BHARAT COKING COAL LTD.
A Mini Ratna Company
(A Subsidiary of Coal India Ltd.)
REGD. Office: Koyla Bhawan, Koyla Nagar, Dhanbad-826005
CIN No.U10101JH1972GOI000918
OFFICE OF THE GENERAL MANAGER
BARORA AREA

Ref No.GM/AR-1/ENV./2024/ 420 **Dated:-** 31/5/24

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 Oct' 2023 to March'2024 in respect of Cluster –XV groups of mines

Ref.:-EC Order No. J-11015/100/2011-IA.II (M) dated- 16.12.2013

Dear Sir,
Kindly find enclosed herewith the six-monthly report on implementation of Environmental measures for the period from **Oct' 2023 to March'2024** in respect of Cluster –XV groups 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,

29.5.24
General Manager
Barora Area

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

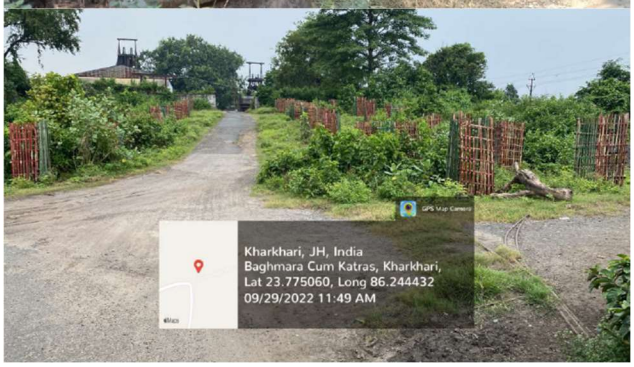
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ENVIRONMENTAL CLEARANCE COMPLIANCE OF CLUSTER-XV

(GRANTED VIDE J-11015/100/2011-IA.II (M) Dated 16.12.2013)
Oct' 2023 to March'2024
Action Plan for compliance of EC conditions

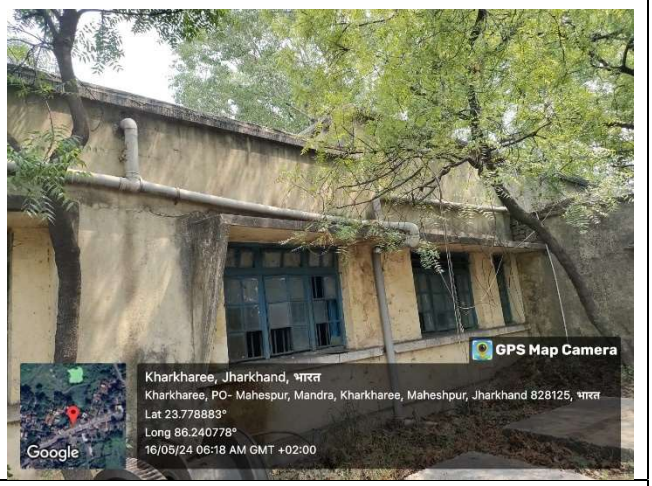
<table>
<tr><th>S. No.</th><th>A. Specific Conditions by MoEFCC:</th><th>Compliance</th></tr>
<tr><td>i</td><td>The maximum production in the cluster shall not exceed beyond that for which environmental clearance has been granted for Cluster –XV as per given below:
<table>
<tr><th rowspan="2">Sl. No.</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>2019-20</td><td>18709</td></tr>
<tr><td>2020-21</td><td>9133</td></tr>
<tr><td>2021-22</td><td>3173</td></tr>
<tr><td>2022-23</td><td>6827</td></tr>
<tr><td>2023-24</td><td>5283.94</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 has been constructed at nullahs.
  </td></tr>
</table>

		 **(Pictures of Check dams is attached as Annexure XV)**
vi	**The coal from the mines will be transported by mechanically covered trucks within two months.**	Presently, coal transportation on public roads is being done by covering vehicle with tarpaulin.
Vii	**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.**	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 is done by DGMS.
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, Master Plan approved by GoI is under implementation for this purpose. Fire control in Jharia and its periphery is being done with the recommendation received from CIMFR.
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 & enclosed herewith. Action is being taken as specified in EC and as per Jharia Master Plan. **(NRSA Report attached as Annexure I)**
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 has been carried out in consultation of DFO, Dhanbad.

		  **(Plantation photos are 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 approved master plan is uploaded on BCCL website. **(Master Plan for Fire, Subsidence and Rehabilitation is enclosed as Annexure III).**
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).**
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.**	It is being complied. The salient actions of this area: 1. Covered transportation of Coal on public roads. 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 & enclosed herewith. **(NRSA Report attached as Annexure I)** Action is being taken as specified in EC and as per Jharia Master Plan.
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)**
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 smoke/dust emission vary from source to source (fuel 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}**	Establishment of ambient environment quality monitoring stations has been finalized with the consultation of Jharkhand State Pollution Control Board. The work of monitoring of ambient environment was 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.

	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.	**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 sides 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.
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 approved Jharia Action Plan.
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 system, haulage roads, transfer points, etc. Major approach roads shall be black topped and properly maintained.**	It is being complied. Water Sprinkling is being done through water tanker. Approach road is black topped and 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 checkup of their workers, 10% of the workers identified from workforce engaged in active mining operations shall be subjected to health checkup 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)**
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,**	It shall be complied. Reclamation has been carried out in phased manner.

	having bearing with movement of wild life until such time they are closed/phased out.	
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. High root density 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 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.**	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 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)**
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. Photos of filter plant 

<table>
<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-62) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May’22, Aug’22, Nov’22 & Jan’23 the Ground water level data is enclosed in the table below:
<table>
<tr><td rowspan="2">Sl No.</td><td rowspan="2">Well No.</td><td rowspan="2">Location</td><td colspan="4">Water level (bgl in meters)</td></tr>
<tr><td>May’23</td><td>Aug’23</td><td>Nov’23</td><td>Jan’24</td></tr>
<tr><td>1</td><td>A-24</td><td>Pipratanr</td><td>5.38</td><td>3.60</td><td>3.90</td><td>5.00</td></tr>
<tr><td>2</td><td>B-32A</td><td>Madhuband</td><td>5.35</td><td>3.93</td><td>3.60</td><td>5.42</td></tr>
<tr><td>3</td><td>B62</td><td>Saiyardih</td><td>4.80</td><td>2.35</td><td>3.10</td><td>4.00</td></tr>
<tr><td colspan="3">Avg. GW (bgl)</td><td>5.18</td><td>3.29</td><td>3.53</td><td>4.81</td></tr>
</table>
Peizometer installation: Construction of 2 nos. Piezometric well is complete. 2 nos. DWLRs have also been installed.

</td></tr>
</table>

		 **(Latest Ground Water Report Attached as Annexure XI)**
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)**
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)**

Lvi	**Corporate Environment Responsibility:** **a) The Company shall have a well laid down Environment Policy approved by the Board of Directors.** **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.** **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** **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.**	A well-defined Corporate Environment Policy has already been laid down and approved by Board of Directors. This is also posted on BCCL website. Url link-https://www.bcclweb.in/environment/CEP_280220.pdf **(Corporate Environment Policy is attached as Annexure XIV)** Complied. A hierarchical system of the company to deal with environmental issues from corporate level already exists. 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.
ii	**No change in the calendar plan of production for quantum of mineral coal shall be made.**	Being complied.
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 withheavy metals such as Hg, As, Ni, Cd, Cr etc. is regularly monitored by CMPDIL. **(Environment Monitoring Report is attached as Annexure IV)**
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 is 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**	The work of monitoring of ambient environment is being done by CMPDIL, Ranchi. Physico-Chemical characteristics of effluents are well within the prescribed limit.

<table>
<tr><td></td><td>installed before discharge of workshop effluents.</td><td>(Water Quality Report is attached as Annexure V)</td></tr>
<tr><td>vii</td><td>Vehicular emissions shall be kept under control and regularly monitored. Vehicles used for transporting the mineral shall be covered with tarpaulins and optimally loaded.</td><td>Being complied. Regular maintenance of vehicle is being practiced to kept vehicular emission under control. Coal is being transported in tarpaulin covered trucks.</td></tr>
<tr><td>viii</td><td>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.</td><td>Monitoring of Environmental quality parameters have been regularly done by CMPDIL, Ranchi with proper analysis equipment.
(Environment Monitoring Report is attached as Annexure IV)</td></tr>
<tr><td>ix</td><td>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.</td><td>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 and occupational health issue to each of the workers working in the mines.</td></tr>
<tr><td>x</td><td>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.</td><td>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. Details of PME conducted is given below:
<table><tr><td rowspan="2">Name of Colliery</td><td colspan="5">FY</td></tr><tr><td>2019-20</td><td>2020-21</td><td>2021-22</td><td>2022-23</td><td>2023-24</td></tr><tr><td>Kharkharee Colliery</td><td>135</td><td>130</td><td>118</td><td>115</td><td>58</td></tr></table>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)</td></tr>
<tr><td>xi</td><td>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.</td><td>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.</td></tr>
<tr><td>xii</td><td>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.</td><td>It is being complied.
Separate head “plantation” & “Environment” is there for recurring expenditure and used for Eco restoration, environmental protection measures, statutory payments, etc.</td></tr>
<tr><td>xiii</td><td>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.</td><td>Complied. Advertisement in local newspaper has been given.</td></tr>
</table>

	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. link-Web https://www.bcclweb.in/?page_id=4731&lang=en
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
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. link-Web https://www.bcclweb.in/?page_id=4731&lang=en
xvii	The project proponent shall submit six monthly compliance reports on status of compliance of the stipulated environmental clearance conditions (both in hard copy and in e-mail) to the respective Regional Office of the Ministry, respective Zonal Office s of CPCB and the SPCB.	Complied/Being complied.
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. The same is also uploaded to company' website along with Environmental Clearance Compliance report

27/05/2019

General Manager
GovindpurArea

28.5.19

General Manager
Barora Area

DELINEATION OF SURFACE COAL FIRE AND ASSOCIATED LAND SUBSIDENCE IN THE JHARIA COALFIELD, USING SATELLITE BASED REMOTE SENSING TECHNIQUES



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HYDERABAD-500 037

AUGUST, 2021

DELINEATION OF SURFACE COAL FIRE AND ASSOCIATED LAND SUBSIDENCE IN THE JHARIA COALFIELD, USING SATELLITE BASED REMOTE SENSING TECHNIQUES

Report for

BHARAT COKING COAL LIMITED (BCCL)

(A SUBSIDIARY OF COAL INDIA LTD.)

ENVIRONMENT DEPARTMENT, KOYLA BHAWAN

KOYLA NAGAR, DHANBAD – 826 005, JHARKHAND

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Coal fire is a serious problem in Jharia coal field, where high grade coals are gradually burnt due to these fires. The combined effect of surface and sub-surface fires and mining related subsidence has affected the environmental stability of Jharia coal field. Coupled with the ecological changes instigated by open cast mining, the landscape in and around Jharia have changed drastically over the years. In the present study, delineation of coal fire and mining related land subsidence have been addressed. Thermal band data of Landsat-8 (100m resolution) have been used to demarcate the coal mine fire areas from non fire areas. For this study, Landsat-8 data of May, 2021 have been used. The band 10 (10.60-11.19 μm) of Landsat-8 data are used to derive the relative radiant temperature. Further ALOS-PALSAR 2, L band microwave data have been used to delineate zone of probable land subsidence (using differential interferometry) due to mining. The study reflects that, compared to 2017, the eastern flanks (Lodna and Tisra etc) show a significant reduction in total fire area. The western flank (Block II and Shatabdi) and the northern flank (Katras and Gaslitand) show isolated fire pockets in active mines as well as in OB dumps. The current total fire area mapped is 1.8 sq.km. Apart from this, one distinctive area of land subsidence has been identified using interferometric method. These are primarily caused by older or active underground mining in the Moonidih Project. The coal mine fire and subsidence areas are further verified on the ground. The final coal mine fire and subsidence maps of Jharia coal field are prepared by using remote sensing data analysis with field validation.

PROJECT TEAM

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   Image processing, interpretation, field survey, maps and report preparation

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EXECUTIVE SUMMARY

Coal fire is a serious problem in Jharia coal field, where high grade coals are gradually burnt due to these fires. The combined effect of surface and sub-surface fires and mining related subsidence has affected the environmental stability of Jharia coal field. Coupled with the ecological changes instigated by open cast mining, the landscape in and around Jharia have changed drastically over the years. In the present study, delineation of coal fire and mining related land subsidence has been addressed. Thermal band data of Landsat-8 (100m resolution) have been used to demarcate the coal mine fire areas from non fire areas. For this study, Landsat-8 data of May, 2021 have been used. The band 10 (10.60-11.19 μm) of Landsat-8 data are used to derive the relative radiant temperature. Further ALOS-PALSAR 2, L band microwave data have been used to delineate zone of probable land subsidence (using differential interferometry) due to mining. The study reflects that, compared to 2017, the eastern flanks (Lodna and Tisra etc) show a significant reduction in total fire area. The western flank (Block II and Shatabdi) and the northern flank (Katras and Gaslitand) show isolated fire pockets in active mines as well as in OB dumps. The current total fire area mapped is 1.8 sq.km. Apart from this, one distinctive area of land subsidence has been identified using interferometric method. These are primarily caused by older or active underground mining in the Moonidih Project. The coal mine fire and subsidence areas are further verified on the ground. The final coal mine fire and subsidence maps of Jharia coal field are prepared by using remote sensing data analysis with field validation.

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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. Subsurface and surface coal fires are a serious problem in many coal-producing countries. The severity and extent of mine fires in some of the Indian coalfields, particularly Jharia and Raniganj coalfields, are quite alarming. Combustion can occur either within coal or in coal dumps on the surface. Considerable economic loss and environmental problem arises due to the coal fire. Coal fire burns valuable coal and also creates difficulties in mining by increasing the cost of production or making existing operations difficult. Noxious gases like sulphur dioxide, nitrogen oxide, carbon monoxide, carbon dioxides, which are the result of coal burning processes, often affect the immediate surroundings of an active coal fire area (Gangopadhyay, 2003). These greenhouse gases not only affect local atmosphere but also play a crucial role in the damages, found associated with coal fire such as land surface subsidence and surface cracking. Coal fires are caused by oxidation of coal but the reaction involved in oxidation of coal is not understood till date. Broadly, the potential for spontaneous combustion lies in its ability to react with oxygen at ambient temperature. This occurs through the reaction of oxygen at the surface of the coal resulting in an exothermic reaction. As a consequence, the temperature of coal rises and if temperature reaches the threshold temperature, ranging between 80^0 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 date back to 1916 when the first incidence of fire was reported from XIV seam of Bhowrah colliery. JCF was nationalised in 1972 and over the decades, the fire has spread or been contained but never extinguished. The combination of underground fire and subsidence have affected vast areas of JCF.

1.1 Background

Remote sensing technique in thermal band offers a cost-effective and time-saving technology for mapping various geoenvironmental / hazardous features such as coal fires, forest fires, oil well fires, volcanic eruptions etc. NRSC has carried out coal fire mapping projects in the past; conducting an airborne campaign in 1989 and using Landsat-5 TM data in 1995 (Bhattacharya *et. al.,* 1995), over Jharia coalfield, Jharkhand and using Landsat-5 TM data for 2001 over Raniganj coalfield, West Bengal. Further, projects were executed in 2006 and 2012 in which coal fires of the JCF were mapped using Landsat-7 ETM+ and ASTER data, respectively. Additionally, a R&D study was taken up in 2013 to delineate subsidence areas using differential interferomteric (DInSAR) technique. An operational fire and subsidence mapping activity was taken up in 2017. In view of the past experiences, based on the letter (Ref. no. MP/19/270) from General manager (JMP), BCCL addressed to Director, NRSC on 24-10-2019, a project was formulated to take up Coal fire and Land Subsidence study of the Jharia Coal Field using space-borne remote sensing technique. The formal Memorandum of Understanding between BCCL and NRSC was signed on 7th August, 2020.

1.2 Objectives

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

I. To map Coal fire in the study area based on pixel integrated relative radiant temperature derived from latest available Landsat-8 data of 2020 time period.
II. To compare the change in the coal fire distribution in the Jharia coalfield between the period of 2017 and 2020.
III. To delineate probable subsidence areas in the region using differential interferometry method.

1.3 Study Area

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

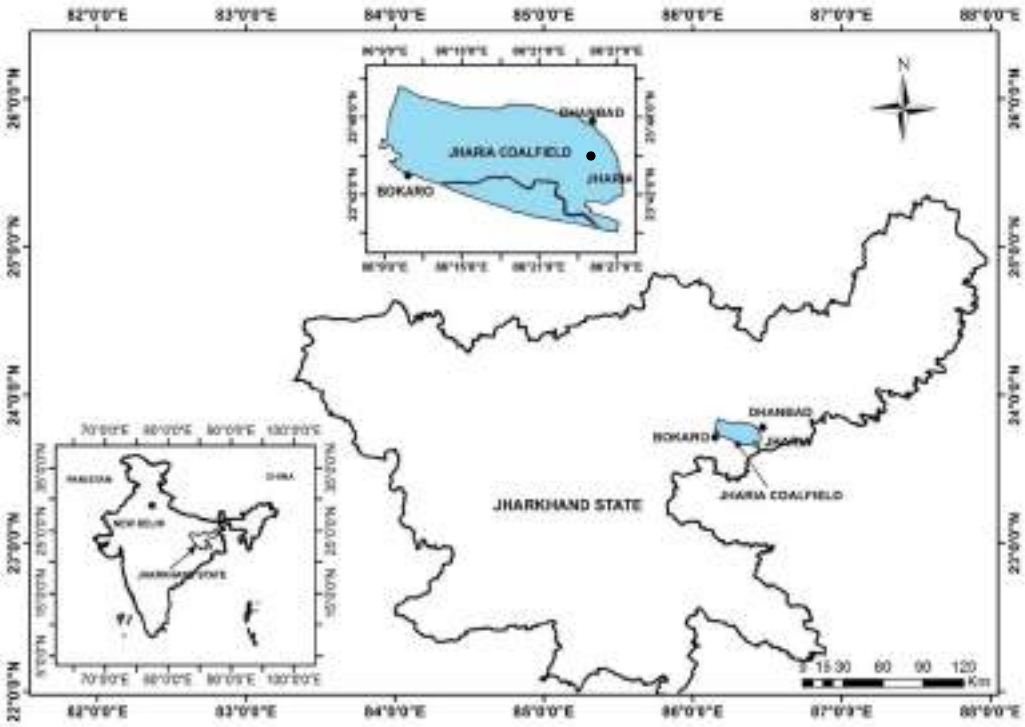


Figure 1: Study area map of Jharia Coalfied, Jharkhand

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

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

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

Table 1: Generalised stratigraphy of JCF.

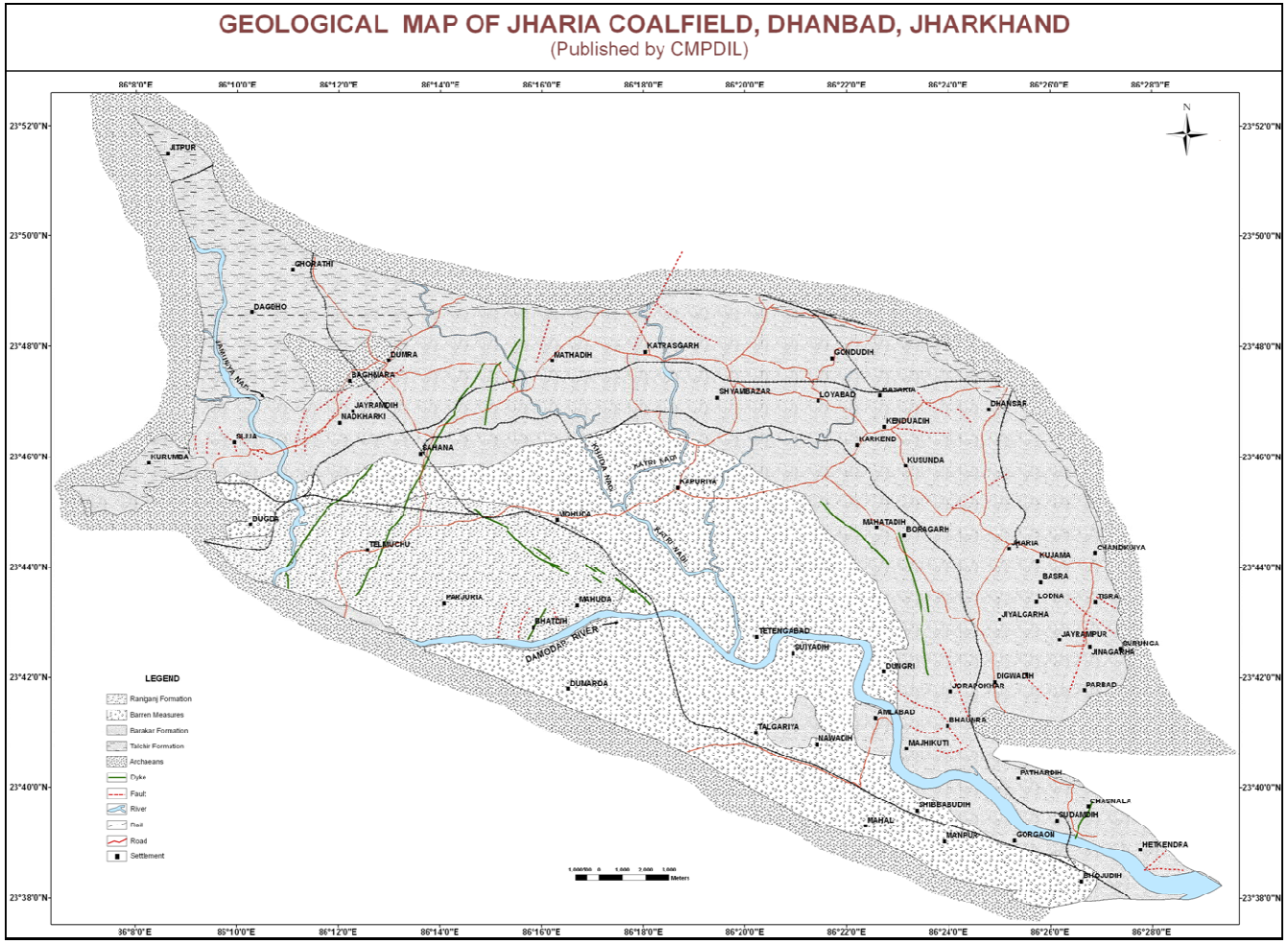


Figure 2 : Geological map of Jharia coal field, Dhanbad, Jharkhand (published by CMPDIL)

CHAPTER III

DATA REQUIREMENTS

3.1 Remote Sensing Data

Coal fire map was created from LANDSAT 8 TIRS data of 22 May 2020. Further, the coal fire map of 2017 prepared by NRSC (NRSC, 2017) from LANDSAT 8 data (of 14 May 2017), was used as a reference to identify the changes that has occurred in the extent and disposition of the fires from 2017 to 2020.

For the land subsidence study, L-band microwave data from ALOS-PALSAR satellite (JAXA) were used. Five scenes of "Fine Beam mode" SLC data were taken from PALSAR-2 archives over a period from September, 2017 to February, 2020. 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	100m resampled to 30m	Daytime	22 May 2020	USGS, USA
ALOS	PALSAR-2 (Fine Beam mode)	10 m	NA	30 September 2017	JAXA, Japan
				3 March 2018	
				19 January 2019	
				02 March, 2019	
				29 February. 2020	

3.2 Ancillary data

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

CHAPTER IV

REMOTE SENSING DATA ANALYSIS

4.1 Methodology

4.1.1 Processing of Landsat 8 Data

With the launch of the LANDSAT-8 mission in February, 2013; thermal space borne data are available from its thermal infrared sensor (TIRS). This has enabled monitoring of the earth with a spatial resolution of 100 m in the thermal domain with a repeat cycle of 16 days. The LANDSAT-8 has two channels (Band 10 and Band 11) in the thermal infrared region (Table 1) which ranges from 10.4 micrometer to 12.5 micrometer (Gangopadhyay et al. 2012). In present study, band 10 of TIRS sensor (acquired on 22 May, 2020) has been used 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 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 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 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. This has been attempted by the statistical analysis of sensor derived radiant temperature to delineate clusters (in the scatter-plot) indicative for fire and non-fire pixels. Mean and maximum radiant temperatures are derived from randomly sampled uniform sized pixel blocks distributed in entire spatial extent of Barakar Formation (Figure 3) known for fire bearing coal seams. The pixel block sizes are chosen to adequately represent the overall areal extent of the coalfield and homogeneously encompass all the mining blocks (27x27 pixels for Landsat-8, Figure 3). The maximum temperature value recorded in each representative area, derived from each of the datasets, is plotted against the mean temperature. The maximum temperature represents that of fire (wherever present), whereas the mean temperature represents the average background temperature, for normalization. The fire and background populations show considerable variance, separating coal fire and background radiant temperatures. The cut-off temperature derived is the maximum temperature of the background cluster, above which all temperatures represent coal fires. In the case of the Landsat-8 data used in this study, the cut-off temperature was determined around 36.5°C (Figure 4). Based on this cut-offs, regional coal fire map was prepared (Figure 5).

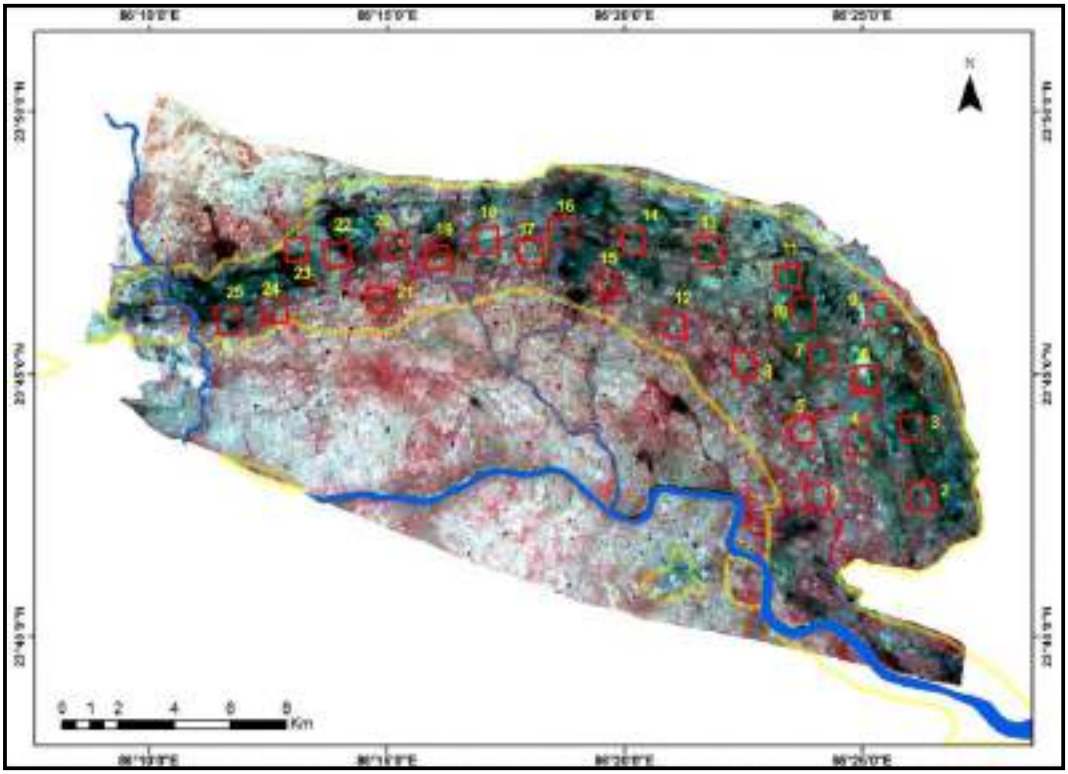


Figure 3. False colour composite image of Jharia Coalfield, with subset blocks (in red boxes) to obtain temperature values (from radiant temperature image) within the Barakar formation across the Jharia coalfield.

