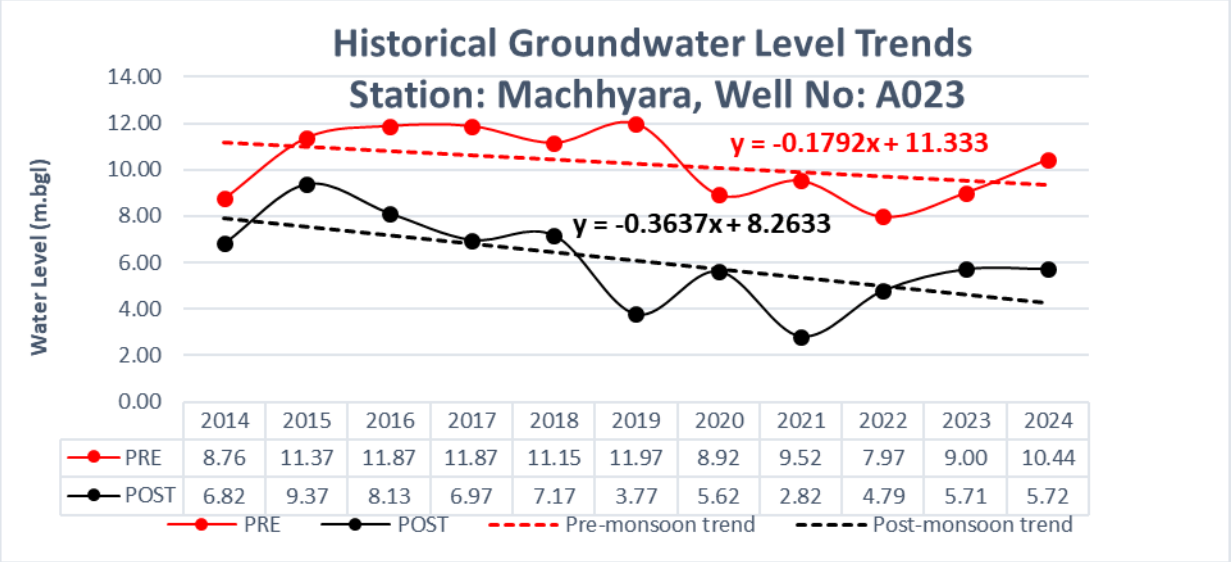


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	3.15	4.41	4.75	3.15	2.80	2.75	1.90	2.35	2.25	3.83	3.51
POST	2.45	2.13	2.10	1.55	0.70	0.95	1.75	0.96	1.75	1.60	1.72

Annexure – VI

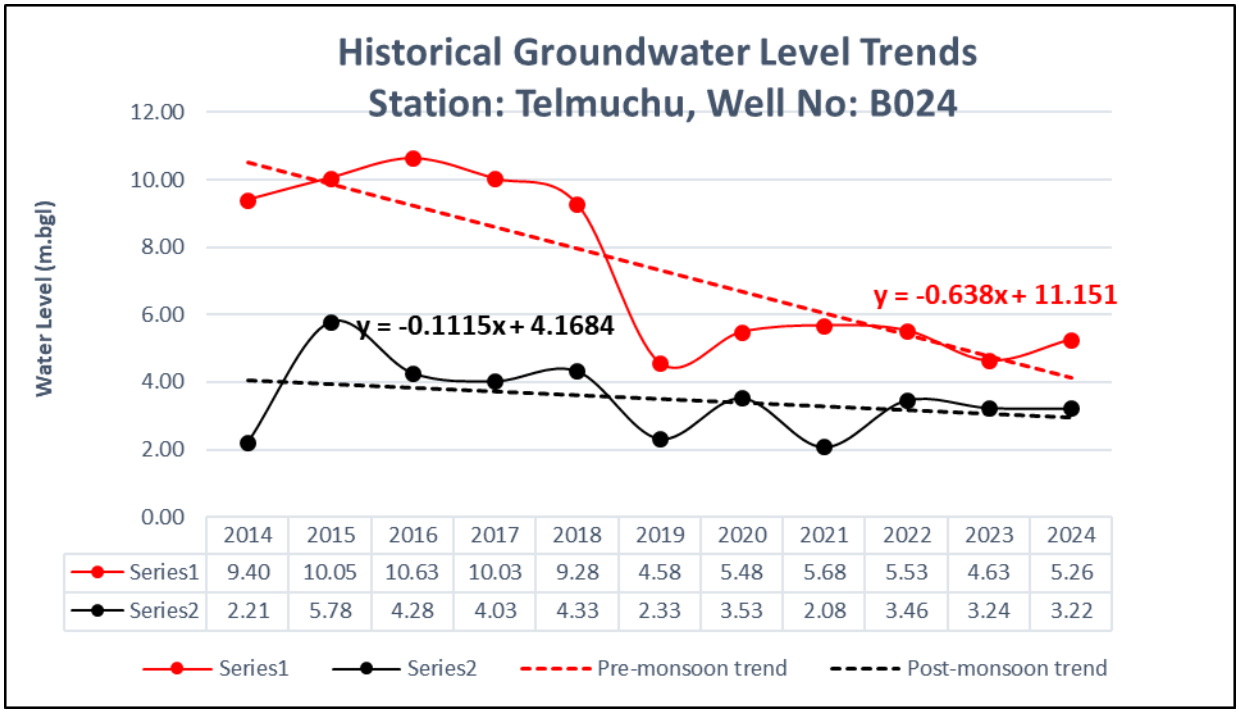
HYDROGRAPHS OF CLUSTER-XIII

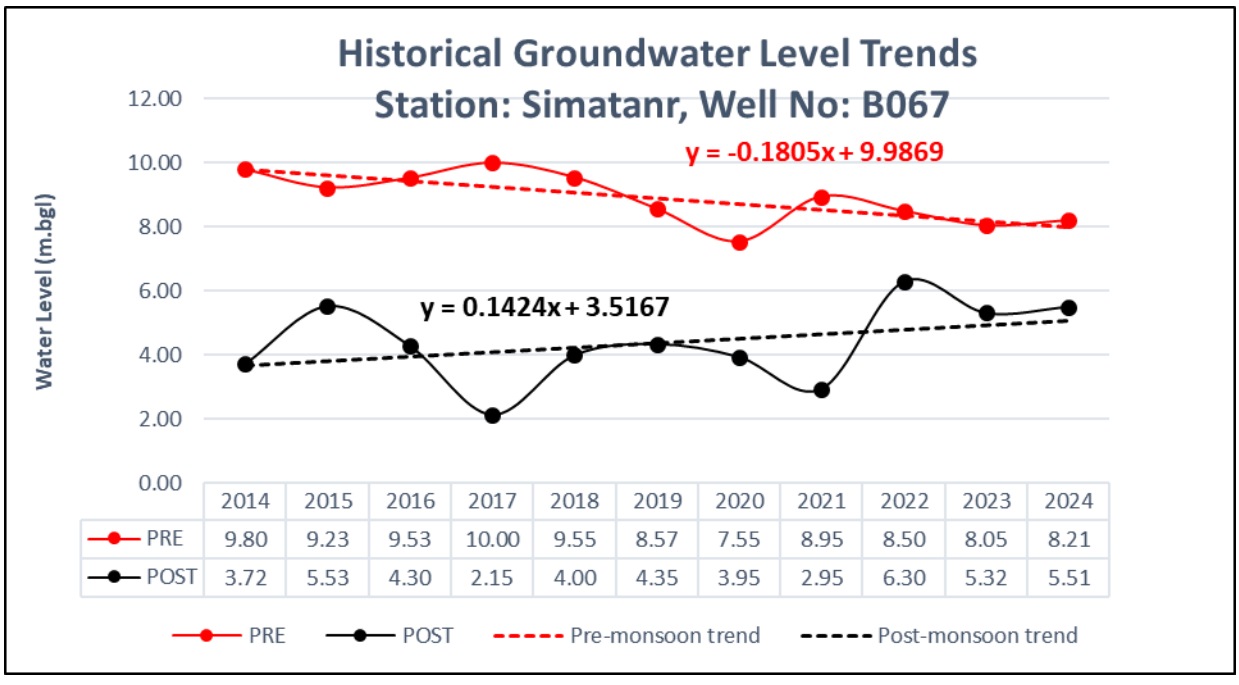




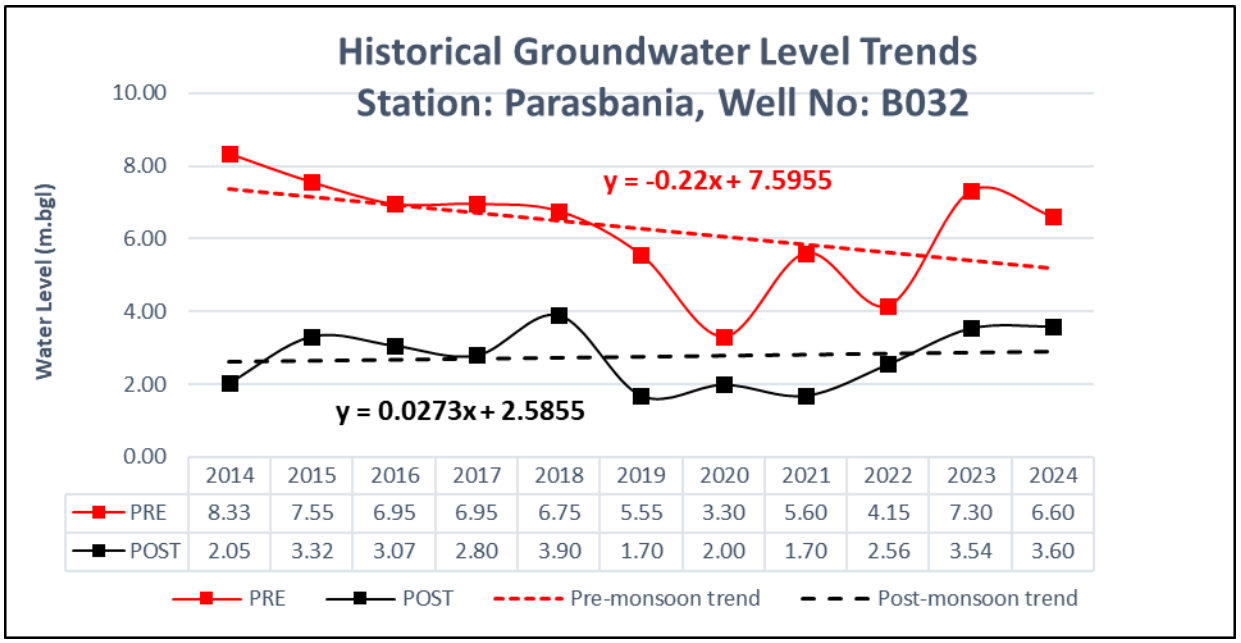
Annexure – VI

HYDROGRAPHS OF CLUSTER-XIV

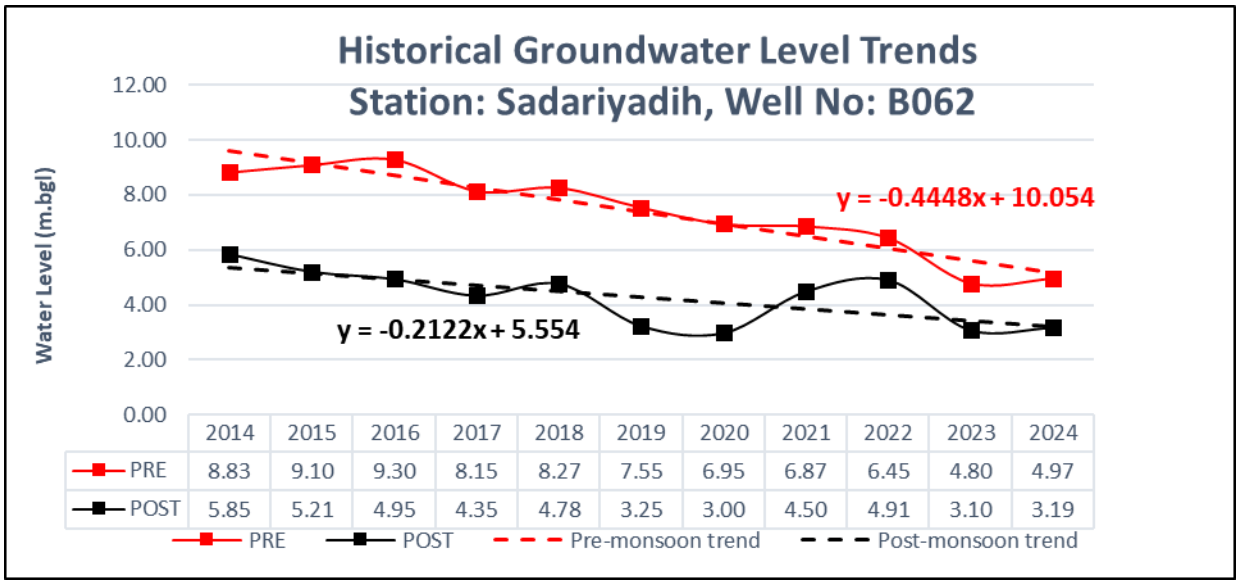




HYDROGRAPHS OF CLUSTER-XV



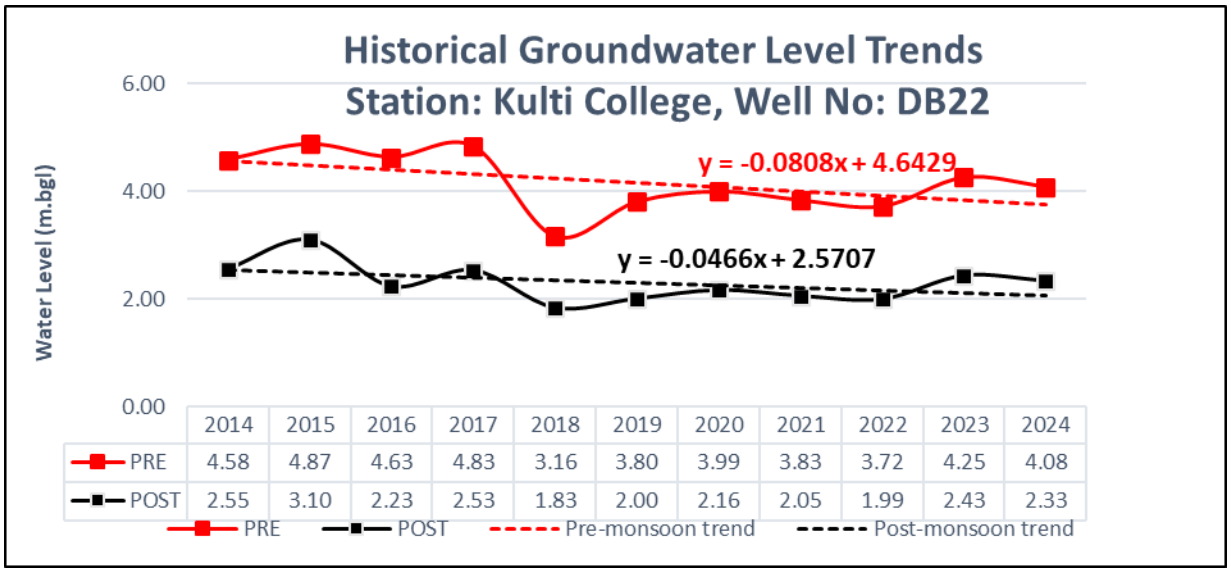
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	8.33	7.55	6.95	6.95	6.75	5.55	3.30	5.60	4.15	7.30	6.60
POST	2.05	3.32	3.07	2.80	3.90	1.70	2.00	1.70	2.56	3.54	3.60



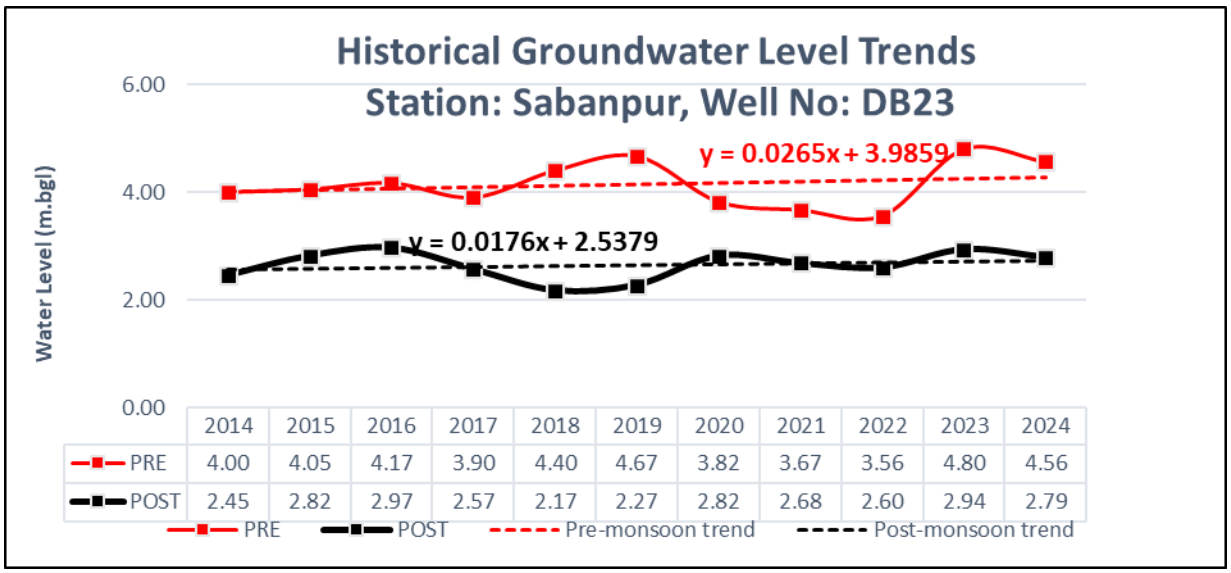
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	8.83	9.10	9.30	8.15	8.27	7.55	6.95	6.87	6.45	4.80	4.97
POST	5.85	5.21	4.95	4.35	4.78	3.25	3.00	4.50	4.91	3.10	3.19

Annexure – VI

HYDROGRAPHS OF CLUSTER-XVI

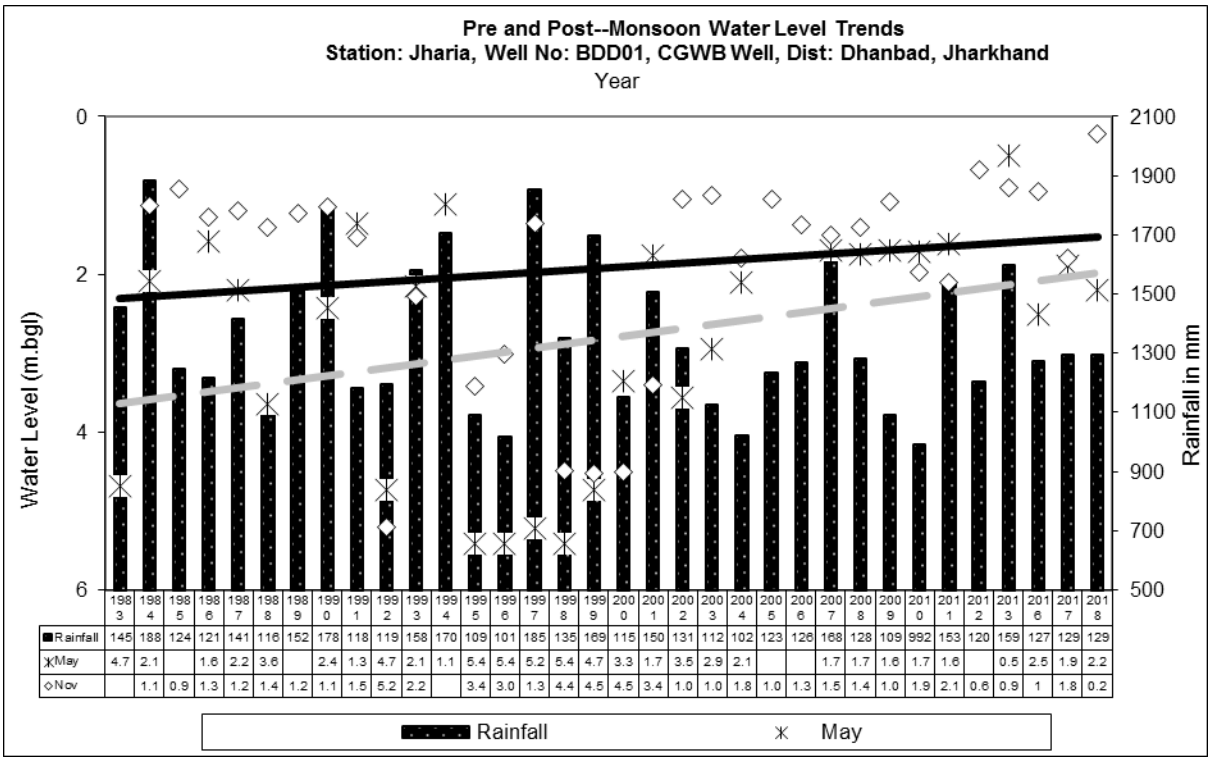


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	4.58	4.87	4.63	4.83	3.16	3.80	3.99	3.83	3.72	4.25	4.08
POST	2.55	3.10	2.23	2.53	1.83	2.00	2.16	2.05	1.99	2.43	2.33

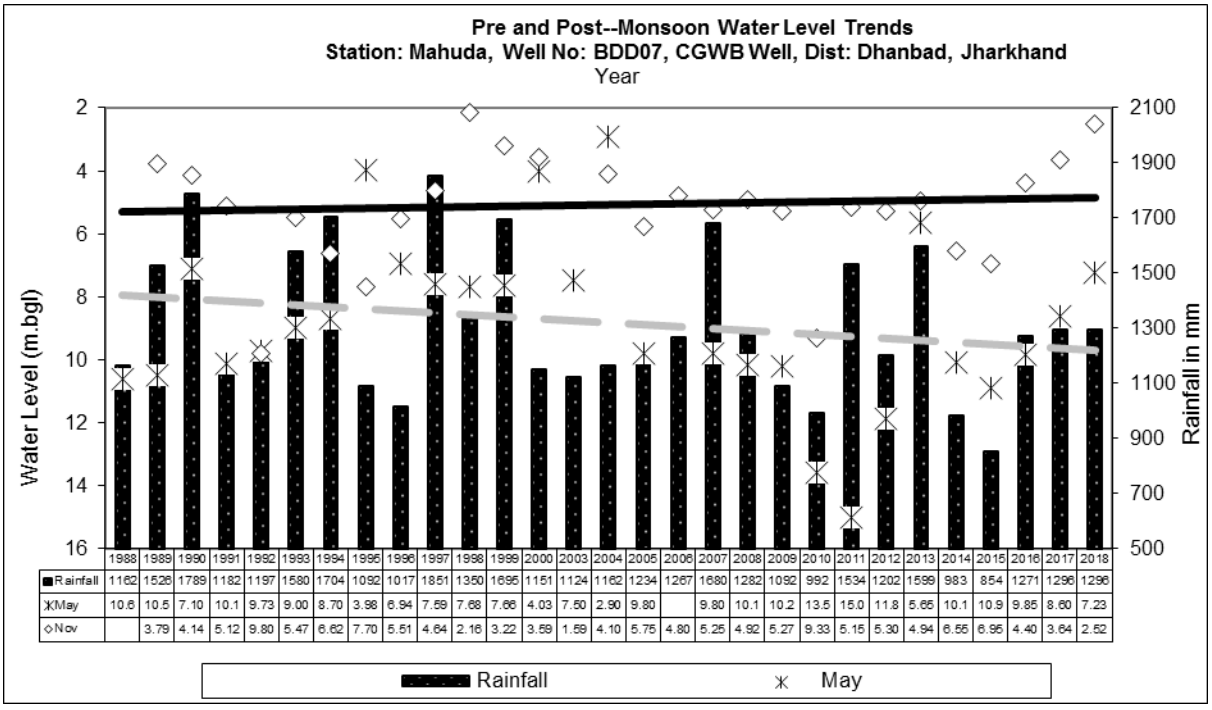


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PRE	4.00	4.05	4.17	3.90	4.40	4.67	3.82	3.67	3.56	4.80	4.56
POST	2.45	2.82	2.97	2.57	2.17	2.27	2.82	2.68	2.60	2.94	2.79

HYDROGRAPHS OF CGWB PERMANENT OBSERVATION STATIONS

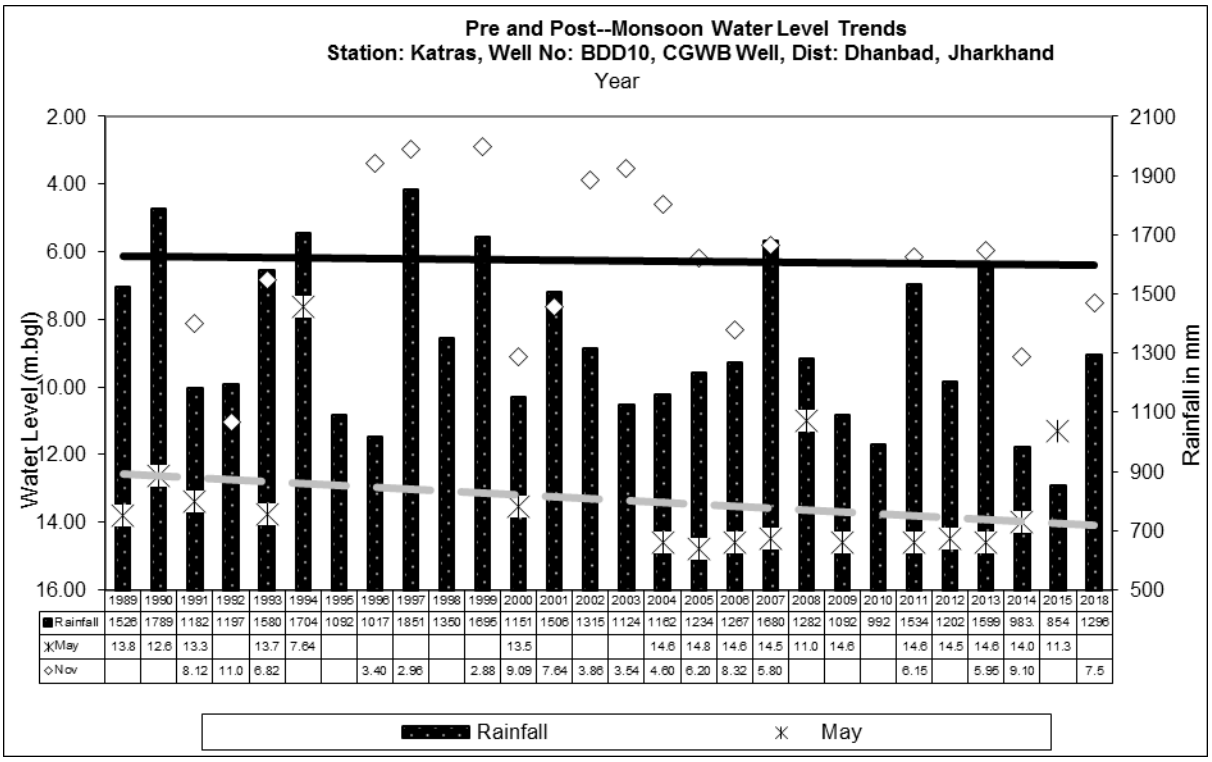


	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	145	188	124	121	141	116	152	178	118	119	158	170	109	101	185	135	169	115	150	131	112	102	123	126	168	128	109	992	153	120	159	127	129	129		
May	4.7	2.1		1.6	2.2	3.6		2.4	1.3	4.7	2.1	1.1	5.4	5.4	5.2	5.4	4.7	3.3	1.7	3.5	2.9	2.1			1.7	1.7	1.6	1.7	1.6		0.5	2.5	1.9	2.2		
Nov		1.1	0.9	1.3	1.2	1.4	1.2	1.1	1.5	5.2	2.2		3.4	3.0	1.3	4.4	4.5	4.5	3.4	1.0	1.0	1.8	1.0	1.3	1.5	1.4	1.0	1.9	2.1	0.6	0.9	1	1.8	0.2		