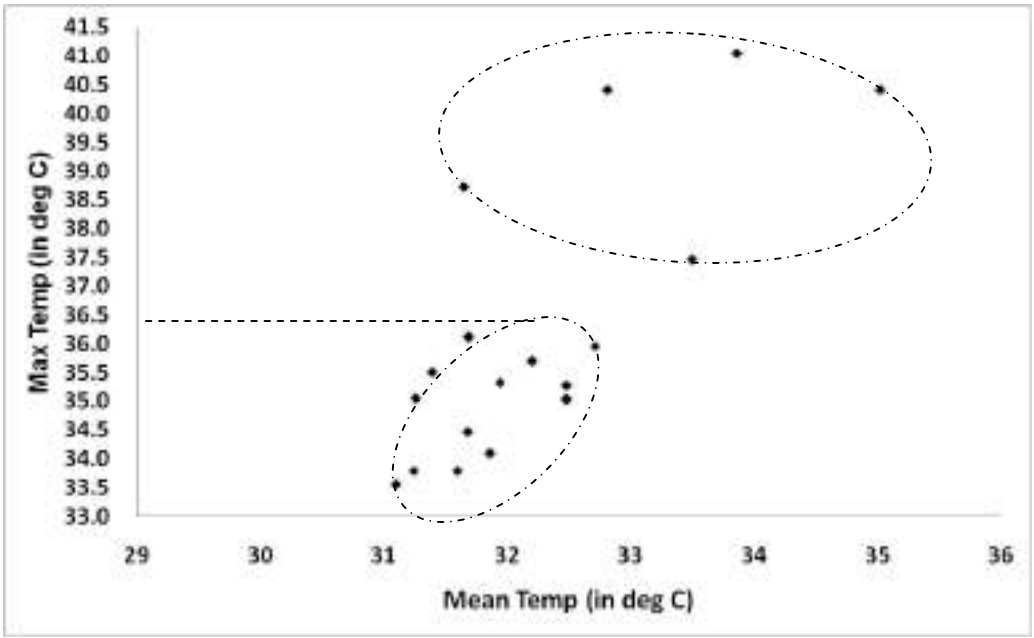


Figure 4. Maximum temperature plotted against mean temperature for various locations; cluster separation observed around 36.5 °C (marked with arrow)

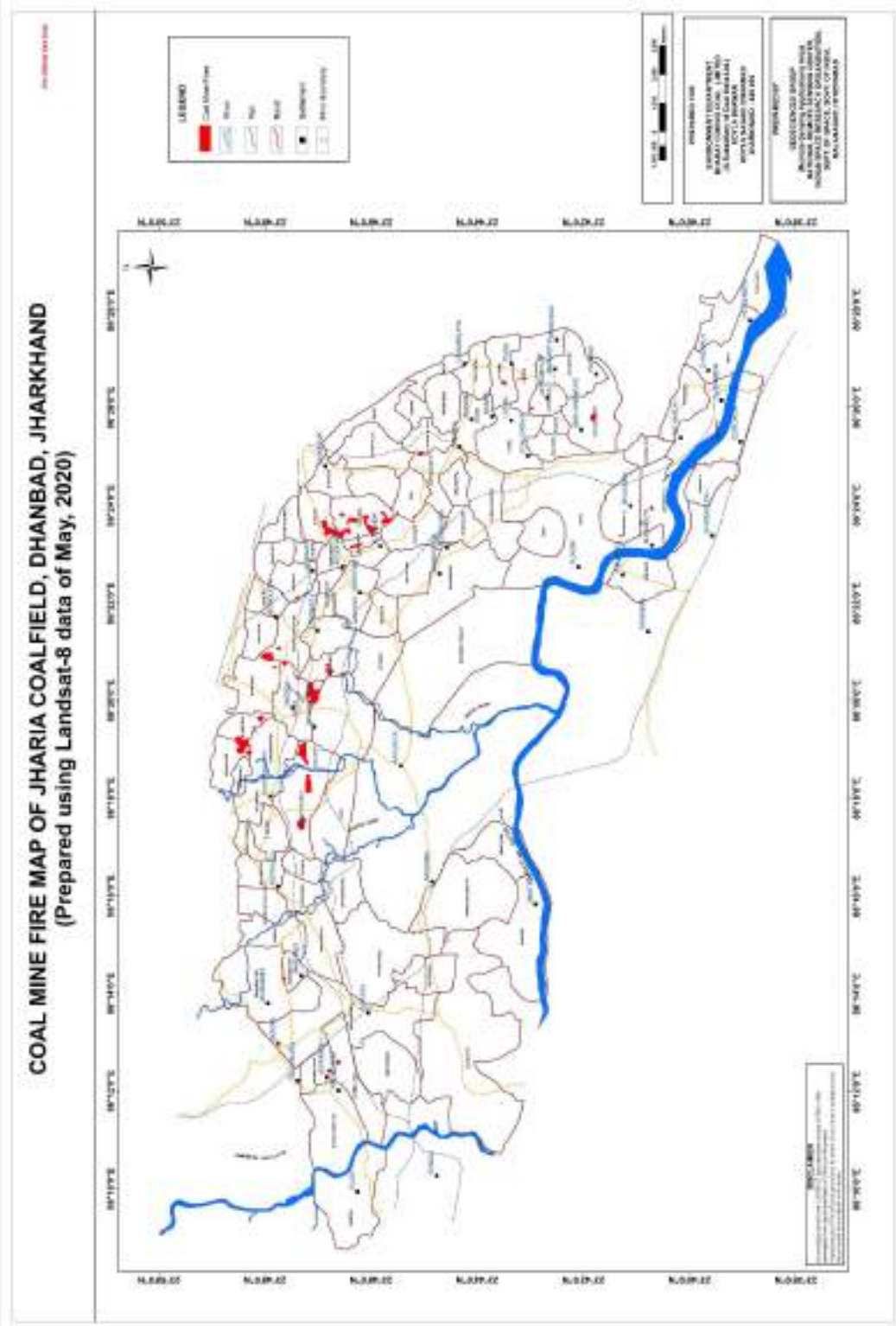


Figure 5: Coal mine fire map (May, 2020) of Jharia coal field, Dhanbad. The fire areas shown in this map have been verified in the field as per field points in figure 12.

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).

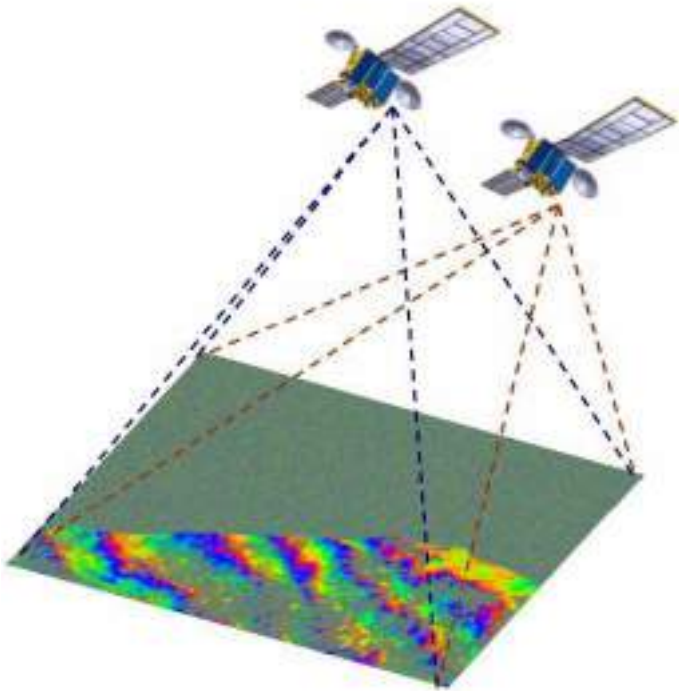


Figure 6. DInSAR acquisition scheme.

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 improvements in SAR differential interferometry that has led to an innovative approach based on the use of a large dataset of SAR images over the same area to overcome the intrinsic limitations of conventional DInSAR in terms of temporal and geometrical decorrelation as well as atmospheric disturbances (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.

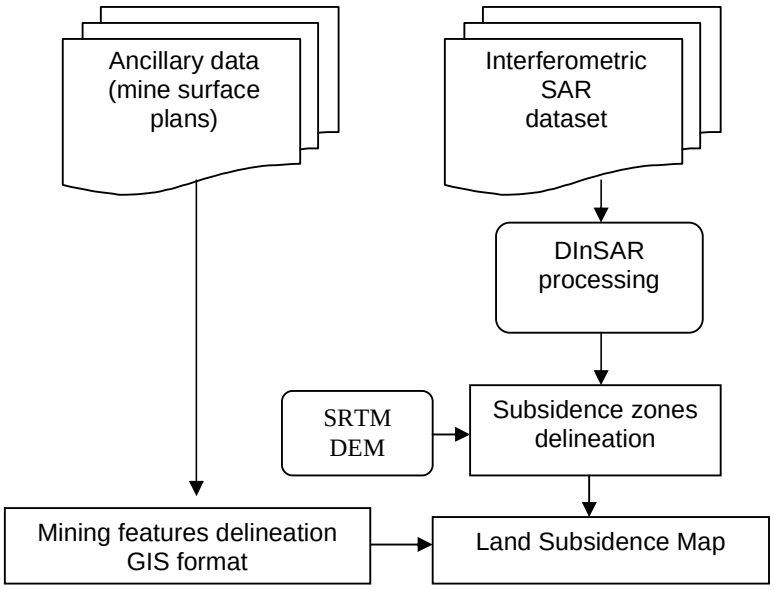


Figure 7. Work flow diagram for generating land subsidence map using DInSAR technique.

In the present study, 5 sets of ALOS-PALSAR L-band microwave data (as mentioned in table 1) were procured. The datasets were paired into master-slave pairs as per short and long temporal baselines. The short temporal base lines include master slave pairs of time difference of six months to one year, whereas long temporal baselines include data pairs of time difference of ~ one year.

This has been illustrated in figure 8.

		SLAVE IMAGE				
		30 September 2017	03 March 2018	19 January 2019	02 March 2019	29 February 2020
MASTER IMAGE	30 September 2017					
	03 March 2018					
	19 January 2019					
	02 March 2019					
	29 February 2020					
		Short Temporal Baseline Pair (less than 1 year)				
		Long Temporal Baseline Pair (~ 1 year)				

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

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

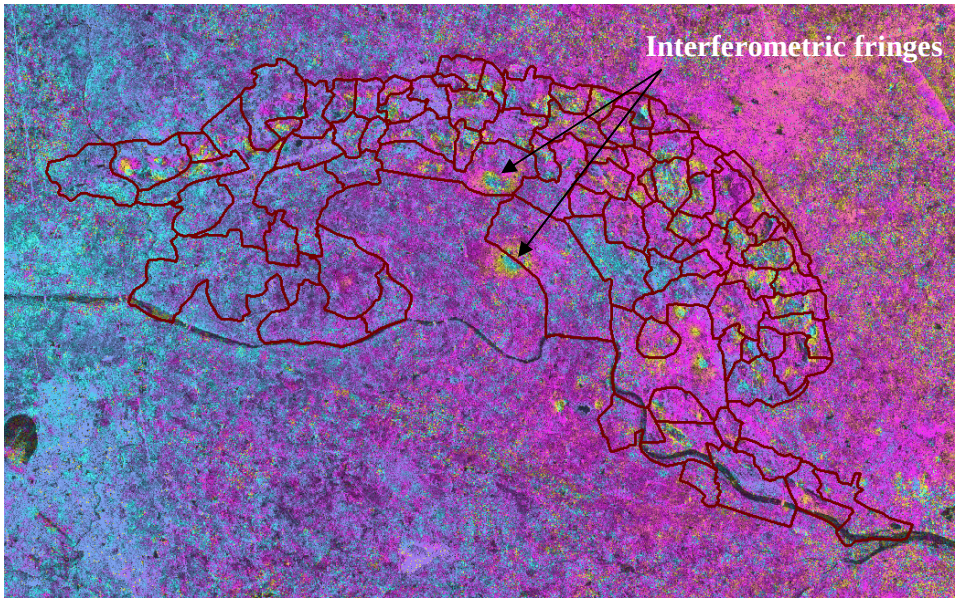


Figure 9. Fringe patterns generated from short baseline processing (e.g. Master: Oct, 19, Slave: Feb, 20).

On the other hand, 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 where ever present (figure10)

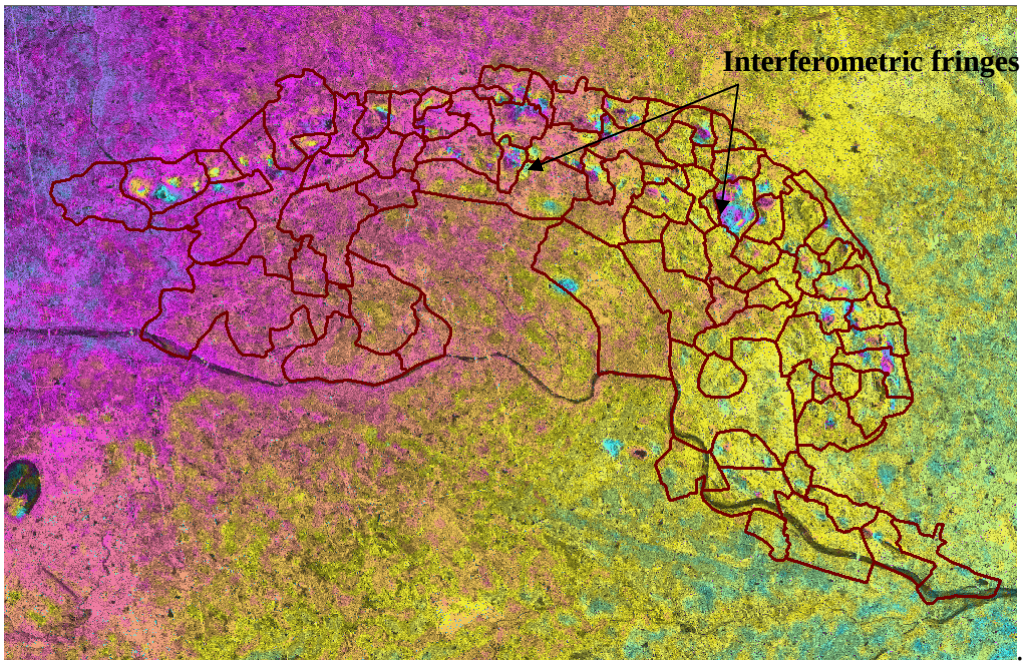


Figure 10. Fringe patterns generated from long baseline processing (e.g. Master: Sept, 17, Slave: Feb, 2020).

The results from the long and short baseline processing can be compared and zone where fringes have been developed due to terrain changes due to mining excavation and dumping, can be systematically identified and demarcated. The remaining fringes from the long temporal baseline processing will then indicated towards zones where subsidence has taken place due to underground mining. Using this, a subsidence map of the Jharia Coalfield was generated due to mining activities and subsidence areas (Figure 11).

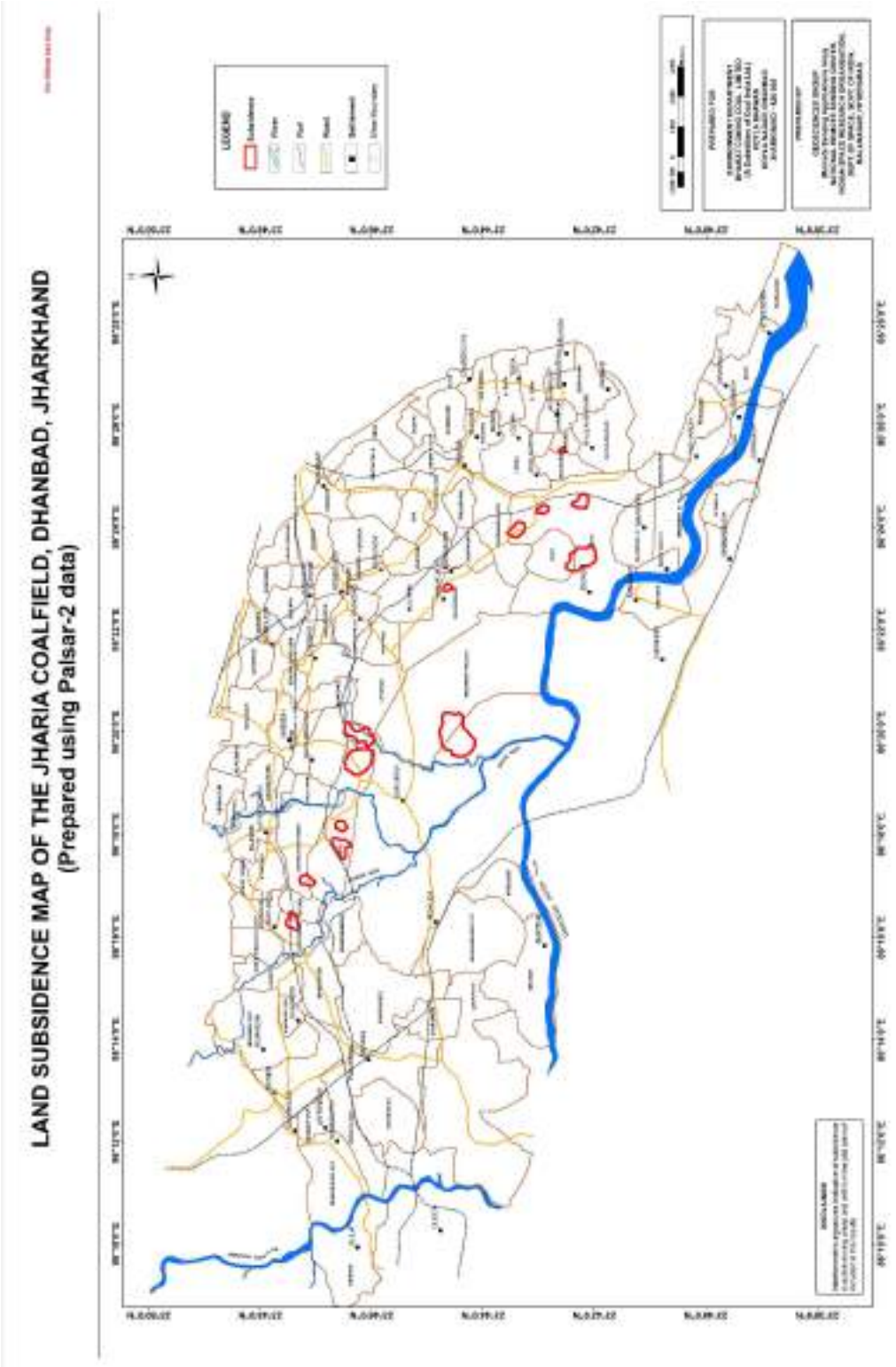


Figure 11: Subsidence map (2017-2020) of the Jharia coal field, Dhanbad.

CHAPTER V

FIELD WORK

A field work for verification of the coal fire locations and the subsidence zones as identified by the satellite data were taken up during 2nd to 8th August, 2021. Both the coal fire and the subsidence locations were further independently verified by NRSC during the fieldwork. A total of 39 coal fire points and 13 land subsidence locations were identified from the satellite data analysis (figure 12). All 39 points were confirmed to be fire bearing as per the present status of fire in Jharia coalfield. The field observations of coal fire at each location are provided in table 3.

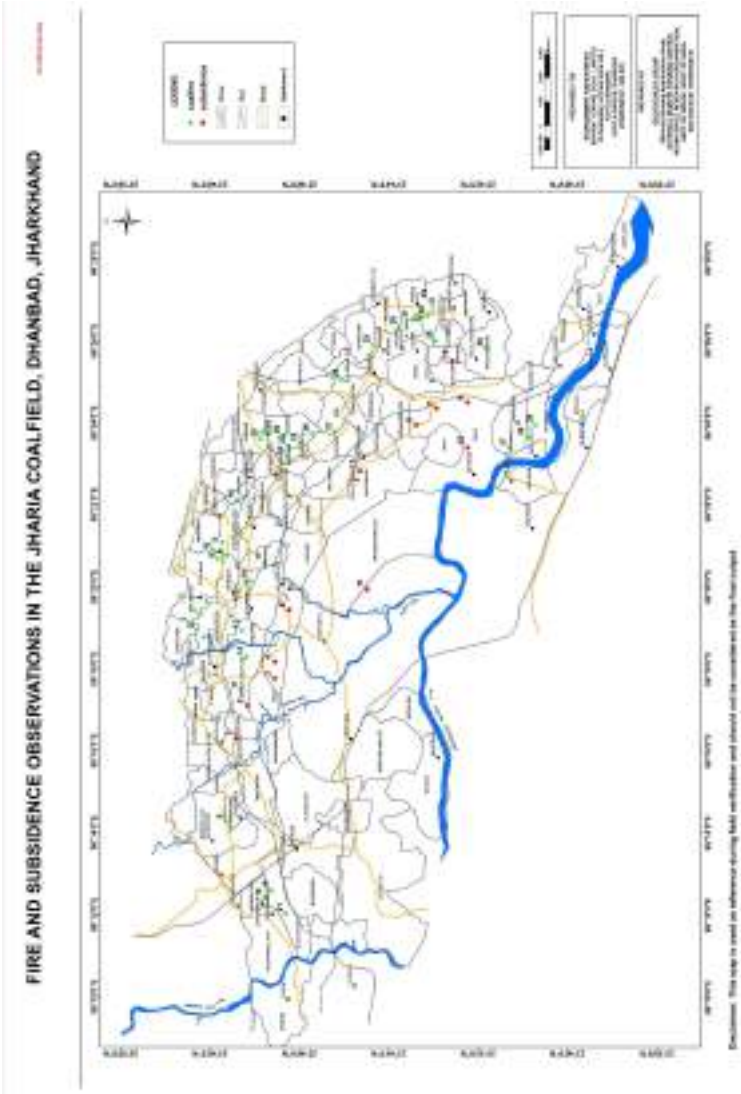


Figure 12. Field data points for coal fire and subsidence verification

Table 3: Summary of field observations (refer figure 12)

Field observation Point	Mine	Status of Fire (comments)*
1	Keshalpur	Active mine fire
2	Keshalpur	Active mine fire
3	W. Mudidih	Active mine fire
4	W. Mudidih	Active mine fire
5	Sendra Bansjora	Active mine fire
6	Tetulmari	Active mine fire
7	Sendra Bansjora	Active mine fire
8	Shatabdhi	Old Fire patch (minor fires)
9	Sendra Bansjora	Active mine fire
10	Sendra Bansjora	OB dump fire
11	Katras-Chotudih	Active mine fire (Confirmed by BCCL)
12	Gaslitand	Active mine fire
13	Katras-Chotudih	Active mine fire (Confirmed by BCCL)
14	Mudidih	Active mine fire
15	Godhar	Active mine fire
16	Benedih OCP	Active mine fire
17	Kankanee	Active mine fire
18	Block II OCP	Active mine fire
19	Kusunda	Active mine fire
20	Godhar	Active mine fire (High Risk)
21	Block II OCP	Active mine fire
22	Kusunda	Active mine fire
23	Kusunda	Active mine fire
24	Alkusha	Active mine fire
25	Kusunda	Active mine fire
26	Kusunda	Active mine fire
27	Ena	OB dump fire (small pockets of active mine fire)
28	R -OCP	Active mine fire
29	Goonhodih	Abandoned mine Fire(Fire cutting planned)
30	NT-ST	OB dump fire (small pockets)
31	NT-ST	Active mine fire (Ongoing mitigation measures)
32	NT-ST	Active mine fire (Ongoing mitigation measures)
33	NT-ST	Active mine fire (Ongoing mitigation measures)
34	NT-ST	Active mine fire (Ongoing mitigation measures)
35	Jayrampur	Abandoned mine Fire
36	Bhulanbarari	OB dump fire
37	Bhaura	OB dump fire (small pockets of active mine fire)
38	Bhaura	OB dump fire (small pockets of active mine fire)
39	Bhaura	OB dump fire (small pockets of active mine fire)

** Fire Temperature reading from hand held IR thermometer were seen to be inconsistent due to rains and wet ground condition and hence are not reported.*

Subsidence location observations:

1. Subsidence locations as identified by the data are difficult to verify in the field, unless there are tell-tale signatures like large cracks or fissures on the ground or damage to anthropogenic constructions like vertical cracks on building cracks etc.
2. Out of the 13 identified subsidence locations from the microwave data, the main area where subsidence is occurring in a pervasive scale is that in the Moonidih Underground Project. The Moonidih Project is an underground long wall mine where excavations are going on for over decades. This may have resulted in pervasive subsidence in the region. The signatures of subsidence such as sagged ground are observed in the area.
3. Three other minor subsidence areas are identified within the South Govindpur, Bhagaband and Bagdigi mines, where old underground workings are present. However, there was no clear evidence of subsidence from the field based observations.
4. The 9 other locations where subsidence is seen from microwave data, falls within the mining lease of TISCO and IISCO, hence are not under the purview of BCCL mining authorities.

CHAPTER VII

DISCUSSIONS AND CONCLUSIONS

7.1 Discussions

7.1.1 Coal fire analysis

The present study is aimed to provide the status of coal fire in the Jharia coal field for the period of 2020. Landsat-8 data of 22 May, 2020 was used to prepare the coal mine fire map (Figure 5) for the year 2020. The data have 100 m spatial resolution in the thermal bands and is as on study date, the best thermal satellite data available. The Coal fire maps of 2020 when compared to map of 2017 (NRSC, 2017) depicts the dynamics of coal fire. Coal fire is difficult to mitigate because of its dynamic nature. But the understanding the trend in the shift of coal fire zones and over all distribution of coal fire will help in environmental and risk management related to coal mining activities.

The coal mine fire map for the year 2020 (Figure 5) illustrates the overall fire distribution in the area. The maps reveal that the coal fires are distributed across the Jharia coal field in pockets associated with major open cast mining activities. All most all the coal mine fires are restricted to the Barakar Formation where coal seams are exposed. In the eastern flank of the arcuate shaped mining extent, the collieries in Tisra (North and South) and Bhaura, Bhulanbarari and R-OCP are affected by multiple small fire pockets. In Bhaura, the fire is seen mostly in OB dumps with minor presence of active mine fires. Similarly in Bhulanbarari, fire is seen in the OB dump only. The North and South Tisra mines have visible presence of fire, mostly manifested by high temperature fume cracks. Active fires are also seen in the R-OCP. Further, towards the north east, in Ena, Alkusha and Kusunda active fires are more prevalent and the area is extensively affected. The highest radiant temperatures (in order of ~50°C) are recorded by the satellite sensors in these areas. In the north, a large number of moderate to small fire pockets are seen in the areas around the related to the mining areas of Katras, Gaslitand, Mudidih and Sendra Bansjora. In the western flank, three distinguishable fire affected zones are seen. Toward the western end of the mining area, the Benedih and Block II OCP are affected by smaller fires from isolated coal seams. An older fire patch is also seen in the Shatabdi mine.

Comparison of the 2020 coal fire map with that of 2017 (NRSC, 2017) indicated the dynamism in the spatial extent and distribution of the coal fires. The changes are highlighted as follows:

i. In reference to the map generated in 2017, the 2020 map shows that the significant decrease of fires in the eastern flank, namely Bhaura, Tisra (North and Soth), Lodna and R-OCP etc. Similar decrease is also observed in Bastacolla and Bhulanbarari.
ii. The areal extent of major fire zone around Kusunda and Ena also appears to have decreased with change in the spatial location of the anomalies. This is probably due to the mitigation and active fire mining in this region.
iii. The fire zones in Benedih/Block II OCP and Shatabdi OCP have also changed/diminished in areal extent with presence of isolated smaller anomalies.
iv. The spatial disposition of fire areas around Katras, Keshalpur, Gaslitand and Mudidih show minor increase. The fire pockets observed in 2017, have given away to a few fire zones of moderate disposition.

In summary, there is a change in the areal disposition of the fires from 2017 to 2020. Satellite and field observations both suggest that there has been an overall decrease in the extent of fire in the JCF. A quantitative comparison of the 2017 and 2020 data was carried out. As compared 2017, when the total fire affected extent of the JCF was about 3.28 km^2; in 2020 total fire affected extent is about 1.89 km^2 (including TISCO mines).Within the mining lease of BCCL (excluding TISCO) in comparison 2017, when the total fire affected extent of the JCF was about 3.27 km^2; in 2020 total fire affected extent is about 1.86 km^2. The colliery wise break-up of change in fire area from 2017 to 2020 is given in Annexure-I. Herein, it should be noted that the minimum mapable unit from satellite image it 30m by 30m or 0.0009 km^2.

7.1.2 Subsidence analysis

An attempt to identify subsidence zones in the Jharia Coalfield was also carried out using ALOS-PALSAR-2 L band microwave data using differential interferometric technique. 5 scenes of PALSAR-2 data spanning over a period of 2017 to 2020 were used to delineate the subsidence if any in the region and separately identify them from the terrain changes due to mining. Verification of the subsidence zones as seen from

data is difficult as it requires visible signatures of subsidence in the form of cracks on the ground and damage to anthropogenic structures. In this study, data analysis and consequent field verification resulted in identification is 4 subsidence areas, within the BCCL mine boundary. Of these, the major area where considerable ground subsidence is occurring is the Moonidih UG project. Long term underground mining has resulted in continuous subsidence in the area. Apart from this, the other three areas are south of South Govindpur, Bagdigi and Bhagaband mines, however, the field evidences of the same are not conclusive. No quantitative estimates of the subsidence have been carried out in the study.

7.2 Conclusions

The following conclusions can be made:

1. As of the date of study in the year 2020 and in comparison with the previous study done in 2017, there has been a change in areal extent and disposition of the fire affected areas. On the other hand, persistent subsidence is seen in the Moonidih area due to underground mining activities.
2. Compared to 2012, the eastern flanks (Lodna, Tisra, Bhulanbarai areas) show considerable decrease in fire disposition and the western flank (Shatabdi and Block II area) show diminished fire presence.
3. The fires are continuation of existing fire affected areas as seen in the 2017 study.
4. The mines in Kusunda remain to be the worst affected with maximum presence of active fires.
5. There is a decrease in areal extent of the fire from 2017 to 2020. As compared 2017, when the total fire affected extent of the JCF was about 3.28 km^2; in 2020 total fire affected extent is about 1.89 km^2 (including TISCO mines). Within the mining lease of BCCL (excluding TISCO) in comparison 2017, when the total fire affected extent of the JCF was about 3.27 km^2; in 2020 total fire affected extent is about 1.86 km^2.

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.) both in 2017 and in the present 2020 study are pixel based. 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 disposition 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 (resampled from spatial resolution of 100m) on the ground whose temperature is considerably higher than its surroundings. This can be attributed to two circumstances, namely the area has a very high intensity fire located within a smaller pocket or there are a number of low intensity fires spread across it. In both the mentioned cases the actual areal extent of the fire on the surface differs, but appears as a single anomalous pixel in the data. Hence, representation of fire affected ground area by means of pixel area is ambiguous and hence should be considered with caution.

2) There are locations as observed during the fieldwork, where coal seams are affected by active fires along vertical/semi-vertical sections of open cast mines (see cover page). In such cases, the actual areal expression of the fire affected area as seen by the sensor changes considerably and the representation from the same is not accurate.

3) As discussed in section 4.1.2, 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 needs to be taken into account diligently, as it is inevitable that the area estimate will not define the actual fire/subsidence affected area on the ground. However, the areal extent estimated from the data can be "like to like" compared to earlier estimates of similar studies to understand the change and dynamism of the fire in terms of area affected and spatial disposition.

References

1. Gangopadhyay, P.K., Lahiri-dutt, K., Saha, K. (2005): "Application of remote Sensing to identify coal fires in the Raniganj coal belt, India." *Int. Jour of Applied Earth Observation and Geoinformation*.
2. Gangopadhyay, P.K., Malthuis.B, Van Dink (2005): "Aster Derived emissivity and coal-fire related surface temperature anomaly a case study in Wuda, North China," *Int. Jour. of Remote Sensing*, vol-26, No.-24, pp-5555-5571.
3. Schmugge, T., French, Ritchie, J.C., Rango, A., Pelgrum, H. (2002): "Temperature and emissivity separation from multispectral thermal infrared observation," *Remote Sensing of Environment*, 79, pp-189-198.
4. Saraf A.K., Prakash A., Sengupta, S., Gupta, R.P (1995): "Landsat-TM data for estimating ground temperature and depth of sub-surface coal fire in the Jharia coalfiled, India," *Int. Jour. Remote sensing vol-16, no-12*, 2111-2124.
5. Gangopadhyay P.K., (2003): "Coalfire detection and monitoring in Wuda, North China, A multispectral and multi-sensor approach:-Ph.D. Thesis, ITC Netherland.
6. Gupta, R.P. (2003): "Remote Sensing Geology", *Springer-Verlag.Third ed*.pp-183-216.
7. Kealey, P.S and Hook S.J(1993): "Separating temperature and emissivity in thermal infrared Multispectral Scanner Data: Implication for recovering land surface temperatures", *IEE Transaction on Geoscience and Remote Sensing,vol,31,no-6*,pp-1155-1164
8. Zhang, J., Wagner, W., Prakash, A., Mehl,H. and Voigt,S.(2004): "Detecting coal fires using remote sensing techniques," *Int. Jour. Remote sensing, vol-25, no-6*, pp 3193-3220.
9. Bhattacharya, A. and Reddy, C.S.S. (1995): Inventory and monitoring of underground and surface coal mine fire in Jharia coalfield, Bihar using thematic mapper thermal IR data: *Geosciences Group, Official report, NRSA.*
10. Coal mine fire delineation and surface features mapping using satellite data in Jharia coal field, Dhanbad, Jharkhand. Geology and Geophysics division. *Official report, NRSA, 2006*
11. Coal mine fire delineation and surface features mapping using satellite data in Jharia coal field, Dhanbad, Jharkhand. Geosciences Group. *Official report, NRSC, 2014*
12. Coal mine fire delineation and surface features mapping using satellite data in Jharia coal field, Dhanbad, Jharkhand. Geosciences Group. *Official report, NRSC, 2017.*

13. Carnec C, Massonnet D, King C (1996) Two examples of the use of SAR interferometry on displacement fields of small spatial extent. Geophysical Research Letters 23:3579–3582, 10.1029/96gl03042.
14. Bürgmann R, Rosen PA, & Fielding EJ (2000). Synthetic aperture radar interferometry to measure Earth's surface topography and its deformation. Annual review of earth and planetary sciences, 28(1), 169-209

Annexure –I

Colliery wise break-up of change in fire area from 2017 to 2020

COLLIERY AREA NAME	FIRE AREA 2017 (SQ. KM.)	FIRE AREA 2020 (SQ. KM.)	AREA CHANGE (SQ. KM.)	Increase/Decrease
BENEDIH OCP	0.045	0.020	-0.026	DECREASE
BLOCK-II OCP	0.135	0.034	-0.101	DECREASE
MURAIDIH OCP	0.002	0.006	0.004	INCREASE
SHATABDI OCP	0.036	0.005	-0.031	DECREASE
PHULARITAND	0.021	0.000	-0.021	DECREASE
KATRAS-CHOITUDIH	0.137	0.214	0.077	INCREASE
KESHALPUR	0.001	0.134	0.132	INCREASE
BASURIA	0.000	0.012	0.012	INCREASE
TETULMARI	0.022	0.011	-0.011	DECREASE
GODHAR	0.000	0.132	0.132	INCREASE
INDUSTRY	0.051	0.000	-0.051	DECREASE
KUSUNDA	0.740	0.399	-0.340	DECREASE
SENDRA-BANSJORA	0.027	0.110	0.083	INCREASE
BASTACOLLA	0.081	0.000	-0.081	DECREASE
GOLUCKDIH	0.112	0.000	-0.112	DECREASE
KUJAMA	0.240	0.000	-0.240	DECREASE
S. JHARIA-R. OCP	0.112	0.010	-0.102	DECREASE
GONHOODIH	0.032	0.001	-0.031	DECREASE
ENA	0.043	0.004	-0.040	DECREASE
N. TISRA	0.180	0.031	-0.149	DECREASE
LODNA	0.353	0.000	-0.353	DECREASE
S. TISRA	0.102	0.021	-0.081	DECREASE
BARAREE	0.107	0.040	-0.068	DECREASE
KENDUADIH	0.000	0.001	0.001	INCREASE
GASLITAND	0.122	0.156	0.034	INCREASE
KANKANEE	0.052	0.057	0.004	INCREASE
MUDIDIH	0.110	0.220	0.110	INCREASE
LOYABAD	0.006	0.000	0.079	DECREASE
E.BHUGGATDIH	0.021	0.020	-0.001	DECREASE
ALKUSHA	0.029	0.046	0.016	INCREASE
KUSTORE	0.046	0.014	-0.032	DECREASE
ANGARAPATRA	0.015	0.036	0.021	INCREASE
BHOWRAH. N	0.098	0.006	-0.092	DECREASE
BAGDIGI	0.021	0.000	-0.021	DECREASE
JEALGORA	0.007	0.000	-0.007	DECREASE
JEENAGORA	0.047	0.000	-0.047	DECREASE
JOYRAMPUR	0.104	0.011	-0.093	DECREASE

TOTAL AREA	**3.3**	**1.8**	**1.5**	**DECREASE**

Note:

1) The minimum mapable unit from satellite image it 30m by 30m or 0.0009 km^2

2) "INCREASE" implies, increase in fire area OR emergence of fire areas not identified in 2017 study

3) "DECREASE" implies, decrease in fire area OR fire areas in 2017 not identified in present study *(either absent or below sensor resolution)*

4) Values marked in "blue" are collieries where fire has was reported in 2017 study but presently shows no such signatures.

Annexure –II



Figure 13: Active fires in Keshalpur-West Mudidih. (Points 1, 2, 3 & 4 in figure 12)



Figure 14: Active fires in Sendra-Bansjora Mines (Points 5, 6, 7 & 9 in figure 12)



Figure 15: OB dump fires in Sendra Bansjora (Points 10 in figure 12)



Figure 16: Active fires in Godhar-Kusunda Mines (Points 20 to 24 in figure 12)



Figure 17: Fire in R-OCP. (Point 28 in figure 12)



Figure 18: Active fires in N-S Tisra mines (Points 31-33 in figure 12).



Figure 19: Subsidence area in Bagdigi Mines



Figure 20: Subsidence (sag ponds) around Moonidih mine area

Annexure –III

Coordinates of Fire locations.

Mine	UTM_X	UTM_Y	Longitude	Latitude
Keshalpur	430560.28	2633068.44	86.3183	23.8074
Keshalpur	430287.86	2632817.14	86.3156	23.8051
W. Mudidih	430935.00	2632710.00	86.3220	23.8042
W. Mudidih	431468.57	2632417.14	86.3273	23.8015
Kendra Bansjora	433626.56	2632140.94	86.3484	23.7991
Tetulmari	433245.00	2631915.00	86.3447	23.7971
Kendra Bansjora	433899.00	2631765.00	86.3511	23.7958
Shatabdhi	422415.00	2631645.00	86.2384	23.7942
Kendra Bansjora	433383.75	2631563.75	86.3461	23.7939
Kendra Bansjora	435666.92	2631113.08	86.3685	23.7899
Katras-Chotudih	427797.06	2630997.35	86.2913	23.7886
Gaslitand	430270.06	2630936.18	86.3156	23.7881
Katras-Chotudih	429170.29	2630763.09	86.3048	23.7865
Mudidih	432313.36	2630596.98	86.3356	23.7851
Godhar	438450.00	2630085.00	86.3959	23.7808
Benedih OCP	419198.18	2630070.00	86.2069	23.7798
Kankanee	433072.50	2629995.00	86.3431	23.7797
Block II OCP	419491.36	2629772.73	86.2098	23.7771
Kusunda	438532.86	2629547.14	86.3967	23.7759
Godhar	438187.50	2630145.00	86.3933	23.7813
Block II OCP	418545.00	2629200.00	86.2006	23.7719
Kusunda	437910.00	2629005.00	86.3906	23.7710
Kusunda	438335.37	2629195.97	86.3948	23.7727
Alkusha	437452.80	2629068.00	86.3861	23.7715
Kusunda	438007.50	2628495.00	86.3916	23.7664
Kusunda	438392.33	2628011.36	86.3954	23.7620
Ena	438465.00	2627070.00	86.3962	23.7535
R -OCP	440644.55	2626785.45	86.4176	23.7510
Goonhodih	442050.00	2625480.00	86.4314	23.7393
NT-ST	442815.00	2624385.00	86.4389	23.7294
NT-ST	443100.00	2623890.00	86.4418	23.7250
NT-ST	443205.00	2623410.00	86.4428	23.7206
NT-ST	443253.33	2623211.67	86.4433	23.7189
NT-ST	443910.00	2623110.00	86.4497	23.7180
Jayrampur	442200.00	2622915.00	86.4330	23.7161
Bhulanbarari	441898.64	2620804.77	86.4301	23.6971
Bhaura	437768.57	2619865.71	86.3896	23.6884
Bhaura	438202.50	2619131.25	86.3939	23.6818
Bhaura	438720.00	2618775.00	86.3990	23.6786

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

(FOR THE MONTH FEBRUARY, 2024)

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

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

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EXECUTIVE SUMMARY

1.0 Introduction

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

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

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

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

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

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

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_2). Respirable Dust Samplers (RDS) and Fine

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

3.2 Water quality

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

3.3 Noise level monitoring

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

4.0 Results and interpretations

4.1 Air quality

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

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

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

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000

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

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 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.**

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

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

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

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

2.1.1 Ambient Air Quality Sampling Locations

I. CORE ZONE Monitoring Location

i) Damoda (A2): Industrial Area

The location of the sampling station is 23°46'9.00"N & 86°10'38.00"E. The sampler was placed at a height of approx. 1.5m above ground level.

II. BUFFER ZONE Monitoring Location

i) Karmatand village (A1) : Residential area

The location of the sampling station is at 23°45'58.20"N & 86° 9'30.59"E in Karmatand village. The sampler was placed at a height of approx. 1.5m above ground level.

ii) Madhuband washery (A3) : Industrial area

The location of the sampling station is at 23°47'24.01"N & 86°11'32.00"E in the Washery premises. The sampler was placed at a height of approx. 1.5m above ground level.

iii) Block II OCP (A4): **Industrial Area**

The location of the sampling station is 23°47'2.00"N & 86°11'15.00"E . The sampler was placed at an elevated platform of approx. height 1.5m above ground level near water treatment plant of Block II OCP.

iv) Regional Hospital Baghmara (A42): Residential Area

The location of the sampling station is 23°47'57"N & 86°12'39"E The sampler was placed at an elevated platform of approx. height 1.5m above ground level at Regional Hospital Baghmara.

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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	**02/2024**	**Cluster**	**Cluster I**	**ULR NO.**	**TC1012224000000577F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.03.2024**
Project	**Damoda (A2)**	**Sample Ref. No.**	**REM/BCCL/2024/02**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**
Date of Sampling	12.02.2024 – 27.02.2024	**Period of Analysis**	**12.02.24 to 15.03.2024**	**Zone of Station:** Core Zone	**AREA** Industrial Area

Sl. No.	Parameter	Method of Analysis	Observed Values (in µg/m³) 1st FN	Observed Values (in µg/m³) 2nd FN	Range Of Testing	LDL	MoEF Standards Notification dated 25th September,2000 (GSR 742 E)	NAAQS, 2009
1	PM_{10}	IS -5182(Part 23):2006, R-2017	74	84	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	30	54	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	**17**	**29**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

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

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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

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Test Report for Ambient Air Samples

Month & Year	**02/2024**	**Cluster**	**Cluster I**	**ULR NO.**	**TC1012224000000577F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.03.2024**
Project	**Karmatand village(A1)**	**Sample Ref. No.**	**REM/BCCL/2024/02**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**
Date of Sampling	**10.02.2024 TO 28.02.2024**	**Period of Analysis**	**10.02.2024 TO 15.03.2024**	**Zone of Station:**	**Buffer zone**	**AREA**	**Residential area**

Sl. No.	Parameter	Method of Analysis	Observed Values (in µg/m³)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September,2000 (GSR 742 E)	NAAQS, 2009
			1st FN	2nd FN				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	86	73	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	32	38	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	**21**	**20**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

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

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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Test Report for Ambient Air Samples

Month & Year	**02/2024**	**Cluster**	**Cluster I**	**ULR NO.**	**TC1012224000000577F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.03.2024**
Project	**Madhuband washery (A3)**	**Sample Ref. No.**	**REM/BCCL/2024/ 02**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**
Date of Sampling 14.02.2024 TO 28.02.2024	**Period of Analysis**	14.02.2024 TO 15.03.2024	**Zone of Station:**	**Buffer Zone**	**AREA** / **Industrial area**

Sl. No.	Parameter	Method of Analysis	Observed Values (in µg/m³) 1st FN	Observed Values (in µg/m³) 2nd FN	Range Of Testing	LDL	MoEF Standards Notification dated 25th September,2000 (GSR 742 E)	NAAQS, 2009
1	PM_{10}	IS -5182(Part 23):2006, R-2017	129	133	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	66	54	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	**32**	**30**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

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

ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Amit Raj Mishra) ***ıthorised Signatory***

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Test Report for Ambient Air Samples

Month & Year	**02/ 2024**	**Cluster**	**Cluster I**	**ULR NO.**	**TC1012224000000577F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.03.2024**
Project	**Block II OCP (A4)**	**Sample Ref. No.**	**REM/BCCL/2024/02**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**
13.02.2024 TO 26.02.2024	**Period of Analysis**	**13.02.2024 TO 15.03.2024**	**Zone of Station:**	**Buffer Zone**	**AREA**	**Industrial Area**

Sl. No.	Parameter	Method of Analysis	Observed Values (in µg/m³)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September,2000 (GSR 742 E)	NAAQS, 2009
			1st FN	2nd FN				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	92	88	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	35	44	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	**17**	**26**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

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

(Gaurav Kant)

(Amit Raj Mishra)

ANALYSED BY ***REVIEWED BY*** ***Authorised Signatory***

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Test Report for Ambient Air Samples

Month & Year	**02/ 2024**	**Cluster**	**Cluster I**			**ULR NO.**	**TC1012224000000577F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.03.2024**
Project	**Hospital Baghmara (A42)**		**Sample Ref. No.**	**REM/BCCL/2024/02**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**	
Date of Sampling 15.02.2024 TO 29.02.2024		Period of Analysis	15.02.2024 TO 15.03.2024		**Zone of Station:** **Buffer Zone**	**AREA**	**Residential Area**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			1st FN	**2nd FN**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	73	69	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	36	39	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	**19**	**18**	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,*

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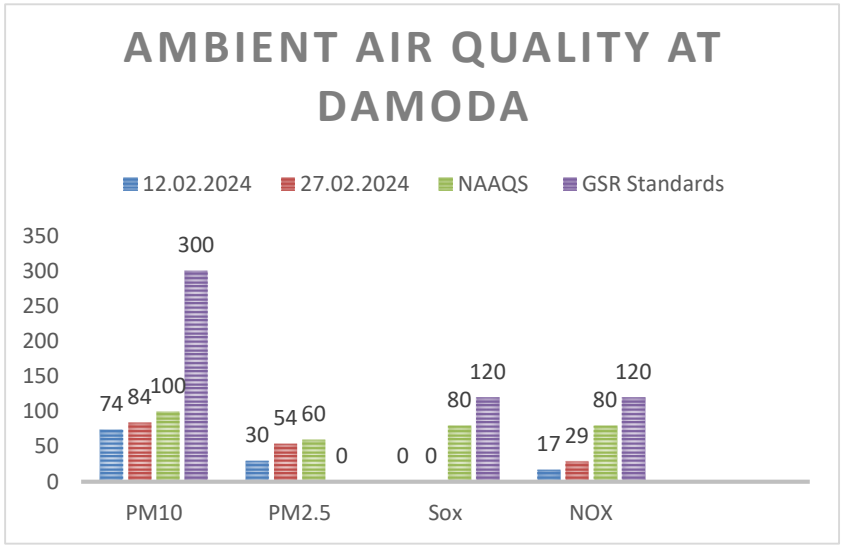
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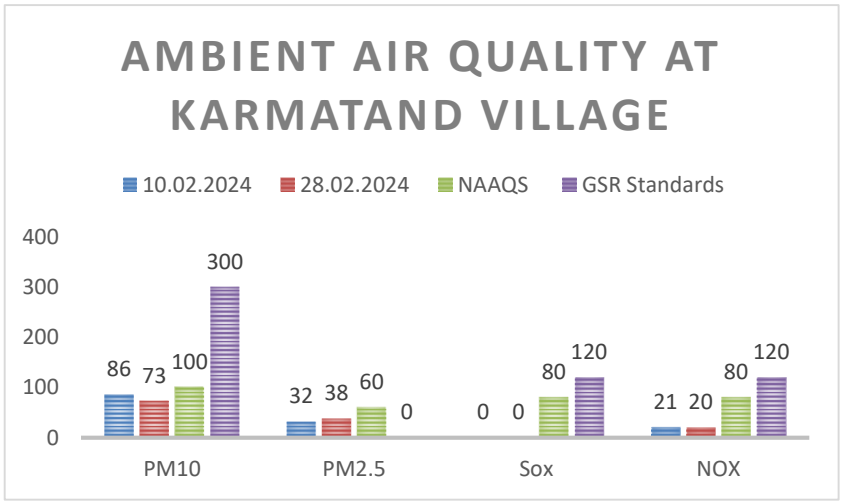
(Gaurav Kant)
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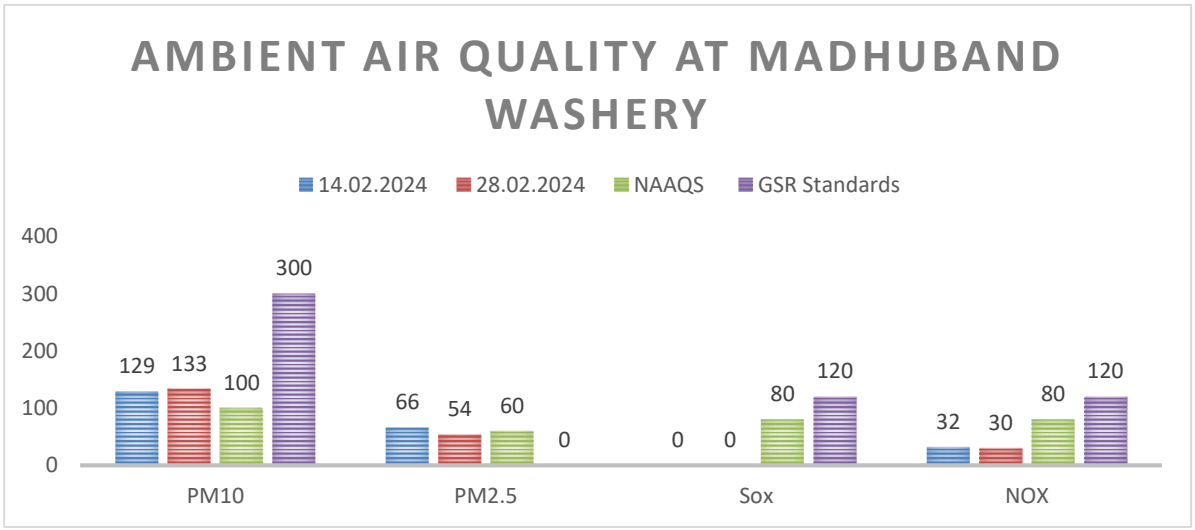
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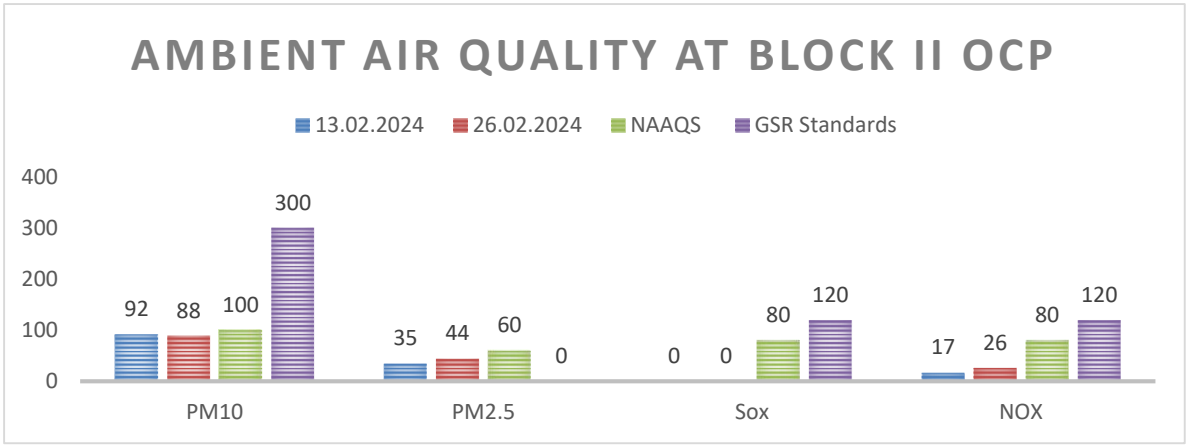
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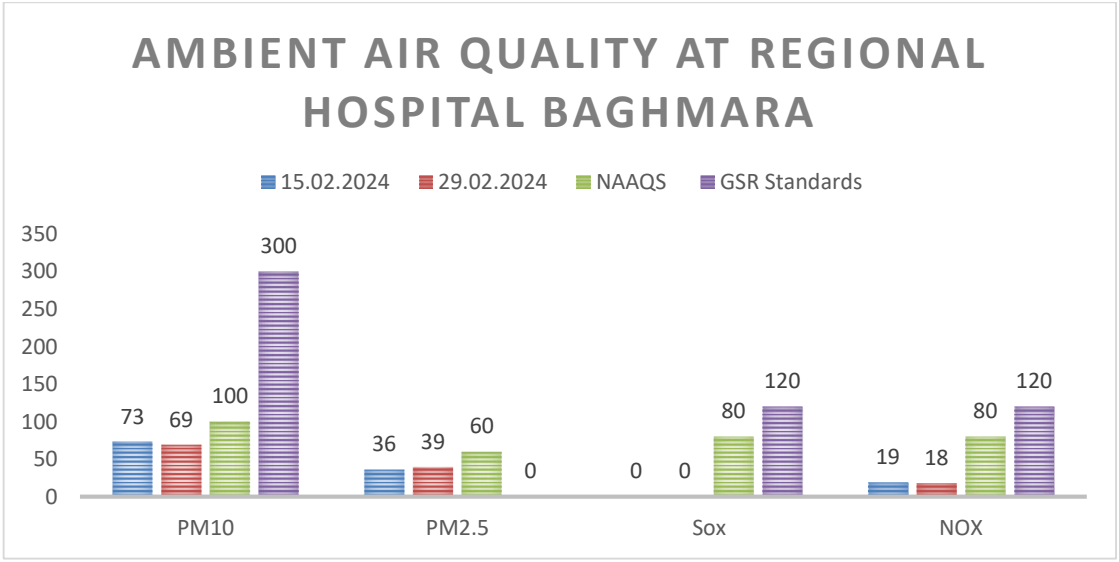
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AMBIENT AIR QUALITY AT DAMODA
12.02.2024
27.02.2024
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
74 84 100 300
30 54 60 0
0 0 80 120
17 29 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT KARMATAND VILLAGE
10.02.2024
28.02.2024
NAAQS
GSR Standards
400
300
200
100
0
86 73 100 300
32 38 60 0
0 0 80 120
21 20 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MADHUBAND WASHERY
14.02.2024
28.02.2024
NAAQS
GSR Standards
400
300
200
100
0
129 133 100 300
66 54 60 0
0 0 80 120
32 30 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT BLOCK II OCP
13.02.2024
26.02.2024
NAAQS
GSR Standards
400
300
200
100
0
92
88
100
300
35
44
60
0
0
0
80
120
17
26
80
120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT REGIONAL HOSPITAL BAGHMARA
15.02.2024
29.02.2024
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
73
69
100
300
36
39
60
0
0
0
80
120
19
18
80
120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) **Mine Discharge of Damoda (MW1)**

A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Jamunia.

ii) **Mine Discharge of Madhuband (MW23)**

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.

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

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
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TC-10122

Test Report for Mine Effluent samples

Month & Year	**02/ 2024**	**Cluster**	**Cluster I**		**ULR NO.**	**TC1012224000000595F**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.03.2024**
Project	**Damoda**	**Sampling Ref. No.**	**REM/BCCL/2024/ 02**		**Sampling Method**	**IS 3025 (Part-1)**	**CMPDI/RI-II/LPM 13**
Period of Analysis	**Damoda**		**Date of Sampling**		**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**		
			12.02.2024	26.02.2024	Period of Analysis	**12.02.2024 TO 15.03.2024**	

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**
			First Fortnight 11.12.2023	**Second Fortnight 25.12.2023**		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	42	44	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.88	7.81	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<2.0	<2.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	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 | (Kumar Vaibhav) ***REVIEWED BY*** | (Amit Raj Mishra) ***Authorised Signatory***

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

---- End of Report ----

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

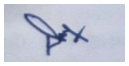
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Test Report for Mine Effluent samples

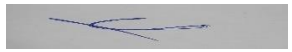
Month & Year	**02/2024**	**Cluster**	**Cluster I**	**ULR NO.**		**TC1012224000000595F**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.03.2024**
Project	**Madhuband**	**Sampling Ref. No.**	**REM/BCCL/2024/ 02**	**Sampling Method**		**IS 3025 (Part-1)**	**CMPDI/RI-II/LPM 13**
station	**Madhuband**		**Date of Sampling**		**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**		
			12.02.2024	26.02.2024	Period of Analysis	12.02.2024 TO 15.03.2024	

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**
			First Fortnight	**Second Fortnight**		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	39	38	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.48	7.51	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<2.0	<2.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	44	40	*250 (Max)*	4

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




ANALYSED BY



(Kumar Vaibhav)
REVIEWED BY



(Amit Raj Mishra)
Authorised Signatory

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

---- End of Report ----

NOISE LEVEL QUALITY MONITORING

4.1Location of sampling sites

i) **Karmatand village (N1)**

ii) **Damoda Colliery(N2)**

iii) **Madhuband Washery (N3)**

iv) **Block – II OCP (N4)**

V) **Regional Hospital Baghmara (N42):**

4.2 Methodology of sampling and analysis

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

4.2 Results & Interpretations

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

TC-10122

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

Month & Year	**02/2024**	**Cluster**	**CLUSTER I**	**ULR NO.**	**TC1012224000000611F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.03.2024**
Project	**Karmatand village**	**Sample Ref. No.**	**REM/BCCL/2024/02**	**Sampling Method**	**CMPDI/RI-II/LPM 22**
Station	**Karmatand**	**Date of Sampling**	**10.02.2024**	**28.02.2024**	**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	41.7	40.7	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial	75
2		07:00 - 08:00	42	43.2				Commercial	65
3		08:00 - 09:00	43.5	44				Residential	55
4		09:00 – 10:00	43.9	44				Silence	50
5		10:00 - 11:00	44.1	44.5					
6		11:00 - 12:00	44.5	44.3					
7		12:00 - 13:00	47.7	46.9					
8		13:00 - 14:00	47.9	47					
9		14:00 - 15:00	48	47.2					
10		15:00 - 16:00	48.9	47.3					
11		16:00 - 17:00	47.6	47.7					
12		17:00 - 18:00	47.3	47.3					
13		18:00 - 19:00	47.1	47					
14		19:00 - 20:00	43.9	44.6					
15		20:00 - 21:00	42.1	44.1					
16		21:00 - 22:00	40.7	40.8					
		Leq DAY	45.8	45.5					
1	Noise Level dB(A)Leq -Night	22:00-23:00	39.7	38.5	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial	70
2		23:00- 00:00	39.4	37.1				Commercial	55
3		00:00- 01:00	35.6	36				Residential	45
4		01.00-02.00	35.4	35.3				Silence	50
5		02.00-03.00	35.2	35.2					
6		03.00-04.00	35.7	35.1					
7		04.00-05.00	35.7	35					
8		05:00-06:00	38.3	34.6					
		Leq NIGHT	37.3	36.0					

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

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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

---- End of Report ----

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

Month & Year	**02/ 2024**	**Cluster**	**Cluster I**	**ULR NO.**	**TC1012224000000611F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.03.2024**
Project	**Damoda Colliery**	**Sample Ref. No.**	**REM/BCCL/2024/ 02**	**Sampling Method**	**CMPDI/RI-II/LPM 22**

			Date of Sampling	12.02.2024	27.02.2024	**Zone Category of Station:**		**Core Zone**	
Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A)) First Fortnight**	**Observed Values (in Leq dB(A)) Second Fortnight**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
								Zones	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	52.6	53.2	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	55.3	57					
3		08:00 - 09:00	58	58.6					
4		09:00 – 10:00	64.5	65.2					
5		10:00 - 11:00	65.7	65.6					
6		11:00 - 12:00	64.5	65.2					
7		12:00 - 13:00	67.6	68.3					
8		13:00 - 14:00	66.4	67.4					
9		14:00 - 15:00	59.3	59.8					
10		15:00 - 16:00	58.7	59.2					
11		16:00 - 17:00	58.2	58.6					
12		17:00 - 18:00	56.1	57.8					
13		18:00 - 19:00	56.4	56.7					
14		19:00 - 20:00	53.6	56					
15		20:00 - 21:00	52.5	53.4					
16		21:00 - 22:00	52.5	53.4					
		Leq DAY	61.8	62.5					
1	Noise Level dB(A)Leq -Night	22:00-23:00	51.4	51.6	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	46.7	47.7					
3		00:00- 01:00	46	46.3					
4		01.00-02.00	44.9	44.9					
5		02.00-03.00	44.3	44.3					
6		03.00-04.00	43.9	43.8					
7		04.00-05.00	43.8	44.4					
8		05:00-06:00	44.4	44.3					
		Leq NIGHT	46.5	46.8					

**LDL indicates Lower Detection Limit*

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

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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

---- End of Report ----

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TC-10122

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

Month & Year	**02/ 2024**	**Cluster**	**Cluster I**	**ULR NO.**	**TC1012224000000611F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.03.2024**
Project	**Madhuband Washery**	**Sample Ref. No.**	**REM/BCCL/2024/ 02**	**Sampling Method**	**CMPDI/RI-II/LPM 22**

				Date of Sampling	14.02.2024	28.02.2024	**Zone Category of Station:**		**Buffer Zone**
Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A))**	**Observed Values (in Leq dB(A))**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
			First Fortnight	**Second Fortnight**				**Zones**	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	67.1	67.3	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	54.3	51.2					
3		08:00 - 09:00	53	48.3					
4		09:00 – 10:00	69.3	72.1					
5		10:00 - 11:00	61.2	57.7					
6		11:00 - 12:00	55	55					
7		12:00 - 13:00	62.7	64.9					
8		13:00 - 14:00	62.2	61.1					
9		14:00 - 15:00	61.9	62.7					
10		15:00 - 16:00	58.4	59.2					
11		16:00 - 17:00	65.7	67.1					
12		17:00 - 18:00	51.6	50.5					
13		18:00 - 19:00	60.8	61.6					
14		19:00 - 20:00	65.7	66.7					
15		20:00 - 21:00	62.1	62.5					
16		21:00 - 22:00	60.8	61.9					
		Leq DAY	63.2	64.4					
1	Noise Level dB(A)Leq -Night	22:00-23:00	58.9	59.8	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	58.6	58.7					
3		00:00- 01:00	58.2	58.4					
4		01.00-02.00	57.8	58.1					
5		02.00-03.00	57.6	56.9					
6		03.00-04.00	56.6	56.7					
7		04.00-05.00	56.7	56.7					
8		05:00-06:00	56.9	57.8					
		Leq NIGHT	57.7	58.0					

**LDL indicates Lower Detection Limit*

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

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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

---- End of Report ----

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

CMPDIL, RI-II
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04/2023	02/2024	Cluster	Cluster II	ULR NO.	TC1012224000000611F
Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)			Date of Issue	30.03.2024
Project	Block – II OCP	Sample Ref. No.	REM/BCCL/2024/ 02	Sampling Method	CMPDI/RI-II/LPM 22

			Date of Sampling	13.02.2024	26.02.2024	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	51.1	49.3	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	50.3	50					
3		08:00 - 09:00	51.3	52.3					
4		09:00 – 10:00	52.4	53.3					
5		10:00 - 11:00	55	55.6					
6		11:00 - 12:00	55.6	55.9					
7		12:00 - 13:00	57.7	59.4					
8		13:00 - 14:00	62.8	64.8					
9		14:00 - 15:00	65.2	67.1					
10		15:00 - 16:00	62.2	64					
11		16:00 - 17:00	62.9	65.2					
12		17:00 - 18:00	65.2	69.2					
13		18:00 - 19:00	67.4	66.3					
14		19:00 - 20:00	65.2	64.7					
15		20:00 - 21:00	62.8	63.6					
16		21:00 - 22:00	61.5	60.5					
		Leq DAY	62.1	63.4					
1	Noise Level dB(A)Leq -Night	22:00-23:00	60.3	57.6	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	59.8	57.2					
3		00:00- 01:00	52.7	53.5					
4		01.00-02.00	52.4	52.5					
5		02.00-03.00	51.7	51.4					
6		03.00-04.00	53	53.6					
7		04.00-05.00	53.4	53.5					
8		05:00-06:00	54.1	54.7					
		Leq NIGHT	56.0	54.7					

**LDL indicates Lower Detection Limit*

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

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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

---- End of Report ----

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

Month & Year	02/ 2024	Cluster	CLUSTER I	ULR NO.	TC1012224000000611F
`	``			Date of Issue	30.03.2024
Project	Regional Hospital Baghmara	Sample Ref. No.	REM/BCCL/2024/ 02	Sampling Method	CMPDI/RI-II/LPM 22

			Date of Sampling	15.02.2024	29.02.2024	Zone Category of Station:		Buffer Zone	
Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	40.1	39.7	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	40.9	41.9					
3		08:00 - 09:00	43	43.2					
4		09:00 – 10:00	44	43.4					
5		10:00 - 11:00	45.1	48					
6		11:00 - 12:00	45.5	47.1					
7		12:00 - 13:00	46	43.9					
8		13:00 - 14:00	46.2	49.2					
9		14:00 - 15:00	46.3	47.1					
10		15:00 - 16:00	46.1	43.5					
11		16:00 - 17:00	43.2	42.9					
12		17:00 - 18:00	42.9	43					
13		18:00 - 19:00	42.1	44.6					
14		19:00 - 20:00	42	42.5					
15		20:00 - 21:00	40.7	41.9					
16		21:00 - 22:00	40.3	39.5					
		Leq DAY	43.9	44.7					
1	Noise Level dB(A)Leq -Night	22:00-23:00	37.2	37.6	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	37.6	37.4					
3		00:00- 01:00	37.2	36.4					
4		01.00-02.00	35.6	35.9					
5		02.00-03.00	34.9	35					
6		03.00-04.00	35.9	36.2					
7		04.00-05.00	35.6	36.3					
8		05:00-06:00	37.6	36.7					
		Leq NIGHT	36.6	36.5					

**LDL indicates Lower Detection Limit*

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

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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 ----

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

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (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.