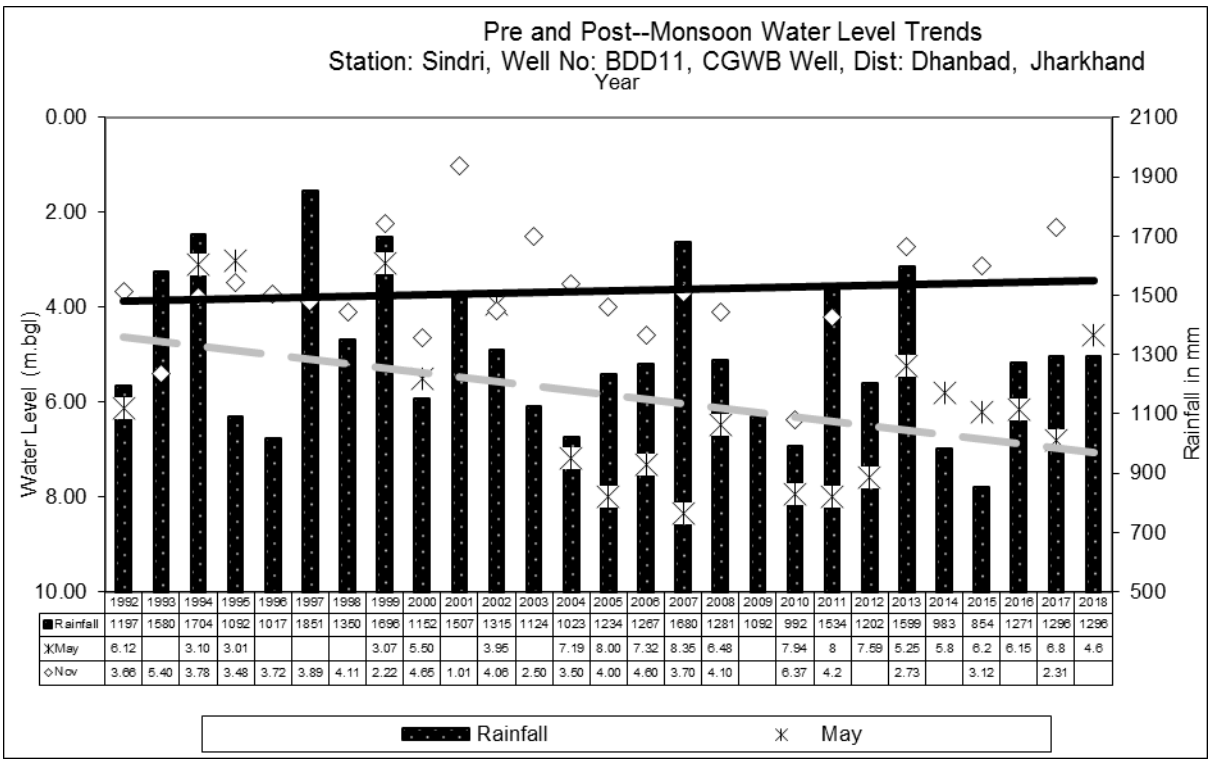


	1988	1989	1990	1991	1992	1993	1994	1996	1996	1997	1998	1999	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1162	1526	1789	1182	1197	1580	1704	1092	1017	1851	1350	1695	1151	1124	1162	1234	1267	1680	1282	1092	992	1534	1202	1599	983	854	1271	1296	1296
May	10.6	10.5	7.10	10.1	9.73	9.00	8.70	3.98	6.94	7.59	7.68	7.66	4.03	7.50	2.90	9.80		9.80	10.1	10.2	13.5	15.0	11.8	5.65	10.1	10.9	9.85	8.60	7.23
Nov		3.79	4.14	5.12	9.80	5.47	6.62	7.70	5.51	4.64	2.16	3.22	3.59	1.59	4.10	5.75	4.80	5.25	4.92	5.27	9.33	5.15	5.30	4.94	6.55	6.95	4.40	3.64	2.52

HYDROGRAPHS OF CGWB PERMANENT OBSERVATION STATIONS

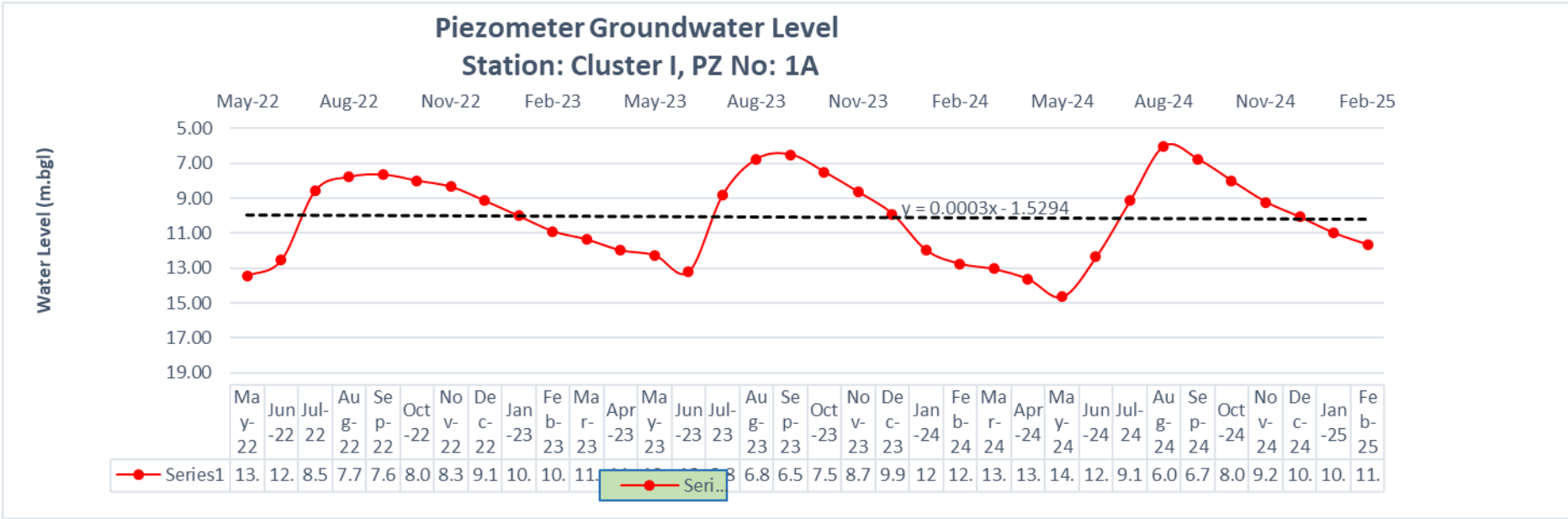


	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2018
Rainfall	1526	1789	1182	1197	1580	1704	1092	1017	1851	1350	1695	1151	1506	1315	1124	1162	1234	1267	1680	1282	1092	992	1534	1202	1599	983.	854	1296
May	13.8	12.6	13.3		13.7	7.64						13.5				14.6	14.8	14.6	14.5	11.0	14.6		14.6	14.5	14.6	14.0	11.3	
Nov			8.12	11.0	6.82			3.40	2.96		2.88	9.09	7.64	3.86	3.54	4.60	6.20	8.32	5.80				6.15		5.95	9.10		7.5



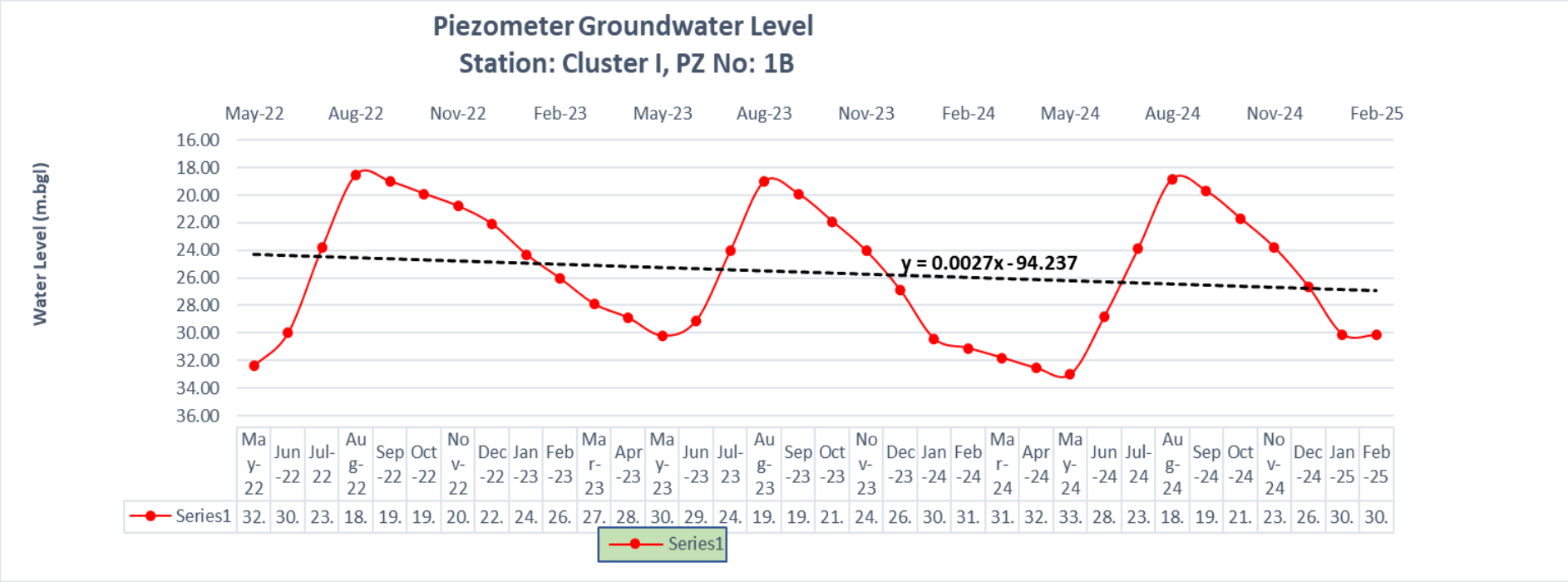
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1197	1580	1704	1092	1017	1851	1350	1696	1152	1507	1315	1124	1023	1234	1267	1680	1281	1092	992	1534	1202	1599	983	854	1271	1296	1296
May	6.12		3.10	3.01				3.07	5.50		3.95		7.19	8.00	7.32	8.35	6.48		7.94	8	7.59	5.25	5.8	6.2	6.15	6.8	4.6
Nov	3.66	5.40	3.78	3.48	3.72	3.89	4.11	2.22	4.65	1.01	4.06	2.50	3.50	4.00	4.60	3.70	4.10		6.37	4.2		2.73		3.12		2.31	