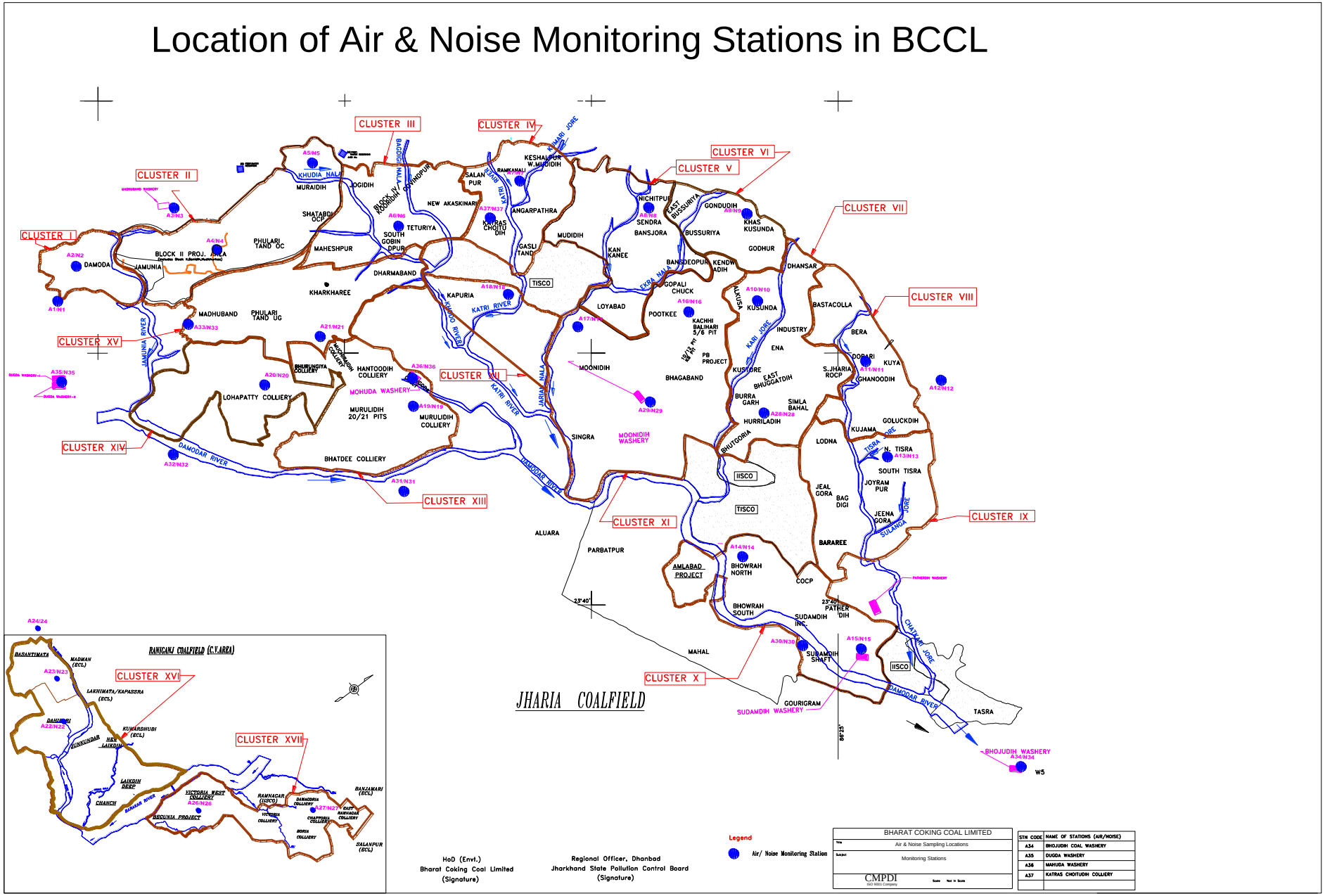
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet 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.

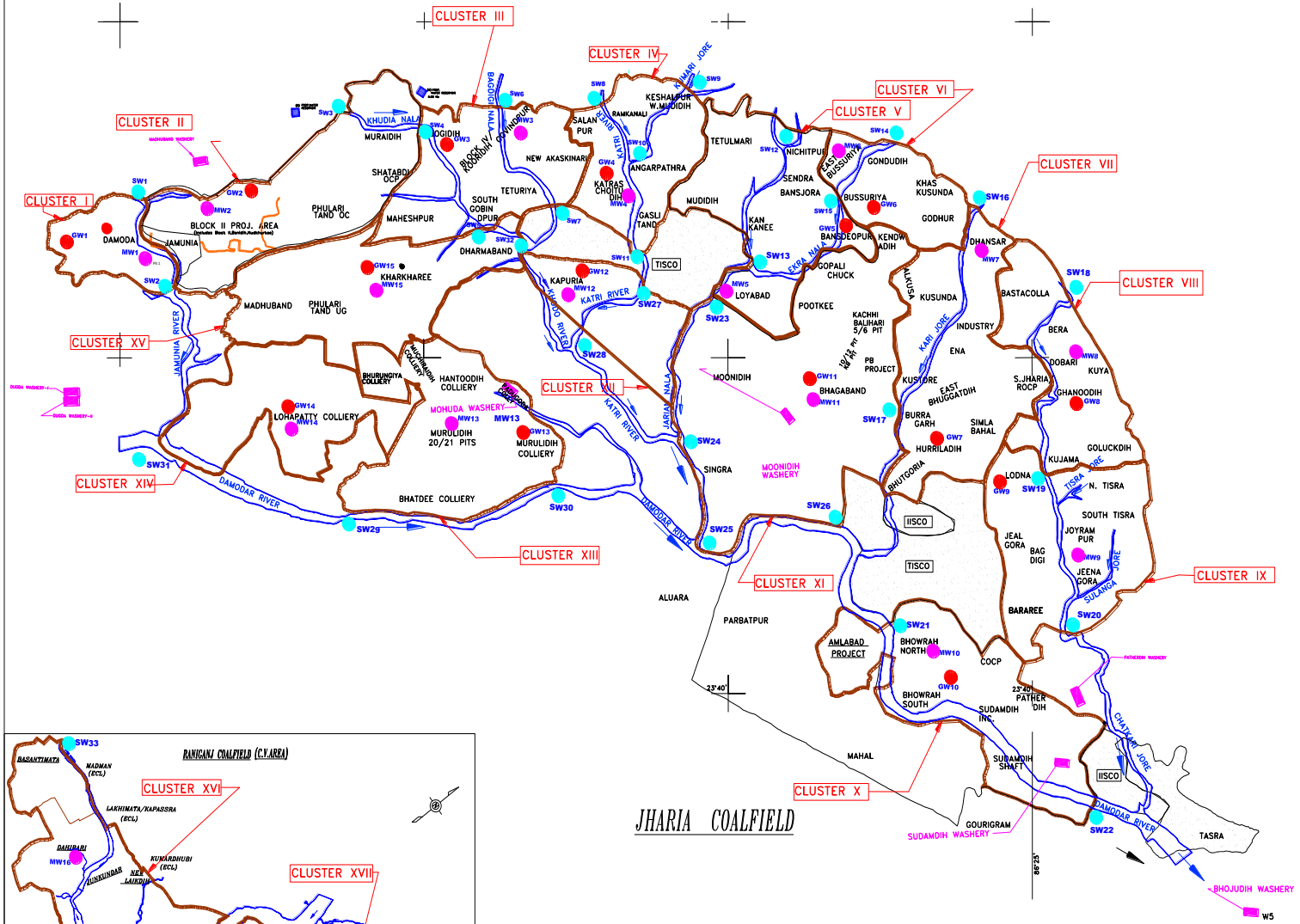
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

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

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

Cluster	Suface Water (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Bagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	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



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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

C O N T E N T

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SUMMARISED DATA

SUMMARISED DATA

SL NO	PARTICULARS	MASTER PLAN'04	MASTER PLAN'06	MASTER PLAN'08
A	Dealing with fire			
1	Total nos. of fires identified at the time of nationalisation	70	70	70
2	Additional fires identified after nationalisation	6	7	7
3	No. of fires extinguished till date	10	10	10
4	Total no of fires excluding the extinguished fires	66	67	67
5	Fires already under control, requiring no action plan except maintenance of status	9 * Kankanee XIII & XIV seam * Loyabad XV, XIV & XIII seam * Kachhi-Balihari XV seam * Bhalgora XIV seam * Bhalgora XV seam * Simlabahal XIV seam * Bhagaband XVI seam * Amlabad XIV seam * Jealgora fire	9 * Kankanee XIII & XIV seam * Loyabad XV, XIV & XIII seam * Kachhi-Balihari XV seam * Bhalgora XIV seam * Bhalgora XV seam * Simlabahal XIV seam * Bhagaband XVI seam * Amlabad XIV seam * Jealgora fire	9 * Kankanee XIII & XIV seam * Loyabad XV, XIV & XIII seam * Kachhi-Balihari XV seam * Bhalgora XIV seam * Bhalgora XV seam * Simlabahal XIV seam * Bhagaband XVI seam * Amlabad XIV seam * Jealgora fire
6	No. of collieries affected by fires	40	41	41
7	Total surface area affected by fires	8.90 sq.km	8.90 sq km	8.90 sq km
8	Potential impact of fire	* Dhanbad-Patherdih Rail Line. * Adra-Gomoh Rail Line. * Chatkari, Kari, Ekra, Katri Jores. * Jharia, Kirkend and many other populated areas.	* Dhanbad-Patherdih Rail Line. * Adra-Gomoh Rail Line. * Chatkari, Kari, Ekra, Katri Jores. * Jharia, Kirkend and many other populated areas.	* Dhanbad-Patherdih Rail Line. * Adra-Gomoh Rail Line. * Chatkari, Kari, Ekra, Katri Jores. * Jharia, Kirkend and many other populated areas.
9	No. of fires for which action plan has been proposed	66	67	67
10	No. of fires considered for Projectisation.	66	67	67

SL NO	PARTICULARS	MASTER PLAN'04	MASTER PLAN'06	MASTER PLAN'08
11	No. of fire projects to be implemented.	40*	45**	45**
12	Maximum No of fire projects to be implemented at a time	15	21	21
13	Total duration proposed for implementation of fire projects (excluding 2 years of pre-implementation activity	15 years	10 years	10 years
14	Technology suggested for controlling fires	* Excavation of fire material *Surface sealing and blanketing.	* Excavation of fire material *Surface sealing and blanketing.	* Excavation of fire material *Surface sealing and blanketing.
		*Isolation by trenching and back filling with cohesive soil.	*Isolation by trenching and back filling with cohesive soil.	*Isolation by trenching and back filling with cohesive soil.
		*Construction of grout barrier and stabilisation against rail, road and jore.	*Construction of grout barrier and stabilisation against rail, road and jore.	*Construction of grout barrier and stabilisation against rail, road and jore.
		*Filling of opencast high wall, shafts, inclines and other subsided areas.	*Filling of opencast high wall, shafts, inclines and other subsided areas.	*Filling of opencast high wall, shafts, inclines and other subsided areas.
		*Cooling and excavation of fire material and filling with cohesive soil.	*Cooling and excavation of fire material and filling with cohesive soil.	*Cooling and excavation of fire material and filling with cohesive soil.
		*Blind flushing with sand / cement / fly ash/grout mixture.	*Blind flushing with sand / cement / fly ash/grout mixture.	*Blind flushing with sand / cement / fly ash/grout mixture.
		*Cooling by water curtain/ in filteration ponds.	*Cooling by water curtain/ in filteration ponds.	*Cooling by water curtain/ in filteration ponds.
		*Seam sealing, tunnel plug and underground	*Seam sealing, tunnel plug and underground	*Seam sealing, tunnel plug and underground
15	Phase wise no of fire projects to be implemented			
	Phase-I (First five year)	27	28	28
	Phase-II (2nd five year)	13	17	17
16	Total Indicative fund requirement for controlling the fires (Rs. Crs:)			

SL NO	PARTICULARS	MASTER PLAN'04	MASTER PLAN'06	MASTER PLAN'08
	• Pre-implementation activities (2 years)	3.27	4.75	4.93
	• Phase-I (3rd to 7th yrs.)	1298.40	1014.55	1101.19
	• Phase-II (8th to 12th yrs.)	1161.48	1133.21	1205.39
	• Phase-III (13th to 17th yrs.)	493.67	-	-
	Total	**2957.82**	**2152.51**	**2311.50**
B.	**Stabilisation**			
17	No. of sites proposed to be stabilized through sand stowing	121	-	-
18	Total duration proposed for implementation of subsidence control projects	20 years	-	-
19	Total capital requirement (Rs. Crs)	**387.48**	-	-
C	**Rehabilitation of in- habitated sites from endangered areas**			
20	No. of sites proposed to be Rehabilitated			
	Full	271	326	326
	Part	261	269	269
	Total	**532**	**595**	**595**
21	No of houses to be vacated			
	BCCL	36208	44155	44155
	Private (Authorized)	15571	29444	29444
	Private (Un -Authorized)	12719	23847	23847
	Other	802	868	868
	Total	**65300**	**98314**	**98314**
22	No of houses proposed to be Resettled/Constructed			
	BCCL	36208	25000	25000
	Private (Authorized)	15571	28444	28444
	Private (Un -Authorized)	12719	23847	23847
	Other	802	868	868
	Total	**65300**	**79159**	**79159**
23	Phase wise no of houses proposed to be rehabilitated			

SL NO	PARTICULARS	MASTER PLAN'04	MASTER PLAN'06	MASTER PLAN'08
	• Phase – I (3rd to 7th yrs)	19984	45795	45795
	• Phase – II (8th to 12th yrs)	18861	33364	33364
	• Phase – III (13th to 17th yrs)	16321	-	-
	• Phase – IV (18th to 22nd yrs)	10134	-	-
	Total	**65300**	**79159**	**79159**
24	Land required for rehabilitation (Ha)			
	For BCCL houses	978.57	400.00	400.00
	For Non BCCL houses	802.07	1104.99	1104.99
	Total	**1760.64**	**1504.99**	**1504.99**
25	Time frame for implementation (excluding 2 years of pre-implementation period)	20 Years	10 years	10 years
26	Estimated Capital required (Rs. Crs.)			
	• Pre Implementation (1st & 2nd yrs)	39.42	143.31	163.79
	• Phase – I (3rd to 7th yrs)	576.61	2184.71	2468.26
	• Phase – II (8th to 12th yrs)	705.59	1657.92	2116.55
	• Phase – III (13th to 17th yrs)	683.16	-	-
	• Phase – IV (18th to 22nd yrs)	442.13	-	-
	Total	**2446.91**	**4185.94**	**4780.60**
27.	• Estimated capital required for BCCL houses		931.10	1068.45
	• Estimated capital required for Non-BCCL houses including others		3254.84	3712.15
	Total		**4185.94**	**4780.60**
C	**Diversion of Rail and Road**			
28	Estimated capital (Rs Crs)	-	20.00	20.00
29	Phase wise total capital			

SL NO	PARTICULARS	MASTER PLAN'04	MASTER PLAN'06	MASTER PLAN'08
	for Master Plan			
	• Pre Implementation (1st & 2nd yrs)	46.58	148.06	168.72
	• Phase – I (3rd to 7th yrs)	1955.45	3199.26	3599.45
	• Phase – II (8th to 12th yrs)	1996.45	2991.13	3323.94
	• Phase – III (13th to 17th yrs)	1296.78	-	-
	• Phase – IV (18th to 22nd yrs)	494.95	-	-
	Total	5792.21	6358.45	7112.11

* Including 6 EMSC / RCFS Schemes
** Including 5 EMSC / RCFS Schemes

30. PHASE WISE SUMMARY OF REHABILITATION

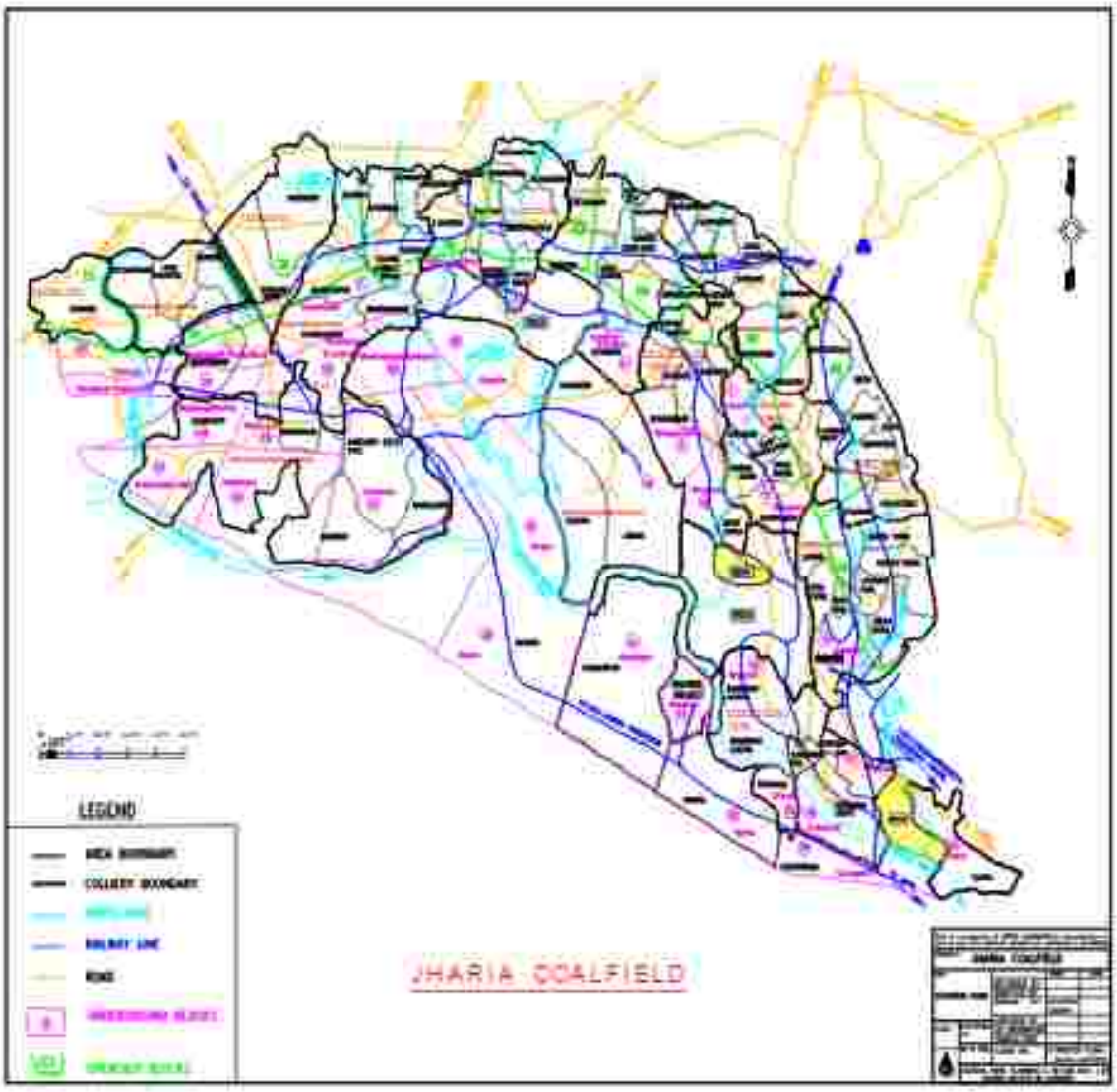
Phase	No of houses (including demo. Scheme)				Total	Land for resettlement (ha)		Total (ha)
	BCCL	PVT.	ENCHR.	OTHER		BCCL	NON-BCCL	
PHASE-I	12462	16671	16166	496	45795	199.39	660.27	859.66
PHASE-II	12538	12773	7681	372	33364	200.61	444.72	645.33
TOTAL	25000	29444	23847	868	79159	400.00	1104.99	1504.99

31. Summary of Physical and Financial Projections

1. Projection - Physical				
Particulars	Pre-implementation (1st & 2nd Yr.)	Phase- I (3rd to 7th Yr.)	Phase-II (8th to 12th Yr.)	Total
A. Dealing with fire				
i) No. of fire project to be implemented	-	28*	17	45
B) Rehabilitation				
i) No. of sites to be rehabilitated	-	300	295	595
ii) No. of houses to be rehabilitated				
a) BCCL	-	12462	12538	25000
b) Private	-	16671	12773	29444
c) Entroachers	-	16166	7681	23847
d) Others	-	496	372	868
Total		**45795**	**33364**	**79159**
2. Projection – Financial (Rs. In crores)				
Particulars	**Pre-implementation (1st & 2nd Yr.)**	**Phase- I (3rd to 7th Yr.)**	**Phase-II (8th to 12th Yr.)**	**Total**
A. Dealing with fire	**4.93**	**1101.19**	**1205.39**	**2311.50**
B) Rehabilitation				
a) BCCLHouses	34.75	478.95	554.75	1068.45
b) Non BCCL Houses	129.04	2019.32	1563.80	3712.15
Total	**163.79**	**2498.27**	**2118.55**	**4780.60**
c. Diversion of Rail & Road (Advance Action)	**20.00**			**20.00**
Grand Total (A+B+C)	**188.72**	**3599.46**	**3323.94**	**7112.11**

* Including fire ongoing EMSC/RCFS scheme and one maintenance project

INTRODUCTION


LEGEND
COLLIERY BOUNDARY
RAILWAY LINE
JHARIA COALFIELD

1.0 INTRODUCTION

1.1 Historical Background

Mining areas in Jharia and Raniganj coal fields, within the leasehold of Bharat Coking Coal Limited, are faced with problems of Fire and subsidence due to the century old history of mining in these coal fields. These problems have been receiving attention of all concerned from time to time and the mitigation measures have been taken on case to case basis at different times.

The problem of danger of subsidence of surface land over mine workings standing on small stooks vis-à-vis danger to habitations have attracted the attention of authorities concerned, technical organizations and institutions from time to time. MMGI of India formed the first subsidence committee in 1922. The second subsidence committee was formed by the same institute, which submitted its report in 1937, recommending remedial measures to minimize the danger due to mine subsidence. A few more committees were set up to examine the problem and areas where danger due to subsidence was apparent. One such committee was "Barakar Subsidence Committee in 1957", which submitted its report on the danger subsidence of G.T. Road and residential building in Barakar town. In 1953 two separate reports were submitted by the erstwhile NCDC entitled "Fire, Subsidence and Problems relating to Mine Workings in Underground ". In 1964, Director, CMRS, Dhanbad submitted a report entitled "Report on the Study of Coal Fires, subsidence and Problems Relating to Mine Workings.

The Govt. of India, Ministry of Energy (Department of Coal), constituted a committee under the Chairmanship of Mr. S.P. Gugnani, Joint Secretary, Dept. of Coal on 5th January 1976, to examine the whole question of safety in the nationalized coal mines. The Committee (Gugnani Committee – 1976) also decided to examine the question of safety of surface dwellers arising out of underground workings. The committee constituted a sub-committee with Sri S. Bagchi as convenor on 11.03.76 to make an in-depth study of the problems of subsidence and fire in coal mining areas and suggest solutions for the same. The committee submitted a report in 1979. The committee observed that the gigantic and multifarious subsidence problems in Jharia Coalfield was caused due to existence of old workings with full height extraction and wide galleries, multi-seam and multi-section development under shallow depths, existence of developed seams under extracted lower seam with stowing etc. There are many towns, villages, rivers, jores, roads, railway line etc., in Jharia Coalfield which are standing over small pillars / stooks reported to be water logged. If, by any chance, this water drains away it may cause subsidence. In addition, fire is also active in some areas, causing danger to the surface structure. In many mines, size of pillars, which were left below the surface structures as a protective measure, is not known because of non-availability of off-set plans of abandoned workings. The committee recommended the following eight (8) main measures to control danger due to subsidence depending upon conditions prevailing in individual mines of BCCL.

a. Vacating and / or dismantling the surface structures over the goaved out or unstable workings – 30 collieries.

b. Stabilisation of underground workings by packing or with suitable support system – 45 collieries.

c. Division of road, railway line, jore etc. and shifting of buildings and other infrastructures from unstable workings – 8 collieries.

d. Keeping the unstable workings under observation by measuring surface movement and assessing stability of workings by investigation –15 collieries.

e. Stopping further extension or extraction of mine workings or further construction of structure on the surface – 4 collieries.

f. Preparation, procurement and updating of mine plans to determine the extent of instability – 4 collieries.

g. Controlling underground fire effectively to prevent surface subsidence and breathing of air through subsided area – 8 collieries.

h. Assessing the danger of inundation to the workings due to surface or underground collapse – 3 collieries.

The committee also recommended the formation of Area Development Authorities by the concerned State Governments by 1981 so that these could regulate the construction of structures over coal baring areas to deal with the problems of subsidence on a permanent footing.

The long history of mining in these coal fields have led to increase in the number of sites prone to danger of safety due to fire and subsidence. Recurrent problems of fire and subsidence in these two coal fields and their spurt in 1996 required identification of subsidence and fire prone areas so that measures could be taken to tackle them. CMRI was engaged by BCCL for identification of such inhabited areas within the leasehold of BCCL. Subsequently, DGMS also identified a number of in-habitated areas, which require attention due to problems of fire and subsidence.

It has been felt right from the beginning of this decade that a comprehensive action plan needs to be prepared for dealing with the problems of fire and subsidence in these two coalfields. As a recourse to this, a project entitled "Jharia Mine Fire Control Technical Assistance Project" was funded by the World Bank under the Development Credit Agreement in April 1993. M/s GAI/MET-CHEM Joint Venture, USA / Canada were engaged for "Development of Fire Fighting Programme in JCF" (a part of the total project, the other part being preparation of Environmental management Plan for JCF). The consultants submitted their study report in 1996, identifying a number of fire projects with their estimated capital requirement.

In December 1996, Govt. of India constituted a high Power Committee under the Chairmanship of Secretary, Ministry of Coal with other members from the Govt. of Bihar & West Bengal, Planning Commission, DGMS, Ministry of Labour, Chairman CIL, CMDs of ECL, BCCL & CMPDI with director (Tech), Ministry of Coal as member Secretary to review the problems of fire & subsidence in Jharia and Raniganj coal fields and suggest measures to deal with problems of existing habitation on subsidence / fire prone areas. The Committee was also asked to suggest areas for resettlement, mechanism for evacuation and resettlement of affected population and Institutional arrangement to prevent new habitation in fire and subsidence prone areas. Subsequently, Ministry of Coal directed CMPDI to study in depth problems of subsidence and fire in BCCL and ECL and submit its report. As the fire problem was already studied under World Bank funding, two separate projects relating to

subsidence and rehabilitation problems were funded by Ministry of Coal, under Coal S&T Grant as EMSC projects. The projects were as follows:

SL. No.	Name of the Project	Sanctioned Capital
1	Generation of data and identification of subsidence prone areas and its segregation into controllable and uncontrollable areas in the leasehold of BCCL (Phase-I)	Rs. 25.84 lakhs
2	Technological Measures for control of subsidence where feasible, assessment of evacuation and resettlement needs where subsidence control is not feasible and assessment of fund requirement for both in the leasehold of BCCL (Phase – II)	Rs. 48.33 lakhs

The study in respect of the first project as mentioned above (Phase – I) was completed in February / April / August '98 and the report submitted in three volumes. The second project as mentioned above (Phase – II) has been prepared in two parts, one dealing with the technological measures for control of subsidence where feasible and the other dealing with rehabilitation and re-settlement needs for the areas where subsidence control is not feasible. These reports were submitted in January 1999.

The Standing Sub-committee of SSRC on Environment and Ecology directed CMPDI in its XVIth meeting held at CIL, Calcutta on 30.06.98 to prepare a Master Plan for dealing with the problems of fire, subsidence and rehabilitation in the leasehold of BCCL, considering the fire control measures, areas to be stabilised, areas requiring rehabilitation including the phased requirement of funds for the same.

Accordingly, three separate Draft Master Plan for "Dealing with Fire Subsidence Control of Inhabitated Areas", and "Rehabilitation of Uncontrollable In-habitated Areas" was prepared in the month of February 1999. The drafts were discussed at CMPDI (HQ), Ranchi on 12.03.1999 and BCCL on 16.03.1999. Thereafter, the final report entitled "Master Plan for dealing with fire Subsidence and Rehabilitation in the Leasehold of BCCL" submitted in March '99 incorporating the views expressed in the above meetings. The three reports mentioned above viz., World Bank funded report for "Development of Fire Fighting Programme in JCF" and coal S&T Grant funded EMSC projects, namely, "Generation of data and identification of subsidence prone areas and its segregation into controllable and uncontrollable areas in the leasehold of BCCL (Phase-I)" and Technological measures for control of subsidence where feasible, evacuation and resettlement needs where subsidence control is not feasible and assessment of fund requirement for both in the leasehold of BCCL (Phase-II)" formed the basis for preparation of the Master Plan prepared in 1999.

2.0 BRIEF OF MASTER PLAN, 1999

It the Master Plan for Fire, Subsidence and Rehabilitation in the Leasehold of BCCL (1999) the following aspects were included.

- Dealing with fire.
- Subsidence Control of the in-habitated Areas
- Rehabilitation of the uncontrollable subsidence prone in-habitated areas.

Master Plan 1999 envisaged the following:

A) Dealing with 55 nos. of fire out of 64 no, within a time frame of 15 years, in three phases, each of 5 years duration for a capital investment of Rs 1481.93 Crs.

B) Subsidence control of 121 unstable and controllable inhabitated sites through sand stowing within a time frame of 20 years in four phases, each of 5 years duration for a Capital Investment of Rs. 291.88. Crs.

C) Rehabilitation of 65300 houses from the unstable and uncontrollable in-habitated areas within a time frame of 20 years, in 4 phases, each of 5 years for a Capital Investment of Rs 1981.14 Crs. Total no. of houses proposed to be rehabilitated were 65300 from 532 localities (271 full, 261 part).

Total indicative fund requirement for dealing with was Rs.3754.95 Crs

3.0 BRIEF OF MASTER PLAN '2004

Cost updation of Master Plan'1999 was done in April '2004 as per directive of Ministry of Coal. The salient features of Master Plan'2004 was as under:

A) Dealing with 57 nos. of fire out of 66 no, within a time frame of 15 years, in three phases, each of 5 years duration for a capital investment of Rs.2952.82 Crs.

B) Subsidence control of 121 unstable and controllable in-habitated sites through sand stowing within a time frame of 20 years in four phases,
each of 5 years duration for a Capital Investment of Rs. 387.82. Crs.

C) Rehabilitation of 65300 houses from the unstable and uncontrollable in-habitated areas with a time frame of 20 years, in 4 phases, each of 5 years for a Capital Investment of Rs 2446.91 Crs. Total no. of houses proposed to be rehabilitated was 65300 from 532 localities (271 in full, 261 in part).

Total indicative fund requirement was Rs. 5792.21 Crs.

4.0 CHRONOLOGICAL EVENT AND NECESSITY OF REVISION OF MASTER PLAN

- The Master Plan prepared in March'99 was approved by BCCL Board in April '99 and submitted to CIL for approval in May'99.

- The Master Plan '99 was submitted by CIL to Ministry of Coal in March'2000.

- As an out come of writ petition (Civil) No. 357/97 filed by Sri Haradhan Roy, EX-MP in 1997, an Action Plan for shifting and rehabilitation, dealing with fire and stabilization of unstable areas was prepared in April '03. This Action Plan was prepared based on Master Plan'99.

- The Action Plan was sent to state Govt. of Jharkhand and West Bengal as well as to Ministry Labour / DGMS for their comments and acceptance.

- The Action Plan was finalized in July '03 incorporating the decisions of State Govt. & DGMS.

- Dy. Secretary, Govt. of India, vide his letter 22020/2/2003 – CRC dated 4th Feb'04 advised BCCL to update the Master Plan '99.

- Cost updation of the Master Plan '99 was done and submitted to BCCL in April '04.

- Supreme Court of India appointed Director General of Mines safety to go through the Action Plan and subsequent affidavit / ATR filed by UOI and to verify the same and file a report in the court within three months.

- DGMS constituted a committee and submitted its report in Aug'05. One of the observations of the committee was

  "As there is no scientific method available to check long-term stability of the site stabilised by sand stowing, it might not be possible to certify that the areas thus stabilised. The present stabilization work may restrict the effect of subsidence and allow some time. The final and permanent solution is evacuation of the affected area and rehabilitation. "

- The updated Master Plan was approved by BCCL and CIL Board in July '04 and submitted to MOC for approval.

- Planning commission accorded "in Principal" approval of the Master Plan vide letter no. M-12026/2/2005 coal dt. 29.03.05. However, planning commission sought some clarifications which were sent to MOC in May'05.

- In June '05, the IMG note of updated Master Plan was submitted to MOC.

- MOC vide letter no. 22020/1-CRC(PT) dt. 25.07.05 communicated that instead of IMG note a PIB note shall be submitted.

- Draft PIB note for Master Plan of BCCL Part was sent to ECL for preparing combined PIB not of BCCL & ECL on 15.10.05.

- MOC vide letter no. 22020/2/2005-CRC dt. 15.12.05 directed for preparation of revised PIB note with the following consideration.

1. All the areas where stabilisation through hydraulic stowing was proposed now have to be considered for total re-settlement.

2. It is being suggested that instead of shifting the affected people from the endangered areas in a number of small townships, it would be prudent to develop large satellite townships through the reputed builders / building organizations providing necessary civic amenities to motivate the people for shifting.

3. To further the rehabilitation process it is being suggested that wherever possible, schemes / project reports may be prepared for the areas where shifting of population is being considered and extraction of the available coal reserves may be undertaken either by O/C or by U/G means.

- On 23.02.06, a meeting was held on Master Plan in the Chamber of Secretary (Coal) where it was decided that as desired by Planning Commission, the execution of Master Plan should be tried to be completed within a period of 10 years. The minutes of the above meeting is enclosed as Annexure – I.

In order to comply with the suggestion of planning commission, Secretary (Coal) and DGMS Committee, it is necessary to revise the Master Plan, April'04.

Accordingly, the Master Plan was revised in April'2006 considering the following.

1. Time frame of Implementation for different activities under Master Plan will be 10 years (excluding 2 years of Pre-Implementation activities) to comply with the suggestion of Planning Commission.

   However, acceptance of such reduction of time frame needs to be obtained from the concerned State Govt.

2. All the sites, which were proposed for stabilization has been considered for rehabilitation to comply with the suggestion of the committee constituted by DGMS.

The above Master Plan, April'2006 with an Indicative Capital requirement of Rs 8637.28 Crs. was presented before Secretary (Coal) in his chamber on 4.7.2006. In the above presentation the following decisions were taken.

I) As the manpower in BCCL is continuously reducing due to super -annuation, only 25000 BCCL houses shall be constructed against 42650 houses as proposed in the Master Plan. Therefore fund for construction of only 25000 houses shall be considered in the Master Plan.

II) The cost estimate of the fire projects should be reduced to the extent possible. Whenever fire is handled by direct removal of coal and OB, the cost shall be set off considering that 50% of coal will be available for selling.

III) A sample survey should be carried out for private (Pucca & Kutcha) for ascertaining suitable fund provision as compensation in the Master Plan.

IV) For the purpose of income generation scheme, it has been decided that head of every displaced house shall be paid wage of 250 days in a year for two years as per minimum wage rate of respective state Govts.

The Master plan, July'2006 has been prepared considering the above decision and was submitted to State Govt. of Jharkhand for their acceptance vide letter no.GM (ENV)/F-rhab/2007/138 dated 6.3.2007. Jharkhand state Govt. has not given acceptance as yet.

Cost up-dation of the Master Plan July'06 has been done up to Feb'08 considering the increase in WPI and Civil Cost Index.. Increase in WPI was about 7% and Civil cost index was 14.28%

5.0 SCOPE OF WORK OF MASTER PLAN '2008

Master Plan now covers only following two aspects:

i) **Dealing with fire**, which includes identification of fire areas, selection of technologies to deal with the fires, prioritization for implementation and assessment of tentative fund requirement.

ii) **Rehabilitation & Resettlement** of the affected people from the areas affected by fire & subsidence including identification of affected sites, identification of resettlement sites and assessment of tentative fund requirement.

Note: "BCCL vide letter no GM(Env)/F- /06 dated 22nd April, 2006 suggested that diversion of railway lines and NH 32 road passing through coal bearing areas of JCF should also be included in the Master Plan'2006.

Diversion of rails and roads passing over the coal bearing areas are affected by fire and subsidence at many places and may further be affected. As the diversion will affect the operation of other coal producing companies like TISCO & SAIL, other industries operating in the coalfield and State Govt. as well as Railway, a joint decision is to be taken involving all the above stakeholders.

Moreover, the diversion of rail and road requires survey of the alternative routes, detail layout planning by expert agencies like RITES and likely to take about two years time.

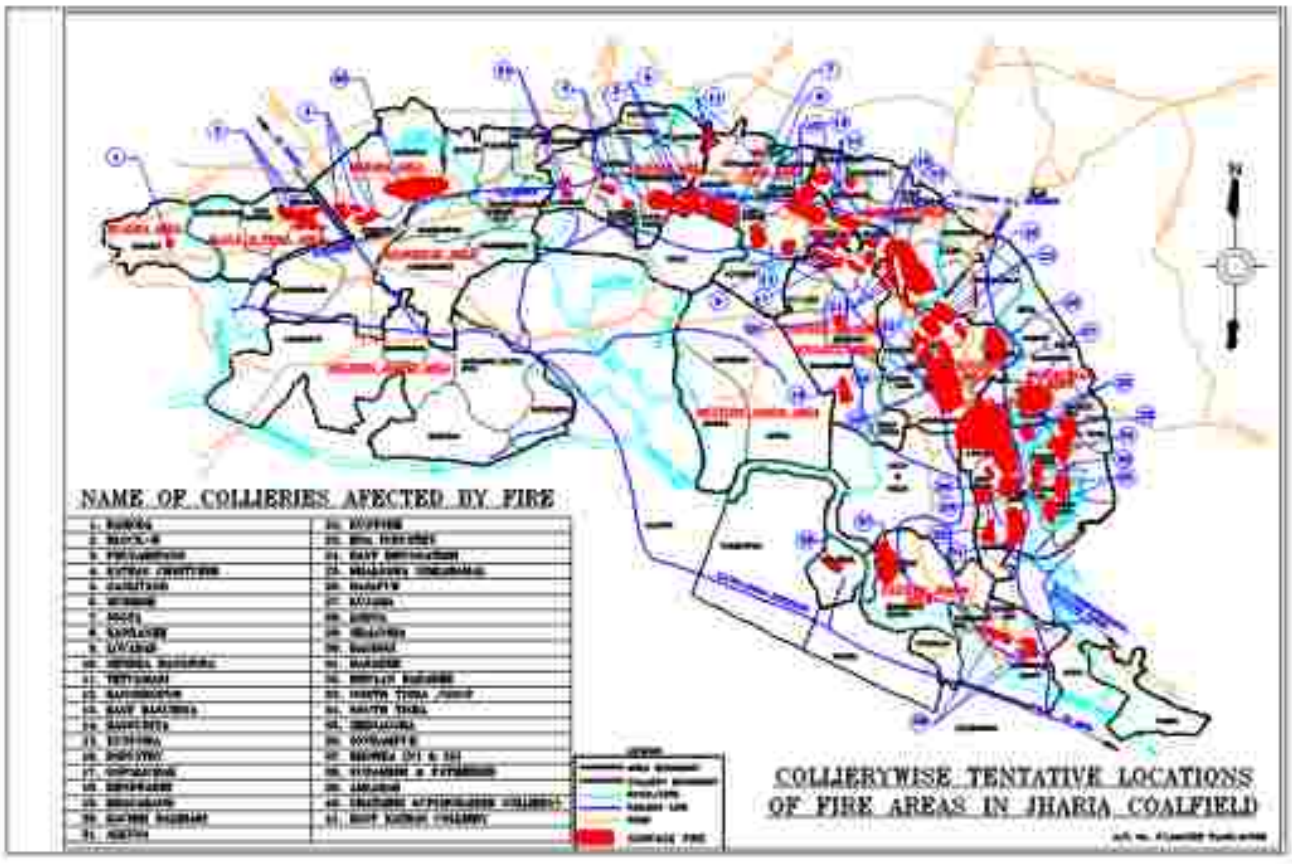
Therefore, in this Master Plan, a lump sum provision of Rs.20 Crs has been kept for survey and planning only as an advance action. The detail proposal for diversion may be taken up as a separate Master Plan in future. "

As per the recommendation of the committee constituted by DGMS, all the sites proposed for stabilization in the Master Plan '99, have now been considered for rehabilitation. The time frame for implementation of Revised Master Plan has been considered as 10 years proposed to be implemented in two Phases (Phase – I & II each of 5 years duration), excluding 2 years of pre-implementation period.

Implementation of the Fire control measures and rehabilitation of BCCL houses from the endangered area will be the responsibility of BCCL, where as rehabilitation of Non-BCCL houses/structures from the endangered areas will be the responsibility of State Govt. of Jharkhand and West Bengal. Land acquisition for BCCL employees shall be done in association with State Govt. of Jharkhand.

Rehabilitation sites will be located on non-coal bearing area along the fringe / periphery of Jharia coalfield. The sites will have the basic infrastructural facilities like Water & Electricity, School, Banks, Hospitals, Market Complex, Play Ground, and Community Center etc.

DEALING WITH FIRE


NAME OF COLLIERIES AFECTED BY FIRE
COLLIERYWISE TENTATIVE LOCATIONS
OF FIRE AREAS IN JHARIA COALFIELD

6.0 MASTER PLAN FOR DEALING WITH FIRE

6.1 Introduction

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. Since then a number of fires have occurred in underground workings, in opencast pits and in opencast overburden debris. According to the investigations made after nationalization 70 fires were known to exit in JCF in the leasehold of BCCL, covering an area of 17.32 Sq.km. It was estimated that about 37 mt of good quality prime coking coal has been destroyed and about 1864 mt of coal has been locked up due to these fires. Subsequently following (7) more fires was identified making the total tally of fires to 77.

- XV seam fire, Kachhi Balihari Colliery
- IX & IX spl seam fire, Bassuria Colliery
- XI & XII seam fire, Kendwadih Colliery
- V/VI/VII seam fire, Shatbdi OCP
- X seam fire, Sendra-Bansjora Colliery
- XI, XIII & XIV seam fire of East Katras colliery.

These 77 fires are spread over in 41 collieries of BCCL. The list of 77 fires is given in **Table-1** and the tentative location of the fire areas are shown in **drawing -2.**

The principal issues that BCCL is facing due to pervasive mine fire problem concern the health and well being of the persons living on or near the fire areas, threat to infrastructures like railway lines, roads, buildings, jores / rivers etc. and associated impacts on the exploitation of coal resources in the light of complications brought about by the fires

Out of 77 fires areas, ten (10) fires got completely extinguished due to control measures taken after formation of BCCL. Out of the balance 67 fires, nine (9) are underground fires, sealed behind the stoppings and are now at dormant state. These nine (9) underground fires do not need any action plan except maintenance of the status quo. Remaining 58 fires are although controlled but still requires action proposed to be dealt under this Master Plan. Area wise no. of fires is given in **Table – 2**

TABLE -1

LIST OF FIRES IN THE LEASEHOLD OF BCCL

Sl. No.	Name of the fire	Fire Status
1	Ganeshpur X, XI , XII & XIII seam fire	Active
2	Burwabera X seam fire	Active
3	Phularitand X, XI, XII seam fire	Active
4	Angarpathra XII, XI, X, IX Spl. seam fire	Extinguished
5	Gasitand XVT, XVB seam fire	Active
6	Jogta XV, XIV, XIII, XII, XI seam fire	Active
7	Kankanee XIII & XIV seam fire	Active
8	Ekra XI & XII seam fire	Active
9	Ekra XIII & XIV seam fire	Active
10	Loyabad XV, XIV, XIII seam fire	Active
11	Bassuriya XIV, XIII & XII, XI and X seam fire	Active
12	Sendra Bansjora XIV, XIII, XII, XI seam fire	Active
13	Bansdeopur XIV, XII seam fire	Active
14	Gopalichak XVI, XV, XIV, XIII, XII XI seam fire	Active
15	Industry XII, XI seam fire	Active
16	Kusunda XII, XI seam fire	Active
17	Alkusa XII, XIV seam fire	Active
18	Kustore XIV, XIII, XII, XI seam fire	Active
19	Ena XII, XI seam fire	Active
20	Pure jharia X seam fire	Active
21	K.P. Dobari X, V/VI/VII/VIII/VIIA seam fire	Active
22	Rajapur X seam fire	Active
23	Kujama XII, XI seam fire	Active
24	Kujama IX, X seam fire	Active
25	Bhalgora XIV seam fire	Dormant
26	Bhalgora XV seam fire	Dormant
27	East Bhuggatdih XV, XIV seam fire	Active
28	Ena XIV seam fire	Active
29	Ena XV seam fire	Active
30	Simlabahal XIV seam fire	Dormant
31	N.S Lodna XIII, XIIIA, XIV seam fire	Active
32	Bagdigi XIV, XIA, XV seam fire	Active
33	Baniahar XV, XIVA, XIV seam fire	Active
34	Bhaga XV seam fire	Active
35	South Tisra VII, VIII, IX, X seam fire	Active
36	Bhowra XIII, XIV seam fire	Active
37	Bararee XV, XIVA, XIV seam fire	Active
38	Bhulan Bararee XIII, XIV seam fire	Active
39	Bhulan Bararee XVI, XV seam fire	Active
40	Sudamdih IX to XIV seam fire	Active
41	Patherdih IX to XIII seam fire	Active

Sl. No.	Name of the fire	Fire Status
42	Bhowra IX , X seam fire	Active
43	Block –II XII, XI/XII, X Spl. seam fire	Active
44	Katras-Choitudih XIII seam fire	Active
45	Katras-Chortudih XIV, XV seam fire	Active
46	Tetulmari IV seam fire	Active
47	Tetulmari VI/VII seam fire	Active
48	Kendwadih XIII seam fire	Dormant
49	Kendwadih XIV, XIII seam fire	Dormant
50	Pootkee XV seam fire	Extinguished
51	East Bassuriya V/VI seam fire	Active
52	East Bassuriya VIII seam fire	Active
53	Kessurgarh V, VI, VII seam fire	Extinguished
54	Bhagaband XVI seam fire	Dormant
55	Amlabad XIV seam fire	Dormant
56	Sudamdih XV seam fire	Extinguished
57	Moonidih XVIIT seam fire	Extinguished
58	Damoda V, VI, VII seam fire	Dormant
59	Mudidih fire	Dormant
60	Jogidih X seam fire	Extinguished
61	Koonidih X seam fire	Extinguished
62	Nudkhurkee X seam fire	Extinguished
63	West Mudidih IX/X seam fire	Extinguished
64	East Katras XIV seam fire	Extinguished
65	North Tisra VII, VIII, IX seam fire	Active
66	North Tisra X seam fire	Active
67	Jeenagora IX, X, XI seam fire	Active
68	Jeenagora IX, X, XI,XII seam fire	Active
69	Joyrampur XI, XII, XIII seam fire	Active
70	Jealgora XV, XIV, XIIIB, XIIIA seam fire	Dormant
71	Bassuriya IX,I X Spl. seam	Active
72	Industry X seam	Active
73	Kathhi Balihari XV seam	Dormant
74	Kendwadih XI, XII seam	Active
75	Shatabdi V/VI/VII seam	Active
76	Sendra Bansjora X seam	Active
77	East Katras XI,XIII & XIV seam fire	Active

TABLE – 2

ADMINISTRTIVE AREA-WISE NUMBER OF FIRES IN BCCL

SL No.	AREA	TOTAL NUMBER OF FIRES		TOTAL
		ACTIONS REQUIRED	ACTION NOT REQUIRED (Except maintenance)	
1	Barora	5	-	5
2	Block-II	1	-	1
3	Western Jharia	-	-	-
4	Govindpur	-	-	-
5	Katras	4	-	4
6	Sijua	9	2	11
7	Kusunda	7	-	7
8	Pootkee-Balihari	4	2	6
9	Kustore	9	3	12
10	Bastacolla	2	-	2
11	Lodna	13	1	14
12	Eastern Jharia	4	1	5
	TOTAL (J.C.F.)	**58**	**9**	**67**
13	Chanch-Victoria (R.C.F)	-	-	-
	GRAND TOTAL BCCL (JCF +RCF)	**58**	**9**	**67**

LIST OF EXTINGUISHED FIRES

1. Angarpathra XII, XI, X Spl. seam (UG Fire)
2. Pootkee XV seam (UG Fire)
3. Kessurgarh V/VI/VII seam (Surface Fire)
4. Jogidih X seam (Surface Fire)
5. Kooridih X seam (Surface Fire)
6. East Katras XIV seam (Surface Fire)
7. West Mudidih IX / X seam (Surface Fire)
8. Nudkhurkee X seam (Surface Fire)
9. Moonidih XVII T seam (UG Fire)
10. Sudamdih XV seam (UG Fire)

6.2 Past Efforts to combat Mine Fire

After the nationalization of coal mines, serious thoughts were given for conservation of prime coking coal in JCF., the only source in the country. A Master Plan of Reconstruction of Jharia Coal Field was drawn up where fire was one of the major problems to be dealt in JCF before starting large opencast blocks as envisaged in the Master Plan of JCF Reconstruction. During 1976-1988, 22 fire projects to deal with the fires were sanctioned by BCCL for a total investment of Rs. 114.57 Crores. These fire projects covered the then 59 fires out of the 70 fires exiting at the time of nationalization.

Between 1998-2001, another eight schemes for dealing with fire and subsidence problems were sanctioned by Govt. of India under S&T grant (EMSC/RCFS) for a capital investment of Rs. 39.85 Crores. Out of these six schemes have been completed, 2 are under implementation.

Massive efforts were made in the implementation of 22 fire projects by the application of best available technology, such as surface sealing, digging, trenching, inert gas infusion and remote sand-bentonite mixture flushing. Besides, stabilization work was carried out to save railway lines, jores and other areas, which were accessible.

Over 22 million cubic metre of blanketing work was carried out, and more than 50 million tones of sand stowed below ground. Approximately 3 million cubic meter of nitrogen gas has been flushed below the ground to control fires. A sum of Rs. 76.00 Cores approximately has been incurred in the fire fighting, measures against the fire projects till March 1997. The implementation of these schemes, though could not extinguish all the fires completely, it was possible to achieve the following:

- Liquidated 10 fires completely.
- Controlled majority of the fires from total devastation. However, slow fire activities continue.
- Reduced the total surface area affected by fire to 8.90 sq.km from earlier reported 17.32 sq.km.
- Reduced the blockage of coal from 1864 MT to 1453 MT.

6.3 Jharia Mine Fire Control Technical Assistance Project

Although the efforts of BCCL in tackling the fire as outlined above and the results obtained were encouraging, it is only minuscule in size if seen in the perspective of all the fires raging in Jharia Coal Filed. The problem of fire is very vital and technical in nature and also due to various other serious issues like environmental pollution, rehabilitation and acute financial constraints, the company approached World Bank through Ministry of coal, Govt. of India for Jharia Mine fire Technical Assistance for exhaustive study of the technology of dealing with fire and environment in Jharia coal field. World Bank provided a loan of 12 million US$ and International Consultant GAI/MET-CHEM was engaged for fire dealing problems. The consultant started the work in 1994 and completed their study in June, 1996. The consultants have used the state of the art technology and modern scientific tools and methods for evaluation of the problems and suggested possible mitigating measures.

6.3.1 Fire Study by GAI/MET-CHEM

Utilising the remote sensing data of NRSA for Fires of JCF and colliery details, GAI/MET-CHEM undertook extensive drilling and temperature / gas monitoring along with field investigations for making inventory, boundaries and critical parameters of fires with possible spread and rate of spread of fires vertically and horizontally, potential danger to surface structures arising from spread and rate of propagation of fires. They also evaluated cost for the most suitable method of remedial actions. The final report for dealing with fire was submitted in June 1996.

The main observations / recommendation of the study of GAI/MET-CHEM are as under:

i) The overall surface area affected by fire has reduced. Latest study indicates 8.90 sq.km. against earlier figure of 17.32 sq.km of surface area occupied by Jharia Fires.

ii) Dhanbad - Patherdih rail line (2.8 km stretch) is endangered by fire and requires immediate grout stabilization or preferably relocation.

iii) Adra-Gomoh rail line requires protection near Phularitand.

iv) Ekra, Kari and Chatkari jores are endangered due to fires and require immediate protection at several places.

v) Jharia and Kirkend towns and many other built up areas are endangered due to fires and require immediate isolation from fires.

vi) Total extinguishment of fires immediately is not achievable but further advance of these fires can be controlled by the application of the recommended fire abatement measures / control measures.

The recommended fire abatement measures are the more improved use of one or combination of the following existing control measures:-

- Excavation
- Isolation by trenching
- Grout barrier and stabilization
- Blanketing / surface sealing
- Blind flushing

6.4 Control Measures For Dealing with Fires.

A variety of methods can be considered for controlling or extinguishing a fire. These are divided into i) conventional Methods of Fire Control and Extinguishment, and ii) Other Methods of Fire Control and Extinguishment.

6.4.1 Conventional Methods of Fire Control and Extinguishment

Conventional Methods that have been employed with varying degree of success are as under :

1) Total Excavation of fire
2) Isolation by trenching
3) Blind flushing
4) Surface sealing
5) Isolation by underground stopping
6) Quenching and cooling
7) Cooling by water curtain
8) Flooding
9) Natural Burnout

6.4.2 Other Methods of Fire Control and Extinguishment

1) Inert Gas injection
2) Chemical Treatment
3) Burnout Control
4) Modified Bulk filling (Water / Slurry)
5) Modified Bulk filling (Pneumatic) and
6) Underground Coal Gasification

6.4.3 Fire Control Measures Proposed in the Master Plan

Out of the various control measures currently available, the recommended control measures are the more improved use of one or combination of the following measures.

- Excavation of fire material and filling with cohesive soil
- Filling of opencast high wall, shafts, inclines and other subsided areas.
- Isolation by trenching and backfilling with soil
- Construction of grout barrier and isolation against rail, road and jores.
- Surface sealing and blanking
- Blind flushing with sand / fly ash / grout mixture
- Cooling by water curtain / infiltration pond
- Cooling, quenching and removal
- Seam sealing, tunnel plug and underground stopping

6.5 Methodology adopted in preparation of the Master Plan

Fire Report submitted by GAI/MET-CHEM in June 1996 under Mine Fire Technical Assistance Project (Fire fighting programme) form the basis of the present Master Plan for dealing with fire. While reviewing the above fire report, it was found that the following underground fires were not considered.

1. Bhagaband XVI seam fire
2. Kachhi Balihari XV seam fire
3. Loyabad XV, XIV and XIII seam fire
4. Industry X seam fire
5. Amlabad XIV seam fire

The above fires have been included in this Master Plan and suggested control measure, time schedule and fund requirement etc. have been given.

6.6 Recommended Technologies

Different alternatives for control measures to deal with each fire have been described in the report submitted by GAI/MET-CHEM. The most suitable control measure for each fire has also been recommended. In majority of cases, the measures as recommended by GAI/MET-CHEM have been considered in this Master Plan to arrive at the fund requirement and time schedule or each fire. However, for Block-II fire, Phularitand fire, Protection of Chatkari jore against Lodna group of fires, protection of Dhanbad – Patherdih Railway line in Lodna, Bagdigi, Bararee & Kujama, ROCP fire, Sudamdih – Patherdih fire, the technology has been changed based on the prevailing condition of the fires. The project wise details of fires and recommended technologies have been given in **Table – 3**.