PIEZOMETER HYDROGRAPHS

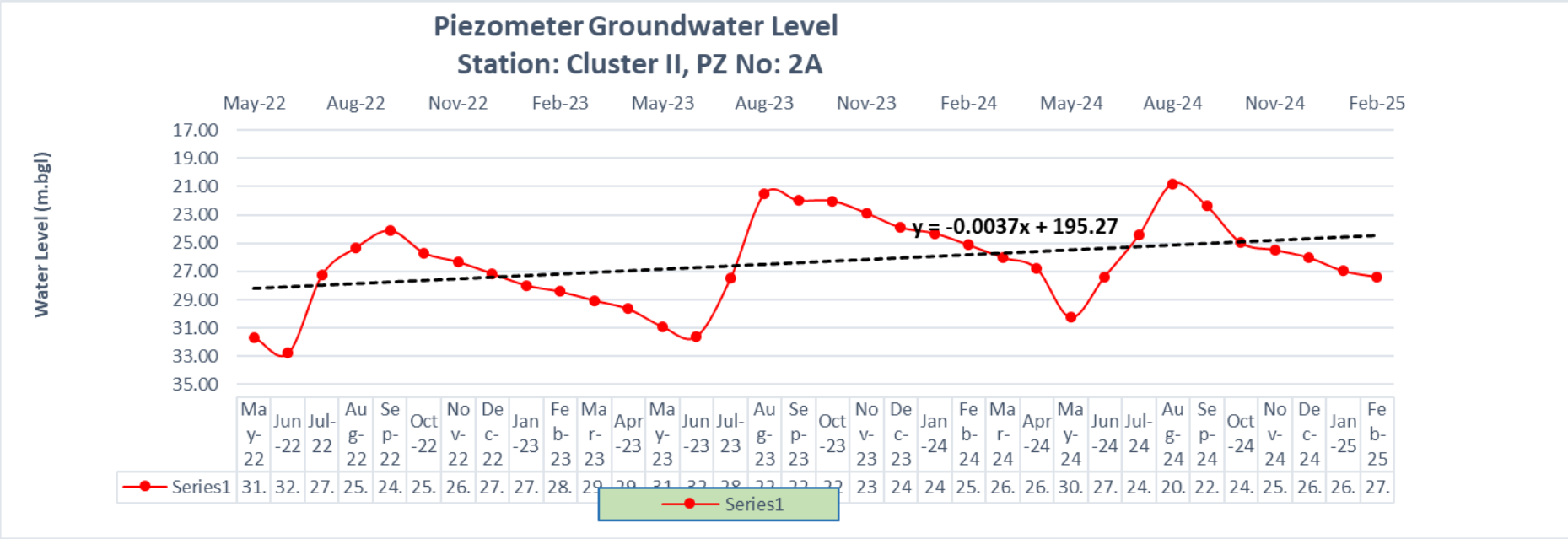


Annexure – VIA

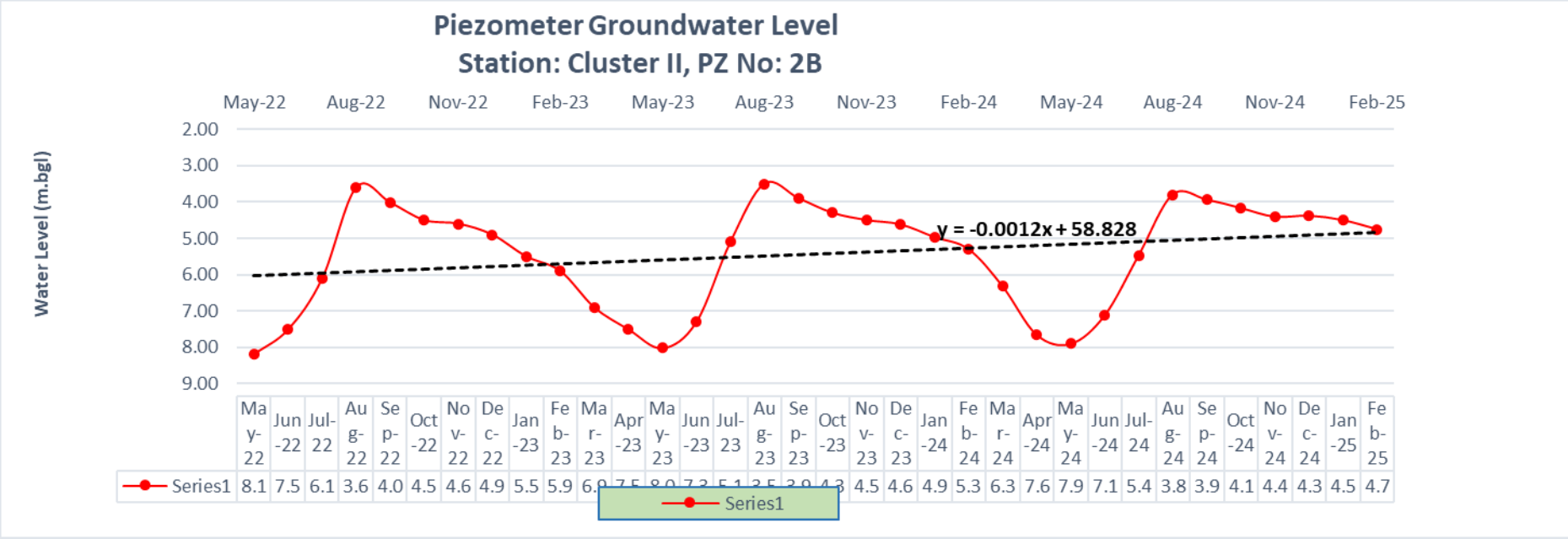
PIEZOMETER HYDROGRAPHS



PIEZOMETER HYDROGRAPHS

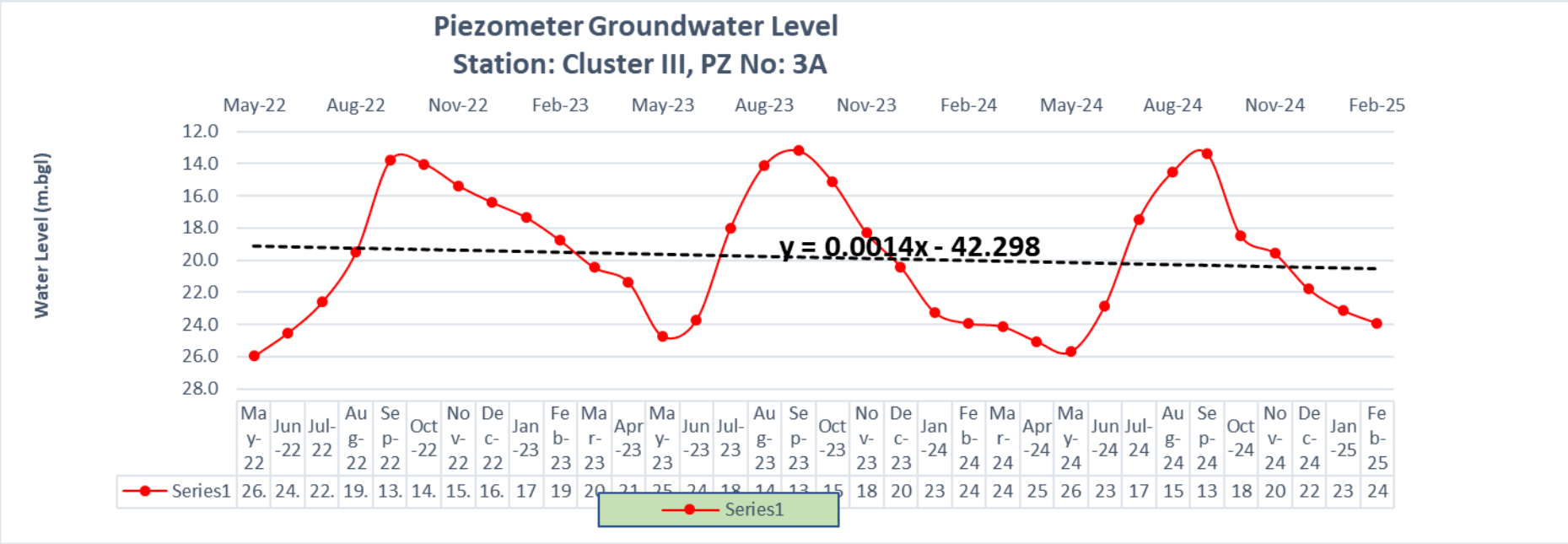


PIEZOMETER HYDROGRAPHS



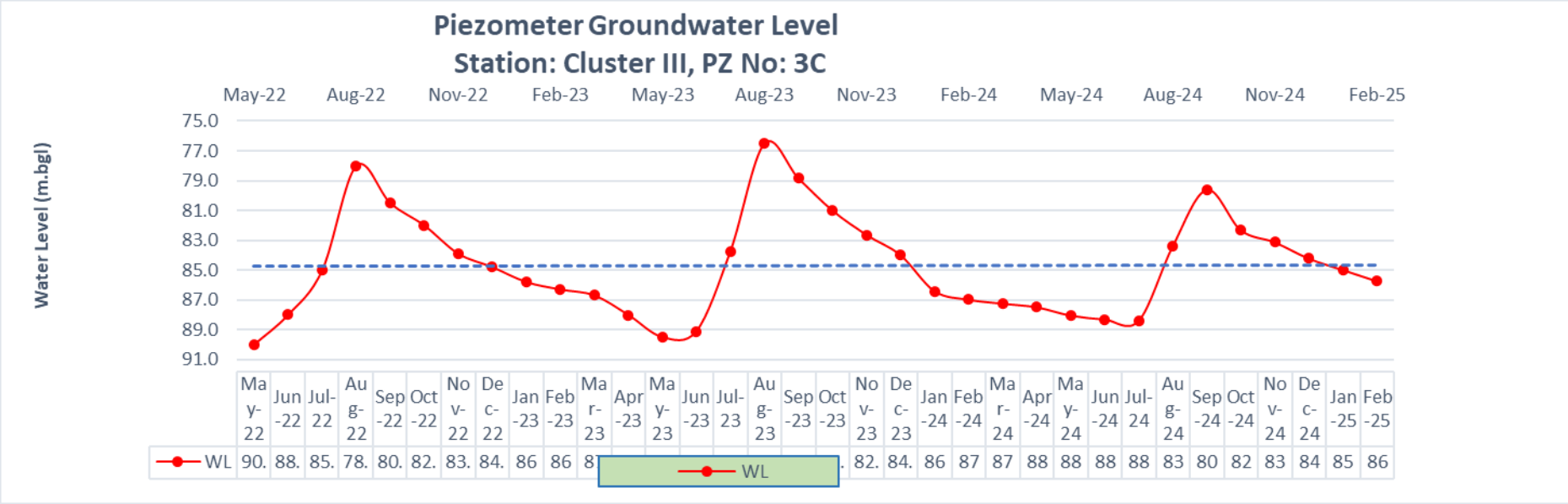
Annexure – VIA

PIEZOMETER HYDROGRAPHS

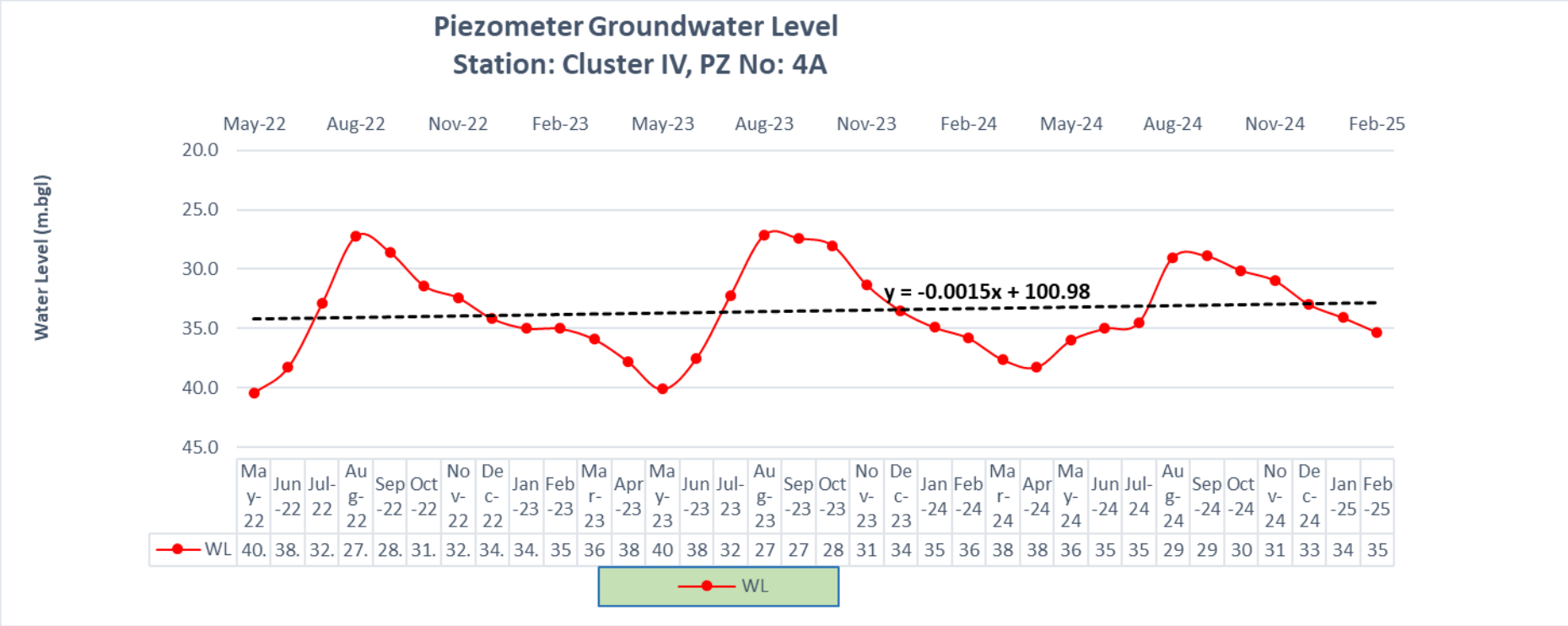


Annexure – VIA

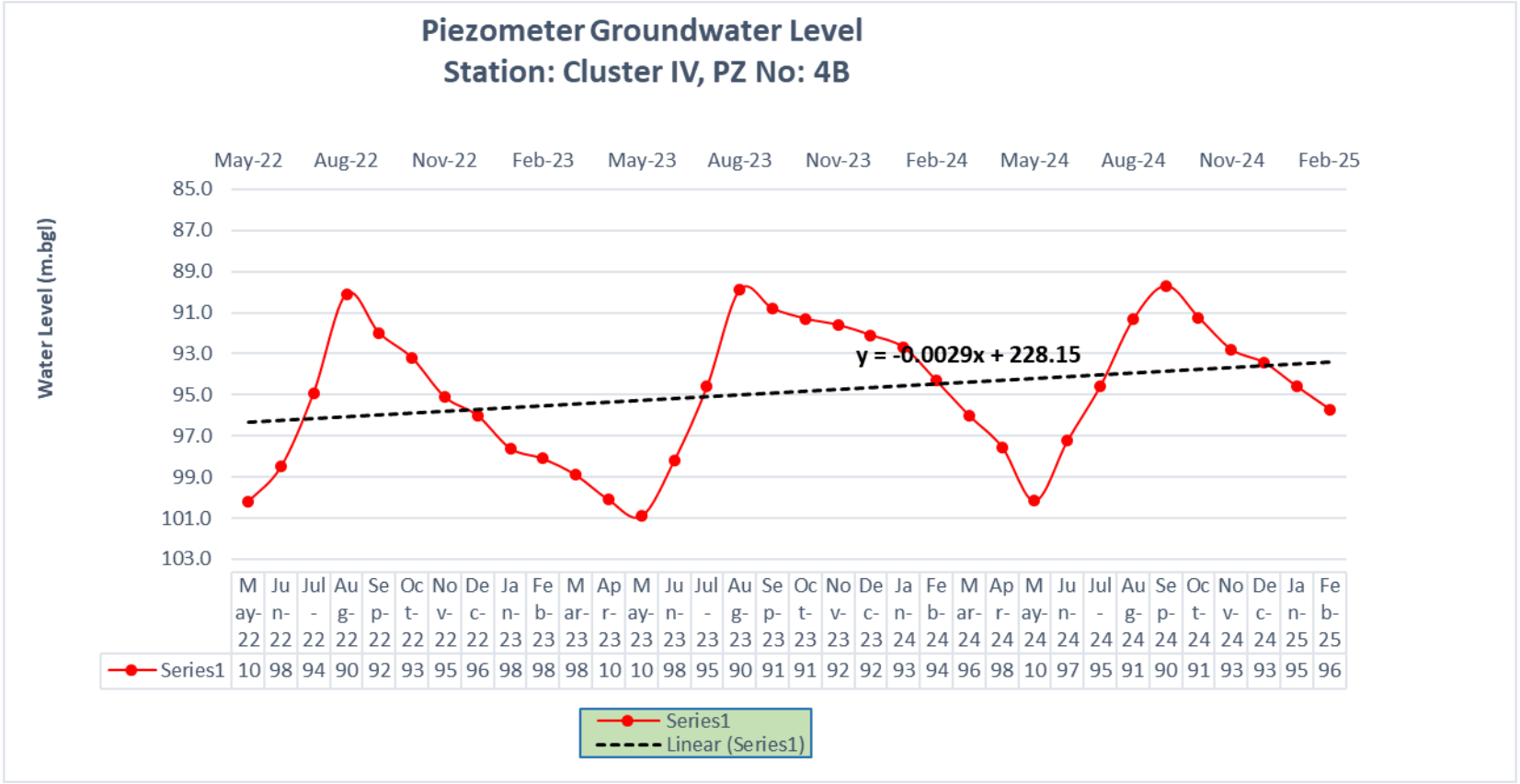
PIEZOMETER HYDROGRAPHS



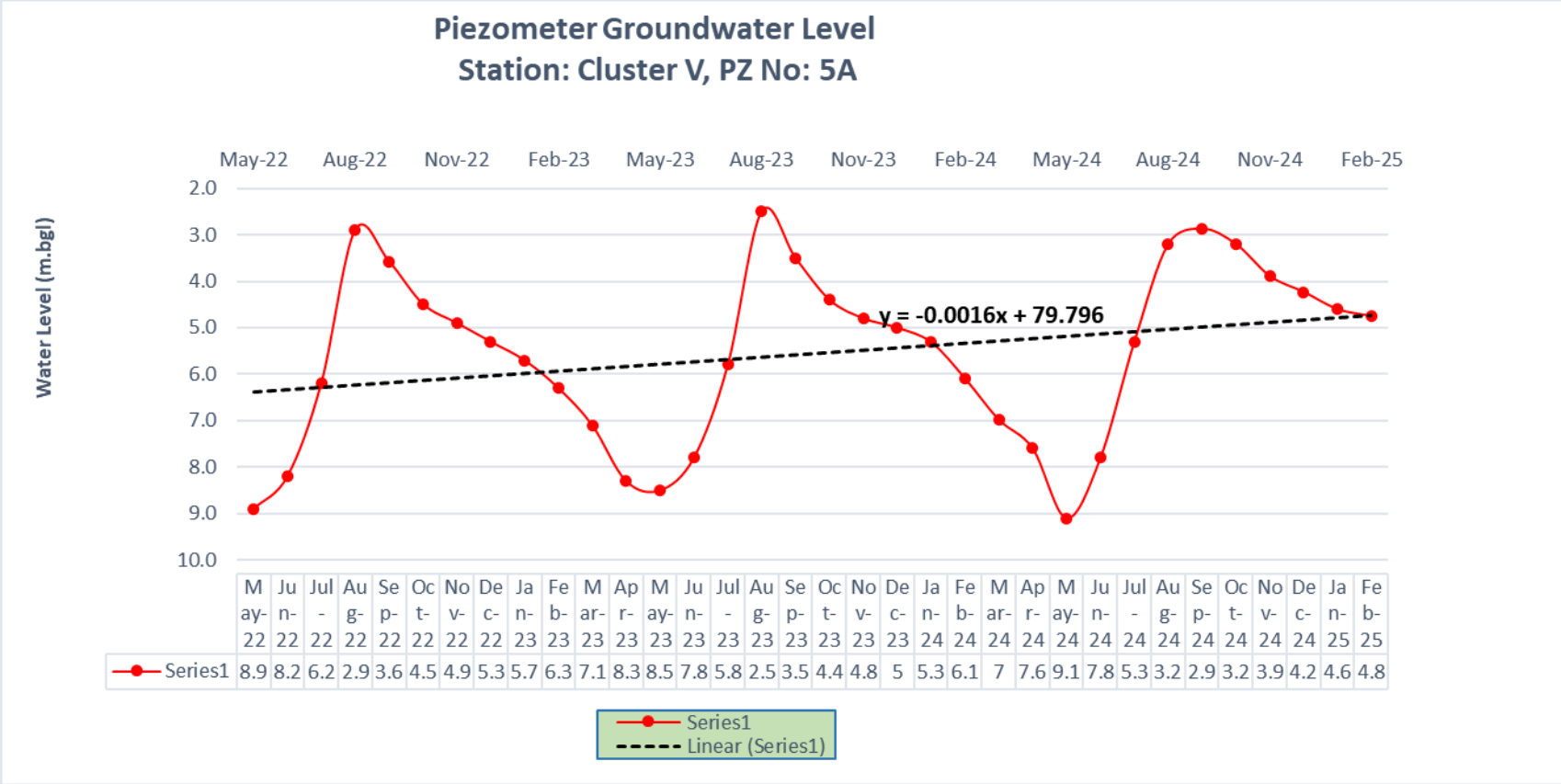
PIEZOMETER HYDROGRAPHS



PIEZOMETER HYDROGRAPHS



PIEZOMETER HYDROGRAPHS



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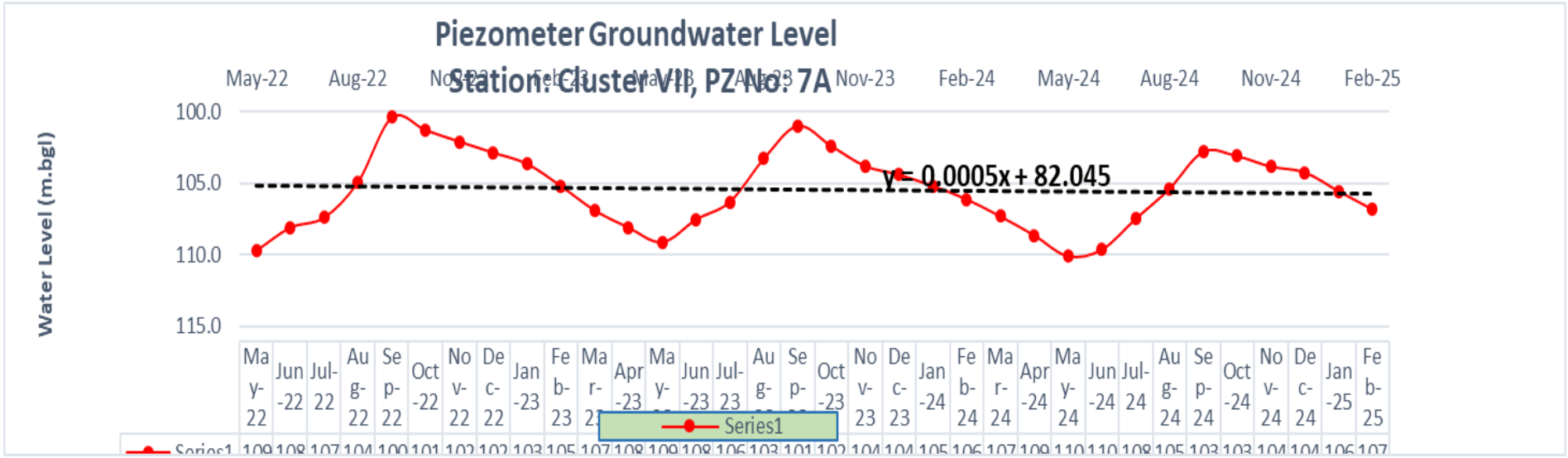

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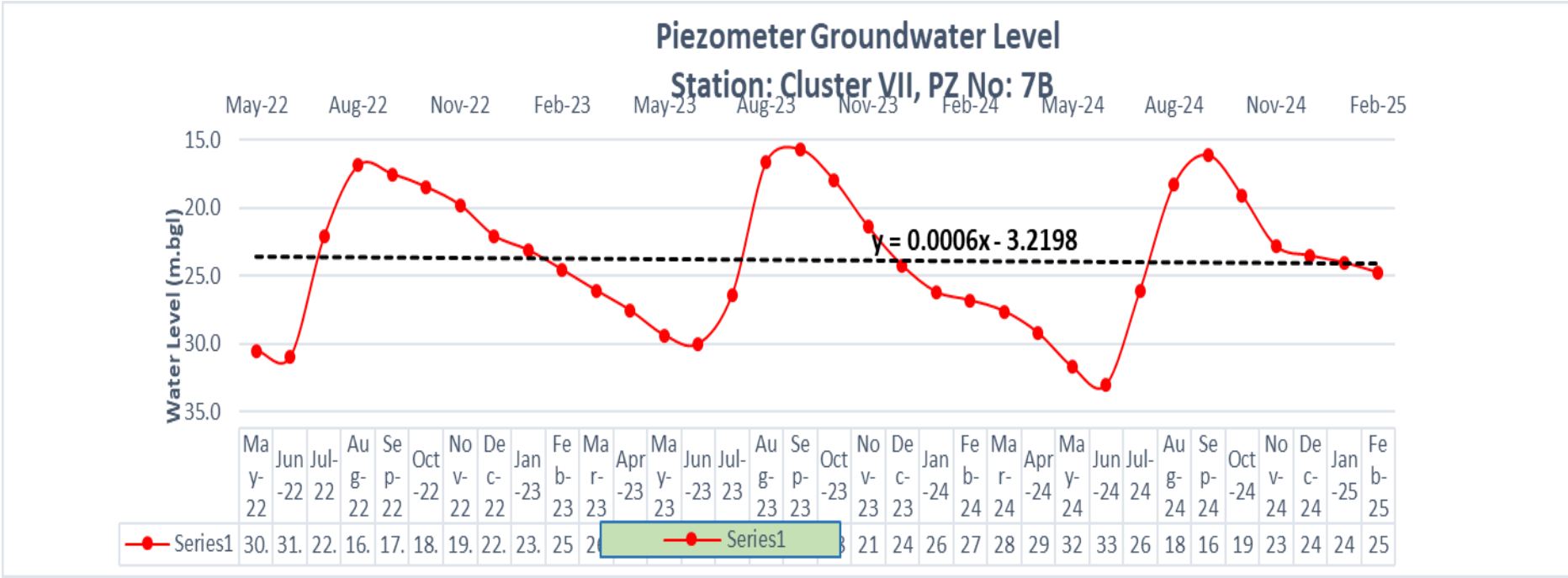

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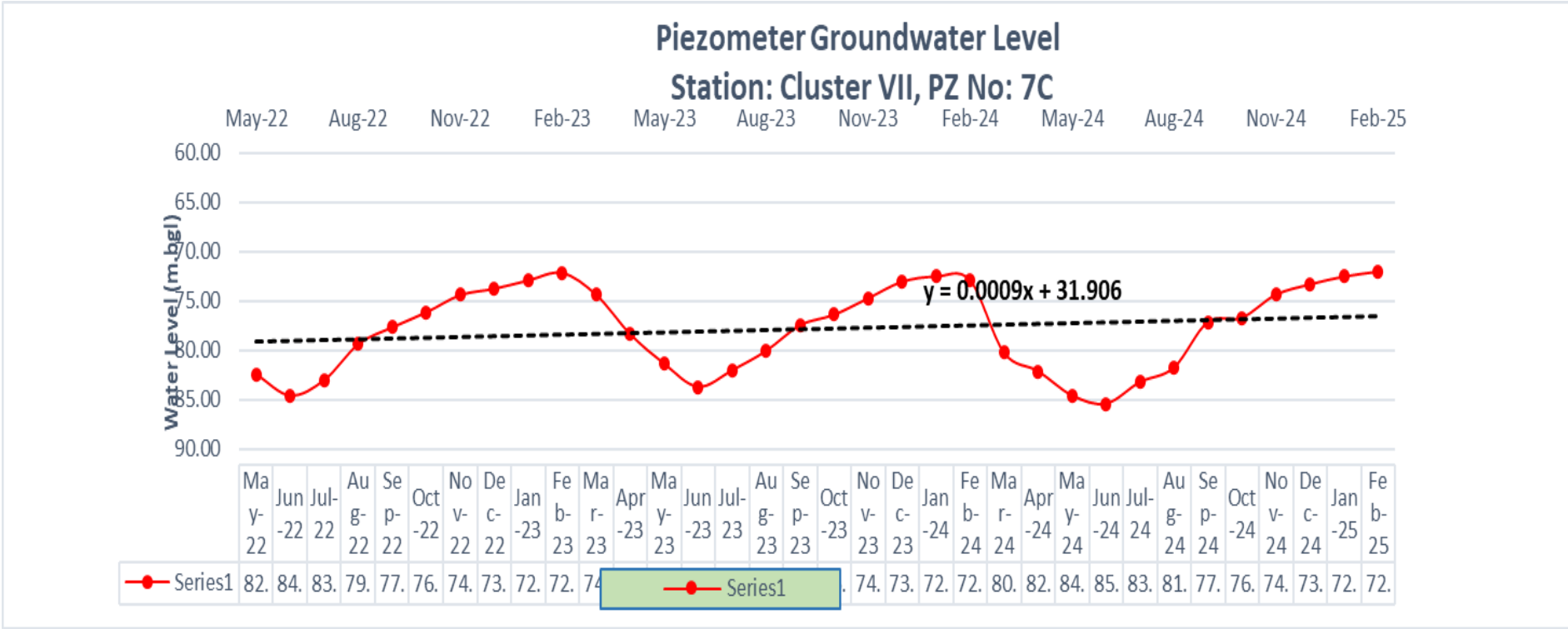
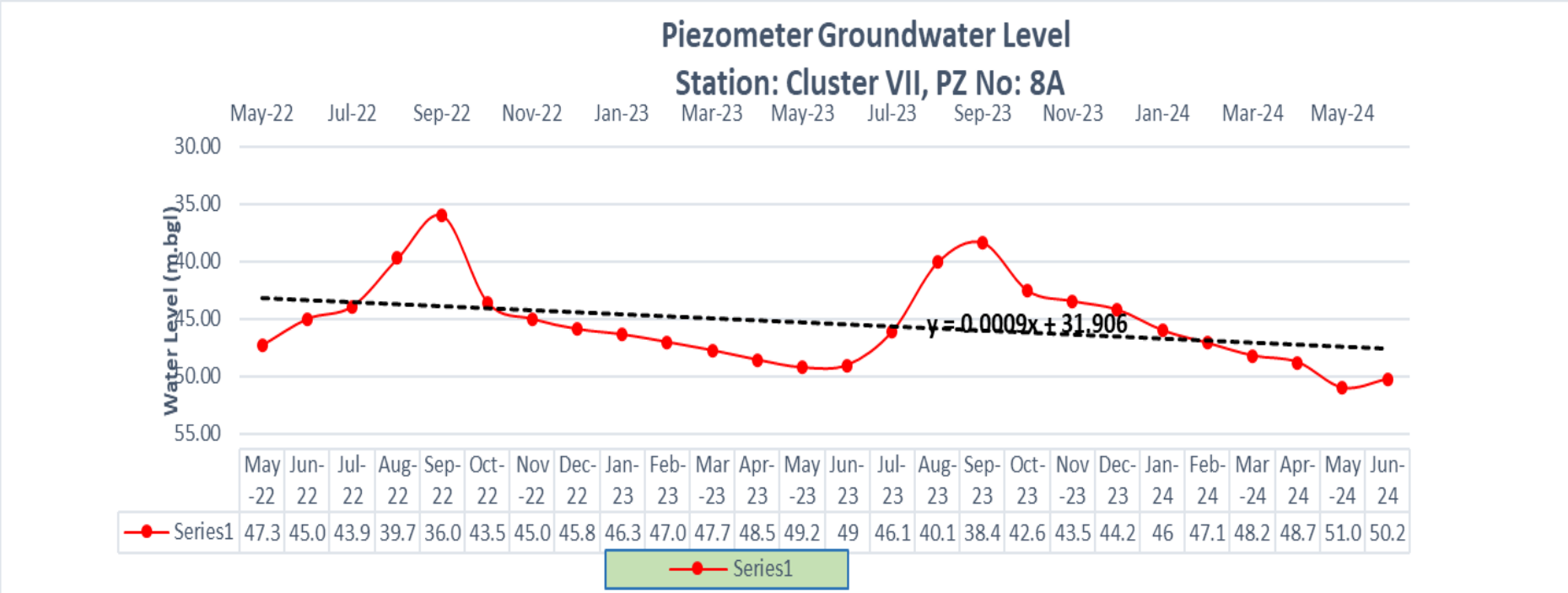


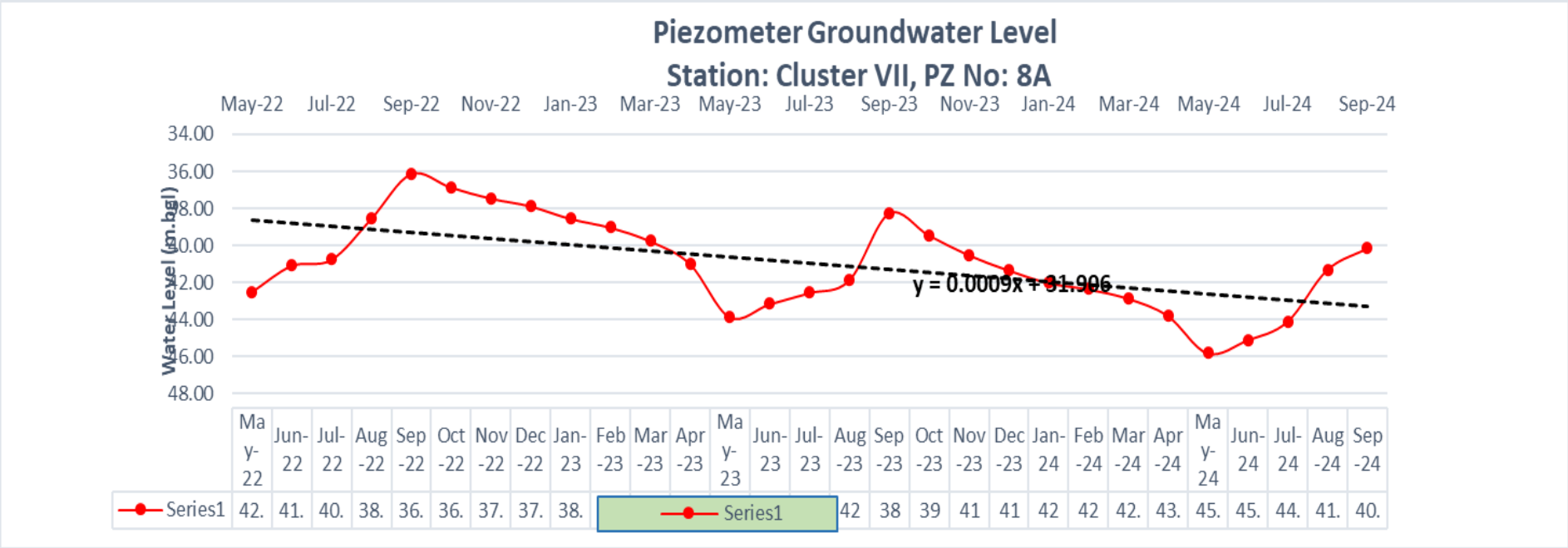
PIEZOMETER HYDROGRAPHS



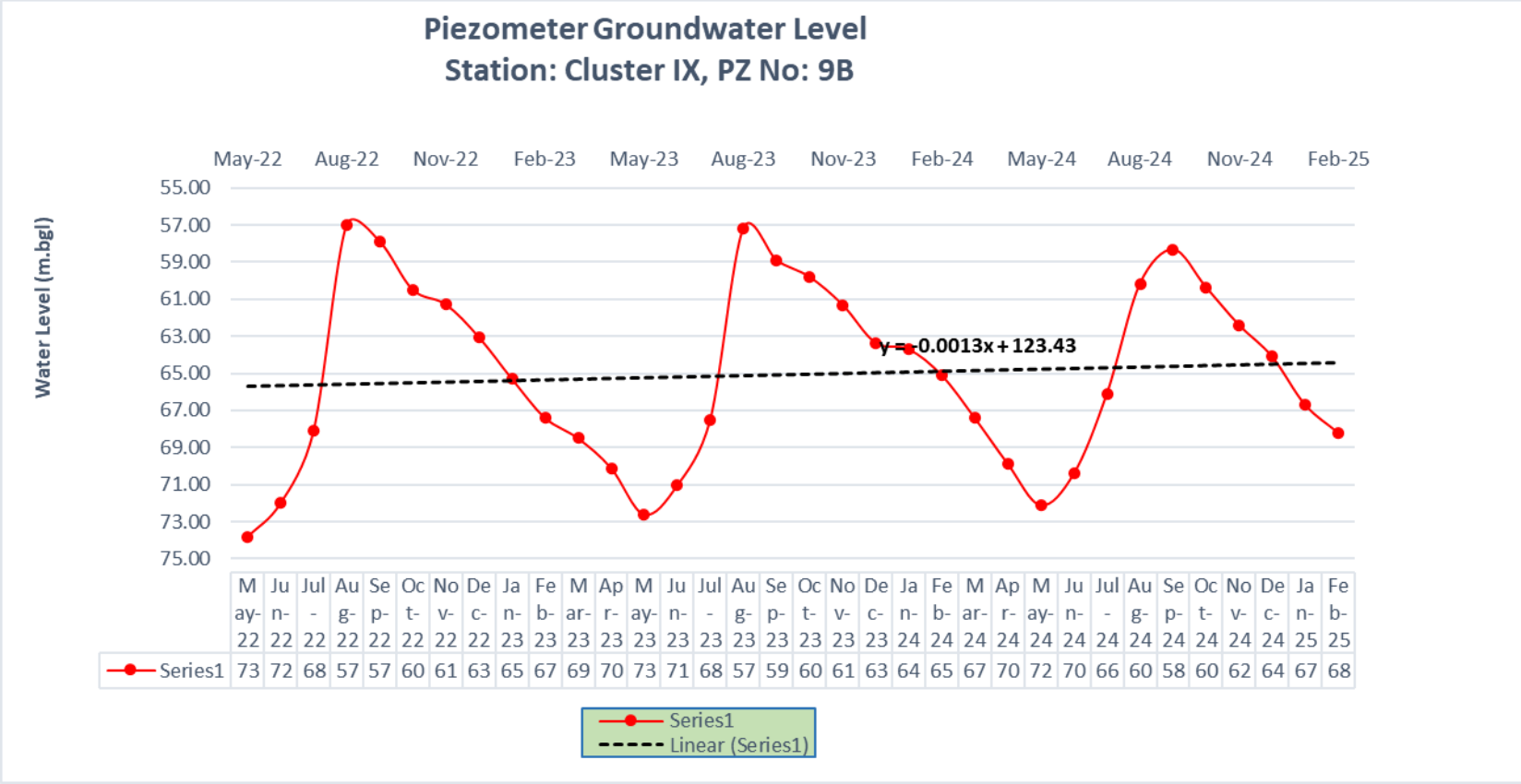
	May -22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov -22	Dec-22	Jan-23	Feb-23	Mar -23	Apr-23	May -23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov -23	Dec-23	Jan-24	Feb-24	Mar -24	Apr-24	May -24	Jun-24
Series1	47.3	45.0	43.9	39.7	36.0	43.5	45.0	45.8	46.3	47.0	47.7	48.5	49.2	49	46.1	40.1	38.4	42.6	43.5	44.2	46	47.1	48.2	48.7	51.0	50.2

Annexure – VIA

PIEZOMETER HYDROGRAPHS

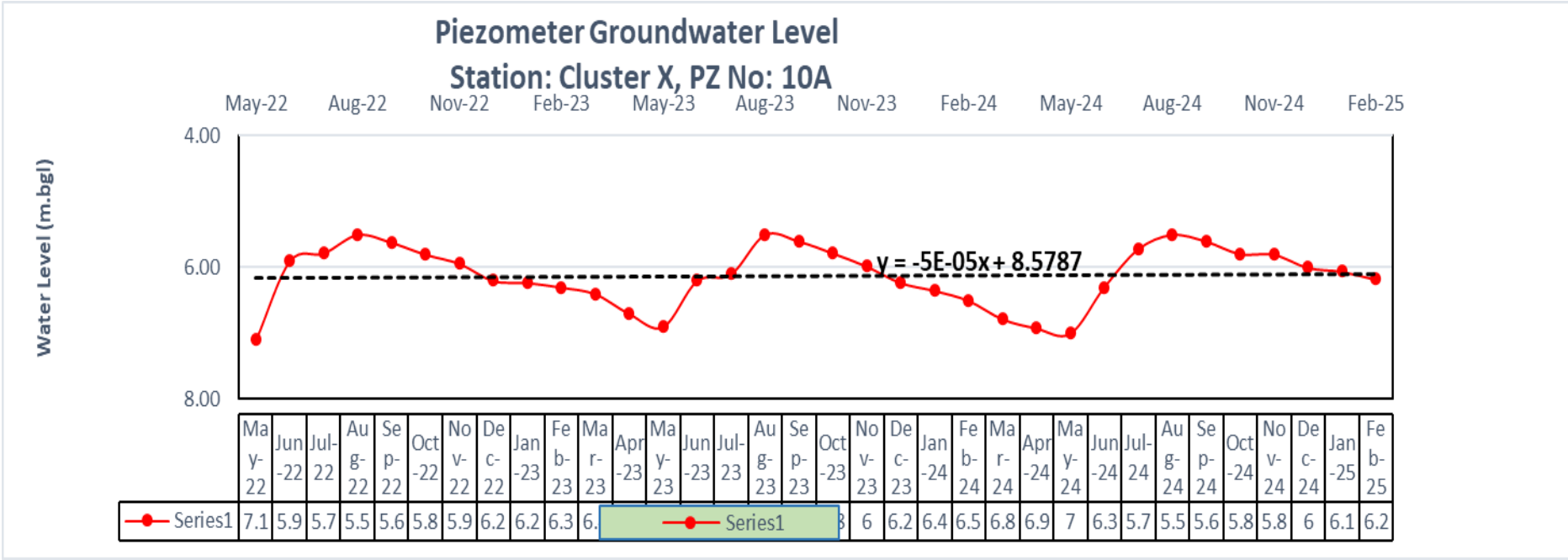


PIEZOMETER HYDROGRAPHS



	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25
Series1	73	72	68	57	57	60	61	63	65	67	69	70	73	71	68	57	59	60	61	63	64	65	67	70	72	70	66	60	58	60	62	64	67	68

PIEZOMETER HYDROGRAPHS



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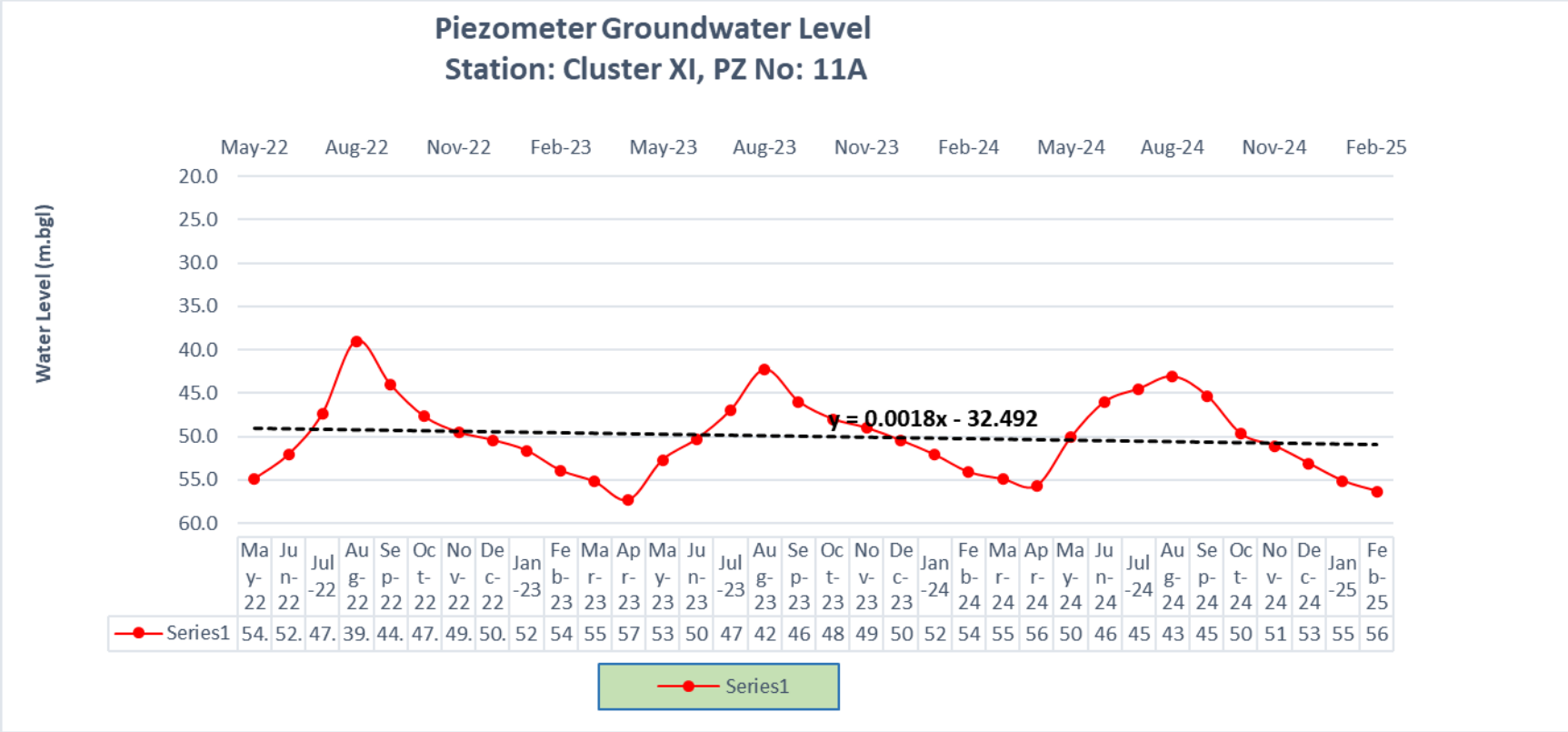

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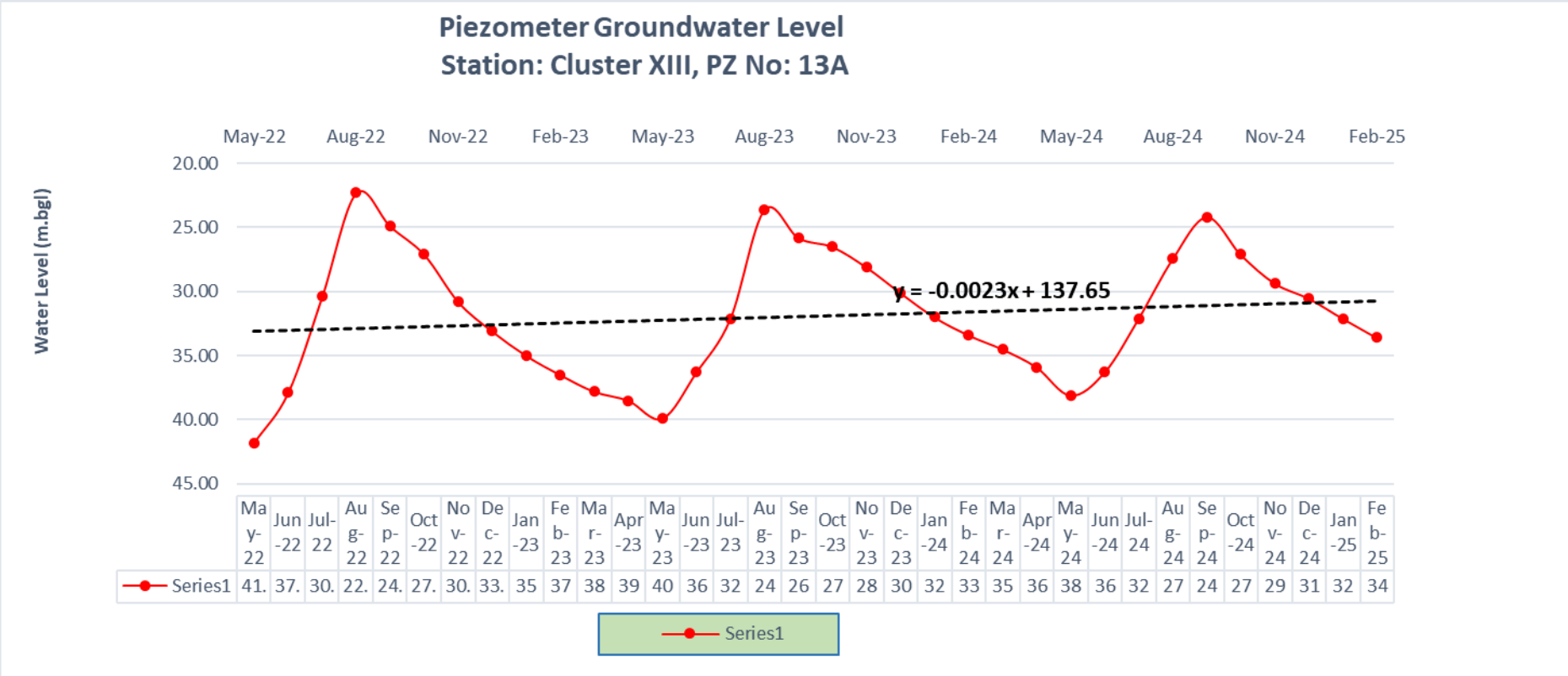
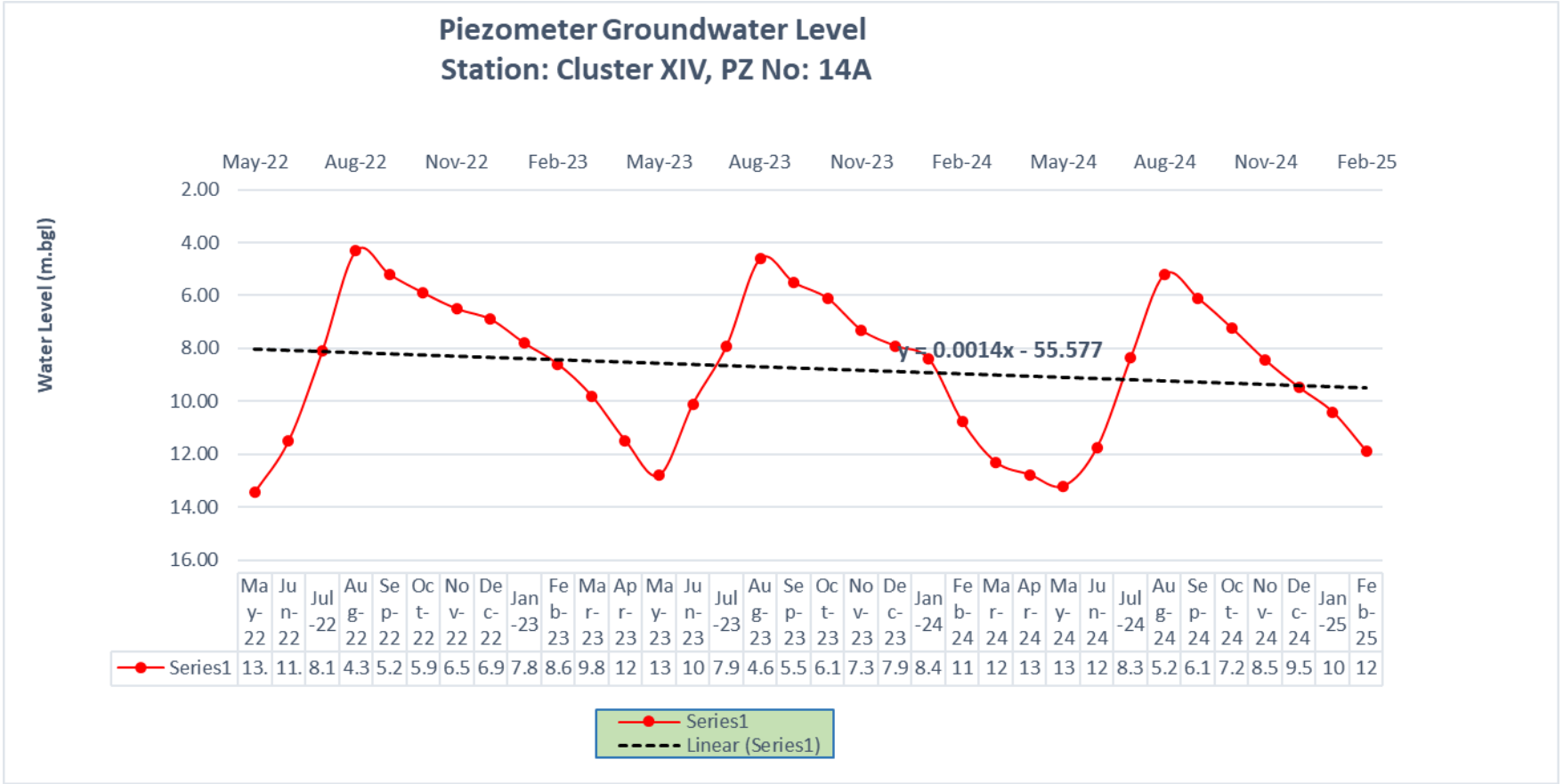


PIEZOMETER HYDROGRAPHS



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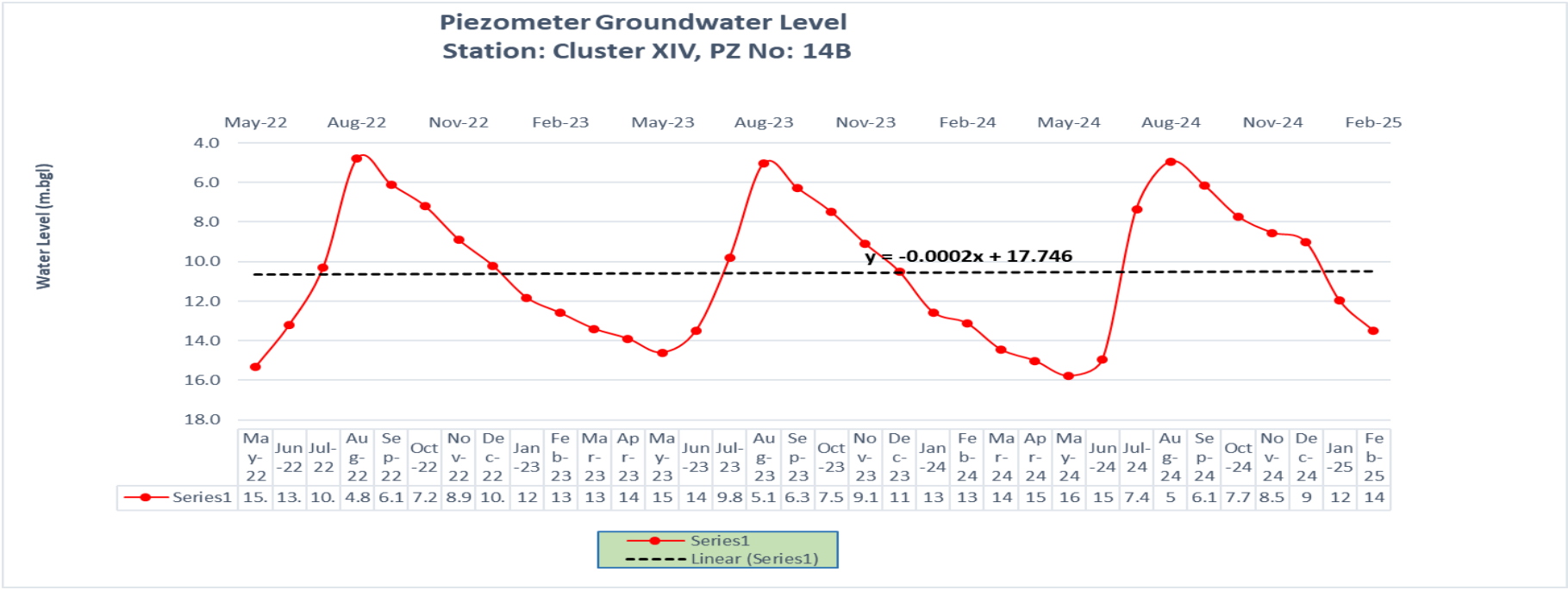

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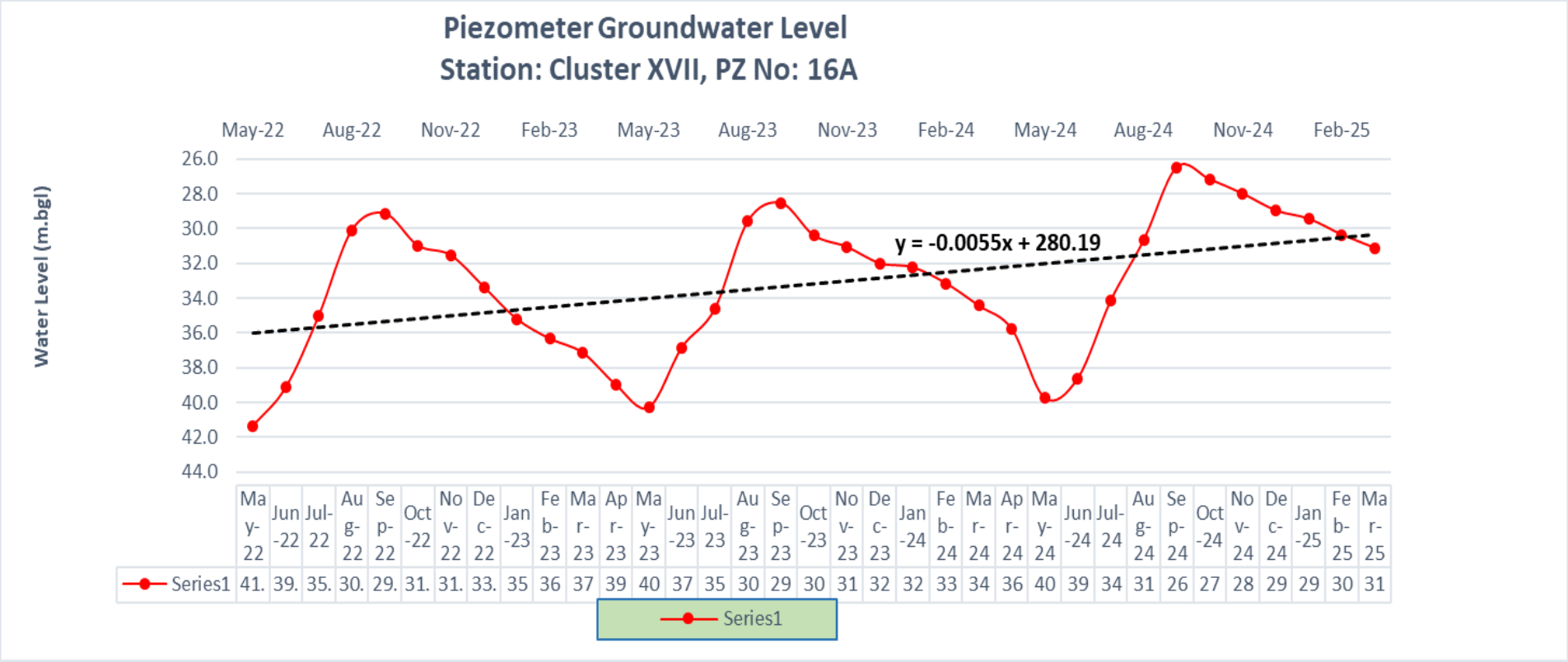

Annexure – VII

GROUNDWATER SAMPLE LOCATION DETAILS

Sampling month: June month of the assessment year of 2023-24

Sl No	Dug well (CMPDI)	Location	Sampling Date
			June'2024
Jharia Coalfield			
1	**A4**	DALDOLI	12.06.24
2	**A9**	SRIRAMPUR	12.06.24
3	**A10**	PHULWAR	12.06.24
4	**A13**	BHELATANR	11.06.24
5	**A23**	MACHHAYARA	05.06.24
6	**A29**	GOVINDPUR, AMBAGAN VILLAGE	06.06.24
7	**A32**	MOONIDIH BAZAR	05.06.24
8	**B10**	AMDIH NARAYANPUR	06.06.24
9	**B15**	BERA VILLAGE	07.06.24
10	**B19**	BHANDARIDAH	07.06.24
11	**B23**	LOHAPATTI VILLAGE	05.06.24
12	**B32**	MADHUBAND VILLAGE	06.06.24
13	**B40**	BHUIANCHITRO	07.06.24
14	**B46**	TELO	07.06.24
15	**B55**	RANTANR VILLAGE	12.06.24
16	**B59**	KHODOVALY VILLAGE	06.06.24
17	**B64**	KESHALPUR, BATIGHAR	06.06.24
18	**D2**	BIRSA MUNDA CHAWK, BANKMORE	03.06.24
19	**D4**	JHARIA THANA	03.06.24
20	**D5**	JIYALGORA (NEAR P.O.)	03.06.24
21	**D14**	KARMATANR	13.06.24
22	**D19**	MEMKO MORE	06.06.24
23	**D25**	GODHUR MORE	05.06.24
24	**D30**	BORKIBOA VILLAGE	06.06.24
25	**D35**	PATHERDIH RAILWAY COLONY	06.07.24
26	**D41**	JOYRAMPUR	03.06.24
27	**D49**	TISRA THANA	03.06.24
28	**D59**	SITALPUR	04.06.24
29	**D70**	JALADIH	04.06.24
30	**D72**	CHATI GOVINDPUR	07.06.24
31	**D80**	DHANSAR MINE RESCUE STATION	03.06.24
32	**D96**	BANSHRA	04.06.24
33	**D107**	BOGULA	04.06.24
34	**D112**	DEMUDI (DOMATANR)	05.06.24
35	**D115**	TELMUCHU	06.07.24

Sl No	Dug well (CMPDI)	Location	Sampling Date
			June'2024
Raniganj Coalfield			
1	DB-2A	Sulibari	13.06.24
2	DB-4	Sarbari	14.06.24
3	DB-8	Chungei	14.06.24
4	DB-10	Kulti	14.06.24
5	DB-12	Sabanpur	14.06.24
6	DB-13	Dendua More	14.06.24
7	DB-18	Luchibad	13.06.24
8	DB-26	Ledaharia	13.06.24
9	DB-27	Hodla	13.06.24
10	DB-29	Kelyasol	13.06.24
11	DB-30	Ramkanali	14.06.24
12	DB-38	Lukudih	14.06.24
13	DB-39	Pandra	14.06.24
14	K-12	Ethora	14.06.24
15	K-20	Majhladih	14.06.24

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - A10 , PHULWAR

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**A10**				
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**REM/BCCL/22-23/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**PHULWAR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**TO**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW3	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. *Ground Water Sampling at Monitoring Station Code: - A13, BHELATANR*

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**A13**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**BHELATANR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW4	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. *Ground Water Sampling at Monitoring Station Code: - A23(MACHHAYARA)*

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**A23**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**MACHHAYARA**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW5	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. *Ground Water Sampling at Monitoring Station Code: - A29, GOVINDPUR,AMBAGAN VILLAGE*

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**A29**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**GOVINDPUR, AMABAGAN VILLAGE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
		Period of Analysis		**TO**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW6	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - A32 , MOONIDIH BAZAR

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**A32**			
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**				**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**MOONIDIH BAZAR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**		
			Period of Analysis		**TO**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW7	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. *Ground Water Sampling at Monitoring Station Code : - A4, DALDOLI*

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**A4**				
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**DALDOLI**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**TO**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW-1	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th d Edition ,Carmine,2023	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 24th Edition, , 4500-Cl-B. (Iodometric Method-I),2023	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th Edition IS-3025,part 56:2003, R-2019/, AAS-VGA,2023	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th Edition, AAS-GTA,2023	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th Edition, AAS-GTA,2023	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. *Ground Water Sampling at Monitoring Station Code: - A9, SRIRAMPUR*

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**A9**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**SRIRAMPUR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW2	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	114	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	88	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.65	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	80	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	22.24	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.44	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	128	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_ac_{O3}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	266	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	782	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	614	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - B10, AMDIH NARAYANPUR

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**B10**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**AMDIH NARAYANPUR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW8	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	132	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	108	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.64	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	86	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	28.35	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.44	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	93	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{O_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	248	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	854	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	682	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - B15, BERA VILLAGE

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**B15**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**BERA VILLAGE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW9	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	144	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	106	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.71	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	59	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	18.49	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.52	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	125	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	265	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	728	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	604	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.6	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - B19 , BHANDARIDIH

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**B19**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**BHANDARIDAH**	**Date of Sampling**	**06.05.2024**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW10	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	136	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	112	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.51	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	90	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	17.17	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.31	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	140	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	242	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	834	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	712	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.3	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code: - B23 , LOHAPATTI VILLAGE

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**B23**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**LOHAPATTI VILLAGE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW11	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	102	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	116	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.78	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	66	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	32.91	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.85	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	119	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	208	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	642	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	528	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.7	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.17	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - B32, MADHUBANDAH

Date of Sampling at Station : June 2024

Month & Year	**June 2024**	**Dug Well No.**	**B32**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**MADHUBNAD VILLAGE**	**Date of Sampling**					
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW12	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	122	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	96	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.67	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	80	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	18.55	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.41	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	151	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	188	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	816	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	636	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.1	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.25	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - B40 , BHUIANCHITRO

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**B40**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**BHUIANCHITRO**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW13	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	144	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	104	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.81	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	92	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	28.13	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.38	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	181	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	256	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	946	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	738	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.5	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. *Ground Water Sampling at Monitoring Station Code : - B46 , TELO*

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**B46**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**TELO**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW14	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	72	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	135	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.59	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	80	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	11.46	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.56	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	96	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{O_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	222	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	652	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	508	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.0	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : -B55 , RANTANR VILLAGE

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**B55**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**		**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**RANTANR VILLAGE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW15	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	110	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	96	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.69	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	70	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	27.68	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.44	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	122	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	258	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	712	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	566	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - B59, KHODOVALY VILLAGE

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**B59**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**KHODOVALY**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW16	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	116	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	128	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.74	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	95	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	19.28	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.72	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	103	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	268	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	906	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	682	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	3.0	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - B64 , KESHALPUR,BATIGHAR

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**B64**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**KESHALPUR , BATIGHAR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW17	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	96	2.0-800.0	2	75	200
4	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	118	2.0-1500.0	5	250	1000
5	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.68	0.2-2.00	0.2	1	1.5
6	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
7	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	83	6.0-700	6	30	100
8	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	17.88	0.5-45.0	0.5	45	No relaxation
9	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
10	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.63	1-14	0.1	6.5-8.5	No relaxation
11	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	109	10.0-400.0	10	200	400
12	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
13	Total Alkalinity (c_ac_{03}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	244	4.0-2000.0	4	200	600
14	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	728	25.0-5000.0	25	500	2000
15	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	582	4.0-2000.0	4	200	600
16	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.8	1-800	0.1	1	5
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.19	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D107, BOGULA

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D107**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**BOGULA**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW33	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	4	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	112	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	128	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.61	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	88	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	39.28	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.72	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	178	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	275	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	808	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	642	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	3.0	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D112, DEMUDI(DOMATANR)

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D112**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**DEMUDI(DOMATANR)**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW34	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	86	2.0-800.0	2	75	200
4	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	136	2.0-1500.0	5	250	1000
5	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.82	0.2-2.00	0.2	1	1.5
6	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
7	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	69	6.0-700	6	30	100
8	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	27.88	0.5-45.0	0.5	45	No relaxation
9	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
10	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.63	1-14	0.1	6.5-8.5	No relaxation
11	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	119	10.0-400.0	10	200	400
12	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
13	Total Alkalinity (c_ac_{O3}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	210	4.0-2000.0	4	200	600
14	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	634	25.0-5000.0	25	500	2000
15	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	498	4.0-2000.0	4	200	600
16	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.8	1-800	0.1	1	5
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D115 , TELMUCHU

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D115**		**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**				**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**TELMUCHU**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**		
			Period of Analysis		**TO**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW35	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
	Colour, Hazen unit	APHA, 24th Edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	106	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	124	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method,2023	0.73	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.26	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th Edition, 3500-Mg B: Calculation Method,2023	97	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th Edition, UV-Spectrophotometric Method,2023	29.58	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 24th Edition, , 2150-C,2023	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.56	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th Edition, 4500 S , Turbidity Method,2023	159	10.0-400.0	10	200	400
11	Taste	APHA,24th Edition, 2160-C , 2023	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	236	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	837	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	665	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.1	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

*17***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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D14 , KARMATANR

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D14**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**		
Sampling Stations	**KARMATANR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**TO**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW21	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	128	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	122	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.59	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	58	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	11.95	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.38	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	114	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{O_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	248	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	664	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	560	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D19, MEMKO MORE

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D19**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**		**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**MEMKO MORE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**TO**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW-22	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	88	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	94	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.67	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.46	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	51	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	17.50	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.52	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	91	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{O_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	242	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	622	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	428	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

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

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. *Ground Water Sampling at Monitoring Station Code : - D2 , BIRSA MUNDA CHAWK,BANKMORE*

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D2**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**BIRSA MUNDA CHAWK , BANKMORE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**TO**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW-18	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
	Colour, Hazen unit	APHA, 24th Edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	114	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	124	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method,2023	0.82	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th Edition, 3500-Mg B: Calculation Method,2023	92	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th Edition, UV-Spectrophotometric Method,2023	12.38	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 24th Edition, , 2150-C,2023	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.56	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th Edition, 4500 S , Turbidity Method,2023	95	10.0-400.0	10	200	400
11	Taste	APHA,24th Edition, 2160-C , 2023	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	230	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	837	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	665	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

*17***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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D25 , GODHUR MORE

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D25**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**GODHUR MORE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**TO**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW23	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	128	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	120	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.62	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	100	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	23.92	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.61	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	138	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{O_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	292	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	832	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	732	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.6	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.24	0.10 – 10.0	0.1	5	15

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

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

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D30 , BORKIBOA VILLAGE

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D30**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**BORKIBOA VILLAGE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW24	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	104	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	116	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.74	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	68	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	22.26	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.56	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	144	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_ac_{O3}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	232	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	742	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	540	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D35 , PATHERDIH RAILWAY COLONY

1.

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D35**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**PATHERDIH RAILWAY COLONY**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**TO**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW25	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	124	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	138	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.78	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	74	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	30.35	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.44	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	167	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	264	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	772	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	615	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.5	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D4 , JHARIA THANA

1.

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D4**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**JHARIA THANA**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**TO**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW19	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	110	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	88	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.71	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	125	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	22.24	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.44	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	168	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{O_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	296	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	942	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	790	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.5	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D41 , JOYRAMPUR

1.

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D41**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**JOYRAMPUR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW26	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	164	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	132	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.71	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	51	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	8.49	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.52	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	67	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	265	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	838	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	620	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.3	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D49 , TISRA THANA

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D49**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**TISRA THANA**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW27	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	118	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	98	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.53	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	79	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	17.58	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.31	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	126	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	229	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	736	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	620	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D5, JIYALGORA (NEAR P.O.)

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D5**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**JIYALGORA (NEAR P.O)**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW 20	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	126	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	98	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.63	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	66	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	13.64	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.52	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	135	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_ac_{03}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	265	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	738	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	586	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D59, SITALPUR

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D59**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**SITALPUR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW28	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	118	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	122	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.83	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	81	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	22.91	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.85	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	134	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	282	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	829	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	630	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D70 JALADIH

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D70**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**JALADIH**	**Date of Sampling**					
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW29	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	92	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	112	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.69	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.21	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	103	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	18.55	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.41	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	111	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	192	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	808	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	654	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.3	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.23	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D72, CHATI GOVINDPUR

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D72**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**CHATI GOVINDPUR**	**Date of Sampling**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**		
			Period of Analysis	**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW30	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	152	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	78	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.74	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	108	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	28.13	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.38	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	158	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_ac_{03}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	278	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	966	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	824	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.5	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D80 DHANSAR MINE RESCUE STATION

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D80**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**DHANSAR MINE RESCUE STATION**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW31	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	116	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	138	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.61	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	63	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	21.46	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.56	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	133	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	278	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	748	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	548	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.2	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.19	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D96 BANSHRA

Date of Sampling at Station: June 2024

Month & Year	**June 2024**	**Dug Well No.**	**D96**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**19.09.2024**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**BANSHRA**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW32	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	126	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	94	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.79	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	50	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	27.68	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.44	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	165	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	232	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	637	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	522	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.6	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - DB2A

Date of Sampling at Station: June 2024

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

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Month & Year	**June 2024**	**Dug Well No.**	**DB-2A**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Joyrampur Village**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW36	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	98	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	88	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.61	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	98	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	24.31	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.94	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	162	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	245	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	782	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	650	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

(Amit Raj Mishra)

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-2A**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Joyrampur Village**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW36	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-4**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Sarbari**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW37	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	116	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	76	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.48	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	95	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	30.19	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.86	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	95	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	265	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	974	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	680	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-4**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Sarbari**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW37	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

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Authorised Signatory

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

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-8**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Chungei**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	Parameter	Method of Analysis	Observed Values GW38	Range Of Testing	LDL	IS 10500: 2012 Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	92	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	58	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.48	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	46	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	2.60	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.01	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	44	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	178	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	537	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	420	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.7	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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.*

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REVIEWED BY

(Amit Raj Mishra)
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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-8**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Chungei**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW38	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-10**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Kulti**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW-39	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	74	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	80	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.54	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	50	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	27.35	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.91	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	114	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	172	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	533	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	390	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.2	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.14	0.10 – 10.0	0.1	5	15

****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.*

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REVIEWED BY

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-10**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Kulti**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW39	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit.*

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-12**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Sabanpur**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW40	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	38	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	42	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.30	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.21	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	21	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	24.09	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.03	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	132	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	292	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	245	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	182	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.6	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.31	0.10 – 10.0	0.1	5	15

****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.*

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-12**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Sabanpur**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW40	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	0.07	0.02-10.0	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 & BDL indicates Below Detection Limit,*

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-13**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Dendua More**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW41	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	58	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	40	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.49	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	33	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	34.4	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.02	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	108	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	158	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	350	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	280	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.6	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.1	0.10 – 10.0	0.1	5	15

****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*

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-13**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Hurriladih**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Dendua More**	**Date of Sampling**	**06.05.2024**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW41	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-18**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**RCF**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Luchibad**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW42	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	62	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	54	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.36	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	39	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	8.07	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.00	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	64	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	162	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	400	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	316	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

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GROUND WATER ANALYSIS TEST REPORT

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Month & Year	**June 2024**	**Dug Well No.**	**DB-18**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**RCF**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Luchibad**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
		Period of Analysis		**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW42	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.10-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	IS APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

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(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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GROUND WATER ANALYSIS TEST REPORT

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Month & Year	**June 2024**	**Dug Well No.**	**DB-26**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ledaharia**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW43	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	64	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	42	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.82	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	39	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	29.30	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.75	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	166	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	155	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	393	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	320	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	3.0	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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.*

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-26**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ledaharia**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW43	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit.*

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-27**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Hodla**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW44	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	54	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	60	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.56	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	45	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	5.16	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.92	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	58	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	228	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	428	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	320	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

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REVIEWED BY

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-27**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Hodla**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW44	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit.*

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REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-29**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**RCF**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Kelyasol**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	Parameter	Method of Analysis	Observed Values GW45	Range Of Testing	LDL	IS 10500: 2012 Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	128	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	164	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.59	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	51	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	6.37	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.93	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	74	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	245	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	692	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	530	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.6	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.1	0.10 – 10.0	0.1	5	15

****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.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-29**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Keliyasol**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW45	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**DB-30**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ramkanali**	**Date of Sampling**			
		Period of Analysis		**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW46	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	102	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	72	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.77	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.26	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	95	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	24.7	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.98	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	111	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	272	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	718	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	648	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.3	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.12	0.10 – 10.0	0.1	5	15

****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.*

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(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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GROUND WATER ANALYSIS TEST REPORT

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Month & Year	**June 2024**	**Dug Well No.**	**DB-30**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ramkanali**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW46	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