PROJECTWISE DETAILS OF FIRE AND TECHNOLOGY SUGGESTED (Table-3)

Sl. No.	Name of the of Fire projects	Seams on fire		UG or Surface fire	Technology of fire control
1	JCF-F/LODNA/RAIL/I/1				
	Excavation of rail road bed and backfill with structural fill (length 3.5 km) at Lodna Bagdigi & Bararee Collieries along with diversion of chatkari jore.	Lodna	XVA,XV,XIVA XIV,XIIIB,XIIIA,XIII,XI/XII	Surface fire	Excavation and Back filling
		Bagdigi	XVA,XV,XIVA XIV,XIIIB,XIIIA,XIII,XI/XII	Surface & U/G	
		Bararee	XVA,XV,XIVA XIV,XIIIB,XIIIA,XIII,XI/XII	Surface & U/G	
2	JCF-F/BASTACOLA/ KUJAMA/JORE/I/2				
	Scheme for dealing with fire for protection of chatkari Jore at Kujama collieriy	Kujama	XI/XII	Surface fire	Temporary diversion of Jore
3	JCF-F / KUSTORE / RAJAPUR /I/3 (Part A , Rajapur OCP)				
	Scheme for dealing with fire at Rajapur Colliery by excavation method with IX/X seam base	Rajapur	X, IX	Surface fire	Back filling of quarry with non combustible material, Excavation in south Jharia Part, Stabilisation along OB road & surface sealing.
4	JCF-F/BARORA/SHATABDI OCP/I/33				
	Scheme for dealing with fire at Shatabdi OCP by excavation method	Shatabdi	V/VI/VII	Surface	Excavation & Back filling
5	JCF-F/KATRA/EAST KATRAS (NEW AKASHKINAREE)/I/35				
	Scheme for dealing with fire at East Katras (New Akashkinaree) colliery	East Katras/New Akashkinaree	XI,XII,XIV	Surface	Trench cutting
6	JCF-F/EJ/SUDAMDIH &PATHREDIH/I/19				
	Scheme for fire dealing at Sudamdih / Patherdih Colliery (Part A)	Sudamdih & Patherdih	XI/XII,XIV,XV	Surface & UG	Filling with incombistible material and high pressure sand flushing
7	JCF-F/SIJUA/SENDRA BANSJORA/I/21 (Part A)				
	Scheme for dealing with Sendra Bansjora X seam fire	Sendra Banjora	X	Surface	Trench cutting, blind flushing & sealing
8	JCF-F/KATRAS/GASLITAND/I/24				
	Scheme for dealing with Gaslitand Fire	Gaslitand	XV,XIV & OB	Surface	Surface sealing & blind flushing
9	JCF-F/KATRAS/KATRAS CHOITUDIH/I/26				
	Scheme for dealing with Katras Chiotudih Fire	Katras Choitudih	XVT&B, XIV,XIII	Surface	Excavation and filling
10	JCF-F/KUSUNDA/EAST BUSSURIYA/I/32				
	Scheme for dealing with East Bassuria Fire (Part A)	East Bassuria	V/VI,VII,VIII	Surface	Surface sealing, Sand flushing

11	JCF -F / LODNA/NT, ST, JEENAGORA, JOYRAMPUR/I/8(SURFACE SEALING)				
	Surface sealing for dealing with fire at North Tisra, South Tisra, Jeenagora & Joyrampur Collieries.	Bararee	XV, XIVA, XIV, XVI	Surface & U/G	Surface sealing with incombustible material and cohesive soil
		N.Tisra	X, IX, VIII & VII	Surface & U/G	
		S.Tisra	X, IX, VIII & VII	Surface & U/G	
12	JCF-F / LODNA / BAGDIGI, BARAREE, B. BARAREE/I/11(SURFACE SEALING)				
	Surface sealing for dealing with fire at Bagdigi, Bararee & Bhulan Bararee Collieries.	Bagdigi	XV,XIVA,XIV	Surface & U/G	Surface sealing with incombustible material & cohesive soil.
		Bararee	XV,XIVA,XIV, XVI	Surface & U/G	
13	JCF-F / LODNA / LODNA / I /12 (SURFACE SEALING)				
	Surface sealing for dealing with fire at Lodna Collieriy.	Lodna	XVA,XV,XIVA XIV,XIIIB,XIIIA	Surface fire	Surface sealing with incombustible material & cohesive soil.
14	JCF-F / BASTACOLLA / KUJAMA / GOCP/I/10 (SURFACE SEALING)				
	Surface sealing for dealing with fire at Kujama & GOCP.	Kujama	XI, XII, XIV &ft XT/B	Surface & U/G	Surface sealing / Blanketting with incombustible material & cohesive soil.
15	JCF-F / KUSTORE / RAJAPUR/I/ 37(Part B ,Bastacolla Annexed)				
	Scheme for dealing with fire at Rajapur Colliery by excavation method with V/VI/VII seam base	Rajapur	V/VI/VII/VIII, IX & X	Surface & U/G	Digging out of fire by excavation method
16	JCF-F / KUSTORE / ALKUSA/I/4 (Part-B)				
	Scheme for dealing with fire at Alkusa Colliery.	Alkusa	XIV, XII, XI) & XI	Surface	Back filling, seam sealing, and surface reclamation
17	JCF-F/BARORA/PHULARITAND/I/6				
	Scheme for dealing with fire at Phularitand Colliery (Block-III Coking).	Phularitand	XI/XII, IX/X	Surface & UG	Excavation with water quenching
18	JCF-F/KUSTORE/KUSTORE/I/7				
	Scheme for dealing with fire at Kustore Colliery (NW & SE fire).	Kustore	XV, XIV, XIII, XII, XI & OB	Surface & UG	Quenching, dozing, surface sealing, trench excavation & back filling
19	JCF-F/KUSTORE/ ENA(NW)/I/13				
	Scheme for dealing with fire at Ena Colliery.	Ena	XIV, XI/XII	Surface & UG	Trench excavation & soil filling
20	JCF-F/KUSTORE/ENA (MID & SE)/I/31				
	Scheme for dealing with Ena (Mid& SE) Fire	Ena	XI,XII,XIII,XIV	Surface	Surface sealing and back filling.
21	JCF-F/SIJUA/MUDIDIH/I/5				
	Scheme for dealing with fire at Mudidih Colliery.	Mudidih	XV Top & Bot	Surface & UG	Maintenance of existing surface seal and establishment of temperature monitoring programme
22	JCF-F/P.B./GOPALICHAK/I/14				

	Scheme for dealing with fire at Gopalichak Colliery.	Gopalichak	XIV, XIII	UG	Back filling of quarry high wall, tranch excavation back filling cement grout injection.
23	JCF-F/BASTACOLA/KUJAMA/RAIL/I/36				
	Excavation of rail road bed and backfill with structural fill (length 1.4km) at Kujama colliery with XI/XII seam base along with diversion of chatkari jore.	Kujama	XI/XII	Surface	Excavation & Back filling
24	JCF-F / BLOCK -II / BLOCK -II/II/5				
	Scheme for dealing with fire at Block-II OCP.	Block-II OCP	XIII, XI/XII, XSpl & Overburden	Surface	Quenching of fire material with water conon & dozing, spreading.
25	JCF-F/SIJUA/ TETULMARI(W)/II/15				
	Scheme for dealing with west fire at Tetulmari Colliery.	Tetulmari	IV/V/VI	UG	Surface sealing & Blanketting
26	JCF-F/SIJUA/TETULMARI(E)/II/16				
	Scheme for dealing with Tetulmari (East) Fire	Tetulmari	V T&B, IVT&B,OB	Surface &UG	Surface sealing & Blanketting
27	JCF-F/EJ/SUDAMDIH&PATHREDIH/II/38 (Part-B)				
	Scheme for fire dealing at Sudamdih / Patherdih Colliery (Part B)	Sudamdih & Patherdih	XI/XII,XIV,XV	Surface & UG	Trench cutting and Filling with incombistible material
28	JCF-F/KUSTORE/EAST BHUGGATDIH/II/17				
	Scheme for dealing with East Bhuggatdih Fire	Kustore	XV,XIV	Surface	Cohesive soil sealing
29	JCF-F/KUSUNDA/BASSURIYA-1/II/18				
	Scheme for dealing with Bassuria 1&2 Fire	Kusunda	XI,XII,XII, XIV	UG	Sand flushing and grout injection
30	JCF-F/PB/KENDWADIH(5)/II/20				
	Scheme for dealing with Kendwadih (South) Fire	Kenwadih	XIII,XIV	UG	Sand flushing
31	JCF-F/PB/KENDWADIH(N)& (E)/I/23				
	Scheme for dealing with Kendwadih (North)& (East) Fire	Kenwadih	XI,XII,XIII	UG	Blind flushing and tunnel plug
32	JCF-F/SIJUA/SENDRA BANSJORA/II/39 (Part B)				
	Scheme for dealing with Sendra Bansjora XI,XII,XIII & XIV seam fire	Sijua	X,XI,XII,XIII,XIV	Surface & UG	Trench cutting, grout injection, Surface sealing
33	JCF-F/BARORA/DAMODA/I/22				
	Scheme for dealing with Damuda Fire	Baraora	V/VI/VII,IX &OB	Surface	Quenching and removal of fire material
34	JCF-F/E J/BHOWRAH(N) & (S)/II/25				
	Scheme for dealing with Bhowra N& S Fire	Jharia	XV,XIV & OB	Surface	Quenching, surface sealing
35	JCF-F/SIJUA/JOGTA/II/27				

	Scheme for dealing with Jogta Fire	Sijua	XIV,XA,X	Surface	Cooling through water curtain,Surface sealing
36	JCF-F/KUSUNDA/BASSURIYA (3&4)/II/28				
	Scheme for dealing with Bassuria 3&4 Fire	Kusunda	IXI,XII,XII, XIV	UG	Trench cutting & filling
37	JCF-F/SIJUA/BANSDEOPUR(E)/II/29				
	Scheme for dealing with Basdeopur (East) Fire	Bansdeopur	XIII,XIV	Surface	Surface sealing, cement/fly ash flushing and filling of highwall
38	JCF-F/SIJUA/BANSDEOPUR(W)/II/30				
	Scheme for dealing with Basdeopur (West) Fire	Bansdeopur	XIV,XIII	Surface	Trench cutting,back filling & surface sealing
39	JCF-F/KUSUNDA/EAST BUSSURIYA/II/32 (Part-B)				
	Scheme for dealing with East Bassuria Fire (Part B)	East Bassuria	V/VI,VII,VIII	Surface	Surface sealing, Sand flushing
40	JCF-F/Maintenance	Fires of all collieries			Maintenance of existing status
	On going EMSC/RCFS schemes				
41	Scheme for dealing with fire and subsidence at Industry colliery	Ena/Industry		Surface & UG	Blind flushing & surface sealing
42	Scheme for dealing with fire and subsidence at Alkusa colliery	Alkusa	XIV, XIII, XII & XI	Surface	Blind flushing & surface sealing
43	Revised Scheme for dealing with fire and subsidence at Lodna & Bagdigi Colliery colliery	Lodna & Bagdigi	XI/XII	Underground	Nitrogen flushing
44	Scheme for dealing with fire and subsidence at Jeenagora colliery for protection of Jore	Jeenagora & Barraree		Surface	Jore diversion, Blind flushing & surface sealing
45	Scheme for dealing with fire and subsidence at Block-II OCP& Phularitand Colliery for protection of Rail colliery for protection of Jore	Block-II & Phularitand		Surface & UG	Blind flushing, Quarry edge filling & surface sealing

6.7 Time Schedule

The requirement of time to deal with a particular fire depends on:

- The nature and the extent of the fire.
- The technology to deal with the fire.

The following criteria have been assumed to determine the duration to deal with each fire depending on situation.

6.7.1 Trench excavation, fire excavation and simultaneous back filling.

It is assumed that excavation will be done with 5.0m^3 capacity shovel. The annual excavation capacity of such a shovel is 8 lakhs m3. A reduction factor of 0.8 has been considered as the excavation would be done in fire areas. Thus annual excavation rate of 8x0.8 = 6.4 lakh m^3 (0.64 million cum.) / year per shovel has been considered.

6.7.2 Surface Sealing / Seam sealing with cohesive soil and filling with non-combustible material.

Where filling and surface sealing need to be done by bringing material from outside, a transportation and filling rate of 200m^3/ day / tripper of 8m^3 capacity has been considered (i.e. 5000 m3/ month).

6.7.3 Sand Flushing (Blind Flushing) through borehole

A sand flushing rate of 15m3 / day / borehole has been considered depending on the volume of sand a minimum of 8 and a maximum of 16 boreholes will remain in flushing operation.

6.7.4 Drilling

For 6" diameter (150 mm) boreholes with rotary cum percussive drill, a drilling rate of 250 m / month / machine has been considered. For 10" diameter (250mm) boreholes, the same has been considered as 150 m/month.

6.7.5 Blind Flushing with fly ash / sand / cement / grout mixture

Rate for blind grout flushing mixture has been considered as 600m3 per month with one mixer / flushing unit. The number of mixing unit / flushing unit will depend on the volume of void to be filled within the stipulated time.

6.7.6 Cooling by water curtain

Depending on the intensity of fire, 2 to 3 years time has been assumed forcooling by water circulation through borehole.

6.7.7 Quenching & Excavation of fire with water

It has been assumed that quenching of hot material before excavation would run simultaneously with excavation. However, a minimum of one month quenching time has been considered before excavation.

6.7.8 Maximum time to deal with a fire

Maximum time required to deal with a particular fire project would depend on the volume of jobs involved and the number of equipment engaged at a particular site. Based on the volume or work, such number of different equipment like shovel, tipper, drilling machine etc. are to be engaged at a particular fire site so as to complete the activities within a maximum period of 10 years.

6.8 Grouping of fire areas in to Projects

One or more fire areas located in close proximity having same priority on urgency of implementation have been grouped together to form a fire project. Out of 77 fires, 10 fires have been extinguished and 9 underground fires have been kept under control by underground stopping. 67 fires including 9 underground fires have been grouped into 45 fire projects proposed to be/is being implemented in a time frame of 10 years. These 45 fire projects include 5 ongoing EMSC/RCFS schemes and one project for maintenance of existing fire. The grouping of exiting fires into 45 fire projects has been shown in **TABLE – 4**.

The fire projects are large in size, requiring large amount of capital for dealing with fire in totality. However, in actual practice, some times smaller projects (sub-projects of the Main Projects), may have to be formulated for implementation depending on the urgency of dealing with a particular section of the fire. All these sub-projects (if required) will bear the same project code with different sub-projects.

TABLE – 4

GROUPING OF FIRES INTO PROJECTS

SL. No.	CODE NAME OF FIRE PROJECTS	ORIGINAL FIRE NAME
1	JCF-F/LODNA/RAIL/I/1	NS Lodna XIII, XIIA ,XIV seam
		Baniahir XV, XIV, XIVA seam
		Bhaga XV seam.
		Bagdigi XIV,XIVA, XV seam
		Bararee XV,XIV,XIVA seam
		Bhulan Bararee XIII, XIV seam
		Bhulan Bararee XV seam
2	JCF-F/BASTACOLLA/KUJAMA/JORE/I/2	Kujama XI/XII seam
3		Pure Jharia X seam

SL. No.	CODE NAME OF FIRE PROJECTS	ORIGINAL FIRE NAME
	JCF-F/KUSTORE/RAJAPUR/I/3 (Part-A)	K.P. Dobari X,XIX,V/VI/VII/VIIA
		Rajapur X seam
4	JCF-F/BARORA/SHATABDIH/I/33	Shatabdih V/VI/VII seam
5	JCF-F/KATRAS/EAST KATRAS (NEW AKASKINAREE)/I/35	East Katras XIV seam & XI seam
6	JCF-F/EASTER JHARIA/SUDAMDIH & PATHERDIH/I/19 (Part-A)	Patherdih IX-XIII seam Sudamdih IX - XIV seam
7	JCF-F/SIJUA/SENDRA BANSJORA/I/21 (Part-I)	Sendra X seam
8	JCF-F/KATRAS/GASLITAND/I/24	Gaslitand XVT & B seam
9	JCF-F/KATRAS/KATRAS CHOITUDIH/I/26	Katras-Choitudih XIII , XIV, XV seam
10	JCF-F/KUSUNDA/EAST BUSSURIYA/I/32	East Bassuria V/VI seam
		East Bassuria VIII seam
11	JCF -F / LODNA/NT, ST, JEENAGORA, JOYRAMPUR/I/8(SURFACE SEALING)	South Tisra VII, VIII, IX, X seam North Tisra VII, VIII, IX seam Jeenagora IX,X, XI, XII seam Joyrampur XI, XII,XIIA seam
12	JCF-F / LODNA / BAGDIGI, RARAREE, B. BARAREE/I/11(SURFACE SEALING)	Bagdigi XIV,XIVA, XV seam
		Bararee XV,XIV,XIVA seam
		Bhulan Bararee XIII, XIV seam
		Bhulan Bararee XV seam.
13	JCF-F / LODNA / LODNA / I /12 (SURFACE SEALING)	NS Lodna XIII, XIIA ,XIV seam
		Baniahir XV, XIV, XIVA seam
		Bhaga XV seam.
14	JCF-F/BASTACOLA/KUJAMA & GOCP/I/10 (SURFACE SEALING)	Kujama IX,X seam
		Kujama XI,XII seam
15	JCF-F/KUSTORE/RAJAPUR/I/37 (Part-B, BASTACOLLA ANNEXED))	Rajapur X,IX,V/VI/VII seam fire.
16	JCF-F/KUSTORE/ALKUSA/I/4 (Part-B)	Alkusa XIII, XIV seam
		Kusunda XI, XII seam
17	JCF-F/BARORA/PHULARITAND/I/6	Phularitand X, XI, XIII seam
18	JCF-F/KUSTORE/KUSTORE/I/7	Kustore XI, XII, XIII, XIV seam
		Kusunda XIII, XIV seam
		Ena XV seam
19	JCF-F/KUSTORE/ENA (NW)/I/13	Industry XI, XII seam
		Ena XIV seam
20	JCF-F/KUSTORE/ENA (MID & SE)/I/31	Ena XI XII seam
		Ena XIV seam
21	JCF-F/SIJUA/MUDIDIH/9	Mudidih Fire
22	JCF-F/PB/GOPALICHUCK/I/14	Gopalichak Fire, Pootkee XVI seam

SL. No.	CODE NAME OF FIRE PROJECTS	ORIGINAL FIRE NAME
23	JCF-F/BASTACOLLA/KUJAMA/RAIL/I/36	Kujama XI & XII seam
24	JCF-F/BL-II/BLOCK-II OCP/II/5	Block-II XIII, XI/XII, X Spl. Seam
25	JCF-F/SIJUA/TETULMARI(W)/II/15	Tetulmari V/VI seam
26	JCF-F/SIJUA/TETULMARI(E)/II/16	Tetulmari IV seam
27	JCF-F/EJSUD & PATH/II/38 (PSRT-B)	Patherdih IX-XIII seam Sudamdih IX –XIV seam
28	JCF-F/KUSTORE/EAST BHUGGATDIH/17	East Bhuggatdih XV, XIV seam
29	JCF-F/KUSUNDA/BASSURIYA-1/I/18	Basseriya XIV, XIII, XII XI seam
30	JCF-F/PB/KENDWADIH(S)/II/20	Kenduwadih XIII, XIV seam
31	JCF-F/PB/KENDWADIH(N)/II/23	Kendwadih XI,XII,XIII seam
32	JCF-F/SIJUA/SENDRA BANSJORA/II/21	Ekra XI,XII seam
33	JCF-F/BARORA/DAMODA/II/22	Damoda, V,VI,VII,IX seam
34	JCF-F/EASTER JHARIA/BHOWRAH(N) & (S)/II/25	Bhowra XIII, XIV seam
35	JCF-F/SIJUA/JOGTA/II/27	Jogta XV, XIV, XIII, XII,XI seam
36	JCF-F/KUSUNDA/BASSURIYA (3&4)/II/28	Busseriya IXT & B, IX spl. XI, XII seam
37	JCF-F/SIJUA/BANSDEOPUR(E)/II/29	Banseopur XIII,XIV seam
38	JCF-F/SIJUA/BANSDEOPUR(W)/II/30	Banseopur XIII,XIV seam
39	JCF-F/KUSUNDA/EAST BASSURIA/II/32 (Part-B)	East Bassuria V/VI/VII East Bassuria VIII seam
40	F/MAINTENANCE/34	Existing fires under control
	On going EMSC/RCFS Schemes	
41	Scheme for dealing with fire at Industry colliery	Ena/Industry, X seam
42	Scheme for dealing with fire at Alkusa Colliery	Alkusa XIII & XIV seam
43	Revised Scheme for dealing with fire at Lodna & Bagdigi collieries	Lodna & Bagdigi XI/XII seam
44	Scheme for dealing with fire at Jeenagora colliery for protection of Jore	Jeenagora XIII & XI/XII seam
45	Scheme for dealing with fire at Phularitand / Block-II OCP for protection of rail	Phularitand / Block-II OCP XI/XII & X seam

6.9 Prioritisation of fire Areas

Depending on the urgency of dealing based on the potential impact, all the fire areas have been prioritized into different priorities. The following factors have been considered to determine the priority of dealing with individual fire.

1. Threat to jore / railway line / existing pits
2. Threat to villages / inhabitated areas
3. Number of seams on fire / loss of reserves
4. Intensity of the fire.

Depending on the above, out of 45 projects, 28 projects have been proposed in Priority – I (i.e. Phase-I) and rest 17 projects in Priority-II (i.e. Phase-II). One project is for maintenance of the existing fires under control.

6.10 Codification of identified projects

Different fire project has been codified based on their urgency of implementation.

The sample code number is JCF-F/KUSTORE/ ALKUSA/I/4,

Where the first code JCF stands for Jharia Coalfield, F stands for fire, KUSTORE stands for name of the Area, ALKUSA stands for name of the colliery, I stand for priority number 1 and 4 stands for serial number of the fire project in terms of implementation schedule.

For Lodna group of fire code number is JCF-F/LODNA/RAIL/I/1 where 4th code 'RAIL' stands for project for protection of rail fire.

Based on the above, each fire project has been codified.

6.11 Action Programme

A composite action programme for all the fire projects have been prepared basedon the following assumptions.

1. There are 45 fire projects of which 28 fire projects including 5 ongoing EMSC/RCFS scheme as well as one maintenance project will be /is being implemented in Phase -I and rest 17 in Phase II. Maximum no. of fire projects to be implemented at any point of time is 21.

2. One Fire Project has been identified for maintenance of existing fires under control including expenses for TIR/GPS/Diagnostic Survey/monitoring of temperature / gas analysis/ scientific studies and plantation of cooled down areas.

The composite Action Plan for all the fire Projects has been shown in **Table-5.**

For speedy implementation, it is suggested that the fire projects should be implemented through contractual means as far as possible.

Table-6

COMPOSITE ACTION PLAN ALONG WITH YEAR WISE REQUIREMENT OF FUND FOR FIRE PROJECTS

Sl. No.	Name of the of fire projects	Capital (Rs. Crores)	Duration (Month)	Pre-implementation Activities	Schedule of implementation Year-wise Requirement of funds									
					Phase-I					Phase-II				
					1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1	JCF-F/LODNA/LODNA/RAIL/V1 Excavation of rail road bed (length 3.5 km) at Lodna Bagdigi & Barakar Collieries along with diversion of chatkidanjore.	626.00	120		105.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	30.00
2	JCF-F/BASTACOLA/KUJAMA/JORE/V2 Scheme for dealing with fire for protection of chatkati Jore at Kajora colliery	6.38	48		2.13	2.54	1.52	0.69						
3	JCF-F/ KUSTORE / RAJAPUR/V3 (Part A , Rajapur OCP) Scheme for dealing with fire at Rajapur Colliery by excavation method with 0/X seam base	62.36	84		30.00	30.00	2.36							
4	JCF-F/BARORA/SHATABDI OCP/V3 Scheme for dealing with fire at Shatabdi OCP by excavation method	46.26	48		1.85	23.00	21.41							
5	JCF-F/KATRA/EAST KATRAS (NEW/AKASHKINAREE)/V5 Scheme for dealing with fire at East Katras colliery	39.82	48		5.84	9.61	19.72	0.65						
6	JCF-F/EJ/SUDAMDIH&PATHERDIH/V19 Scheme for fire dealing at Sudamdih / Patherdih Colliery (Part A)	25.04	60		1.40	9.85	10.89	2.44	0.30					
7	JCF-F/SUJUA/SENDRA BANSJORA/V2.1 (Part A) Scheme for dealing with Sendra Bansjora X seam fire	9.61	24		2.83	7.80								
8	JCF-F/KATRAS/AGASLITAND/V24 Scheme for dealing with Gaslitand fire	20.10	84		3.30	6.73	2.59	2.67	2.66	1.95	0.09			
9	JCF-F/KATRAS/KATRAS CHOITUDIH/V25 Scheme for dealing with Katras Choitudih Fire	16.20	48			3.77	5.17	1.30	0.5				.25	.25
10	JCF-F/KUSUNDA/EAST BUSURIYA/V32 Scheme for dealing with East Bassuriya fire	8.52	48		3.75	4.20	0.30	0.10						
11	JCF-F/ LODNA/NT, ST, JEENAGORA, JOYRAMPUR/W1(SURFACE SEALING) Surface sealing for dealing with fire at North Tisra, South Tisra, Jeenagora & Joyrampur Collieries	30.30	36				10.00	15.00	11.30					
12	JCF-F/ LODNA / BAGDIGI, BARAREE, E BARAREE/V11(SURFACE SEALING) Surface sealing for dealing with fire at Bagdigi, Barakar & Eastern Barakar Collieries.	30.30	36					12.00	12.00	6.30				

13	JCF-F/ LODNA / LODNA / 1712 (SURFACE SEALING) Surface sealing for dealing with the at Lodna Colliery.	27.50	72				4.50	4.50	4.50	4.50	4.50	4.50		
14	JCF-F/ BASTACOLLA / KUJAMA / GOCP/W18 (SURFACE SEALING) Surface sealing for dealing with the at Kujama & GOCP.	40.03	48				10.15	10.15	10.15	10.18				
15	JCF-F/ KUSTORE / RAJAPUR/1137(Part B, Bastacolla annexed) Scheme for dealing with the at Rajapur Colliery by excavation method with V/V Well seam base	91.00	72				40.00	15.00	15.00	10.00	10.00	1.00		
16	JCF-F/ KUSTORE / ALKUSA/P4 Scheme for dealing with the at Alkusa Colliery.	9.00	36				4.50	4.50						
17	JCF-F/BARORA/PHULARITANDIH Scheme for dealing with the at Phularitand Colliery (Block-II) Coking).	60.00	84					12.05	12.05	12.05	12.05	12.05	12.05	12.80
18	JCF-F/KUSTORE/KUSTORE/IF Scheme for dealing with the at Kustore Colliery (NW & SE file)	32.22	36			7.11	8.23	8.23	8.65					
19	JCF-F/KUSTORE/ENA(NW)W13 Scheme for dealing with the at Ena Colliery.	29.11	47						7.50	7.50	7.50	6.36		
20	JCF-F/KUSTORE/ENA (MIDS SE)W11 Scheme for dealing with Ena (Mids SE) File	31.04	48				5.10	8.04	8.07	8.06				
21	JCF-F/SUJUA/MUDIDIH/M Scheme for dealing with the at Mudidih Colliery.	16.05	48				3.00	3.00	3.00	3.00	4.05			
22	JCF-F/P.BAGOPALICHAW14 Scheme for dealing with the at Gopalichak Colliery.	66.28	48						13.37	13.37	13.37	13.37	13.40	
23	JCF-F/BASTACOLLA/KUJAMA/RAIL/W16 Excavation of railroad bed and back fill with a tractor at fill depth(1.4km) at Kujama colliery with X/Cut seam base along with diversion of chatkari pur	210.00	60							50.00	40.75	40.75	40.75	40.75
24	JCF-F/ BLOCK -II / BLOCK -II/IIA Scheme for dealing with the at Block-II OCP (A) and (A) Basin (B)	43.51	60				11.00	11.0		6.30	3.40	3.40	3.40	4.75

25	JCF-R/SUUA/TETULMARI(V)/W16 Scheme for dealing with west file at Tetulmari Colliery	12.84	48								3.21	3.21	3.21	3.21
26	JCF-R/SUUA/TETULMARI(E)/W16 Scheme for dealing with Tetulmari (East) File	16.05	48								4.00	4.00	4.00	4.05
27	JCF-R/EJ/SUDAMDIH&PATHREDIH/W28 Scheme for the dealing at Sudamdih / Pathardih Colliery (Part B)	22.84	28								8.00	10.00	4.84	
28	JCF-R/KUSTORE/EASTBHUGGATDIH/W17 Scheme for dealing with East Bhuggatdih File	6.99	33								2.50	2.50	1.99	
29	JCF-R/KUSUNDAR/BASSURIYA-I/W18 Scheme for dealing with Bassuriya I&II File	14.78	38								3.21	6.07	4.56	1.34
30	JCF-R/PB/KENDWADIH(S)/W20 Scheme for dealing with Kendwadih (South) File	11.70	48							1.00	3.00	3.00	3.00	1.70
31	JCF-R/PB/KENDWADIH(N)& (E)/W23 Scheme for dealing with Kendwadih (North)& (East) File	12.91	60							0.40	4.00	4.00	2.50	1.93
32	JCF-R/SUUA/SENDRA BANSJORA/W39 (Part B) Scheme for dealing with Sendra Bansjora X(XII,XIII & XIV) area file	32.81	36							6.00	13.10	6.60	5.11	
33	JCF-R/BARORA/DAMODA/W22 Scheme for dealing with Damodar File	14.97	17										7.68	7.29
34	JCF-R/EASTEJHARIA/BHOWRAH(N)& (S)/W24 Scheme for dealing with Bhowra N&S File	22.12	30									4.00	10.00	8.12
35	JCF-R/SUUA/JOGTA/W27 Scheme for dealing with Jogta File	6.16	36								2.43	2.29	0.61	0.84
36	JCF-R/KUSUNDAR/BASSURIYA (3&4)/W38 Scheme for dealing with Bassuriya 3&4 File	23.47	22									6.00	8.00	9.47

37	JCF-P/S U/A/BANS DEOPUR(E)/W39 Scheme for dealing with Bandeopur (East) Tie	56.10	60							12.30	12.54	10.75	8.46	12.00
38	JCF-P/S U/A/BANS DEOPUR(W)/W38 Scheme for dealing with Bandeopur (West) Tie	14.62	14										6.36	8.26
39	JCF-P/KUSUNDA/EAST BUSSURY/W39 Scheme for dealing with East Bassuria Tie (Part B)	8.14	30									1.60	4.23	2.31
40	P/MAINTENANCE/34	53.80			5.35	5.35	5.35	5.35	5.35	5.35	5.35	5.35	5.35	5.35
	New Tie Lines	107.00			10.70	10.70	10.70	10.70	10.70	10.70	10.70	10.70	10.70	10.70
	Sub Total	2118.46			170.76	190.82	246.78	199.22	197.06	242.09	238.79	232.10	233.73	187.14
	Contingencies Charges@ of3%	63.55			5.12	5.72	7.40	5.98	5.91	7.26	7.16	6.96	7.01	5.61
	Supervision Charges @ 0%	105.92			8.54	9.54	12.34	9.96	9.85	12.10	11.94	11.61	11.69	9.36
	Sub Total with contingency & supervision charges	2287.94			184.41	206.09	266.52	215.15	212.82	261.46	257.90	250.67	252.43	180.51
	Preparation of project/Fine schemes	10.05		2.14	1.21	1.21	1.22	1.22	1.22	1.22	1.21			
	Total	2298.99		2.14	185.62	207.30	267.74	216.37	214.04	262.68	259.11	250.67	252.43	180.51
	TIR Survey	2.79		2.79										
	Grand total	2301.38		4.93	185.62	207.30	267.74	216.37	214.04	262.68	259.11	250.67	252.43	180.51
	Phase Wise total			4.93	1081.08					1206.30				

ON GOING EMSC/RCFS SCHEMES (5 NOS) BALANCE AMOUNT

SL No.	Name of the EMSC/RCFS Projects	Capital (Rs. Crores)	Duration (Month)	Pre-implementation Activities	Schedule of Implementation Year-wise Requirement of funds									
					Phase-I					Phase-II				
					1	2	3	4	5	6	7	8	9	10
41	Scheme for dealing with fire at Indistry colliery (EMSC-23)	1.23			0.70	0.53								
42	Scheme for dealing with fire at Akasa Colliery (EMSC-27)	0.004			0.004									
43	Scheme for dealing with fire at Lodna & Bagdigi Collieries (RCFS-01)	2.90			2.2	0.70								
44	Scheme for dealing with fire at Jeenagora Colliery for protection of loss	3.40			1.50	1.90								
45	Scheme for dealing with fire at Pootkee/Balihari/Block-II OCP for protection of Auto-Ground facilities (RCFS-02)	2.58			1.50	1.08								
	Sub Total	10.114			5.90	4.21								
	Grand Total	2911.60		4.93	911.82	211.61	267.78	210.37	214.04	262.08	269.11	260.67	262.40	180.61
	Phase wise Total	2911.60		4.93	1101.19					1206.38				

6.12 Present status of formulation & implementation of the fire schemes

Out of the 45 fire schemes/ projects proposed to be prepared and implemented within 10 years of time, 5 schemes under EMSC/RCF is uder implementation and would be completed in next two years, 7 schemes have already been prepared, 6 have been approved and under implementation. Three schemes are under preparation.

The status of preparation & implementation of fire schemes is as under:

Sl no	Name of the schemes/project	Status
1	JCF-F/BASTACOLA/KUJAMA/JORE/I/2 Scheme for dealing with fire for protection of Chatkari Jore at Kujama colliery	Report prepared, sanctioned and under implementation.
2	JCF-F/KATRA/EAST KATRAS (NEW AKASHINAREE)/I/35 (Revised) Scheme for dealing with fire at East Katras (New Akashkinaree) Colliery	Report prepared, sanctioned, again revised and submitted and in the process of approval.
3	JCF-F/EJ/SUDAMDIH&PATHREDIH/I/19 Scheme for fire dealing at Sudamdih / Patherdih Colliery (Part A)	Report prepared, sanctioned and under implementation.
4	JCF-F/SIJUA/SENDRA /I/21 (Part-A) Scheme for dealing with Sendra Bansjora X seam fire	Report prepared, sanctioned and under implementation.
5	JCF-F/KUSUNDA/EAST BUSSURIYA/I/32 Scheme for dealing with East Bassuria Fire (Part A)	Report prepared, sanctioned and under implementation.
6	JCF-F/BARORA/SHATABDI OCP/I/33 Scheme for dealing with fire at Shatabdi OCP by excavation method	Report prepared & sanctioned and under implementation.
7	JCF-F / KUSTORE / RAJAPUR/I/3 (Part A , Rajapur OCP) Scheme for dealing with fire at Rajapur Colliery by excavation method with IX/X seam base.	Report prepared , under process of approval.
8	JCF-F/LODNA/LODNA/RAIL/I/1 Excavation of rail road bed and backfill with structural fill (length 3.5 km) at Lodna Bagdigi & Bararee Collieries along with diversion of chatkari jore.	Report is under preparation
9	JCF-F/KATRAS/GASLITAND/I/24 Scheme for dealing with Gasliland Fire	Report prepared and under approval
10	JCF-F/KATRAS/KATRAS CHOITUDIH/I/26 (Part A & B) Scheme for dealing with Katras Chotudih Fire	Draft Report prepared but could not be finalized due to land problem
11	Scheme for dealing with fire at kustore colliery	Draft report prepared, under process of finalisation
12	Scheme for dealing with fire at Rai basti Block-II area	Draft report prepared, under process of finalisation
13	Scheme for dealing with fire at Industry colliery	Under implementation.
14	Scheme for dealing with fire at Alkusa Colliery	Under implementation
15	Revised Scheme for dealing with fire at Lodna & Bagdigi collieries	Under implementation
16	Scheme for dealing with fire at Jeenagora colliery for protection of Jore	Under implementation
17	Scheme for dealing with fire at Phularitand/ Block-II OCP for protection of rail	Under implementation

6.13 Pre-Implementation Activities

Before implementation of the fire projects, certain pre -implementation activities like TIR survey for delineation of present extent of fire, preparation of fire schemes for the projects to be implemented in the 1st and 2nd year of the implementation period, etc. Fund requirement for the pre-implementation activities are as under.

Sl. No.	Activities	Year wise fund (Rs. Crs.)		Total
		1st Yr.	2nd Yr.	
1	TIR Survey and other surveys for delineating fire areas	1.62	1.17	2.79
2	Preparation of some of the schemes for dealing with fire for Phase-I	1.07	1.07	2.14
	Total	**2.69**	**2.24**	**4.93**

6.14 Organization

Implementation of the 45 nos. fire projects within a time frame of 10 yrs., in two phases, each of 5 yrs duration will be the responsibility of BCCL. In phase-I, 28 nos. and in phase-II 17 nos. of projects are to be implemented. For speedy implementation it is proposed that the projects will be implemented through contractual means wherever feasible.

For implementation the fire abatement measures at different locations, it is proposed to have a separate division for implementation of fire control measures at Company Head Quarter headed by an official of Chief General Manager Rank. The responsibility of Fire division at Company (HQ) level would be as under :

- Implementation of pre-implementation activities as per Master Plan
- Preparation and approval of fire dealing Projects/Schemes
- Preparation of tender documents, tendering and award of work
- Arrangement and disbursement of fund to concerned Areas
- Monitoring and supervision of various fire projects under implementation
- Organising R&D jobs and special study required for dealing with fire.

The fire control measures are proposed to be implemented through a separate fire Cell at each Area, under the administrative control of General Manager/Chief General Manager of the concerned Areas.

The expenditure for running the separate fire cell /division at HQ and at Area level will be met from the supervision cost (5% of total capital) considered in the Master Plan/

6.15 Fund Requirement

The fund requirement for dealing with each fire by different alternative technologies was estimated by GAI/MET-CHEM in US in 1996. The fund requirement for the recommended technology has been escalated upto June'06 based on wholesale Price Index (WPI) and has been considered in this Master Plan. However, in some cases the requirement as estimated by GAI/MET-CHEM has been judiciously reduced depending on the present cost of particular activity. Moreover, where the fire schemes have already been prepared, the actual cost based on the technology proposed has been considered.

"While approving the Updated Master Plan '2004 for a total outlay of Rs. 5792.21 Crs. For dealing with fire, subsidence and rehabilitation in the lease hold of BCCL, CIL Board in its meeting held on 19.07.04 directed that as and when fire is handled by direct removal of coal and OB , the cost thereof shall be set off from sale value of coal realised if any"

As actual recovery of coal depends on many factors and can not be correctly ascertained, It has been assumed that 50% of total in-situ coal may be recovered for sale and accordingly sale realization of 50% of total in-situ coal has been off set against the total excavation cost for the fire projects where excavation technology has been proposed. However, the amount may vary from place to place. The cost of rehabilitation of the stable sites falling within the area of excavation for dealing with fire has been considered in rehabilitation projects.

Total indicative capital requirement to deal with all the fires of BCCL is estimated to be Rs.**2311.50** Crores including the fund required for pre implementation activities and balanced fund of ongoing EMSC / RCFS schemes. The total capital is proposed to be spent in 10 years of time.

Total fund requirement includes fire dealing cost, 3% contingency and 5% supervision charges. The supervision charges will cover the expenditure (Revenue, furniture & fittings , vehicle, office equipment etc) of separate fire cell/ organization at BCCL.

Implementation of fire dealing projects will take about 12 years time . During this time new fires may come up which require extra fund.

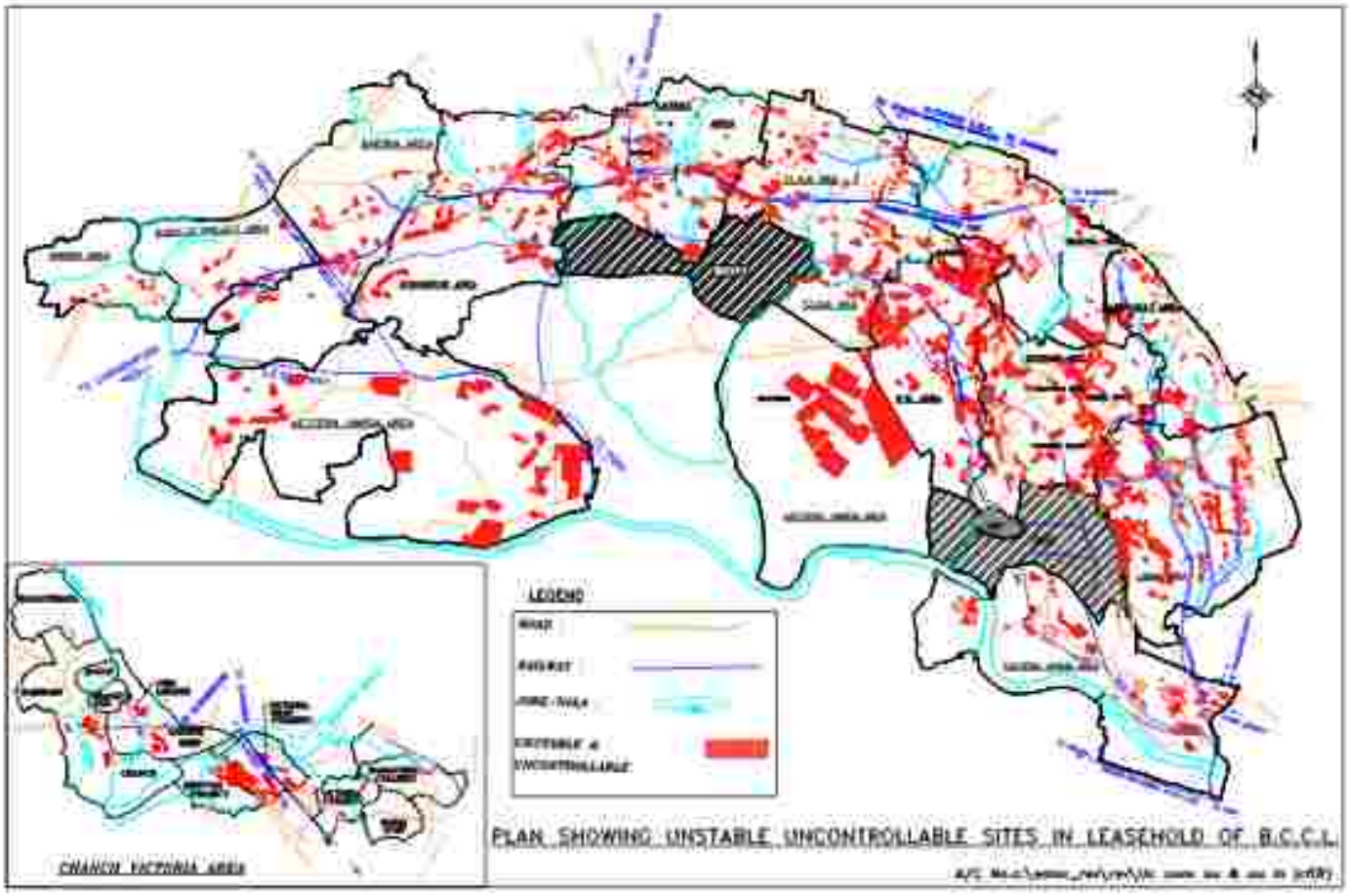
The year wise& phase wise indicative requirement of capital is shown in **TABLE – 6.**

TABLE -6

YEAR-WISE INDICATIVE CAPITAL REQUIREMENT FOR DEALING WITH FIRE PROJECTS

PHASE	YEAR	INDICATIVE FUND (Rs.Crs)
Pre-implementation Phase		
	1st	2.69
	2nd	2.24
Total Pre-Implementation Phase		**4.93**
Implementation Phase		
Phase-I	3rd	191.52
	4th	211.51
	5th	267.76
	6th	216.36
	7th	214.04
Sub Total Phase-I		**1101.19**
Phase-II	8th	262.68
	9th	259.11
	10th	250.67
	11th	252.43
	12th	180.50
Sub Total Phase-II		**1205.38**
Grand total		**2311.50**

REHABILITATION & RESETTLEMENT


LEGEND
CHANCH VICTORIA AREA
PLAN SHOWING UNSTABLE UNCONTROLLABLE SITES IN LEASEHOLD OF B.C.C.L.

7.0 MASTER PLAN FOR REHABILITATION OF INHABITATED FIRE & SUBSIDENCE PRONE AREAS.

7.1 Introduction:

In the updated Master Plan of April'04, altogether 532 sites (271 in full & 261 in part) were considered for rehabilitation as the houses over these sites were declared unstable & uncontrollable (UU) as ground movement can not be controlled by stowing. Total no. of houses proposed to be evacuated from 532 sites were 65300 which includes

BCCL houses	:	36208
Non-BCCL : Private houses	:	15571
Non- BCCL : Un-authorised houses (Encroacher)	:	12719
Others : (Religious places, schools, Hospitals, Post offices, Police stations etc).	:	802

Apart from these 532 sites, 121 sites were considered unstable but controllable (UC) i.e where ground movement could be controlled by stowing.

In accordance with the directive of Supreme court of India, on 3rd May, 2005, Director General of Mines Safety (DGMS) constituted a Committee to go through the Action Plan and subsequent affidavit/ATR filed by UOI and to verify the same in connection with PIL case filed by Sri Haradhan Roy, Ex MP.

The Committee concluded that as there are no scientific methods available to check long term stability, it might not be possible to certify that the areas thus stabilized. The present stabilization work may restrict the effect of subsidence and allow some time. The final and permanent solution is evacuation of the affected area and rehabilitation.

In view of the above, 121 sites which were proposed for stabilization have now been considered for rehabilitation.

7.2 Total no. of houses in the endangered areas

Over the period of time from original Master Plan of March'1999 to date, 24 Nos. of sites have been demolished and shifted to other places by BCCL management. These sites have been deleted from this Master Plan.

Where fire dealing has been proposed by excavation method some stable parts are necessarily to be evacuated for digging out the fire. Such stable parts have now been

considered in rehabilitation. 26 such sites (23 part & 3 full) have been included in this Master Plan.

Considering the above & combining the earlier stabilization sites with Rehabilitation, total no. of sites proposed to be rehabilitated under the present Master Plan comes to 595 (326 in full & 269 in part). Total affected area under these site is estimated to be 25.70 sq.km.

The number of houses under stabilization sites (now proposed for rehabilitation were supplied by BCCL after survey done in March '06 and the same has been considered for rehabilitation. Total no of houses from stabilization sites were 17302 (BCCL : 6480, Private : 6533, Encroachers and others : 4289). Total no of houses from stable parts were 3055. (BCCL : 1505, Pvt. : 591 and Encroachers : 959)

The no. of Non-BCCL houses under uncontrollable sites as per Master plan'1999 was 28290. Over the time of 7 years, there was further construction of houses in the endangered areas. JRDA/State Govt. of Jharkhand has done demographic survey in 2005 for 119 sites of Phase – I of Master Plan' 2004. It has been verbally reported by JRDA that the total no of Non-BCCL houses in 119 sites under Phase-I has increased to 14075 from 9850, i.e. an increase of 42.89% over a period of seven years with an annualized increase of 5.25%. This has been considered as a sample survey and has been uniformly applied for other sites in this Master Plan.

However no increase in BCCL houses has been considered as there has not been any construction over the years in those areas.

On the above considerations, total no. of houses in the endangered areas has now been estimated at 98314. The details are as under:

BCCL houses	:	44155
Non-BCCL : Private houses	:	29444
Non- BCCL : Un-authorised houses (Encroacher)	:	23847
Others : (Religious places, schools, Hospitals, Post offices, Police stations etc.)	:	868
TOTAL	:	**98314**

7.2.1 Total no. of houses proposed to be constructed/ resettled

In the meeting held with Secretary (Coal) on 4.7. 2006, it was decided that due to decrease in the manpower strength in BCCL only 25000 houses for BCCL employees required to be constructed. With this consideration total no of houses proposed to be resettled comes to **79159**. The details are as under:

BCCL houses	:	25000
Non-BCCL : Private houses	:	29444
Non- BCCL : Un-authorised houses (Encroacher)	:	23847
Others : (Religious places, schools, Hospitals, Post offices, Police stations etc.	:	868
TOTAL	:	**79159**

It is proposed that as soon as a person residing in endangered areas of BCCL houses retires, the house shall be demolished.

7.3 Demographic Survey and valuation of Properties

Demographic survey and valuation of the properties of the houses to be rehabilitated should be conducted for assessment of actual compensation and benefits before implementation of rehabilitation project.

7.4 Rehabilitation & Resettlement Package

7.4.1 PROPOSED R & R PACKAGE FOR THE NON-ECL/NON- BCCL PEOPLE FOR THE REHABILITATION FROM THE UNSTABLE LOCATIONS

It is proposed that R & R package for both BCCL and ECL for Non BCCL/ Non ECL employees should be similar as far as possible. The main elements of the proposed R&R package to be offered to the people to be rehabilitated are as follows :-

1. It is proposed that resettlement should be done in satellite townships located on non-coal bearing areas/ Barren measures identified as per Master Plan.

2.a) Head of every family will be entitled to the compensation equivalent to the assessed cost of homestead land and other infrastructure within their homestead land. In addition, the head of each family shall be provided with a plot of land of 100m^2 free of cost at the resettlement site having all amenities and infrastructural facilities.

If the above offer is not acceptable then head of each house will be provided a constructed flat of around 40m^2 as super built up area having two room , a kitchen and an attached toilet in triple storey building. In such case no other cash compensation shall be paid.

In case the requirement of land is more than 100m^2, additional land may be provided at the resettlement site subject to the maximum quantity of land owned at the rehabilitation site on payment basis as per market rate or adjusted against the entitled cash compensation, if land is available.

The assessment for compensation will be done by state Govts./Implementing agencies of State Govts.

2b) In case a house owner does not want to construct house on the 100 m^2 free plot of land at the resettlement site, he will be offered equivalent cash compensation in lieu of the free plot along other entitled cash compensation.

3 Those who opt for free plot and cash compensation shall have the choice of constructing their houses over the plot of land allotted to them. No additional money for the construction would be provided. Such house owners shall also be provided assistance (free of cost) in designing the house to be constructed, if they so desire.

4 No compensation will be paid to the house owner having no homestead land. They are proposed to be resettled in newly constructed resettlement site with all basic amenities (road, light, water supply etc). Head of each house will be provided with a constructed house of around 27 sq. m. as super built up area in triple- storey building.

5 Proper procedure shall be developed for payment of compensation to those families who opt for cash compensation and construction of their own houses at the new site.

6 Each house owner will be paid a maximum of Rs. 10000/- (Ten thousand) as shifting allowance from their present living places to the new houses at the resettlement site.

7 It will be binding to all house owners that the final payments are made only after they have shifted to the resettlement site and handed over the possession of existing homestead land and buildings to the company along with executing a registered deed of exchange. The existing house at the unstable site shall be demolished.

8 For the purpose of income generation due to displacement/shifting to the new resettlement site, it is proposed to pay minimum wage per day for 250 days in a year for 2 years to the head of each family as per minimum wage rate of respective State Govts.

9 The town planning and construction at the proposed resettlement site will also include infrastructure development like road, street lighting, drainage, sewerage treatment, community centre, water supply etc.

10 The community facilities like primary schools, community centre, small dispensary and shopping centre will also be included in the town planning. These common facilities will be constructed as per the plan under the proposed compensation package. However, the running cost of all the facilities, i.e. water supply, power supply, schools, dispensary etc. shall not be the part of compensation package and will have to be looked after by the Panchayat and other bodies of the State Government.

11 Common structures such as religious places etc. shall be built at resettlement site on mutual agreement basis from Rehabilitation fund of Master Plan.

12 The proposed location of resettlement site is guided by the following considerations:-

a) Preferably the proposed resettlement site should be either land owned by BCCL or vested to the state Government.

b) In case such land are not available, then the required land may be purchased from private owner by State Govt.

13. No employment shall be offered for any rehabilitation under the Master Plan.

7.4.2 BCCL Houses:

BCCL houses from the endangered areas are proposed to be rehabilitated in four Satellite Township in non-coal bearing areas along the periphery of JCF. The houses over endangered houses will be rehabilitated with equivalent type of house in satellite township in triple storied building having all basic infrastructural facilities. As soon as an employee residing in the identified endangered area retires, the house shall be demolished.

It is proposed that Rehabilitation/resettlement work of BCCL houses shall be the responsibility of BCCL whereas the same for Non BCCL houses including encroachers shall be the responsibility of concerned state Govt. However acquisition of land for rehabilitation of BCCL employees shall be done in association with State Govts of Jharkhand/West Bengal.

7.5 Amenities & Infrastructures:

The resettlement sites of the affected population for BCCL & Non-BCCL has been identified exclusively on non coal bearing areas sufficiently away from the impact of future mining. For this purpose, it is proposed that satellite township should be constructed along the fringe of Jharia Coal Field. The size of township should be large enough to accommodate at least 12500 Non-BCCL families and 6000 BCCL families. In each locality, there will be separate town ship for BCCL houses and Non-BCCL (both private & encroachers) adjacent to each other. In each township the following amenities will be provided as per BPE norm.

- Primary school
- High school
- Bank
- Post office
- Community center
- Shopping center
- Hospital
- Play ground & children park
- Water Supply ,Sewage disposal & sanitation
- Road, Culverts & Drains
- Power Supply

It is proposed that rehabilitation sites for Non-BCCL families should be adjacent to rehabilitation sites of BCCL houses.

7.6 Requirement of land at Resettlement site :

A) For BCCL houses

The BCCL houses will be resettled in satellite townships with equivalent type of houses in triple storey building. The weighted average plinth area of the houses proposed to be rehabilitated has been estimated at 48.09 sq m /house. Considering the amenities, infrastructure, internal roads etc to be provided in the township, requirement of land for BCCL houses has been estimated at 400.00 Ha. (@ 160 m^2 /House)

B) For Non BCCL Houses

i) Private (Authorised)

Head of every family will be provided a plot of land measuring 100 sq.m. Considering the amenities, infrastructure, internal roads etc to be provided in the township, requirement of land for private authorized houses has been estimated at 794.98 Ha. (@ 270 m^2 /house)

ii) Private Houses (Encroachers)

Encroachers will be provided with a house constructed on about 27 sq.m land in triple storied building in the resettlement site. However provision of 11 sq m of land has been considered for construction of another room in future . Considering the amenities, infrastructure, internal roads etc to be provided in the township, requirement of land for encroachers has been estimated at 310.01 Ha. (@ 130 m^2/house)

With the above consideration, total requirement of land has been estimated at **1504.99 hactre** of which **400.00** ha of land is required for resettlement of BCCL houses and **1104.99** ha for Non-BCCL houses. Phase wise Requirement of land is as under:

Sl.no	Particulars	Phase-I	Phase II	Total
1.	BCCL houses	199.39	200.61	400.00
2.	Non BCCL Houses	660.27	444.72	1104.99
	Total (Ha)	**859.66**	**645.33**	**1504.99**

7.7 Duration of Implementation:

Planning Commission vide letter no.M-12026/2/2005 dated 29.3.2005, suggested that the time frame of implementation of the Master Plan should be reduced to 7-8 years. In the meeting held with Secretary (Coal) on 23.2.06, it was decided to reduce the time frame to 10 years. Accordingly, duration of implementation has been considered as 10 years (excluding 2 years of Pre Implementation activities)
in 2 phases, each of 5 years duration.

The no. of houses, proposed to be rehabilitated under each phase are as under:

Sl. No.	NAME	BCCL	PVT	ENCR.	OTHER	TOTAL
1	PHASE -I	12462	16671	16166	496	45795
2	PHASE -II	12538	12773	7681	372	33364
	TOTAL	**25000**	**29444**	**23847**	**868**	**79159**

7.8 Prioritisation of Rehabilitation sites:

Depending on the urgency of evacuation based on the ground condition all the sites were prioritised into 4 different priority. (Priority – I to Priority – IV) in Master Plan'1999 & '2004. As desired by planning Commission, the time frame of implementation has been reduced to 10 years in 2 phases (excluding 2 years of Pre Implementation activities) from 20 years in 4 phases. Therefore, the houses which were proposed in lower priority/phase has now been considered in higher priority/phase i.e. sites of priority III & IV have been considered in Priority - I or II and so on. With the above considerations all the sites have now been prioritised into Priority – I & Priority – II.

UOI has submitted an affidavit against the PIL case filed by Sri Haradhan Roy, Ex MP indicating that houses over 119 sites will be shifted in 1st phase within five years. All those 119 sites has been retained in Phase –I. Out of the total 595 sites, 300 sites will be rehabilitated in priority / Phase – I & 295 sites in Phase- II.

However even after rehabilitating all the sites under Priority – II, or I it may not be possible to start opencast mining operations until the stable sites falling with the area are evacuated. These stable sites, proposed to be evacuated along with mining operation, cost of which will

be included in the mining project report, if mining operation is taken up. However, where fire dealing by excavation method has been proposed no further rehabilitation will be required.

7.9 Codification & Grouping of uncontrollable sites into projects

The uncontrollable sites are proposed to be rehabilitated in a group with proper codification. Each project has been assigned a code name showing the name of the Phase / Priority. The project code JCF / Rehab / I/ 1 indicates that :

JCF	:	Jharia Coalfield
Rehab.	:	Rehabilitation
I	:	Phase
1	:	Priority /project

Total 4 no. of projects has been envisaged.
Phase wise, Project wise details are given in **table no. 7**

Table-7

ACTION PLAN FOR REHABILITATION IN PHASE - I

1ST TO 5TH YEAR

Sl.No.	Area	Colliery	Site name & no.	Affected Area (Sq.m.)
	JCF/REHAB/P-I/2			
1	Barora	Damuda	Albion Section/O9	1600
2	Barora	Damuda	BJ Section B/O7	3200
3	Barora	Damuda	North Damuda Sec C/O3	4800
4	Barora	Damuda	North Damuda Sec D/O4	1200
5	Barora	Damuda	North Damuda Sec E/O5	1600
6	Barora	Damuda	Pathrakuli Village/10	3200
7	Barora	Muraidih	Barora Village No. 2/ O5	30400
8	Barora	Muraidih	Central Kenduadih Village/O7	1600
9	Barora	Muraidih	Kenduadih Village/ O6	24400
10	Barora	Phularitand	Akashkinaree Gwala Patti/O8	17600
	Barora	Phularitand(S)	Akashkinaree Gwala Patti/O8	1600
11	Barora	Phularitand	Ashakhuti Qtrs./O9	13600
	Barora	Phularitand(S)	Ashakhuti Qtrs./O5	14400
12	Barora	Phularitand	Badora/13	8400
13	Barora	Phularitand	Birajpur/10	8400
14	Barora	Phularitand	Mandira,Ganheshpur& Barwabera/O6	11200
	Barora	Phularitand(S)	Mandira,Ganheshpur& Barwabera/O6	41600
15	Barora	Phularitand	Manjura near Phularitand station/O6	16000

	Barora	Phularitand(S)	Manjura near Phularitand station/O6	9600
16	Barora	Phularitand	Mohalpatti Eastern Rly. Quarters/O7	18400
	Barora	Phularitand(S)	Mohalpatti Eastern Rly. Quarters/O7	4800
17	Barora	Phularitand	Nawagarh & Part of Muchikuli/16	19200
18	Bastacolla	Bastacolla	BastaCollaS2 / 05	167255
19	Bastacolla	Bastacolla	Chandmari Sec-2/O7	12211
20	Bastacolla	Bastacolla	Leper colony/O8	4350
21	Bastacolla	Bastacolla	Manjhi Bhasti/O9	7890
22	Bastacolla	Bastacolla(S)	Bastacolla Section 1/04	96347
23	Bastacolla	Bera	Bera Kala/Indira Awas/O3	41535
24	Bastacolla	Bera	Chandmari/O2	49972
25	Bastacolla	Bera	Jorapathak Road/O1	49972
26	Bastacolla	Dobari	BCCL Colony-2/O3	4999
27	Bastacolla	Dobari	Sahana Village/O2	41535
28	Bastacolla	Ghanoodih	4/5 Pit Area/O3	20179
29	Bastacolla	Ghanoodih	Buffer dhowra/O5	20179
30	Bastacolla	Ghanoodih	Mallah Patti/O1	28182
31	Bastacolla	GOCP	Bhuiya Dhowra / 05	4061
32	Bastacolla	Kuiya	ACM Qtrs /O2	1706
33	Bastacolla	Kuiya	Colliery Office/O1	2678
34	Bastacolla	Kujama	Road Side Durgapur/O2	65436
35	Bastacolla	Kujama	Jharia Town / 05	108271
36	Bastacolla	Kujama(S)	Pandebera/03	11748
37	Bastacolla	Kujama	South Kujama /01	104301
38	Block-II	Benedih	Khoki Bigha/O1	8800
39	Block-II	Block-II	Bilaspuri Dhowrah /10	2400
40	Block-II	Block-II	Kessurgarh Bastee/ O7	46000
41	Block-II	Block-II	Sidpuki Village/O6	1600
42	Block-II	Nudkhurkee	Nudkhurkee Bastee no: 2/ O9	1600
43	Block-II	Nudkhurkee	Nudkhurkee Bastee no: 3 /O7	4000
44	C-V Area	Basantimata	Company Colony near Office/O2	3929
45-48	C-V Area	Begunia	Barakar Town/1A,1B,1C, &1D	375299
49	C-V Area	Laikdih	Nutugram/O1	74956
50	C-V Area	New Laikdih	Jograd Bastee/12	5388
51	C-V Area	New Laikdih	Office Complex,W/S,CHP/O2	14690
52	C-V Area	Old Chanch	Bautdih 1/O4	11368
53	C-V Area	Old Chanch	Yadavpur Luchi Bsi/O6	18000
54	C-V Area	Old Chanch (Closed)	Bautdih 2/O5	39861
55	C-V Area	Old Chanch (Closed)	Reliance Factory 1/O2	8539
56	C-V Area	Old Chanch (Closed)	Reliance Factory 2/O3	93769
57	C-V Area	Victoria West	Baltoria/O2	81656
58	C-V Area	Victoria West	Barakar Town /O3	239416
59	C-V Area	Victoria West	Jhanakpura/O4	71270
60	C-V Area	Victoria West	Jhewri Mohalla/O6	30491
61	C-V Area	Victoria West	Karimdanga/O7	45382
62	C-V Area	Victoria West	Pahalsadarga /O5	15235
63	E. Jharia	Amlabad	Bhuiya Patti/O3	16000
64	E. Jharia	Patherdih	Huchuktand /O2	4800
65	E. Jharia	Patherdih	Pure Chasnalla/O9	30400