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(Kumar Vaibhav)
REVIEWED BY

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GROUND WATER ANALYSIS TEST REPORT

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Month & Year	**June 2024**	**Dug Well No.**	**DB-38**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Lukudih**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
		Period of Analysis	**13.05.2024**	**to**	**07.08.2024**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW47	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	122	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	68	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.39	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	97	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	22.68	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.06	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	142	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	278	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	826	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	705	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.5	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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.*

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GROUND WATER ANALYSIS TEST REPORT

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Month & Year	**June 2024**	**Dug Well No.**	**DB-38**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Lukudih**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**13.05.2024** to **07.08.2024**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW47	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

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GROUND WATER ANALYSIS TEST REPORT

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Month & Year	**June 2024**	**Dug Well No.**	**DB-39**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Pandra**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**06.05.2024 to 07.08.2024**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW48	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	120	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	84	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.86	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	73	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	9.54	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.09	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	71	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	264	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	748	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	602	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.2	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.18	0.10 – 10.0	0.1	5	15

****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.*

ANALYSED BY

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REVIEWED BY

(Amit Raj Mishra)
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GROUND WATER ANALYSIS TEST REPORT

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Month & Year	**June 2024**	**Dug Well No.**	**DB-39**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Pandra**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**06.05.2024** to **07.08.2024**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW48	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

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

Month & Year	**June 2024**	**Dug Well No.**	**K-12**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ethora**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW49	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	72	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	44	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.73	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	73	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	1.40	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.41	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	41	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{O_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	210	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	591	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	480	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

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(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
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Environment Laboratory, Regional Institute-II
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GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**K-12**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ethora**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW49	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

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REVIEWED BY

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**K-20**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Majhladih**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW50	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	62	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	58	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.76	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	40	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	28.55	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.64	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	103	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	235	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	438	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	318	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****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,*

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**June 2024**	**Dug Well No.**	**K-20**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.08.2024**
Project	**RCF**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Majhladih**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**13.05.2024 to 07.08.2024**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW50	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	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 & BDL indicates Below Detection Limit,*

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(Amit Raj Mishra)
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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: Nephlometric Turbidity unit
OC / UG: Opencast / Underground
OCP / UGP: Opencast Project / Underground Project
RL: Reduced Level
RWH: Rainwater Harvesting
FF: Fire Fighting

PLATES

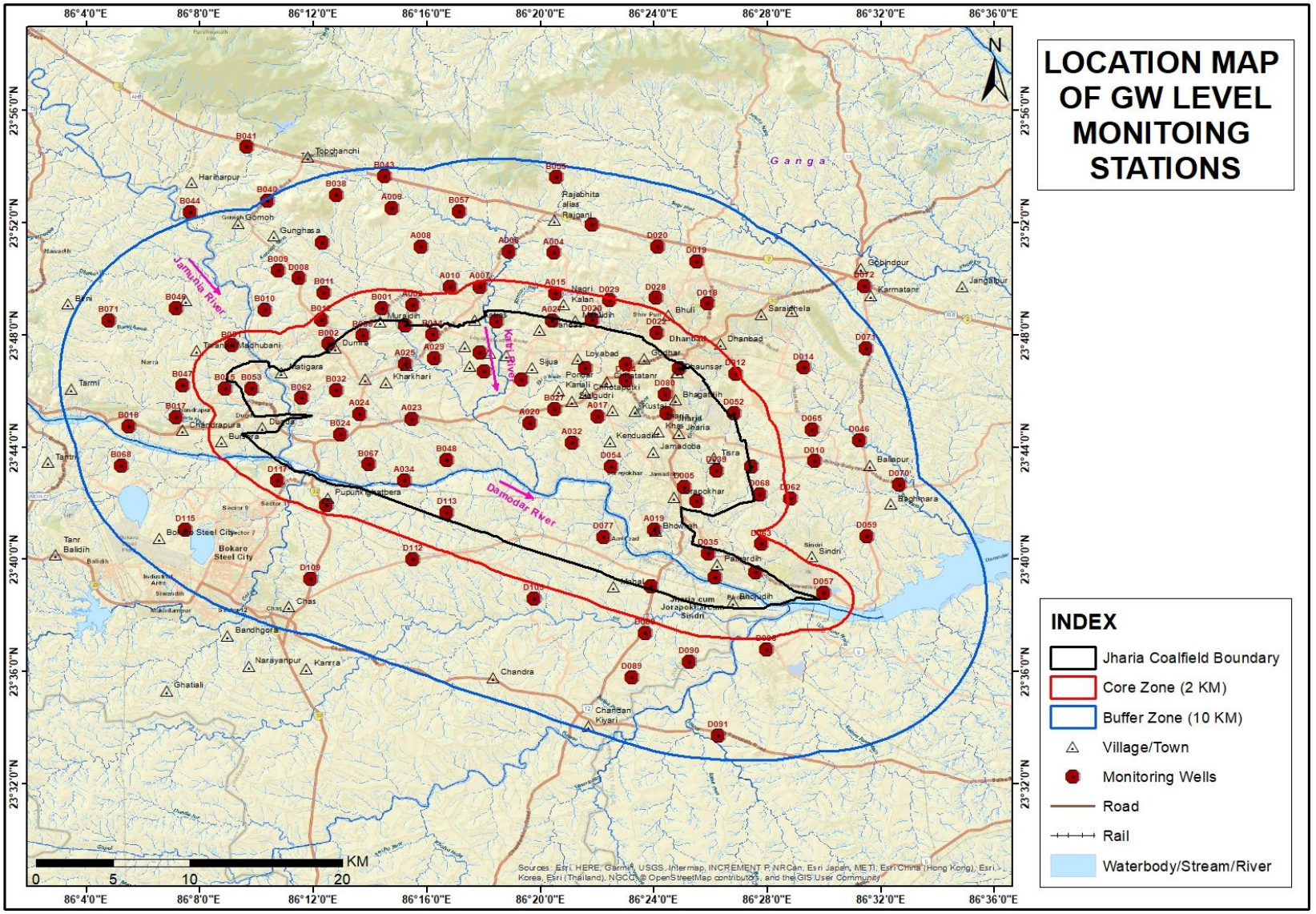


Plate- I: Location Map of Groundwater Level Monitoring stations

JOB NO: 200424005

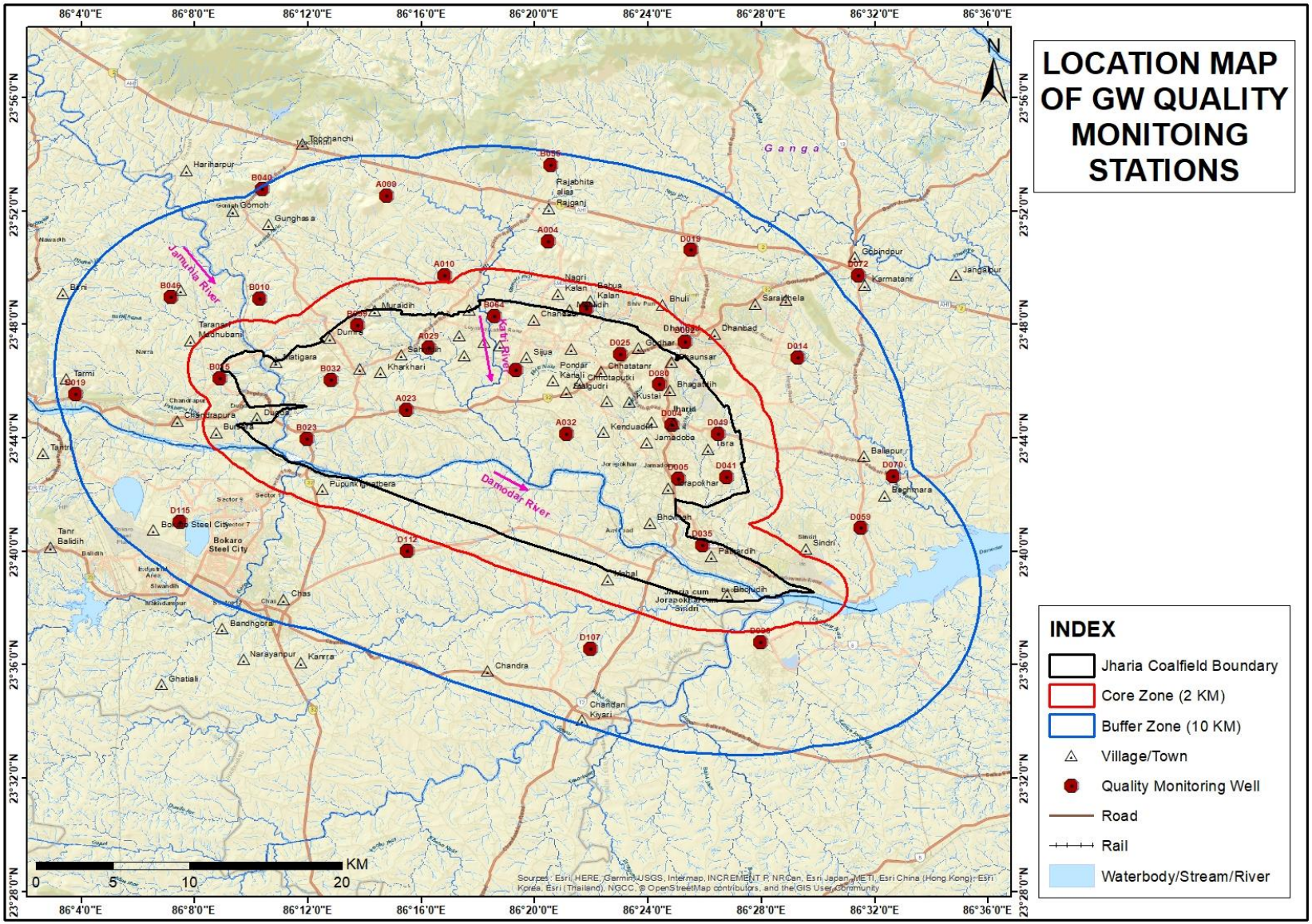


Plate- II: Location Map of Groundwater Quality Monitoring stations

JOB NO: 200424005

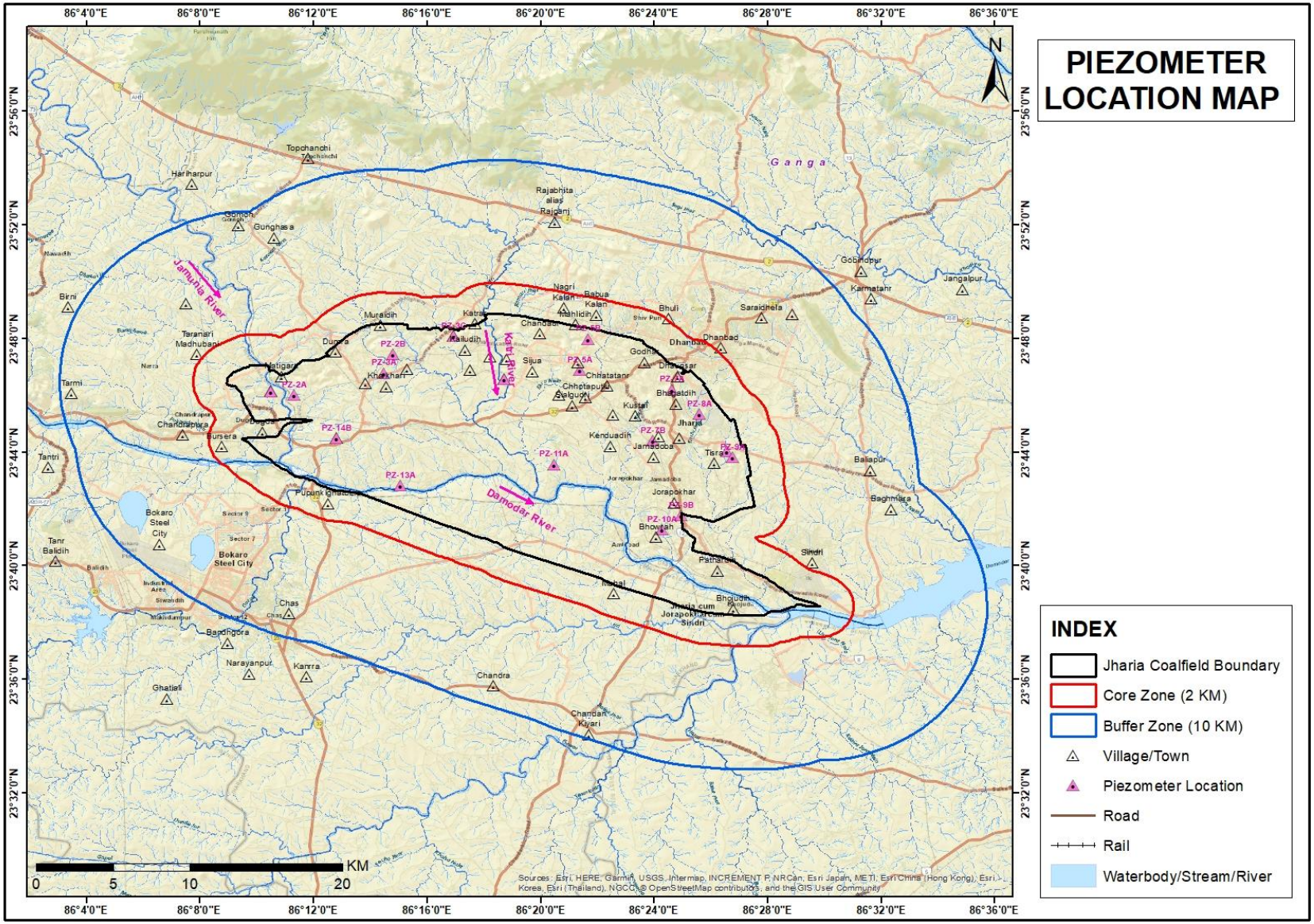


Plate- III: Location Map of Piezometers

JOB NO: 200424005

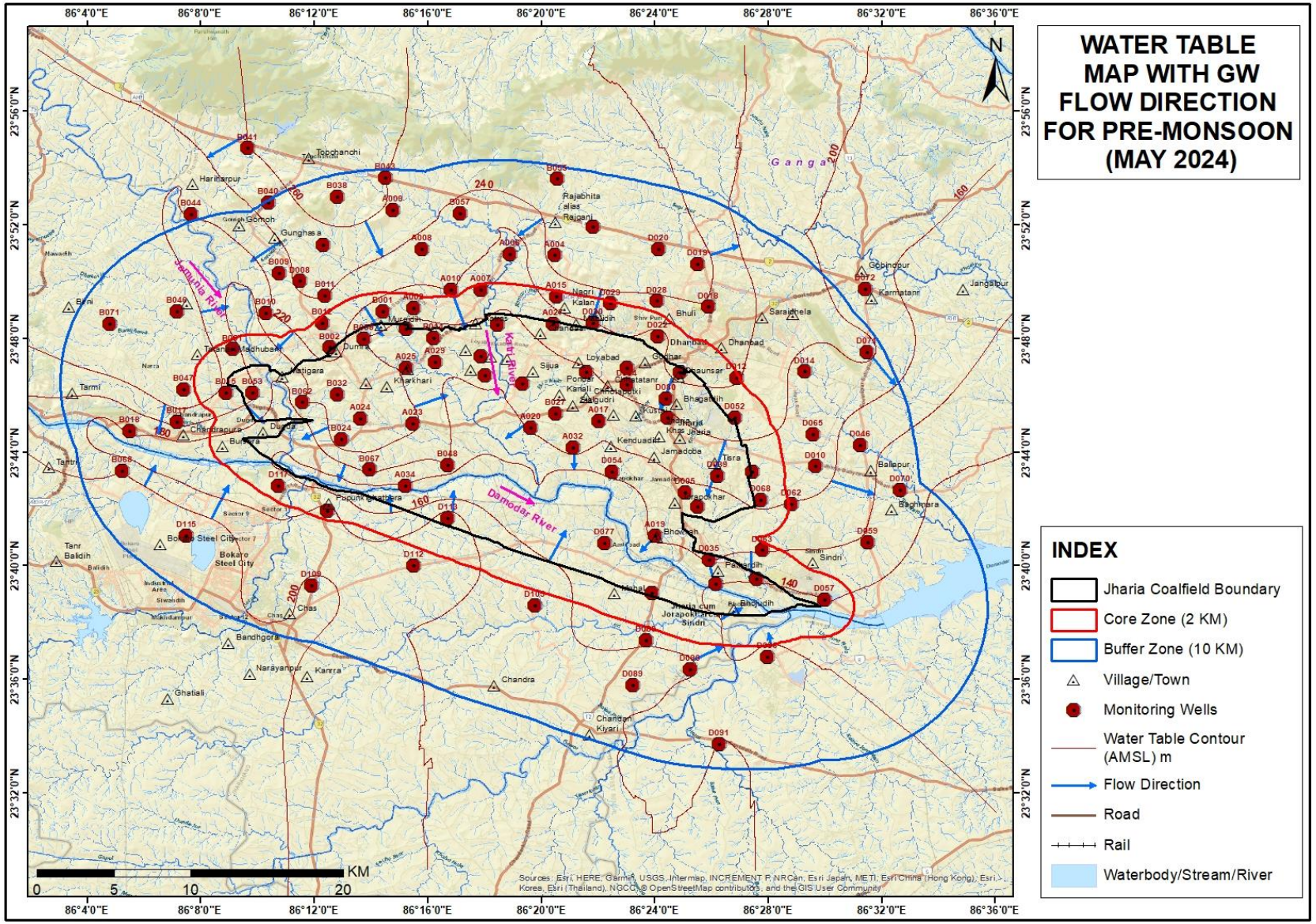


Plate- IVA: Water table Contour Map of JCF, Pre Monsoon (May'24)

JOB NO: 200424005

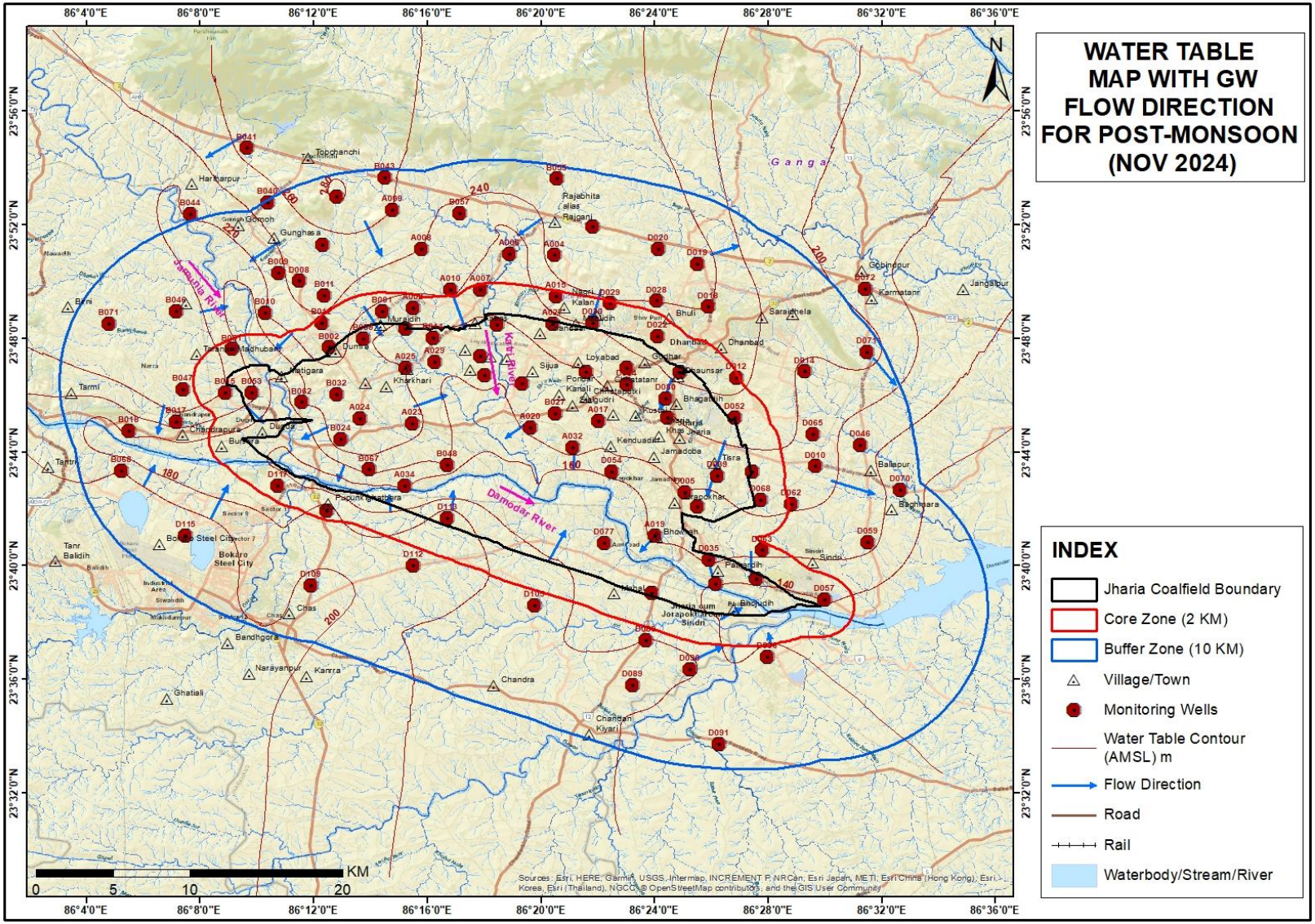


Plate- IVB: Water table Contour Map of JCF, Post Monsoon (Nov'24)

JOB NO: 200424005

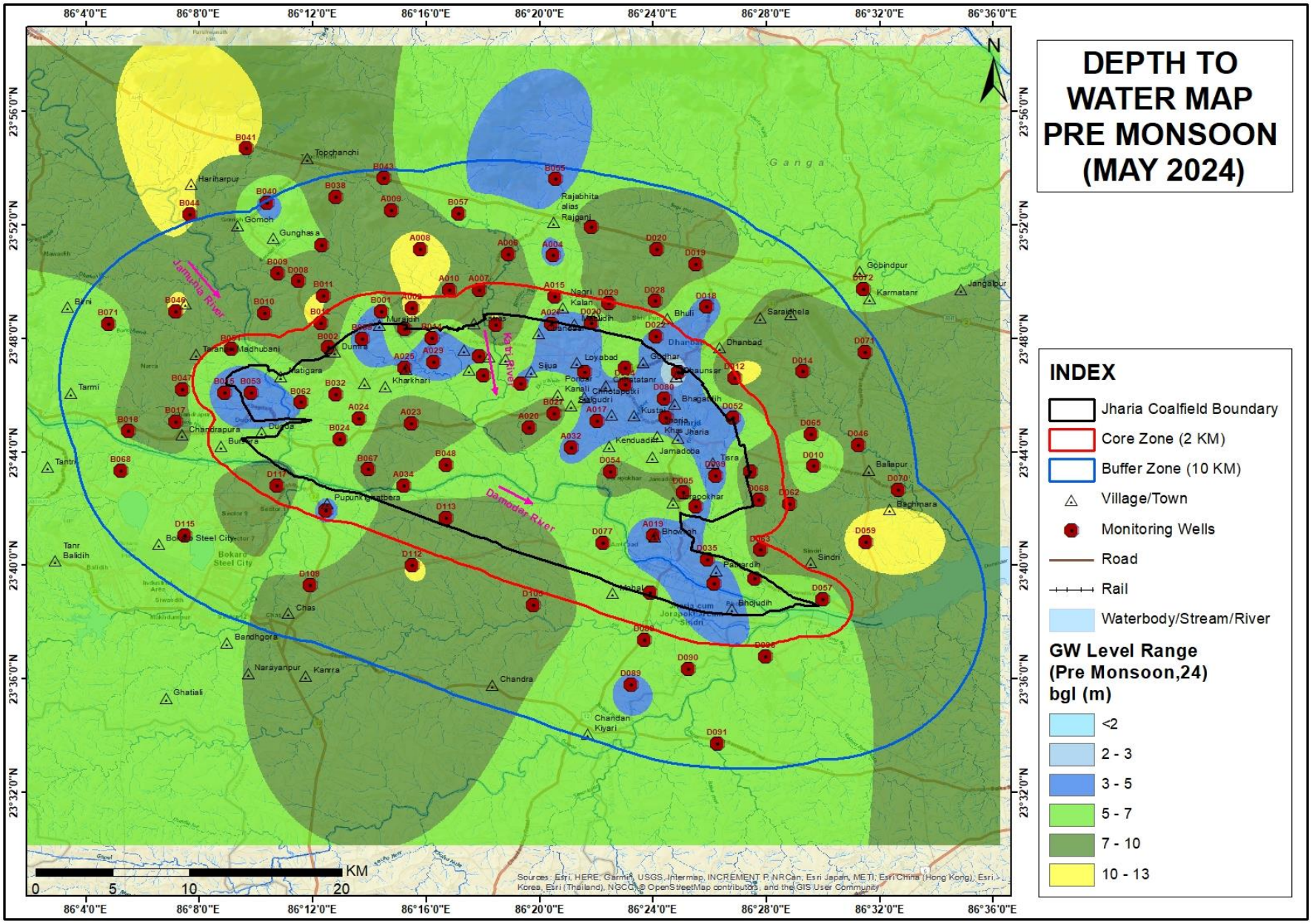


Plate- VA: Depth to Groundwater Level map of JCF, Pre Monsoon (May'24)

JOB NO: 200424005

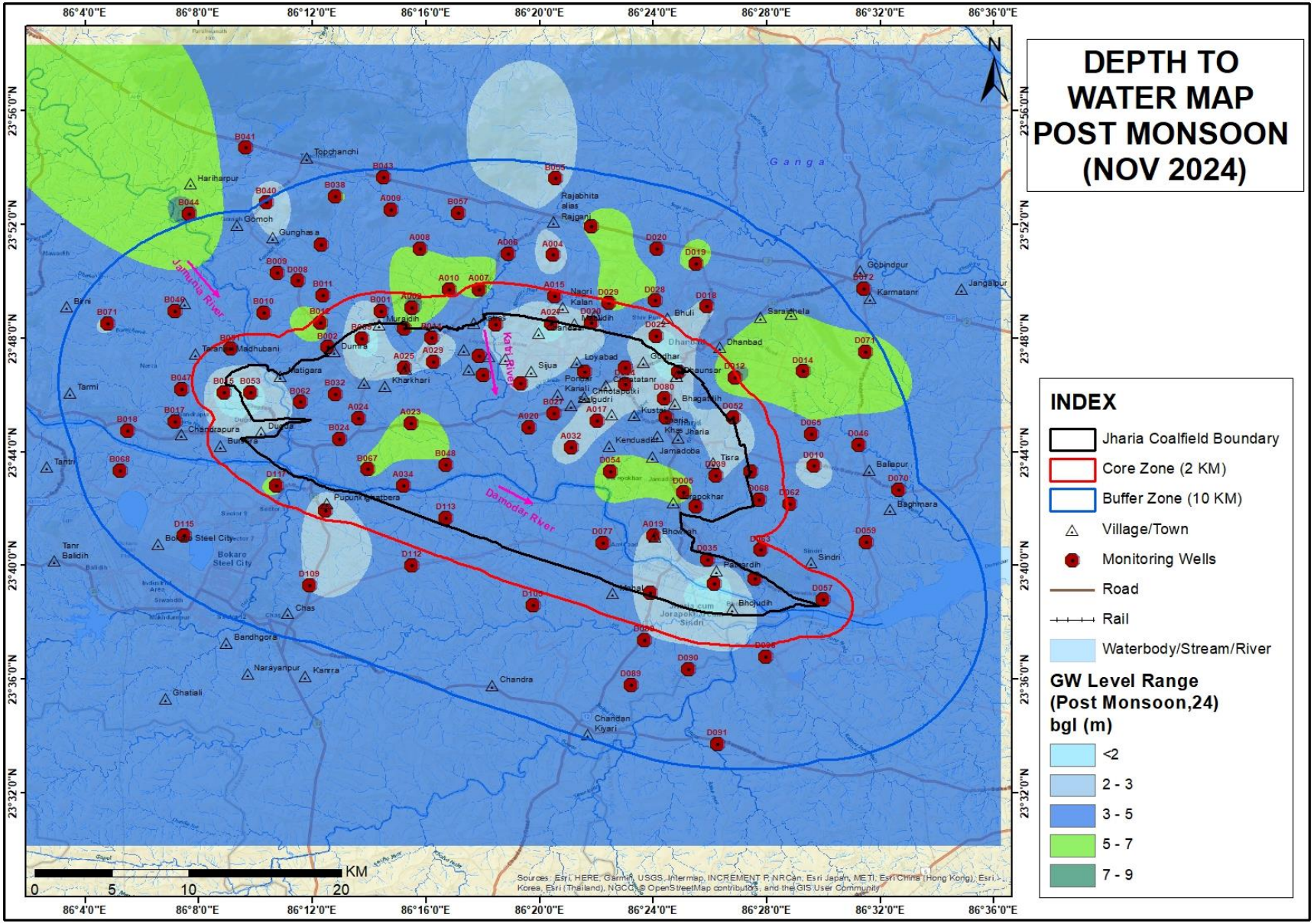


Plate- VB: Depth to Groundwater Level map of JCF, Post Monsoon (Nov'24)

JOB NO: 200424005

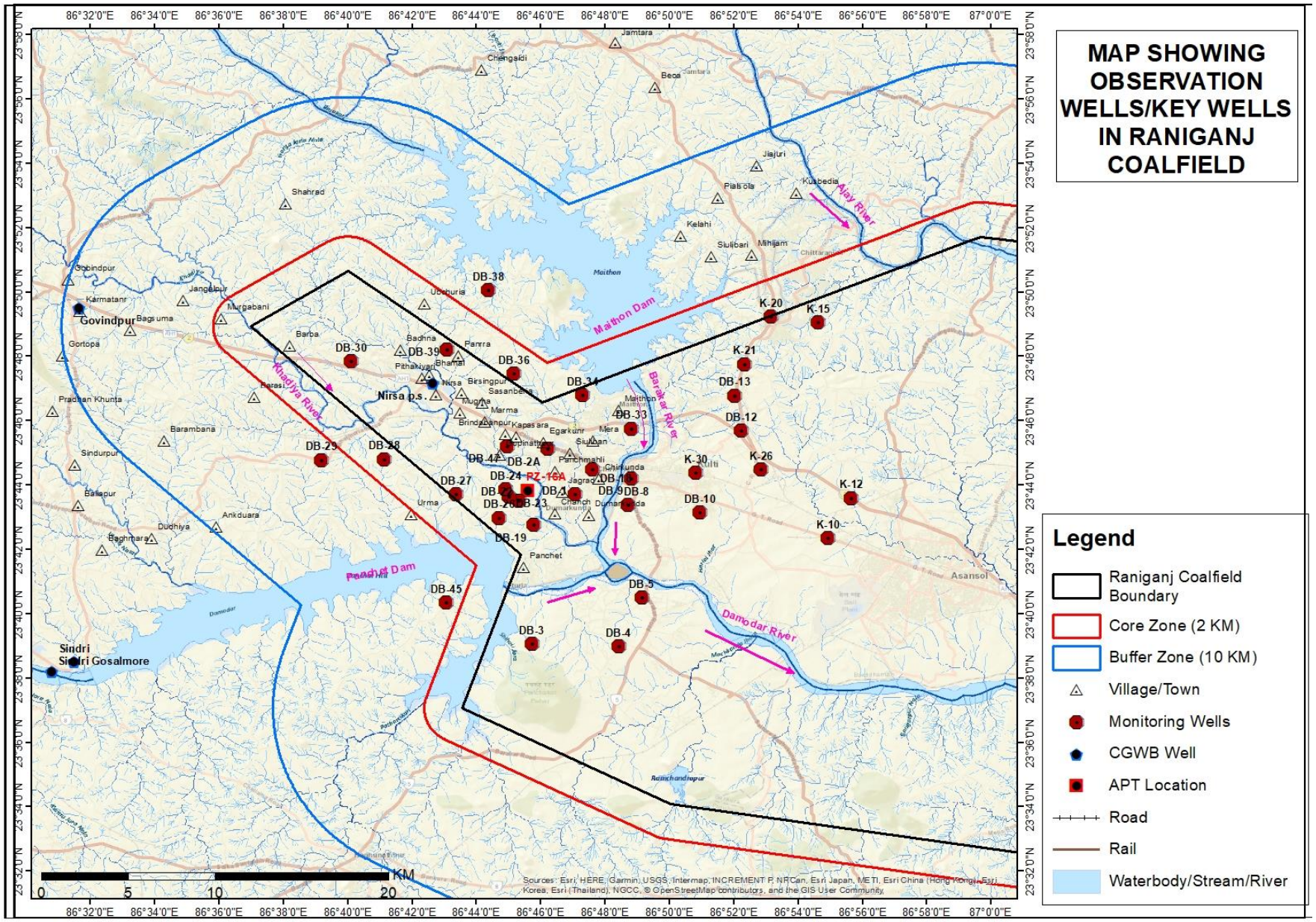
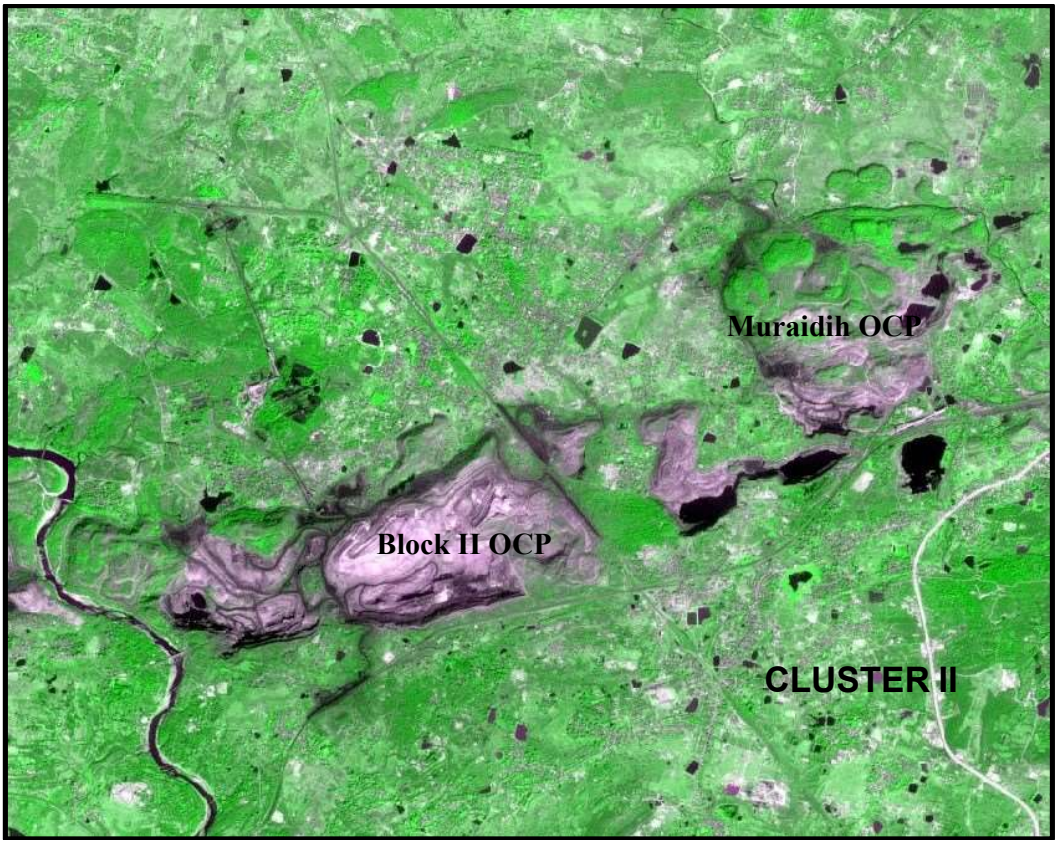


Plate- VI: Drainage Map (Part of RCF Coalfield under BCCL Command Area)

JOB NO: 200424005

Land Reclamation/ Restoration Monitoring of Five Clusters of (Opencast + Underground) Coal Mines of Bharat Coking Coal Limited based on Satellite Data of the Year 2022



Submitted to

Bharat Coking Coal Limited

Land Reclamation/ Restoration Monitoring of Five Clusters of (Opencast + Underground) Coal Mines of Bharat Coking Coal Limited based on Satellite Data of the Year 2022

March - 2023

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

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3 Methodology 2
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Executive Summary

1. Project — Land reclamation/ restoration monitoring of five clusters of (Opencast + Underground) coal mines of Bharat Coking Coal Ltd. (BCCL) based on satellite data on every three-year basis.

2. Objective — Objective of land reclamation/ restoration monitoring is to assess the area of backfilled, plantation, social forestry, active mining area, water bodies, distribution of wasteland, agricultural land and forest in the leasehold area of the project. This will help in assessing the progressive status of mined land reclamation and to take up remedial measures, if any, required for environmental protection.

3. Salient Findings

- Out of 5 Clusters of mines viz. II, VI, XIV, XV and XVI, considered for land reclamation monitoring during the year 2022-23, cluster II, VI, XIV and XVI were as per CIL Work Order and cluster XV group of mines was added after receipt of letter of request from BCCL vide पत्रसंख्या:भाकोकोलि.विभागाध्यक्ष.पर्या.संचिका.C-12/2022/1365-1368 dated 21.07.2022.

- Out of the total mine leasehold area of 8140.24 Ha. of the 05 clusters considered for monitoring during the year 2022-23; total excavated area is 1030.85 Ha. out of which 115.10 Ha. area (11.17%) is plantation on backfill (Biological Reclamation) and 621.40 Ha. area (60.28%) is under backfilling (Technical Reclamation) and 294.35 Ha. area (28.55%) is under active mining. Cluster wise details of land reclamation of the above Clusters is given in Table-1.

- It has been observed from the analysis of Satellite Data of the year 2022 that area under technical reclamation has decreased from 624.23 Ha. (Yr. 2019) to 621.40 Ha. (Yr. 2022) which indicates a decrease of 2.83 Ha. with respect to the year 2019.

- Area under biological reclamation has increased from 111.78 Ha. (Yr. 2019) to 115.10 Ha. (Yr. 2022) which indicates an increase of 3.32 Ha. with respect to the year 2019.

- Plantation on OB dumps in the above 5 clusters has increased from 62.48 Ha. (Yr. 2019) to 70.30 Ha. (Yr. 2022) which indicates an increase of 7.82 Ha. with respect to the year 2019.

- Plantation under Social forestry, Avenue plantations etc. in the above mentioned clusters has increased from 306.55 Ha. (Yr. 2019) to 360.84 Ha. (Yr. 2022) which indicates an increase of 54.29 Ha. with respect to the year 2019.

- Area under Active Mining in the above selected 5 clusters has increased from 273.50 Ha. to 294.35 Ha. which indicates an increase of 20.85 Ha. with respect to the year 2019.

- Total excavated area in the above selected 5 clusters has increased from 1009.51 Ha. to 1030.85 Ha. which indicates an increase of 21.34 Ha. with respect to the year 2019.

- Total area under plantation (green cover) has increased from 480.81 Ha. to 546.24 Ha. which indicates an increase of 65.43 Ha. with respect to the year 2019.

- The increase in area under Biological Reclamation is the result of the efforts of BCCL taken up towards land reclamation and environmental protection.

- On comparing the status of land reclamation of the above mentioned 5 clusters, it is evident from the analysis that total area under land reclamation has increased from 736.01 Ha. to 736.50 Ha. which indicates an increase of 0.49 Ha. with respect to the year 2019.

- 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 2022

(Area in Hectare)

Sl. No.	Cluster No.	Total Leasehold Area		Technical Reclamation		Plantation						Area under Active Mining		Total Excavated Area		Total Area under Plantation (% Green Cover Generated in Leasehold)		Total Area under Reclamation	
						Biological Reclamation		Other Plantations											
				Area under Backfilling		Plantation on Excavated / Backfilled Area		Plantation on External OB Dumps		Social Forestry, Avanue Plantation Etc.									
1	*2*	*3*		*4*		*5*		*6*		*7*		*8*		*9 (=4+5+8)*		*10 (=5+6+7)*		*11(=4+5)*	
		2019	2022	2019	2022	2019	2022	2019	2022	2019	2022	2019	2022	2019	2022	2019	2022	2019	2022
1	Cluster II	2260.54	2025.71	422.51	422.00	86.42	87.42	43.28	47.29	154.37	128.03	129.98	148.85	638.91	658.27	284.07	262.74	508.93	509.42
				66.13%	64.11%	13.53%	13.28%					20.34%	22.61%			12.57%	12.97%	79.66%	77.39%
2	Cluster VI	831.83	876.55	134.15	134.15	0.00	0.00	5.89	9.70	26.79	28.41	77.75	70.36	211.90	204.51	32.68	38.11	134.15	134.15
				63.31%	65.60%	0.00%	0.00%					36.69%	34.40%			3.93%	4.35%	63.31%	65.60%
3	Cluster XIV	1418.25	1577.22	0.00	0.00	0.00	0.00	0.00	0.00	74.13	72.42	0.00	0.00	0.00	0.00	74.13	72.42	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					0.00%	0.00%			5.23%	4.59%	0.00%	0.00%
4	Cluster XV	-	1696.55	-	0.00	-	0.00	-	0.00	-	80.72	-	0.00	-	0.00	-	80.72	-	0.00
					0.00%		0.00%						0.00%				4.76%		0.00%
5	Cluster XVI	2008.4	1964.21	67.57	65.25	25.36	27.68	13.31	13.31	51.26	51.26	65.77	75.14	158.70	168.07	89.93	92.25	92.93	92.93
				42.58%	38.82%	15.98%	16.47%					41.44%	44.71%			4.48%	4.70%	58.56%	55.29%
	TOTAL	**6519.02**	**8140.24**	**624.23**	**621.40**	**111.78**	**115.10**	**62.48**	**70.30**	**306.55**	**360.84**	**273.50**	**294.35**	**1009.51**	**1030.85**	**480.81**	**546.24**	**736.01**	**736.50**
				61.83%	**60.28%**	**11.07%**	**11.17%**					**27.09%**	**28.55%**			**7.38%**	**6.71%**	**72.91%**	**71.45%**

(% is calculated with respect to Excavated Area as applicable)

Note: In reference of the above Table, different parameters are classified as follows: (Cluster XV 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".

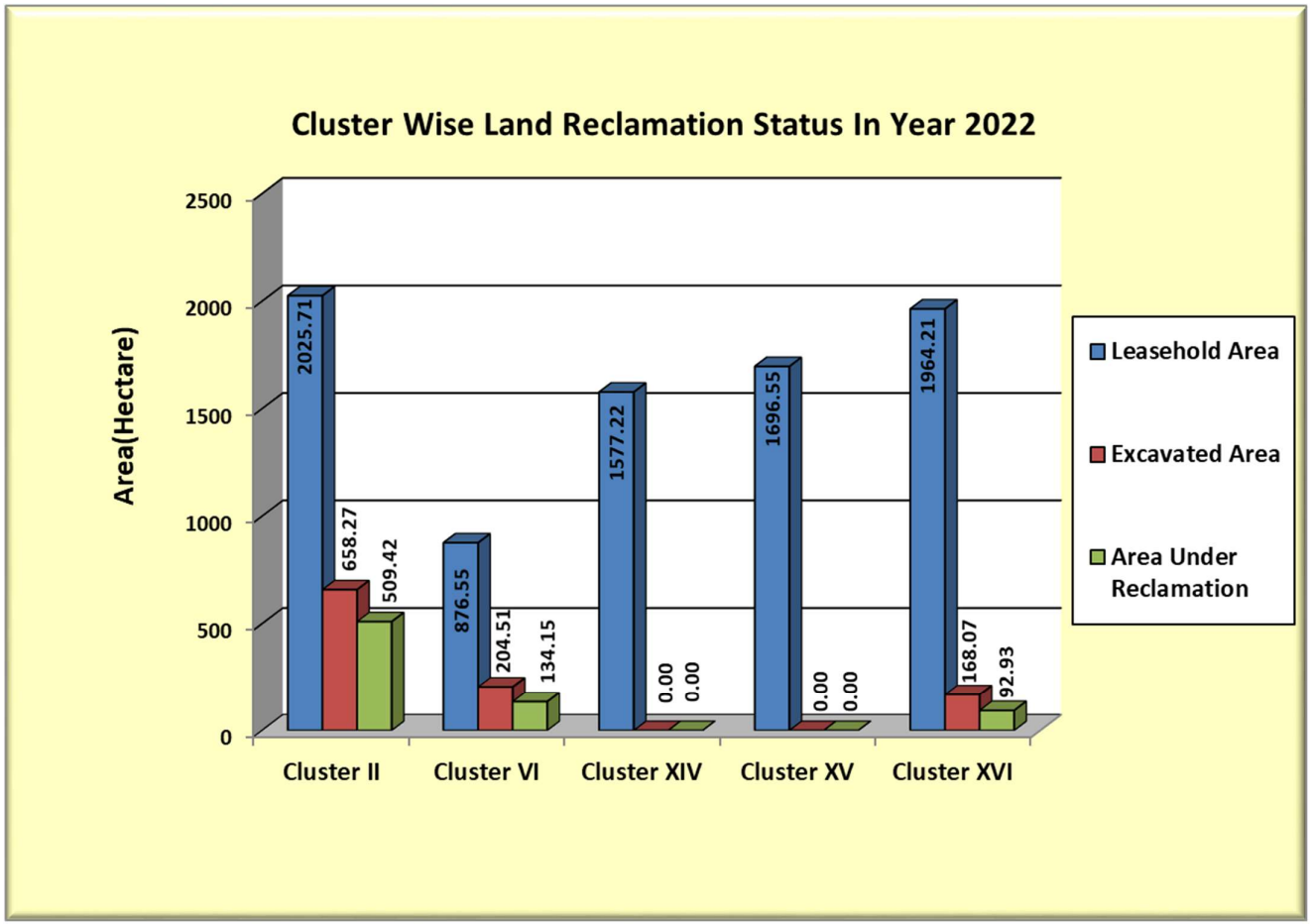


Fig. 1: Cluster wise Land Reclamation Status in five Clusters - 2022 (BCCL)

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 m^3 per annum capacity (Coal +OB) at an interval of three years based on remote sensing satellite data for sustainable development of mining. Earlier, CMPDI used to carry out land reclamation monitoring for individual projects of less than 5 million capacities, but from 2017 the same was carried out cluster wise for mines of BCCL. For operational reasons and convenience, underground and opencast mines (often with multiple overlapping seams), have now been clustered together. Further, a revised work order was issued vide letter no. CIL/ENVT/2022-23/W.O/10899 dated 06.07.2022 from Coal India Limited for the period 2022-23 to 2023-24. According to this work order, 76 OC projects having more than 5 million cu. m (coal +OB) per annum capacity shall be monitored every year and also land reclamation monitoring of 33 OCPs having less than 5 million cu. m (coal +OB) per annum capacity, totaling 109 OC mines will be monitored in

2022-23 covering all the subsidiaries of Coal India Ltd. The result of land reclamation status of all such mines are hosted on the website of CIL, (www.coalindia.in), CMPDI (www.cmpdi.co.in) and the concerned coal companies in public domain. Detailed report is submitted to Coal India and respective subsidiaries.

1.3 Land reclamation monitoring of all 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 2022 carried out for five clusters of mines comprising both underground and opencast projects of 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:

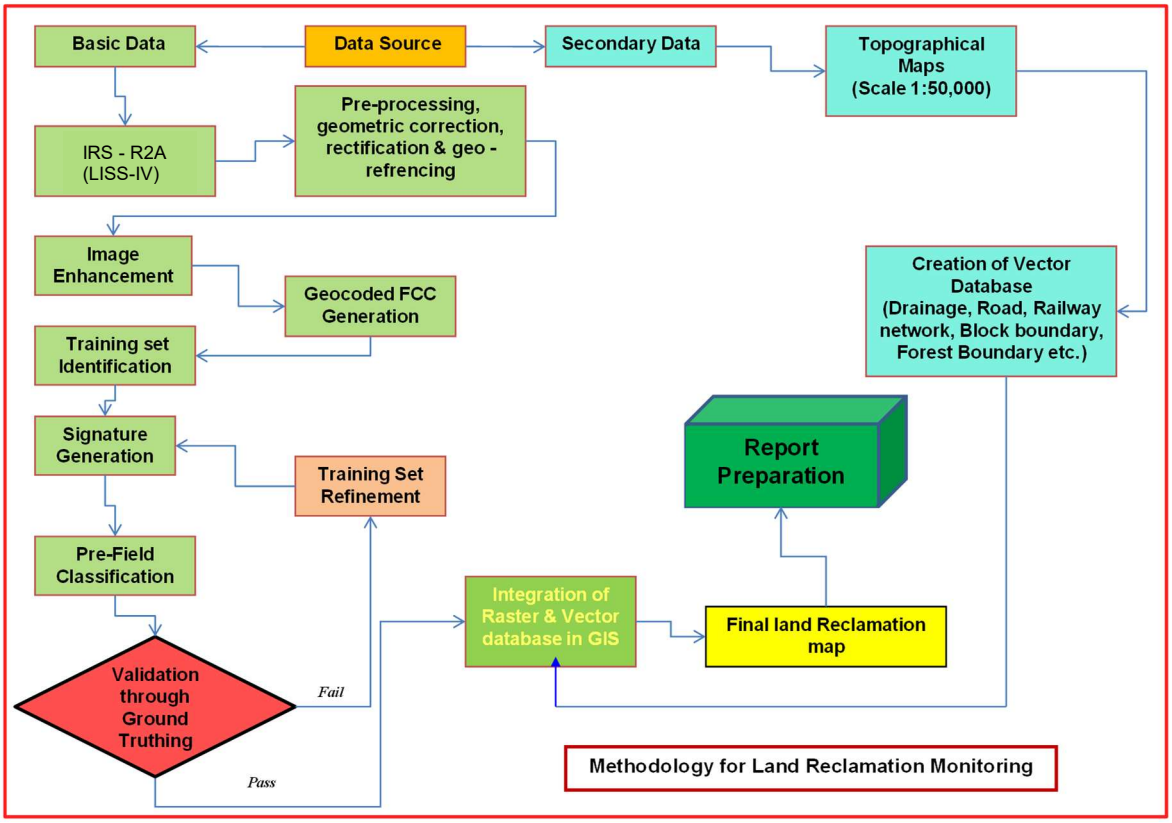


Fig. 2: Methodology of Land Reclamation Monitoring

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 SoI toposheet.

- **Image enhancement:**

  To improve the interpretability of the raw data, image enhancement is necessary. Local operations modify the value of each pixel based on brightness value of neighbouring pixels using ERDAS IMAGINE 2022 s/w. and enhance the image quality for interpretation.

- **Training set selection**

  Training set requires to be selected, so that software can classify the image data accurately. The image data are analysed based on the interpretation keys. These keys are evolved from certain fundamental image-elements such as tone/colour, size, shape, texture, pattern, location, association and shadow. Based on the image-elements and other geo-technical elements like land form, drainage pattern and physiography; training sets were selected/identified for each land use/cover class. Field survey was carried out by taking selective traverses in order to collect the ground information (or reference data) so that training sets are selected accurately in the image. This was intended to serve as an aid for classification.

- **Classification and Accuracy assessment**

  Image classification is carried out using the maximum likelihood algorithm. The classification proceeds through the following steps: (a) calculation of statistics [i.e. signature generation] for the identified training areas, and (b) the decision boundary of maximum probability based on the mean vector, variance, covariance and correlation matrix of the pixels. After evaluating the statistical parameters of the training sets, reliability test of training sets is conducted by measuring the statistical separation between the classes that resulted from computing divergence matrix. The overall accuracy of the classification was finally assessed with reference to ground truth data.

- **Area calculation**

  The area of each land use class in the leasehold is determined using ERDAS IMAGINE 2022 s/w.

- **Overlay of Vector data base**

  Vector data base is created based on secondary data. Vector layer like drainage, railway line, leasehold boundary, forest boundary etc. are superimposed on the image as vector layer in the Arc GIS database.

- **Pre-field map preparation**

  Pre-field map is prepared for validation of the classification result.

3.3 Ground Truthing:

Selective ground verification of the land use classes is carried out in the field and necessary corrections if required, are incorporated before map finalization.

3.4 Land reclamation database on GIS:

Land reclamation database is created on GIS platform to identify the temporal changes identified from satellite data of different cut - of dates. The database boundary shape files (.shp), kml files and the maps thus prepared confirm to the WGS-84 datum and UTM projected co-ordinate system.

4. 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 2022-23:

- **Cluster II** (Block II Colliery, Jamunia OCP, Shatabdi OCP, Muraidih OCP, Phularitand OCP)
- **Cluster VI** (East Bassuriya Colliery, Bassuriya Colliery, Gondudih Khaskusunda Colliery, Godhur Colliery)
- **Cluster XIV** (Lohapatti Colliery)
- **Cluster XV** (Kharkharee Colliery, Madhuband Colliery, Phularitand Colliery, Dharmaband Colliery)
- **Cluster XVI** (Dahibari Basantimata OCP, Basantimata UG mine, New Laikdih OCP (including Dahibari Coal Washery), Laikdih Deep UG, Chanch UG)

4.2 Cluster wise Land Reclamation status of above mentioned clusters in BCCL is given in Table 1 and also shown graphically in Fig 1. Area statistics of different land use classes present in the mine leasehold of the above clusters for the year 2022 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 8140.24 Ha. of the 5 clusters of mines (Underground + Opencast) of BCCL mentioned above taken for this study in 2022-23, total excavated area is 1030.85 Ha. out of which 115.10 Ha. (11.17%) has been planted (*Biologically Reclaimed*), 621.40 Ha. (60.28%) is under backfilling (*Technically Reclaimed*) and balance 294.35 Ha. (28.55%) is under active mining.

4.4 Land reclamation monitoring for cluster XV of BCCL is taken up for the first time in the year 2022-23. Hence comparison of this cluster in year 2022 has

not been made with respect to year 2019. The data thus generated in the year 2022 will be considered as base data for further comparison of land reclamation of this cluster of mines.

4.5 It is seen that technical reclamation in the above clusters has decreased from 624.23 Ha. (Yr 2019) to 621.40 Ha. (Yr 2022). This is due to increase in biological reclamation in cluster II and cluster XVI.

4.6 Study indicates that cluster II and cluster XVI of BCCL considered for this study in the year 2022-23 indicate increasing trend in Biological Reclamation (plantation on backfill) with respect to the year 2019. Area under plantation on backfill has increased from 86.42 Ha. (Yr 2019) to 87.42 Ha. (Yr 2022) in cluster II and from 25.36 Ha. (Yr 2019) to 27.68 Ha. (Yr 2022) in cluster XVI. As cluster XIV & cluster XV comprise of underground mines, there is no biological reclamation.

4.7 On comparing the status of plantation on OB dumps for the year 2022 with respect to the year 2019 in all cluster of mines of BCCL considered for land reclamation monitoring in the year 2022-23, it is evident from the analysis that area under plantation on OB dumps has increased from 43.28 Ha. (Yr 2019) to 47.29 Ha. (Yr 2022) in cluster II and from 5.89 Ha. (Yr 2019) to 9.70 Ha. (Yr 2022) in cluster VI. This is due to the sincere effort made by BCCL towards environmental protection in OC projects. Cluster XIV and Cluster XV consist of UG mines, so there is no plantation on OB. In cluster XVI there is no change or plantation on OB is static during the last three-year duration.

4.8 It is seen that plantation under social forestry has decreased from 154.37 Ha. (Yr 2019) to 128.03 Ha. (Yr 2022) in cluster II and from 74.13 Ha. (Yr 2019) to 72.42 Ha. (Yr 2022) in cluster XIV. This decrease of 26.34 Ha. area in cluster II and 1.71 Ha. in cluster XIV is due to change in shape and area of these clusters.

4.9 In Cluster VI, it is seen that total excavated area has decreased from 211.90 Ha. (Yr 2019) to 204.51 Ha. (Yr 2022). This decrease of 7.39 Ha. area is due to reduction in area under active mining which is due to change in shape and area of this cluster. The cluster boundary is updated as per EC.

4.10 After analyzing the satellite data of the year 2019 vs 2022, it reveals that area under total plantation (Green cover) carried out on backfilled area, OB dumps as well as under social forestry in the above clusters of BCCL has increased from 480.81 Ha. (7.38%) to 546.24 Ha. (6.71%) in span of last three years. This significant increase of 65.43 Ha. area under total plantation (Green Cover) in the leasehold boundary during three years is due to increase in plantation on OB dumps in cluster II and cluster VI, increase in plantation under social forestry in cluster VI and plantation on backfill in cluster II and cluster XVI and also due to addition of cluster-XV.

4.11 On comparing the status of land reclamation for the year 2022 with respect to the year 2019 in all cluster of mines of BCCL considered for land reclamation in the year 2022-23, it is evident from the analysis that area under total land reclamation has increased from 736.01 Ha. (Yr 2019) to 736.50 Ha. (Yr 2022).

4.12 Out of the 5 Clusters in BCCL considered for satellite data based land reclamation monitoring in year 2022, Cluster II tops with 77.39% reclamation followed by Cluster VI with 65.60% and Cluster XVI with 55.29%. Cluster XIV and Cluster XV consist of UG mines, so there is no reclamation activity.

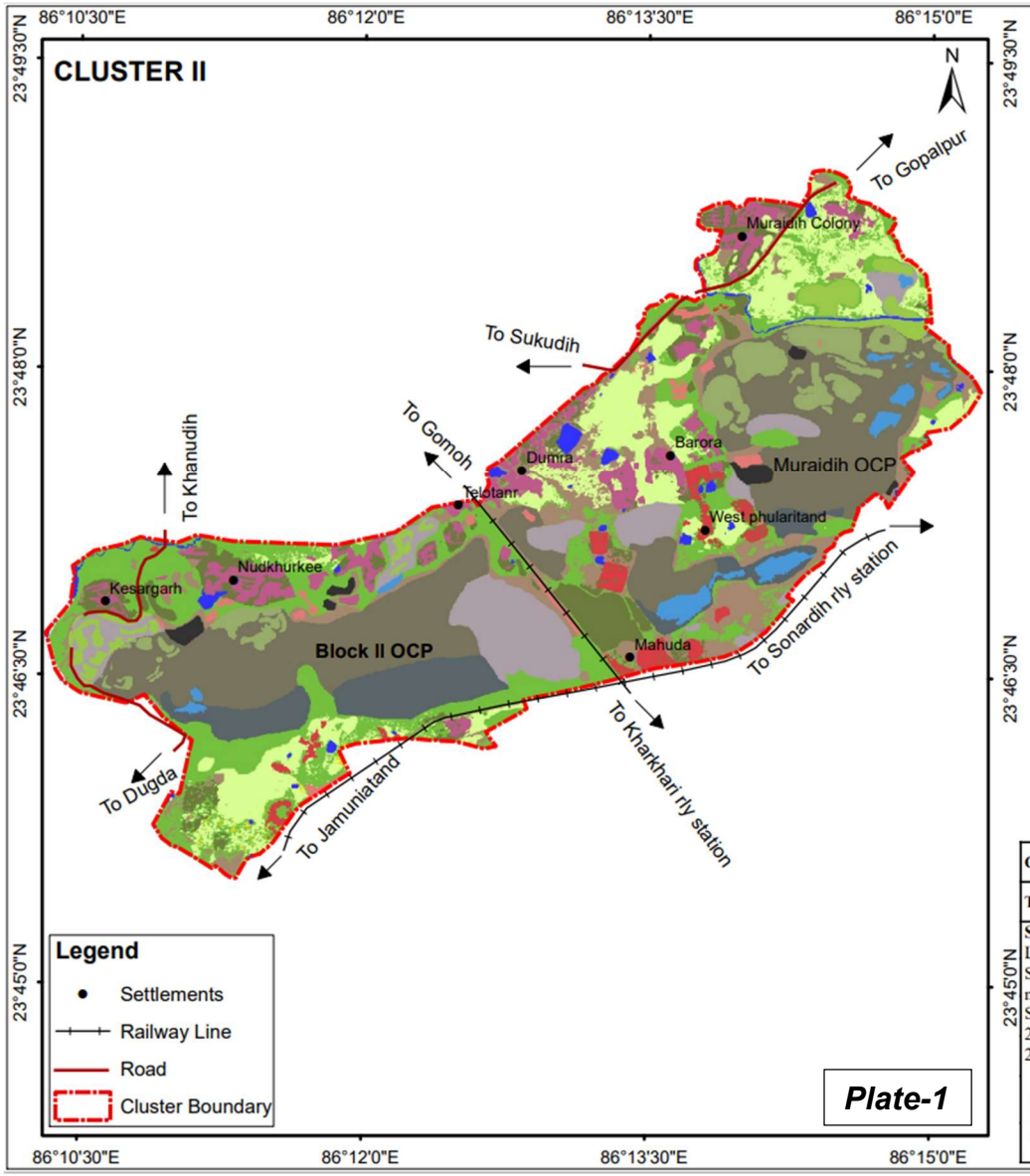
4.13 The area under total plantation (Green Cover) is maximum in Cluster II (12.97%) followed by Cluster XV with (4.76%), Cluster XVI with (4.70%), Cluster XIV with (4.59%) and Cluster VI with (4.35%).

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 2022

(Area in Hectare)

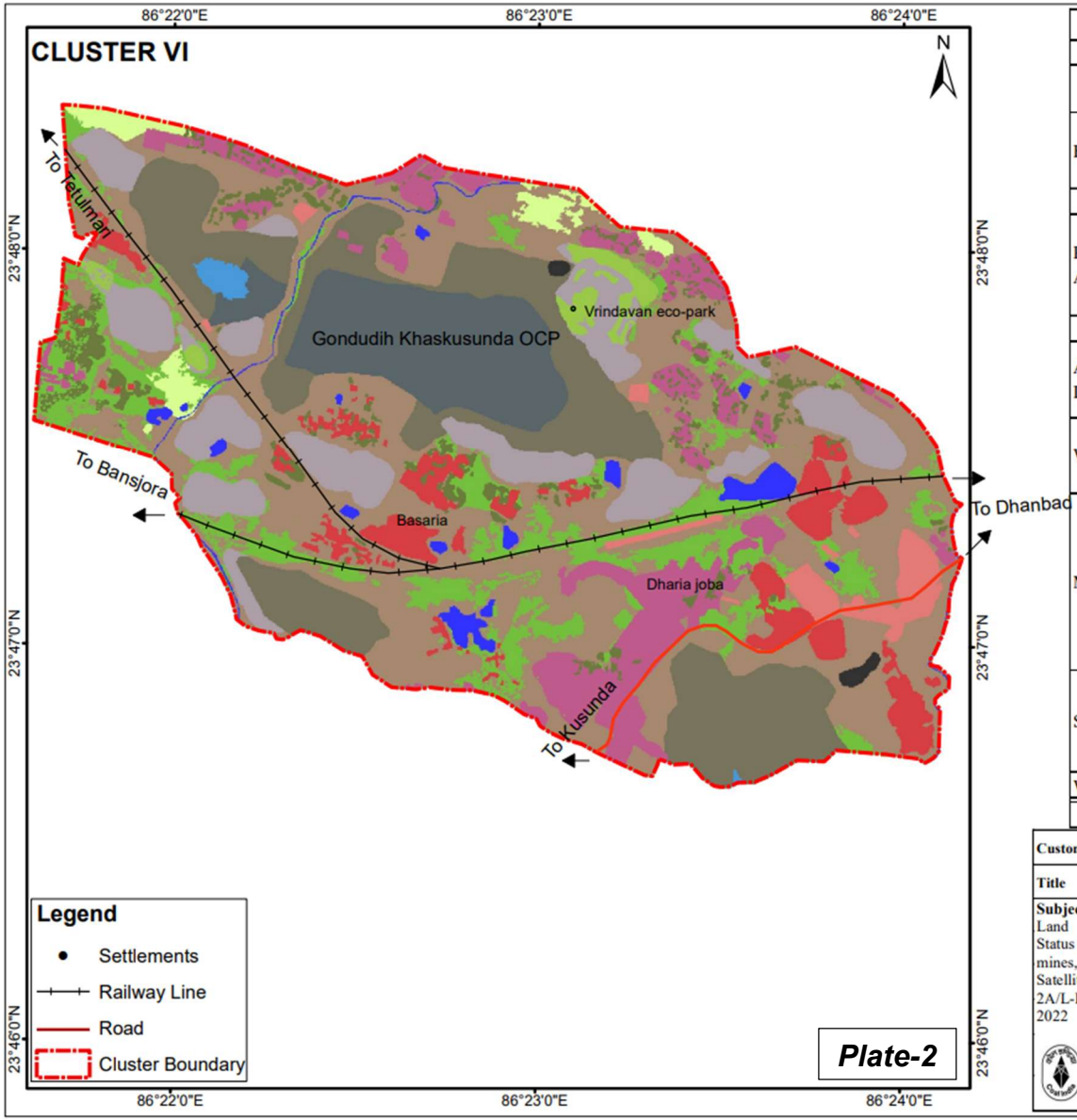
		CLUSTER II		CLUSTER VI		CLUSTER XIV		CLUSTER XV		CLUSTER XVI		TOTAL	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FORESTS	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.30	1.34	26.30	0.32
	Total Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.30	1.34	26.30	0.32
SCRUBS	Scrubs	381.65	18.84	87.34	9.96	443.67	28.13	525.26	30.96	537.34	27.36	1975.26	24.27
PLANTATION	Social Forestry/Avenue Plantation	128.03	6.32	28.41	3.24	72.42	4.59	80.72	4.76	51.26	2.61	360.84	4.43
	Plantation on OB Dump	47.29	2.33	9.70	1.11	0.00	0.00	0.00	0.00	13.31	0.68	70.30	0.86
	Plantation on Backfill (Biological Reclamation)	87.42	4.32	0.00	0.00	0.00	0.00	0.00	0.00	27.68	1.41	115.10	1.41
	Total Plantation	262.74	12.97	38.11	4.35	72.42	4.59	80.72	4.76	92.25	4.70	546.24	6.71
	Total Vegetation	**644.39**	**31.81**	**125.45**	**14.31**	**516.09**	**32.72**	**605.98**	**35.72**	**655.89**	**33.40**	**2547.80**	**31.30**
	Coal Dump	15.58	0.77	2.08	0.24	0.00	0.00	0.00	0.00	7.49	0.38	25.15	0.31
ACTIVE MINING	Coal Quarry	116.08	5.73	66.86	7.63	0.00	0.00	0.00	0.00	53.80	2.74	236.74	2.91
	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	32.77	1.62	3.50	0.40	0.00	0.00	0.00	0.00	21.34	1.09	57.61	0.71
	Total Area under *Active Mining*	**148.85**	**7.35**	**70.36**	**8.03**	**0.00**	**0.00**	**0.00**	**0.00**	**75.14**	**3.83**	**294.35**	**3.62**
	Barren OB Dump	146.93	7.25	89.04	10.16	0.00	0.00	1.33	0.08	41.69	2.12	278.99	3.43
RECLAIMED	Area Under Backfilling (Technical Reclamation)	422.00	20.83	134.15	15.30	0.00	0.00	0.00	0.00	65.25	3.32	621.40	7.63
	Total Area under *Technical Reclamation*	**422.00**	**20.83**	**134.15**	**15.30**	**0.00**	**0.00**	**0.00**	**0.00**	**65.25**	**3.32**	**621.40**	**7.63**
	Total Area under Mine Operation	**733.36**	**36.20**	**295.63**	**33.73**	**0.00**	**0.00**	**1.33**	**0.08**	**189.57**	**9.65**	**1219.89**	**14.99**
WASTELAND	Waste Lands	191.19	9.44	295.63	33.73	56.80	3.60	346.35	20.41	110.43	5.62	1000.40	12.29
	Fly Ash Pond / Sand Body	2.01	0.10	0.00	0.00	36.74	2.33	0.00	0.00	65.99	3.36	104.74	1.29
	Total Wasteland	**193.20**	**9.54**	**295.63**	**33.73**	**93.54**	**5.93**	**346.35**	**20.41**	**176.42**	**8.98**	**1105.14**	**13.58**
WATERBODIES	Reservoir, nallah, ponds	25.96	1.28	13.72	1.57	44.92	2.85	24.26	1.43	29.89	1.52	138.75	1.70
	Total Waterbodies	**25.96**	**1.28**	**13.72**	**1.57**	**44.92**	**2.85**	**24.26**	**1.43**	**29.89**	**1.52**	**138.75**	**1.70**
AGRICULTURE	Crop Lands	2.51	0.12	0.00	0.00	8.45	0.54	5.75	0.34	108.34	5.52	125.05	1.54
	Fallow Lands	254.68	12.57	13.92	1.59	827.60	52.47	583.26	34.38	554.54	28.23	2234.00	27.44
	Total Agriculture	**257.19**	**12.70**	**13.92**	**1.59**	**836.05**	**53.01**	**589.01**	**34.72**	**662.88**	**33.75**	**2359.05**	**28.98**
SETTLEMENTS	Urban Settlement	111.11	5.48	68.18	7.78	0.00	0.00	85.25	5.02	135.64	6.91	400.18	4.92
	Rural Settlement	41.15	2.03	46.68	5.33	85.72	5.43	40.92	2.41	96.72	4.92	311.19	3.82
	Industrial Settlement	19.35	0.96	17.34	1.98	0.90	0.06	3.45	0.20	17.20	0.88	58.24	0.72
	Total Settlement	**171.61**	**8.47**	**132.20**	**15.08**	**86.62**	**5.49**	**129.62**	**7.64**	**249.56**	**12.71**	**769.61**	**9.45**
	Grand Total	**2025.71**	**100.00**	**876.55**	**100.00**	**1577.22**	**100.00**	**1696.55**	**100.00**	**1964.21**	**100.00**	**8140.24**	**100.00**



Area Statistics - Cluster-II (2022)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**381.65**	**18.84**
Plantation Area	Social Forestry		128.03	6.32
	Plantation on OB		47.29	2.33
	Plantation on Backfill		87.42	4.32
	Total Plantation (C)		**262.74**	**12.97**
	Total Vegetation (A+B+C)		**644.39**	**31.81**
Agriculture Land	Crop land		2.51	0.12
	Fallow Land		254.68	12.57
	Total Agriculture Land		**257.19**	**12.70**
Waste Land	Waste Land		191.19	9.44
	Sand Body		2.01	0.10
	Total Waste Land		**193.20**	**9.54**
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		116.08	5.73
	Barren OB Dump		146.93	7.25
	Back Fill		422.00	20.83
	Coal Dump		15.58	0.77
	Water Filled Qry		32.77	1.62
	Total Mining Area		**733.36**	**36.20**
Settlements	Urban Settlements		111.11	5.48
	Rural Settlements		41.15	2.03
	Industrial Settlements		19.35	0.96
	Total Settlement Area		**171.61**	**8.47**
Water Body	**River/ Ponds**		**25.96**	**1.28**
	Total Area		**2025.71**	**100.00**

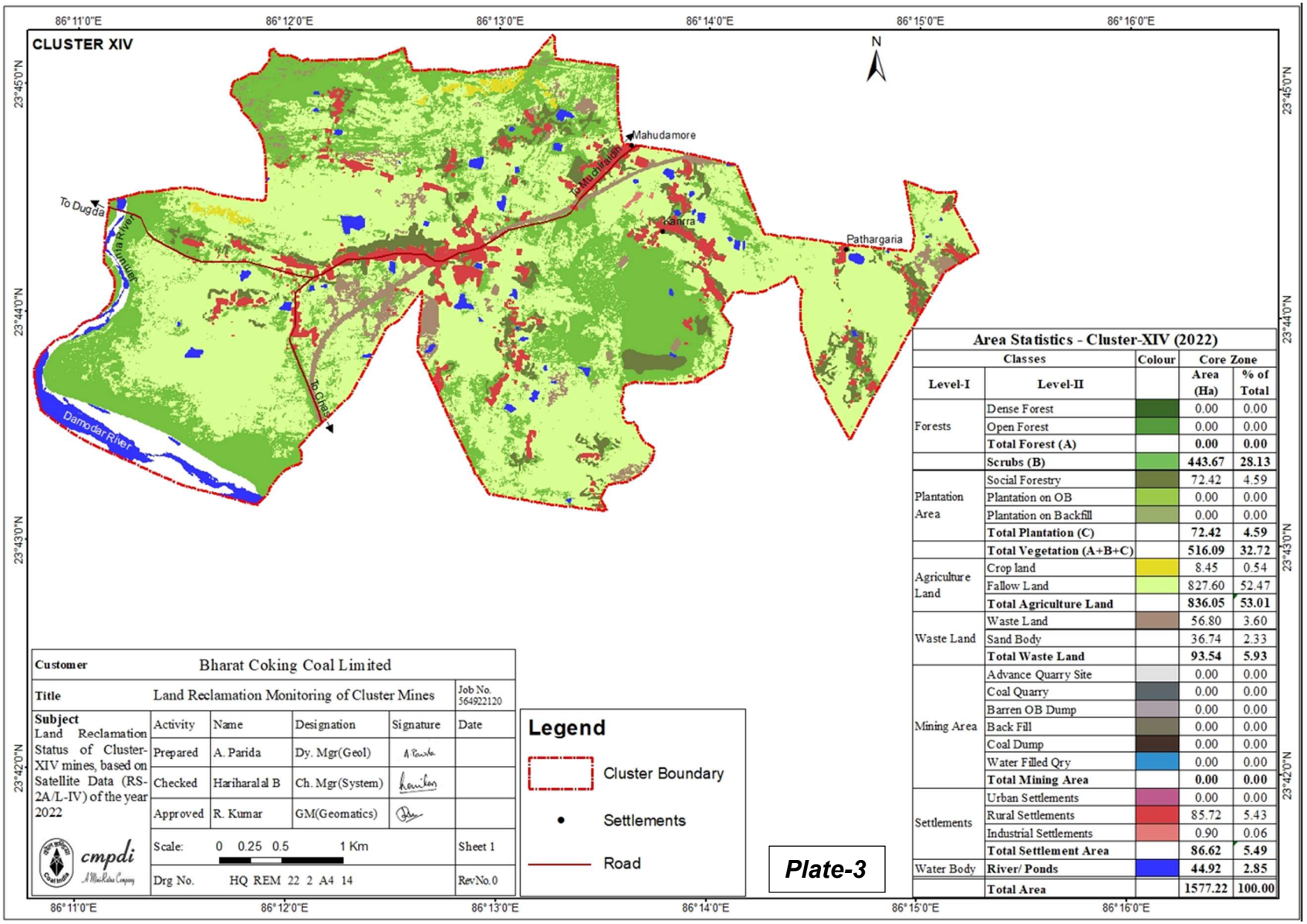
Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 564922120
Subject Land Reclamation Status of Cluster-II mines, based on Satellite Data (RS-2A/L-IV) of the year 2022	Activity	Name	Designation	Signature	Date
	Prepared	A. Parida	Dy. Mgr(Geol)		
	Checked	Hariharalal B	Ch. Mgr(System)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi	Scale: 0 0.5 1 2 Km				Sheet 1
	Drg No. HQ REM 22 2 A4 02				Rev No.0



Area Statistics - Cluster-VI (2022)

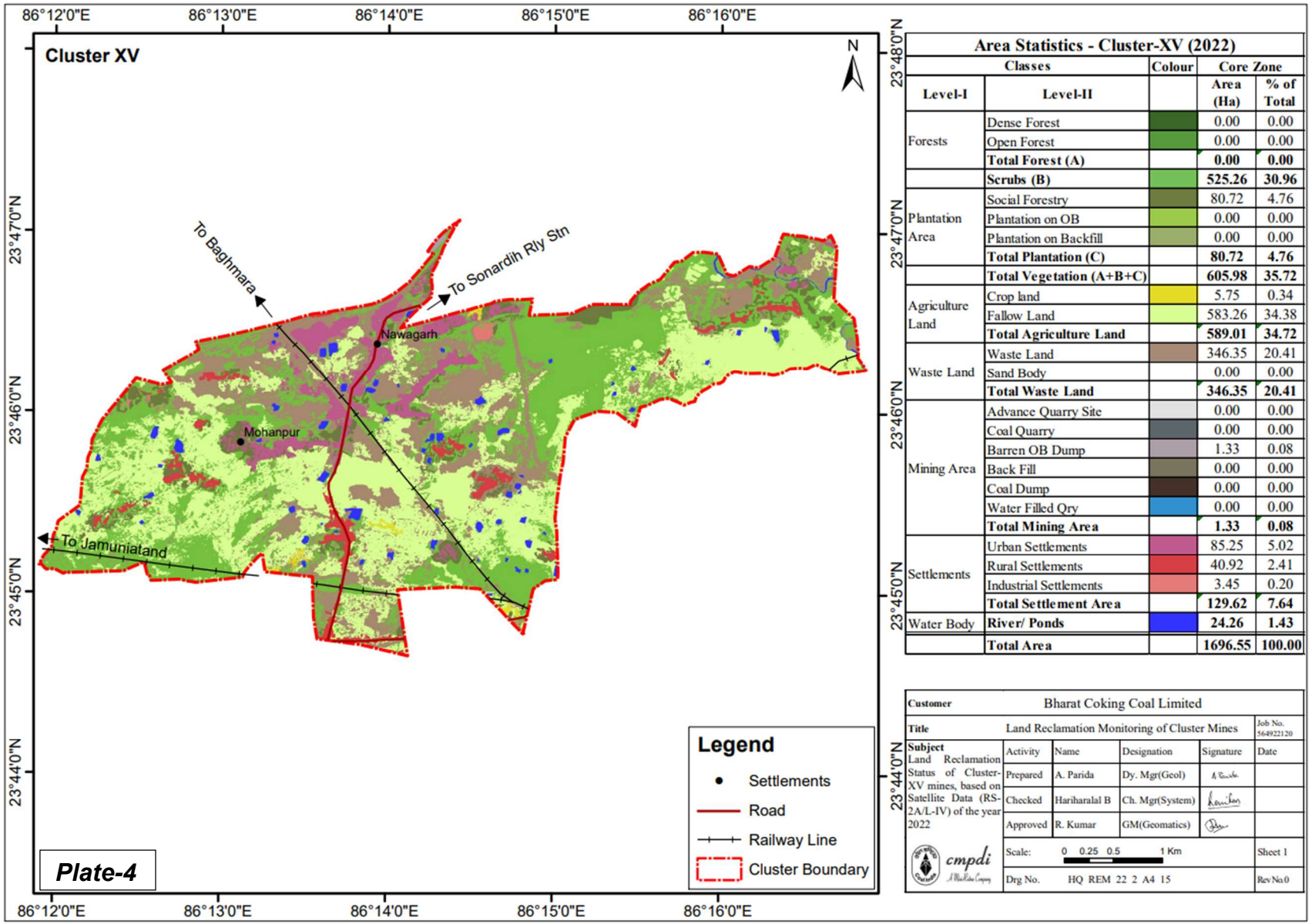
Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**87.34**	**9.96**
Plantation Area	Social Forestry		28.41	3.24
	Plantation on OB		9.70	1.11
	Plantation on Backfill		0.00	0.00
	Total Plantation (C)		**38.11**	**4.35**
	Total Vegetation (A+B+C)		**125.45**	**14.31**
Agriculture Land	Crop land		0.00	0.00
	Fallow Land		13.92	1.59
	Total Agriculture Land		**13.92**	**1.59**
Waste Land	Waste Land		295.63	33.73
	Sand Body		0.00	0.00
	Total Waste Land		**295.63**	**33.73**
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		66.86	7.63
	Barren OB Dump		89.04	10.16
	Back Fill		134.15	15.30
	Coal Dump		2.08	0.24
	Water Filled Qry		3.50	0.40
	Total Mining Area		**295.63**	**33.73**
Settlements	Urban Settlements		68.18	7.78
	Rural Settlements		46.68	5.33
	Industrial Settlements		17.34	1.98
	Total Settlement Area		**132.20**	**15.08**
Water Body	**River/ Ponds**		**13.72**	**1.57**
	Total Area		**876.55**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 564922120
Subject Land Reclamation Status of Cluster-VI mines, based on Satellite Data (RS-2A/L-IV) of the year 2022	Activity	Name	Designation	Signature	Date
	Prepared	A. Parida	Dy. Mgr(Geol)		
	Checked	Hariharalal B	Ch. Mgr(System)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 22 2 A4 06				RevNo.0



Area Statistics - Cluster-XIV (2022)

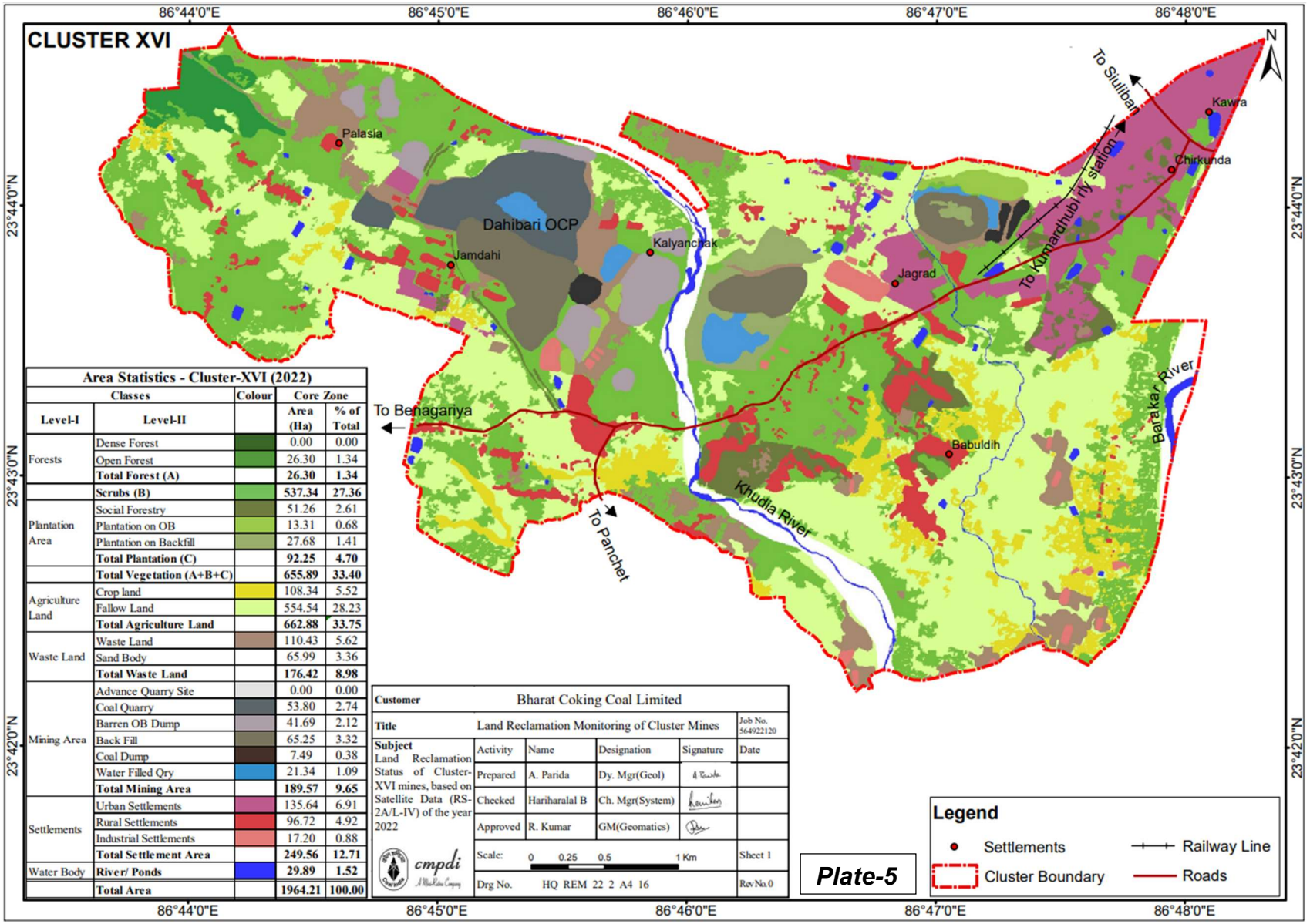
Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**443.67**	**28.13**
Plantation Area	Social Forestry		72.42	4.59
	Plantation on OB		0.00	0.00
	Plantation on Backfill		0.00	0.00
	Total Plantation (C)		**72.42**	**4.59**
	Total Vegetation (A+B+C)		**516.09**	**32.72**
Agriculture Land	Crop land		8.45	0.54
	Fallow Land		827.60	52.47
	Total Agriculture Land		**836.05**	**53.01**
Waste Land	Waste Land		56.80	3.60
	Sand Body		36.74	2.33
	Total Waste Land		**93.54**	**5.93**
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		0.00	0.00
	Barren OB Dump		0.00	0.00
	Back Fill		0.00	0.00
	Coal Dump		0.00	0.00
	Water Filled Qry		0.00	0.00
	Total Mining Area		**0.00**	**0.00**
Settlements	Urban Settlements		0.00	0.00
	Rural Settlements		85.72	5.43
	Industrial Settlements		0.90	0.06
	Total Settlement Area		**86.62**	**5.49**
Water Body	**River/ Ponds**		**44.92**	**2.85**
	Total Area		**1577.22**	**100.00**



Area Statistics - Cluster-XV (2022)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**525.26**	**30.96**
Plantation Area	Social Forestry		80.72	4.76
	Plantation on OB		0.00	0.00
	Plantation on Backfill		0.00	0.00
	Total Plantation (C)		**80.72**	**4.76**
	Total Vegetation (A+B+C)		**605.98**	**35.72**
Agriculture Land	Crop land		5.75	0.34
	Fallow Land		583.26	34.38
	Total Agriculture Land		**589.01**	**34.72**
Waste Land	Waste Land		346.35	20.41
	Sand Body		0.00	0.00
	Total Waste Land		**346.35**	**20.41**
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		0.00	0.00
	Barren OB Dump		1.33	0.08
	Back Fill		0.00	0.00
	Coal Dump		0.00	0.00
	Water Filled Qry		0.00	0.00
	Total Mining Area		**1.33**	**0.08**
Settlements	Urban Settlements		85.25	5.02
	Rural Settlements		40.92	2.41
	Industrial Settlements		3.45	0.20
	Total Settlement Area		**129.62**	**7.64**
Water Body	**River/ Ponds**		**24.26**	**1.43**
	Total Area		**1696.55**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 564922120
Subject Land Reclamation Status of Cluster-XV mines, based on Satellite Data (RS-2A/L-IV) of the year 2022	Activity	Name	Designation	Signature	Date
	Prepared	A. Parida	Dy. Mgr(Geol)		
	Checked	Hariharalal B	Ch. Mgr(System)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 22 2 A4 15				Rev No.0



Area Statistics - Cluster-XVI (2022)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		26.30	1.34
	Total Forest (A)		**26.30**	**1.34**
	Scrubs (B)		**537.34**	**27.36**
Plantation Area	Social Forestry		51.26	2.61
	Plantation on OB		13.31	0.68
	Plantation on Backfill		27.68	1.41
	Total Plantation (C)		**92.25**	**4.70**
	Total Vegetation (A+B+C)		**655.89**	**33.40**
Agriculture Land	Crop land		108.34	5.52
	Fallow Land		554.54	28.23
	Total Agriculture Land		**662.88**	**33.75**
Waste Land	Waste Land		110.43	5.62
	Sand Body		65.99	3.36
	Total Waste Land		**176.42**	**8.98**
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		53.80	2.74
	Barren OB Dump		41.69	2.12
	Back Fill		65.25	3.32
	Coal Dump		7.49	0.38
	Water Filled Qry		21.34	1.09
	Total Mining Area		**189.57**	**9.65**
Settlements	Urban Settlements		135.64	6.91
	Rural Settlements		96.72	4.92
	Industrial Settlements		17.20	0.88
	Total Settlement Area		**249.56**	**12.71**
Water Body	**River/ Ponds**		**29.89**	**1.52**
	Total Area		**1964.21**	**100.00**

Customer	Bharat Coking Coal Limited			Job No. 564922120
Title	Land Reclamation Monitoring of Cluster Mines			
Subject Land Reclamation Status of Cluster-XVI mines, based on Satellite Data (RS-2A/L-IV) of the year 2022	Activity	Name	Designation	Signature / Date
	Prepared	A. Parida	Dy. Mgr(Geol)	
	Checked	Hariharalal B	Ch. Mgr(System)	
	Approved	R. Kumar	GM(Geomatics)	
	Scale: 0 0.25 0.5 1 Km			Sheet 1
	Drg No. HQ REM 22 2 A4 16			Rev No. 0

Legend

- Settlements
- Cluster Boundary
- Railway Line
- Roads

Plate-5

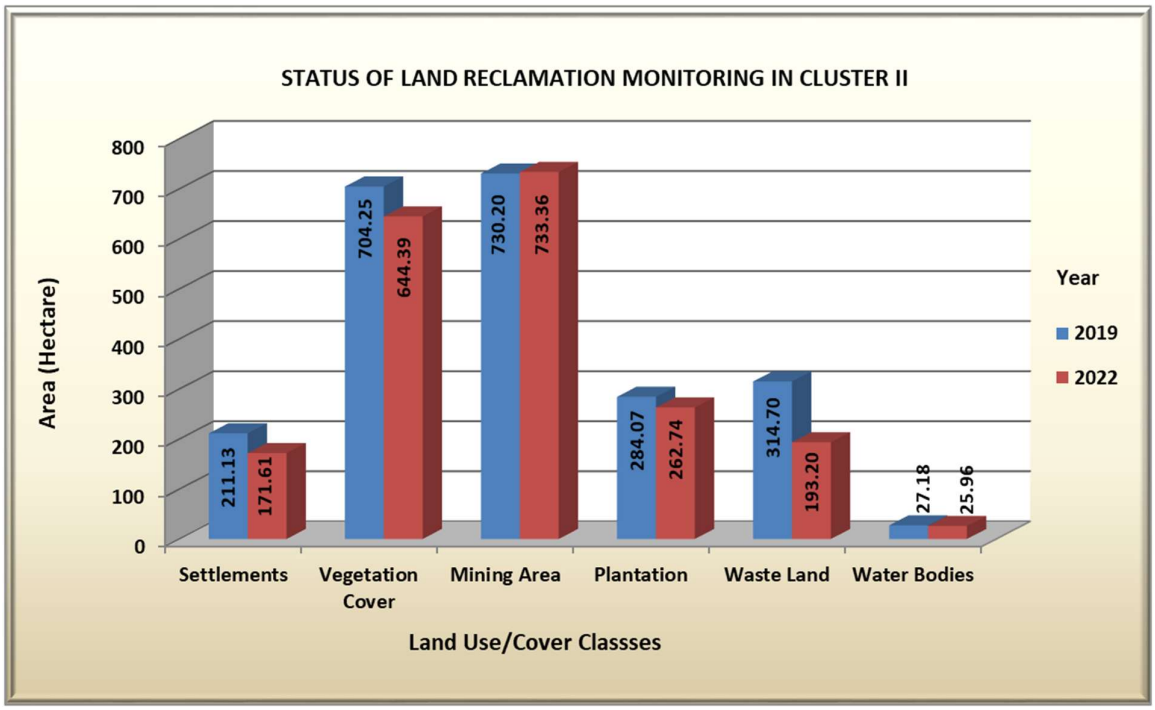


Fig. 3: Land Reclamation Status of Cluster II

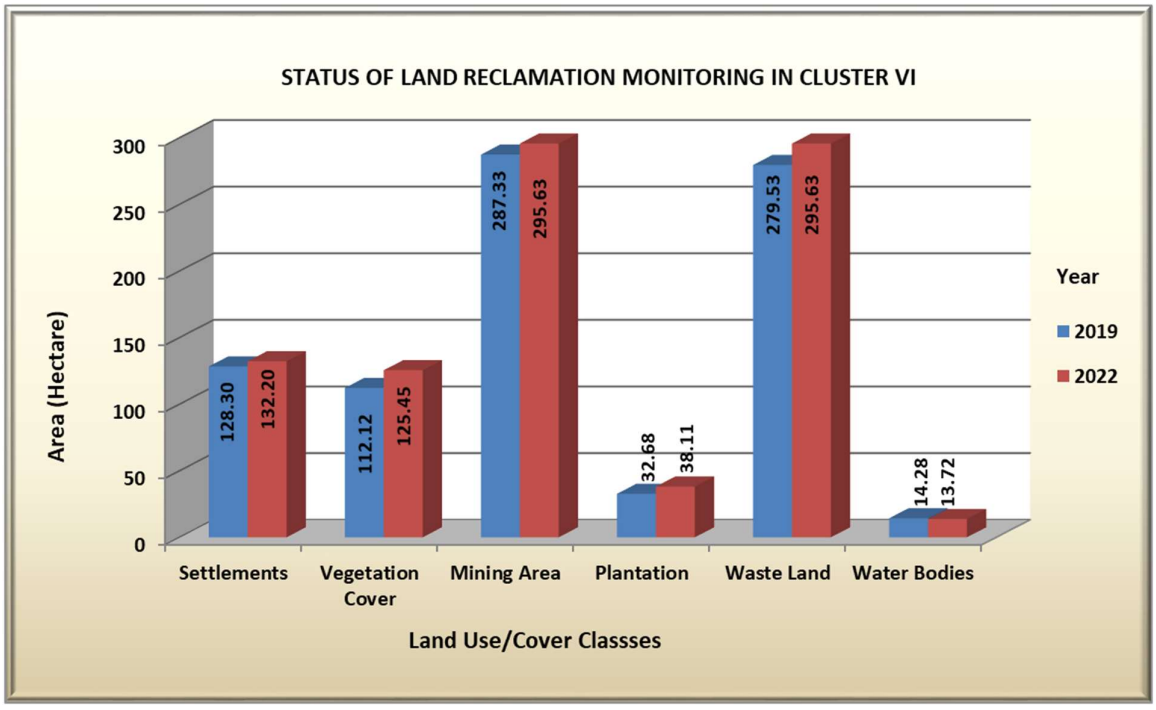


Fig. 4: Land Reclamation Status of Cluster VI

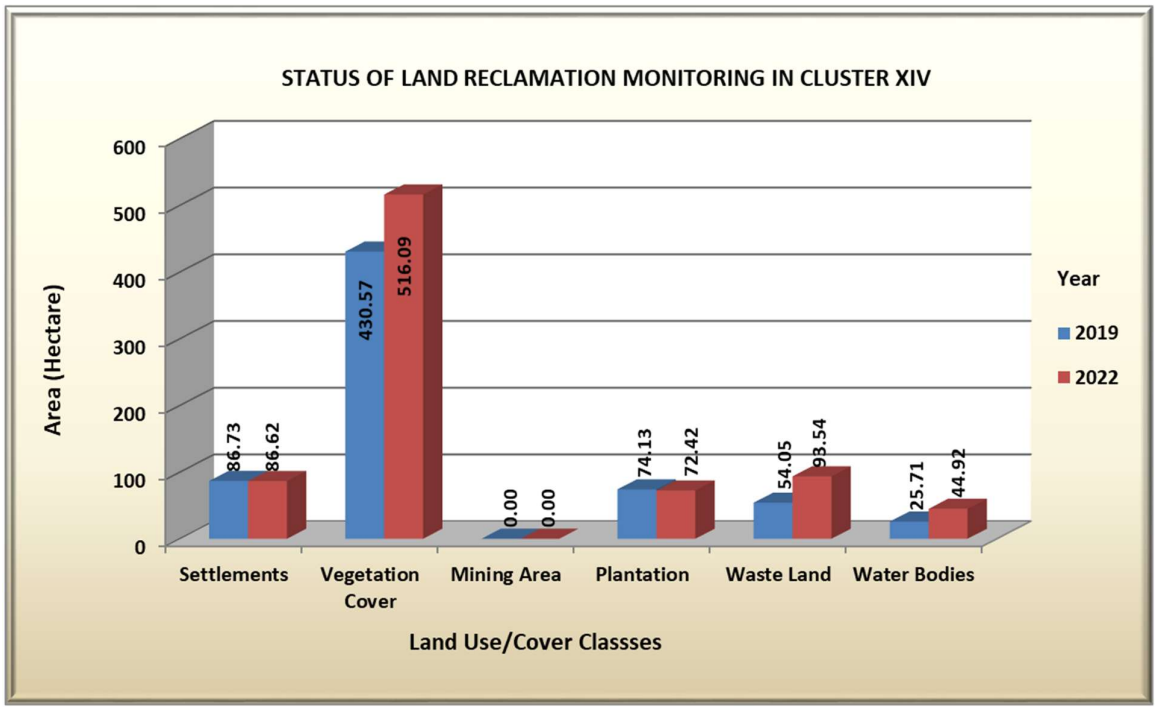


Fig. 5: Land Reclamation Status of Cluster XIV

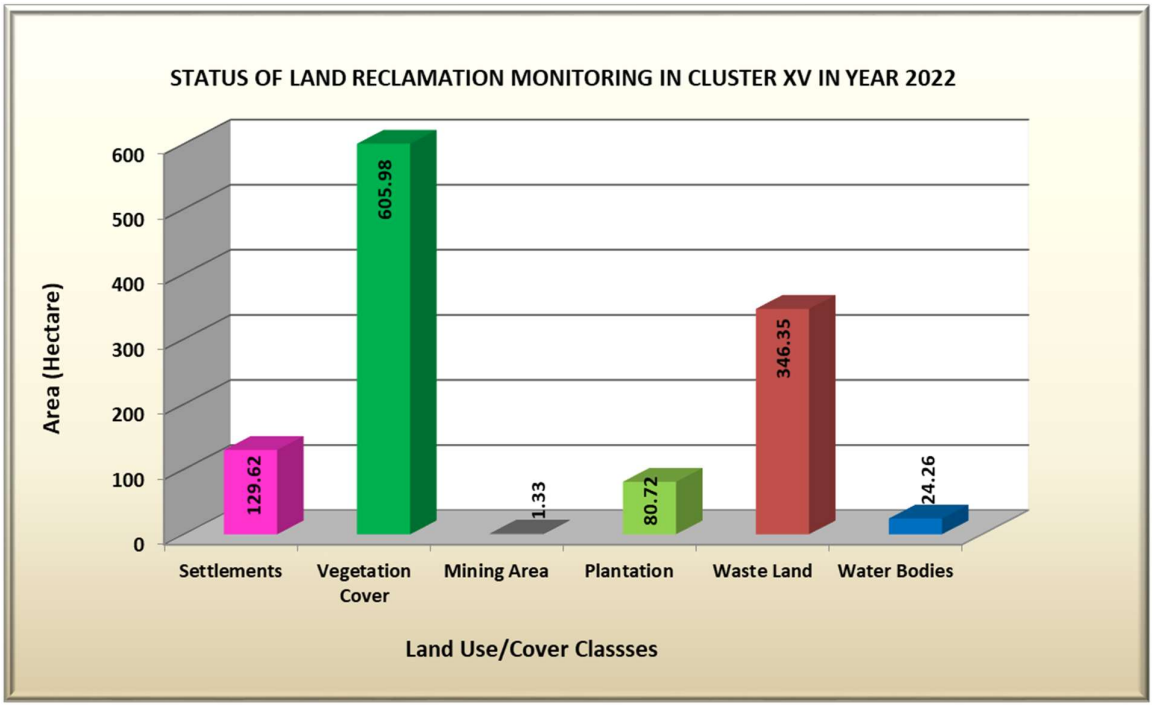


Fig. 6: Land Reclamation Status of Cluster XV

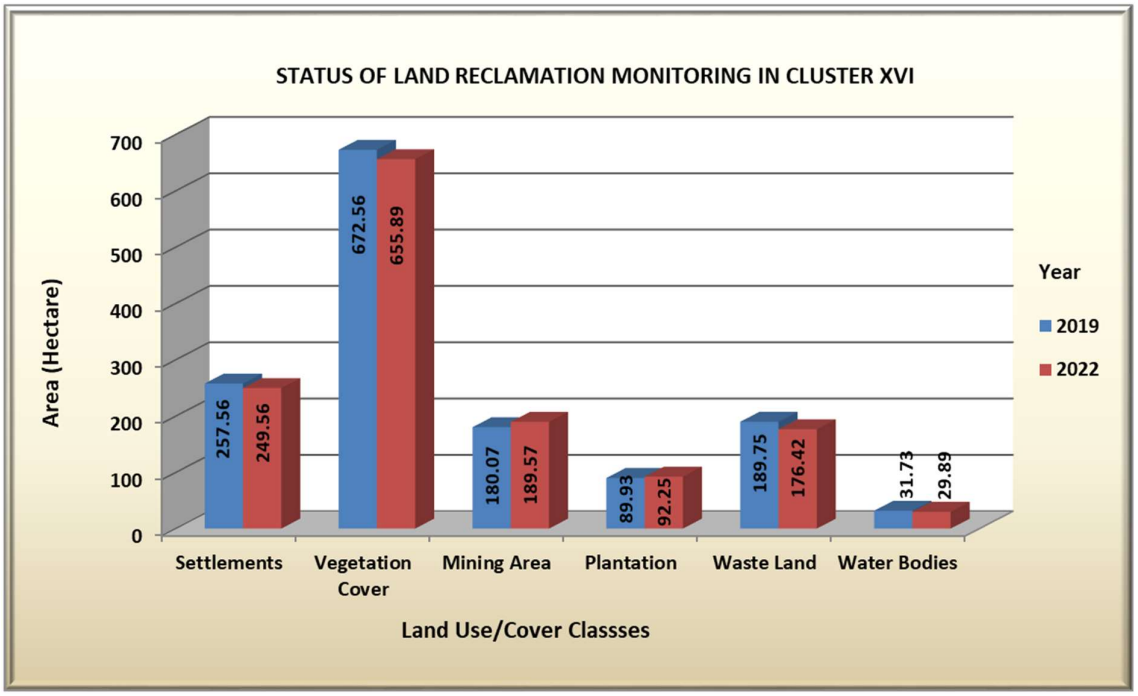


Fig. 7: Land Reclamation Status of Cluster XVI

Photo 1: Plantation on Backfill in Muraidih OCP, Cluster II

Photo 2: Plantation on OB Dump in Block II OCP, Cluster II

Photo 3: Vrindavan Ecopark in Cluster VI

Photo 4: Plantation on Backfill in Cluster XVI

ABBREVIATIONS

SoI	Survey of India
MoEF & CC	Ministry of Environment, Forest & Climate Change
CIL	Coal India Limited
ECL	Eastern Coalfields Limited
BCCL	Bharat Coking Coal Limited
CCL	Central Coalfields Limited
WCL	Western Coalfields Limited
SECL	South Eastern Coalfields Limited
NCL	Northern Coalfields Limited
MCL	Mahanadi Coalfields Limited
NEC	North Eastern Coalfields
CMPDIL	Central Mine Planning & Design Institute Ltd
NRSC	National Remote Sensing Centre
R2/ R2A	ResourceSat Satellites
LISS - 4	Linear Imaging and Self Scanning Sensor
FCC	False Colour Composite
OCP	Opencast Project
UGP	Underground Project
OB	Over Burden
GCP	Ground Control points
GIS	Geographic Information System
WGS-84	World Geodetic System
UTM	Universal Transverse Mercator

GLOSSARY

Sl.	Term	Definition
1.	Land Reclamation	To manage, reclaim and restore mined out/ degraded land as close as possible to its original stage.
2.	Over Burden	The material that lies above the coal seam/ deposit
3.	Monitoring	A process of evaluation to check or keep record for a period of time.
4.	Opencast Coal Mine	Open-pit mining, also known as opencast mining, is a surface mining technique that extracts minerals from an open pit in the ground.
5.	Social Forestry	Social forestry is the management and protection of forests and afforestation of barren and deforested lands with the purpose of helping environmental, social and rural development. Plantation (Social/ Avenue or other) carried out outside mining area.
6.	Biological Reclamation	Plantation on Backfilled areas (Stablised Internal Dumps)
7.	Technical Reclamation	Area under backfilling (Over burden dumped inside the mine voids) in mining area.
8.	Green Cover Generated	Total Plantation carried out in the lease area of Project. This includes Plantation on Backfill, Plantation on OB and Social Forestry.
9.	Leasehold Area	The area, for which lease is granted for the purpose of undertaking mining and allied operations.
10.	Excavated area	Mined out area which includes active mining, area under backfilling and plantation on backfilled areas
11.	Active Mining	Mining areas which include Coal Quarry, Advance Quarry, Quarry Filled with Water etc.
12.	Environmental Protection	It is the practice of protecting the natural environment by individuals, organizations and governments. Its objectives are to conserve natural resources and the existing natural environment and, where possible, to mitigate damage and reverse trends.
13.	Remedial Measure	Any measure or action required or undertaken to investigate, monitor, clean up, remove, treat, prevent, contain or otherwise remediate the presence or release of any hazardous substance or activity.
14.	Systematic Error	Every measurement differing from the true measurement in the same direction, and even by the same amount in some cases.

15.	Geometric Distortion	It refers to the improper positioning of any image with respect to their true geographic position when viewed in a properly scaled common image display plane.
16.	Land Use/ Cover Class	Land cover is what covers the surface of the earth and land use describes how the land is used.
17.	Accuracy	The closeness of agreement between a measured quantity value and a true quantity value.
18.	Environmental Clearance	Environmental Clearance (EC) for any developmental projects like coal mining projects etc. has been made mandatory by the Ministry of Environment, Forests and Climate Change (MoEF & CC) through its Notification issued on 27.01.1994 under the provisions of Environment (Protection) Act, 1986.
19.	Rectification and Geo-referencing	Geo-referencing is the assigning of absolute location of a data point or data points. Geo-rectification refers to the removal of geometric distortions between sets of data points, most often the removal of terrain, platform, and sensor induced distortions from remote sensing imagery.
20.	Image Enhancement	It is the process of modifying digital images so that the results are more suitable for processing or further image analysis.
21.	Training set selection	It is a portion of a data set used to fit or train a model for prediction or classification of values that are known in the training set, but unknown in other (future) data.
22.	Image Classification	It refers to the task of extracting information classes from a multiband raster image. The resulting raster from image classification can be used to create thematic maps.
23.	Temporal Changes	The 'temporal change' means the change in any entity with a period of time.
24.	Ground Truthing	Collection of primary/ basic information from ground realities for satellite image interpretation and thematic mapping.
25.	Cluster	Group of opencast and/ or underground mines clubbed together for administrative purposes.
26.	Arc GIS	GIS Software used for Map preparation
27.	ERDAS IMAGINE	Satellite Image Data Classification Software

Central Mine Planning & Design Institute Ltd.

(A Subsidiary of Coal India Ltd.)

Gondwana Place, Kanke Road, Ranchi 834031, Jharkhand

Phone : (+91) 651 2230001, 2230002, 2230483, FAX (+91) 651 2231447, 2231851

Website : www.cmpdi.co.in, Email : cmpdihq@cmpdi.co.in

BHARAT COKING COAL LIMITED

DEPOSIT OF AMOUNT IN ESCROW ACCOUNT WITH BANK OF BARODA IN FY 2025-26

Sl No	Name of Mine	Escrow Account No.	AMOUNT IN RS
1	DAMODA GROUP OF MINES	00150100008869	3,50,74,500.00
2	AMALGATED MURAIDIH PHULARITAND (PART) COLLIERY	00150100012014	7,97,33,500.00
3	BLOCK-II GROUP OF MINES	00150100009044	4,13,11,200.00
4	KHARKHAREE COLLIERY	00150100008824	16,50,000.00
5	AMALGAMATED KESHALPUR WEST	00150100009051	9,62,24,400.00
6	AMALGAMATED ANGARPATHRA	00150100009053	3,63,58,100.00
7	LOYABAD COLLIERY	00150100008826	8,21,000.00
8	AMALGAMATED SENDRA BANSJORA AND NICHITPUR COLLIERY	00150100015633	2,82,12,900.00
9	KANKANEE COLLIERY	00150100010973	5,91,85,000.00
10	BANSDEOPUR COLLIERY	00150100011831	1,24,79,900.00
11	MUDIDIH COLLIERY	00150100008829	42,48,500.00
12	KUSUNDA OCP	00150100008870	3,54,32,500.00
13	GODHUR GROUP OF MINES	00150100009048	1,27,44,900.00
14	GONDUDIH KHAS KUSUNDA OC	00150100008875	2,85,49,700.00
15	EAST BASSURIA OC	00150100008876	70,70,600.00
16	BUSSERYA UG MINE	00150100008944	1,14,97,900.00
17	ENA OCP	00150100008938	1,79,20,300.00
18	AMALGAMATED DHANSAR-INDUSTRY	00150100008939	1,06,84,000.00
19	BHUTGORIA UG	00150100008818	12,12,300.00
20	GOPALICHUK COLLIERY	00150100010972	89,18,900.00
21	HURRILADIH UG	00150100008820	12,34,000.00
22	BURRAGARH UG	00150100008821	10,55,000.00
23	POOTKEE BALIHARI GROUP OF	00150100009045	6,18,63,500.00
24	KENDWADIH OC MINE	00150100011209	81,93,700.00
25	BASTACOLLA COLLIERY	00150100008877	2,96,13,600.00
26	AMALGAMATED BERA DOBARI KUYA GHANOODIH COLLIERY	00150100015511	3,49,92,000.00
27	RAJAPUR/SOUTH JHARIA OCP	00150100008937	20,14,600.00
28	SIMLABAHAL UG	00150100008822	3,74,33,800.00
29	NT-ST JEENAGORA GROUP OF	00150100009046	7,71,73,400.00
30	KUJAMA COLLIERY	00150100008941	3,06,94,200.00

Dy. Manager (Fin.), Fund
BCCL, Koyla Bhawan

Sr. Manager (Fin) Fund
Fund Section
BCCL, Koyla Bhawan

31	AMALGAMATED JOYRAMPUR COLLIERY	00150100011026	12,68,28,500.00
32	BHOWRAH (NORTH AND SOUTH) COLLIERY	00150100016217	1,88,34,700.00
33	AMALGAMATED SUDAMDIH PATHERDIH MINE	00150100011524	2,40,00,000.00
34	SUDAMDIH SHAFT MINES	00150100011673	76,13,600.00
35	BASANTIMATA COLLIERY	00150100008827	1,25,50,600.00
36	DAHIBARI BASANTIMATA OCP	00150100008828	6,16,97,600.00
37	KALYANESWARI GROUP OF MINES	00150100009042	9,68,36,700.00
38	BEGUNIA COLLIERY	00150100011365	46,30,200.00
39	MOONIDIH UNDERGROUND COLLIERY	00150100008943	1,20,63,200.00
40	MURULIDIH 20/21 PITS COLLIERY	00150100009047	57,94,200.00
41	LOHAPATTI COLLIERY	00150100009043	4,42,95,700.00
		GRAND TOTAL	**1,22,87,42,900.00**

Dy. Manager (Fin.), Fund
BCCL, Koyla Bhawan

Sr. Manager (Fin) Fund
Fund Section
BCCL, Koyla Bhawan

Bharat Coking Coal Limited

BHARAT COKING COAL LIMITED

COPRPORATE ENVIRONMENT POLICY 2025

Back Ground:

Bharat Coking Coal Limited (BCCL) subscribes to the view of Sustainable Development. Unless the environment can sustain all the developmental activities, any pursuit of development in isolation can cause irreparable damage to the ecosystem and associated environmental attributes.

The present policy is the revision of the Corporate Environment Policy 2019 and is complimentary to the National Environmental Policy, 2006.This modification in the present policy is the outcome of the experience gained since 2019 keeping in view the modifications / amendments made time to time in environmental policies and additional stipulations notified by MoEF&CC (Ministry of Environment, Forest& Climate Change) and other organizations concerning mine closure, reclamation of degraded land, environmental clearance etc. and also with the objective of revisiting the corporate policy. Government of India is signatory to few international conventions/agreements relevant to BCCL amongst others and activities associated with such conventions/agreements are embodied in the present policy

This Policy has a vision of Green Mining and mission of 100% compliance of environmental statutes applicable to coal mining industry.

Policy Statement: Bharat Coking Coal Limited(BCCL) is committed to promote low carbon, sustainable and socially inclusive coal mining by protecting the environment through integrated project planning & design, prevention/mitigation of pollution, conservation of natural resources, restoration of ecology & biodiversity, recycling/ proper disposal of wastes, addressing climate change and inclusive growth. It also aims to bringing awareness amongst its stakeholders for continual improvement in environmental performances following good environmental practices.

Objectives:

BCCL shall endeavour to-

1. Plan & design projects with due consideration to environmental and social concerns for Sustainable Development and reduction in emission intensity of its operations.

2. Conduct mining and associated operation in an environmentally responsible manner to comply with applicable laws and other requirements related to environmental aspects.

3. Prevent pollution in surrounding habitation by continuous monitoring and adopting suitable measures for environment protection.

4. Ensure effective implementation of Environment Management Plans (EMPs) in all our mines / projects to mitigate pollution, conservation of natural resources and restoration of ecology & biodiversity.

5. *Ensure compliance of all statutory conditions prescribed by regulatory agencies.*
6. *Ensure waste management in each unit on the principle of REDUCE, REUSE, RECYCLE and SAFE DISPOSAL.*
7. *Put special thrusts on efficient energy utilization / renewable energy and other measures to reduce carbon foot-print.*
8. *Strive for continual improvement in our environmental performances by setting targets, measuring progress and taking corrective action.*
9. *Take measures to gainful repurposing of land and render productive post mining land use for ensuring environmentally sustainable closure of mine, keeping in view the social needs and requirement of the locals.*
10. *Take steps for dealing, prevention and control of coal mine fire and related subsidence.*
11. *Ensure implementation of activities applicable to BCCL arising out of International Conventions.*
12. *Create environmental awareness and ensure environmental education among the employees, local communities and other stakeholders through pro-active communication and training.*
13. *Promote R&D projects/innovations addressing various environmental concerns like minimization of carbon footprints of BCCL and environmental issues in mining & surrounding areas.*
14. *Establish eco-parks in the reclaimed mined areas and promote eco-mining tourism in the coalfield areas.*
15. *Ensure transparency in Environmental reporting / disclosure to stakeholders.*

Review of Environmental Policy:

In view of the present fast changing social, economic and environmental scenario, this policy shall be reviewed every 5 years to incorporate the changes in the legal, technical, environmental, economic and social inputs prevailing at that time. Whenever, there is change in National Environmental Policy or other National / State relevant policies, Acts etc, this Corporate Environmental Policy would be reviewed and suitably revised.

29/5/25

Chairman-cum-Managing Director,

BCCL

Place: Dhanbad

Saturday, November 29 2025, 09:55:56 AM
Q694+P66, Sidpoki, Jharkhand 828307, India
23° 46' 9" N, 86° 12' 22" E 135m
22.9°C 7.9Km/h 43%
Google
Madhuban

Saturday, November 29 2025, 09:55:07 AM
Q694+P66, Sidpoki, Jharkhand 828307, India
23° 46' 9" N, 86° 12' 22" E 162m
22.9°C 7.9Km/h 43%
Google
Madhuban

Saturday, November 29 2025, 09:54:42 AM
Q694+P66, Sidpoki, Jharkhand 828307, India
23° 46' 9" N, 86° 12' 22" E 142m
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Google
Madhuban