66	E. Jharia	Sudamdih SM	Patherdih Village/O3	16000
67	Gobindpur	Dharmaband	Barat Area of NHS/O6	9600
68	Gobindpur	Dharmaband	Dharmaband Village/O5	35200
69	Gobindpur	Dharmaband	Dispensar Qrts Area/O2	17600
70	Gobindpur	Dharmaband	No:6 NHS Qtrs/O3	51200
71	Gobindpur	Dharmaband	Office Area/O4	57600
72	Gobindpur	Dharmaband	Thana Area Qrts /O1	32000
73	Gobindpur	Gobindpur	Tiwari Bastee /O2	4750
74	Gobindpur	Jogidih	Central Sinidih Bastee/12	2645
75	Gobindpur	Jogidih	East Sinidih Unit/11	3825
76	Gobindpur	Jogidih	HZL Factory Surroundings/13	16485
77	Gobindpur	Jogidih	Tundoo Khas Village/15	43859
78	Gobindpur	Jogidih	Tundoo Village/10	9210
79	Gobindpur	Kharkharee	Kharkharee & Newagarh/O2	62400
80	Gobindpur	Maheshpur	Ashakhuti Phularitand 6/O3	5618
81	Gobindpur	Maheshpur	Bamandih Colony/15	3159
82	Gobindpur	Maheshpur	Maheshpur Colliery Office & Houses/O5	26304
83	Gobindpur	Maheshpur	Sinidih Basti, Quarters & Hutments(North of DB Road)/13	1149
84	Gobindpur	Maheshpur	Sinidih NHS Qtrs & Hutments(East & West of HZL Road)/12	13056
85	Gobindpur	Maheshpur	Sinidih Quarters & houses surround sub-station/12	10948
86	Gobindpur	S.Gobindpur	15 A Seam B/16	1600
87	Gobindpur	S.Gobindpur	Aam Bagan Bastee- A/17	22400
88	Gobindpur	S.Gobindpur	Aam Bagan Bastee-B/18	30400
89	Gobindpur	S.Gobindpur	Bilbera 'B' /10	18400
90	Gobindpur	S.Gobindpur	Bilbera Jealgora Section/05	22400
91	Gobindpur	S.Gobindpur	Diamond-Teturia B/O6	1600
92	Gobindpur	S.Gobindpur	Hanuman Nagar/11	8000
93	Gobindpur	S.Gobindpur	South Govindpur 'A' / O3	4000
94	Gobindpur	S.Gobindpur	South Govindpur-C/O9	16000
95	Gobindpur	S.Gobindpur	Tanda Beri 'B' /O4	8000
96	Gobindpur	Teturia	4 Pit Area /O5	25600
97	Gobindpur	Teturia	Agent Bunglow/O4	12800
98	Gobindpur	Teturia	Baru Bhutu Bastee/O6	400
99	Gobindpur	Teturia	Dharmaband Agent Bunglow/O7	3800
100	Katras	Angarpathra	A.P. Section -I/O1	212100
101	Katras	East Katras	Choltudih/19	26280
102	Katras	East Katras	Koliudih 6/17	2500
103	Katras	Gaslitand	Gaslitand Colony/O1	132960
104	Katras	Gaslitand	Gaslitand Upper Dhowra/O5	25100
105	Katras	Katras-Chaitudih	Bastee No 4/11	30450
106	Katras	Katras-Chaitudih	Kathal Dhowrah /O6	1300
107	Katras	Katras-Chaitudih	Lakurka Vill. No. 1/ 12	21375
108	Katras	Katras-Chaitudih	Lakurka Vill. No. 2/ 13	5575
109	Katras	Katras-Chaitudih	Lal Dhowra To Pokherpar/03	8350
110	Katras	Katras-Chaitudih	Near 3 Pit Habitation/02	8350
111	Katras	Katras-Chaitudih	North of 1 Pit/04	4850
112	Katras	Katras-Chaitudih	Ramakant Bhartiya House/16	465
113	Katras	Katras-Chaitudih	Yule Pit Qtrs /07	8650
114	Katras	Salanpur	Central Salanpur Block -II /O8	17420
115	Katras	Salanpur	East Salanpur Block 1 /21	14980
116	Katras	Salanpur	East Salanpur Block -1&2/ (1&2)	36110

117	Katras	Salanpur	New Lakurka Section Block -1 /16	6000
118	Katras	Salanpur	North Salanpur Block -2/05	33888
119	Katras	Salanpur	North Salanpur Block -3/06	88320
120	Katras	Salanpur	Railway Colony/03	16160
121	Kustore	Alkusa	DAV School & G. Camp / 02	43330
122	Kustore	Alkusa	Hutment near Durga Mandir / 05	33800
123	Kustore	Alkusa	Officers Qtr. near Thana / 01	43330
124	Kustore	Burragarh	Burragarh Office Complex// 08	29049
125	Kustore	E. Bhagatdih	1 Pit Area / 04	15612
126	Kustore	E. Bhagatdih	Boka Pahari / 01	13166
127	Kustore	E. Bhagatdih	Chowthai Kuli &Hussainabad / 09	172269
128	Kustore	E. Bhagatdih	Katras More Area / 11	34064
129	Kustore	E. Bhagatdih	Khas Jharia / 06	44060
130	Kustore	E. Bhagatdih	No. 3&5 Colony /0 2	22739
131	Kustore	E. Bhagatdih	No. 4 Pit Area/0 5	33685
132	Kustore	Ena	Colliery Qtrs / 03	2165
133	Kustore	Ena	No.2 Colony/ 04	27751
134	Kustore	Ena	Officers colony &B.up Area / 05	99685
135	Kustore	Ena	Parsatand Basti/ 02	9869
136	Kustore	Kustore	08 No.Dhowra / 01	14000
137	Kustore	Kustore	3 No. Colony &D Mandir /08	100489
138	Kustore	Kustore	Simla bahal Basti / 03	70000
139	Kustore	Rajapur	Kukur Thapa / 02	27889
140	Kustore	Rajapur	N. WB Colony / 04	19250
141	Kustore	Rajapur	New Colony &Ena Islampur / 05	59500
142	Kustore	Rajapur	Rajapur Colony / 03	10720
143	Kustore	Rajapur	Fatehpur Bastee/01	21263
144	Kustore	Simla bahal	Bhalgora Dheslia Patti / 01	176574
145	Kustore	Simla bahal	Fire Brigd. Area / 09	30129
146	Kustore	Simla bahal	Inside Colliery Comd. Area / 05	71539
147	Kustore	Simla bahal	Jharia Town (P. Area) / 02	125143
148	Kustore	Simla bahal	Shamsher nagar / 03	240123
149	Kusunda	Basseriya	Gwala Patti /01	59705
150	Kusunda	Basseriya	No. 1 Basti /03	4099
151	Kusunda	Godhur	Rawani Bastee	
152	Kusunda	Gondudih	Surender Colony (East Loyabad)/ 07	11584
153	Kusunda	Industry	West Ena 1 & 2 pit / 01	268687
154	Kusunda	Khas Kusunda	Colliery Office Complex & company's qtrs / 10	
155	Kusunda	Kusunda	Kusunda village /01	21042
156	Kusunda	Kusunda	Workshop, Office & Qtrs (PK-1&2 pit area)/ 04	78198
	JCF/REHAB/P-I/1			
157	Lodna	Bagdigi	Bagdigi Basti /01	89600
158	Lodna	Bagdigi	Bagdigi Colony / 02	27200
	Lodna	Bagdigi(S)	Bagdigi Colony / 02	41600
159	Lodna	Bararee	Along Jore Side Colony/11	17600
	Lodna	Barsree(S)	Along Jore Side Colony/11	11200
160	Lodna	Bararee(S)	Bazaar Dhowrah/12	7200
161	Lodna	Bararee	Brahman Basti / 02	14400
162	Lodna	Bararee	Chhata Dhowra & Durga Mandir /05	35200
163	Lodna	Bararee	Chireiyatand Colony /01	30400
164	Lodna	Bararee	Colony near 1 pit /04	35200
165	Lodna	Bararee	Colony near Bararee School / Bagan Dhowra /03	19200

166	Lodna	Bararee	Digwadih New Colony / O8	41600
167	Lodna	Bararee	Dom Dhowra /O6	10400
168	Lodna	Bararee	East side of DB Road /O9	24000
169	Lodna	Bararee	Mudivita Village/10	1600
	Lodna	Bararee(S)	Mudivita Village/10	1600
170	Lodna	Bararee	Naya Dhowra Colony/ O7	19200
171	Lodna	Jealgora	1&2 Pit Area/11	32000
172	Lodna	Jealgora	Bagdigi Basti / 12	26400
173	Lodna	Jealgora	Bucherkhana Area / O1	43200
174	Lodna	Jealgora	Buriband /14	13600
175	Lodna	Jealgora	Check Post area /O6	4000
176	Lodna	Jealgora	North Jealgora 3&4 Pit/ O2	64000
177	Lodna	Jealgora	Stadium Area colony/O5	76800
178	Lodna	Jealgora	Sweeper Dhowra /O9	16000
179	Lodna	Jeenagora	Central Sulunga Colony No 1/ O9	2400
180	Lodna	Jeenagora	E.B. Section colony no. 1/O1	6400
	Lodna	Jeenagora(S)	E.B. Section colony no. 1/O1	800
181	Lodna	Jeenagora	EB Sec. Colony No. 2/O2	21600
182	Lodna	Jeenagora	Khas Jeenagora Colony No 1/O3	32000
183	Lodna	Jeenagora	Khas Jeenagora & Kalisthan /O5	7200
184	Lodna	Jeenagora	Khas Jeenagora Colony No. 2/ O4	4000
185	Lodna	Jeenagora	Khas Jeenagora Colony no. 3/ O6	15200
186	Lodna	Jeenagora	Khas Jeenagora Colony no. 4/O7	10400
187	Lodna	Joyrampur	6 pit Dhowra & Atta Chaki /O1	27200
	Lodna	Joyrampur(S)	6 pit Dhowra & Atta Chaki /O1	40000
188	Lodna	Joyrampur	Around Area Office/WS & No. 2 Basti/O3	56000
189	Lodna	Joyrampur	Beer Company Locality/O5	8800
190	Lodna	Joyrampur	Durga Mandir Area /O4	40000
191	Lodna	Joyrampur	Hazaribagh Colony near Hosptal /O2	30400
	Lodna	Joyrampur(S)	Hazaribagh Colony near Hosptal /O2	27200
192	Lodna	Lodna	2 pit Bhaga Colony/ 26	44800
193	Lodna	Lodna	16 no incline Jore side Colony / 22	8000
194	Lodna	Lodna	2 No. Incline Colony / 23	3200
	Lodna	Lodna(S)	2 No. Incline Colony / 23	30400
195	Lodna	Lodna	3 pit basti /O9	4800
	Lodna	Lodna(S)	3 pit basti /O9	600
196	Lodna	Lodna	4 pit Colony / 24	26600
197	Lodna	Lodna	5 No. Colony/ (C-17)	46400
198	Lodna	Lodna	8 pit area colony / 19	17600
	Lodna	Lodna(S)	8 pit area colony / 19	27200
199	Lodna	Lodna	Balugada Colony / 26	7200
	Lodna	Lodna(S)	Balugada Colony / 26	3200
200	Lodna	Lodna	Chalchalia Labour Colony /25	20800
201	Lodna	Lodna	Chalchalia Labour Colony/ (C-13)	24000
202	Lodna	Lodna	Firkuband Colony / 30	7200
203	Lodna	Lodna	Hanumangari Basti/14	16000
204	Lodna	Lodna	Indira Chowk Road side Basti /O7	3200
	Lodna	Lodna(S)	Indira Chowk Road side Basti /O7	3200
205	Lodna	Lodna	Jealgora Barrier Colony / 18	30400
206	Lodna	Lodna	Jeenagora Branch site / 20	1280
	Lodna	Lodna(S)	Jeenagora Branch site / 20	1920
207	Lodna	Lodna	Jharia Club & road side Basti /O6	28000

208	Lodna	Lodna	Joyrampur / Badigi Barrier / 21	11200
209	Lodna	Lodna	Kalidham Colony / 27	10400
210	Lodna	Lodna	Kujama Village /O2	2880
	Lodna	Lodna(S)	Kujama Village /O2	1920
211	Lodna	Lodna	Lodna Village /O1	46400
	Lodna	Lodna(S)	Lodna Village /O1	6800
212	Lodna	Lodna	Nadiapar Kujama Basti /O4	12800
213	Lodna	Lodna	New Bhaga Bast / 11	99200
214	Lodna	Lodna	New Colony Baniahir /13	49600
215	Lodna	Lodna	Niluri Patra Bastee /O5	1600
216	Lodna	Lodna	Office Compelx Area / 31	84800
	Lodna	Lodna(S)	Office Compelx Area / 31	2400
217	Lodna	Lodna	Suratand Basti /O6	4000
	Lodna	Lodna(S)	Suratand Basti /O6	6400
218	Lodna	Lodna	Tar Plant Area / 12	20800
	Lodna	Lodna(S)	Tar Plant Area / 12	6400
219	Lodna	North Tisra	BCCL Colony No. 1/O1	12800
220	Lodna	North Tisra	SG Section Basti /O3	14400
221	Lodna	North Tisra	Tilaboni Basti/O2	25600
	Lodna	North Tisra(S)	Tilaboni Basti/O2	12800
222	Lodna	South Tisra	B.J. & S.T. Section/ O3	24000
223	Lodna	South Tisra	Huchuktand Basti/O1	36000
224	Lodna	South Tisra	No.1 Pit S.T. Section /O2	1600
225	P-B Area	Balihari 10/12 Pit	63 Dhowra/O1	16300
226	P-B Area	Balihari 10/12 Pit	BCCL Colony No.1/13	7900
227	P-B Area	Balihari 10/12 Pit	Miner's Colony/11	5800
228	P-B Area	Balihari 10/12 Pit	Miner's Qtrs./O9	2400
229	P-B Area	Bhagaband	Aralgoria Basti/O2	18000
230	P-B Area	Bhagaband	Bhagaband Bastee/O4	235800
231	P-B Area	Bhagaband	DVC Colony/O1	44650
232	P-B Area	Bhagaband	Kashiatand/O5	33500
233	P-B Area	Bhagaband	Kenduadih Bastee(6B)/O7	0
234	P-B Area	GopaliChak	1 No. Dhowra/13	19534
235	P-B Area	GopaliChak	Bowri Basti No.3/11	6511
236	P-B Area	GopaliChak	In Chandra /O3	68016
237	P-B Area	GopaliChak	Leper Bastee/O5	3720
238	P-B Area	GopaliChak	Marine Qtrs. /O7	10790
239	P-B Area	GopaliChak	Pasi Dhowra / 10	21395
240	P-B Area	GopaliChak	Rly. Colony & Station/O6	25116
241	P-B Area	GopaliChak	West Side NH-32/O9	11348
242	P-B Area	Hydro-Mining	4 Pit Bastee/O6	35200
243	P-B Area	Hydro-Mining	Balihari Bastee/O4	33340
244	P-B Area	Hydro-Mining	Kumar Patti/O3	5200
245	P-B Area	Hydro-Mining	Nehru Nagar/O5	7740
246	P-B Area	Kenduadih	2/12 incl.Dhowra & Hutments/18	3060
247	P-B Area	Kenduadih	Atwal Colony/12	19000
248	P-B Area	Kenduadih	Babubasa Colony/O2	6600
249	P-B Area	Kenduadih	Colony near Post Office /O3	40000
250	P-B Area	Kenduadih	East of Hindi Bhawan / 16	22900
251	P-B Area	Kenduadih	E-B Section/O9	4800
252	P-B Area	Kenduadih	Kathgola Maidan/O6	47770
253	P-B Area	Kenduadih	Kenduya Bazar /O7	146500

254	P-B Area	Kenduadih	Khoira Pit Head Bath/19	8360
255	P-B Area	Kenduadih	Labour Dhowra/17	7000
256	P-B Area	Kenduadih	Muslim Bastee/O8	36700
257	P-B Area	Kenduadih	Naya Dhowra Colony O4	52200
258	P-B Area	Kenduadih	Officer's Colony/10	4800
259	P-B Area	Kenduadih	Rajput Basti /O5	15340
260	P-B Area	Pootkee	Staff Qrts /O4	794600
261	Sijua	Bansdeopur	6 No. Dhowra /O8	9000
262	Sijua	Bansdeopur	BSP GH office / 14	9000
263	Sijua	Bansdeopur	Elec. Sub-station/12	3000
264	Sijua	Bansdeopur	Harijan Basti /O1	5460
265	Sijua	Bansdeopur	Indira Awas/11	5880
266	Sijua	Bansdeopur	Mallah Basti /O2	8775
267	Sijua	Kankanee	South of 7 pit /O2	6000
268	Sijua	Loyabad	5 pit Area /O9	45000
269	Sijua	Loyabad	7 / 8 Area /O1	21500
270	Sijua	Loyabad	8 pit area /O2	19200
271	Sijua	Mudidih	10 pit colony /O7	5000
272	Sijua	Mudidih	Jogta Colony / 13	93200
273	Sijua	Mudidih	Liprosy Area /O9	11500
274	Sijua	Mudidih	Nepali Dhowra /O6	95000
275	Sijua	Mudidih	New Shyam Bazar /12	10000
276	Sijua	Mudidih	No. 4 pit area / 11	1800
277	Sijua	Mudidih	Shyam Bazar/ O8	66000
278	Sijua	Mudidih	Tetulmari Vill. /O4	1500
279	Sijua	Nichitpur	Hard coke Bhatta/O3	5800
280	Sijua	Nichitpur	Nichitpur Bastee/O2	10000
281	Sijua	Nichitpur	Staff Qrts. /O4	46046
282	Sijua	Nichitpur	Staff Qrts. /O5	12560
283	Sijua	Sendra Bansjora	11 No. Colony/11	1900
284	Sijua	Sendra Bansjora	13 No. Colony/13	7500
285	Sijua	Sendra Bansjora	Gareria Colony /15	5700
286	Sijua	Sendra Bansjora	Gareria Colony 1/14	2000
287	Sijua	Sendra Bansjora	Habitation west of DB Road/12	10375
288	Sijua	Tetulmari	Director's Bunglow / 14	25200
289	Sijua	Tetulmari	Hirak & Private/12	12150
290	W. Jharia	Bhatdee	Belakhanda Co. Qrts./O6	24200
291	W. Jharia	Hartoodih (Closed)	Kultand Village/O3	116900
292	W. Jharia	Hartoodih (Closed)	Washery colony/O1	49600
293	W. Jharia	Lohapatti	Koraldih & Santadih/O8	4700
294	W. Jharia	Lohapatti	Kusumtand /10	221100
295	W. Jharia	Lohapatti	Modidih/O9	47900
296	W. Jharia	Lohapatti	Telmocho/O4	73200
297	W. Jharia	Moonidih	Lalpur Rutha Bastee/O6	1178600
298	W. Jharia	Murulidih (Closed)	BSEB & its surroundings /O1	56220
299	W. Jharia	Murulidih (Closed)	Murulidih Village/O4	266200
300	W. Jharia	Murulidih 20/21 Pit	Bhuli Qrts./O2	47000
			Total for Phase - I	12044691

ACTION PLAN FOR REHABILITATION IN PHASE - II

6TH TO 10TH YEAR

Sl.No.	Area	Colliery	Site name & no.	Affected Area (Sq.m.)
	JCF/REHAB/P-II/1			
1	Barora	Damuda	BJ Section 'A/O6	17600
2	Barora	Damuda	Karmatand Section/11	24000
3	Barora	Damuda	North Damuda Section F/18	400
4	Barora	Damuda	Sijua Village/ O8	9600
5	Barora	Madhuband	Colliery Office & Qtrs./O6	24000
6	Barora	Madhuband	Dhowatand Village/O4	40000
7	Barora	Madhuband	Kutkutia Patti/ O5	27200
8	Barora	Phularitand	Nawagarh Bastee (Part)/12	16000
9	Barora	Phularitand	Phularitand Bazar / Hatia/11	41600
10	Barora	Phularitand	West Side of Punduvita Village/14	5600
11	Bastacolla	Bastacolla	Colony near Dhansar Police Station/ O3	12436
12	Bastacolla	Kujama	Khas Jharia/O4	17491
13	Block-II	Block-II	Madhuband Colony /O5	51200
14	C-V Area	Laikdih	Dumarkunda & company Qutrs./4A&4B	38585
15-16	C-V Area	Laikdih	Dumarkunda Village/2A&2B	78617
17	C-V Area	Laikdih	Manjhi Bastee/O6	12285
18	C-V Area	New Laikdih	CMW Colony/O6	51138
19	C-V Area	Victoria	Heslok Pit Area/O1	20806
20	E. Jharia	Amlabad	Bhuli Quarter & Staff Colony/ (1&2)	52000
21	E. Jharia	Bhowra North	No. 6 Block/O9	33600
22	E. Jharia	Bhowra North	No. 7 Bastee/O2	16000
23	E. Jharia	Bhowra North	No.9 Block Near Hospital/10	8000
24	E. Jharia	Bhowra North	No-8 Block/O1	12800
25	E. Jharia	Bhowra North	Parasiabad Bastee/O5	4800
26	E. Jharia	Bhowra North	Parasiabad Labour Block/O4	12000
27	E. Jharia	Bhowra South	12 No. Area Colliery Office to Kumar Patti/ 16	104000
28	E. Jharia	Bhowra South	35 Area Chhapra More/12	52000
29	E. Jharia	Bhowra South	36 Jore Area behind Area Office/14	20000
30	E. Jharia	Bhowra South	4 no. Dhowrah/Amlabad Road/18	52800
31	E. Jharia	Bhowra South	Gourkhunti 35 Incline/13	77600
32	E. Jharia	Bhowra South	Jahaj Tand/19	5600
33	E. Jharia	Patherdih	Chandrabad/11	30400
34	E. Jharia	Patherdih	Hattalla Village/ O5	51200
35	E. Jharia	Patherdih	Kamini Nagar/10	14400
36	E. Jharia	Patherdih	Modern Sudamdih/O8	12800
37	E. Jharia	Patherdih	Pandey Bastee/O7	11200
38	E. Jharia	Patherdih	Patherdih/ O4	14400
39	E. Jharia	Sudamdih Inc.	Main Colony Chief House/ O4	8000

40	E. Jharia	Sudamdih Inc.	Main Colony Miners house/05	19200
41	E. Jharia	Sudamdih Inc.	Main Colony/ 03	16000
42	E. Jharia	Sudamdih Inc.	Old Incline Colony/06	4800
43	E. Jharia	Sudamdih S.M.	New Miners colony/02	33600
44	E. Jharia	Sudamdih S.M.	River side colony/01	30400
45	Gobindpur	Akashkinaree	Akashkinare Colony/ 06	3837
46	Gobindpur	Akashkinaree	Labour Qtrs. Along PWD Road/ 02	19139
47	Gobindpur	Akashkinaree	Part of Bhatmurma Bastee/03	6996
48	Gobindpur	Akashkinaree	Qtrs. Along office compound/04	37973
49	Gobindpur	Akashkinaree	Qtrs.on South side of Akashkinaree/05	32070
50	Gobindpur	Block-IV / Kooridih	Kooridih 3 seam Area Hutment/ 04	1870
51	Gobindpur	Block-IV / Kooridih	LCH Dhowrah Govindpur/18	720
52	Gobindpur	Block-IV / Kooridih	Near Block-IV Office/15	26846
53	Gobindpur	Block-IV / Kooridih	Near Gobindpur Hospital/14	24280
54	Gobindpur	Block-IV / Kooridih	NHS Qrts/12	1400
55	Gobindpur	Block-IV / Kooridih	South Gobindpur Bastee/16	7040
56	Gobindpur	Block-IV / Kooridih	South Gobindpur Dhowra/17	1562
57	Gobindpur	Gobindpur	Agardih Labour Qtrs/07	17580
58	Gobindpur	Gobindpur	Darpan Bastee/05	132
59	Gobindpur	Gobindpur	Imli Dhowrah/03	31145
60	Gobindpur	Gobindpur	IV Seam Colony/01	57408
61	Gobindpur	Gobindpur	Labour Qrts /08	1174
62	Gobindpur	Gobindpur	Mehtadih Colony & Bunglow/04	31145
63	Gobindpur	Jogidih	Beiherdih Colony 'B'/ 1B	9365
64	Gobindpur	Jogidih	Beiherdih Village/1A	5116
65	Gobindpur	Kharkharee	Nawagarh More & Phulariland Village/ 03	14400
66	Gobindpur	Kharkharee	Part of Phulariland Village/ 3A	24000
67	Gobindpur	Maheshpur	Maheshpur Bastee/01	33309
68	Gobindpur	Maheshpur	NHS Qtrs. & House North of DB Road/11	43823
69	Gobindpur	Maheshpur	Premnagar Colony Bastee etc / 14	13418
70	Gobindpur	Maheshpur	Staff Qtrs. & Hutment/04	2806
71	Gobindpur	S.Gobindpur	Bilbera - C/13	8000
72	Gobindpur	S.Gobindpur	Bilbera 'A'/ 07	1600
73	Gobindpur	S.Gobindpur	Kali Nagar Bilbera/12	8000
74	Gobindpur	S.Gobindpur	South Govindpur 'B'/06	2400
75	Gobindpur	S.Gobindpur	Tandabari-A/01	16400
76	Gobindpur	Teturia	Colliery Office Area/03	22400
77	Gobindpur	Teturia	NHS Qtrs.& Hutment/01	43600
78	Gobindpur	Teturia	No.2 Locality/02	32800
79	Katras	Angarpathra	AP Section-2 /02	16800
80	Katras	Angarpathra	JK Khas/04	2200
81	Katras	Angarpathra	JK Section/03	62400
82	Katras	Angarpathra	National Angarpathra-2/06	6500
83	Katras	East Katras	Akashkinaree 04/06	2800
84	Katras	East Katras	Akashkinaree -2/02	400
85	Katras	East Katras	Akashkinaree 3/04	3840
86	Katras	East Katras	Akashkinaree 5/07	1000
87	Katras	East Katras	Akashkinaree-6/08	4350
88	Katras	East Katras	Bhandardih 2 /11	2500
89	Katras	East Katras	Koiludih 01/03	3900
90	Katras	East Katras	Koiludih 3/10	40180
91	Katras	East Katras	Koiludih 4/15	65752

92	Katras	East Katras	Koiludih-2/O9	2450
93	Katras	East Katras	Koiludih-5/16	65752
94	Katras	East Katras	Malkera/18	3940
95	Katras	East Katras Project	Bhanderdih 3/12	32400
96	Katras	Gaslitand	Qtrs. Near 6 Pit VAP/O4	43900
97	Katras	Gaslitand	Qtrs. Near 7 Pit & Colliery Office/O2	36500
98	Katras	Gaslitand	Qtrs. Near Ground UAP/O3	6500
99	Katras	Katras-Chaitudih	2 Pit Dhowrah/O6	9450
100	Katras	Katras-Chaitudih	5 No Pit Area/10	4550
101	Katras	Katras-Chaitudih	Bengali Dhowra/O5	6650
102	Katras	Katras-Chaitudih	Dhowra of SW portion of 9 Pit/15	1850
103	Katras	Katras-Chaitudih	Habitation North of 13 Seam Quarry/17	1400
104	Katras	Katras-Chaitudih	Lakurka Bunglow Surrounding Area/O9	32550
105	Katras	Katras-Chaitudih	Lakurka Staff Qtrs./14	29370
106	Katras	Katras-Chaitudih	Loading Dhowrah (Lakurka Section) /16	13940
107	Katras	Keshelpur	Huts near 3/2 Incline/O6	3550
108	Katras	Keshelpur	Quarter near 3/2 Incline/O7	460
109	Katras	Keshelpur	Quarter near Agent Office/O4	2050
110	Katras	Salanpur	Central Salanpur Block 4 (10) & Lakurka Khas Block 4/ 15	27780
111	Katras	Salanpur	Central Salanpur Block 5 (12), Lakurka Khas Block 3/ 14 & 9	20170
112	Katras	Salanpur	Khas Gobindpur Area/23	12800
113	Katras	Salanpur	Khas Gobindpur Block 1 /22	14400
114	Katras	Salanpur	Lakurka Khas Block 1 (11) & Central Salanpur Block 1/ 07	15312
115	Katras	Salanpur	Lakurka Khas Block 2/ 13	2450
116	Katras	Salanpur	New Lakurka Section Block 2/17	19180
117	Katras	Salanpur	New Lakurka Section Block 3/18	1040
118	Katras	Salanpur	New Lakurka Section Block 5/ 20	4800
119	Katras	West Mudidih	2 Seam Area near 8/2 Incline/O2	550
120	Katras	West Mudidih	Dalahi Bastee/O5	7200
121	Katras	West Mudidih	House near 4 no. Sub-station/O8	1004
122	Katras	West Mudidih	Huts near Caplamp Room no. 1/ O6	1100
123	Katras	West Mudidih	Near 10/2 Incline 1 Area /11	1100
124	Kustore	Alkusa	GM Bunglow & Qtrs./O4	36188
125	Kustore	Alkusa	Qtrs. Near 6/7 Pit/O3	2494600
126	Kustore	Burragarh	Burragarh Basti/O2	15339
127	Kustore	Burragarh	Burragarh CISF Centre/O7	6084
128	Kustore	Burragarh	Nagu Centre & Bachha Centre/O4	30412
129	Kustore	Burragarh	Officer's & Staff Colony/O3	18860
130	Kustore	Burragarh	Pure Burragarh Basti/O5	20299
131	Kustore	Burragarh	Surendra Colony/Karmik Ngr/O1	27713
132	Kustore	E. Bhagatdih	Bihar Talkies & Raja Bari Area/12(A)	219387
133	Kustore	E. Bhagatdih	Jharia Water Board Area /O6	35750
134	Kustore	E. Bhagatdih	Bihar Talkies & Raja Bari Area/12(B)	10518
135	Kustore	E. Bhagatdih	Gopalichak Basti/O3	21185
136	Kustore	E. Bhagatdih	Koni Bandh Area/10	7363
137	Kustore	Hurriladih	7 No. Colony/O4	35526
138	Kustore	Hurriladih	Bhutgoria Old Complex/O7	16473
139	Kustore	Hurriladih	Hurriladih Bastee/O2	39223
140	Kustore	Hurriladih	Hurriladih Old Colony/O6	14914
141	Kustore	Hurriladih	New Colony 1&2 No/O3	30436
142	Kustore	Hurriladih	Pather Bunglow Bastee/O1	26499
143	Kustore	Hurriladih	Sarguja Bastee/O5	24894

144	Kustore	Kustore	Bhagwan Das Centr/O9	19173
145	Kustore	Kustore	BNR Kustore/O4	40308
146	Kustore	Kustore	Dak Banglow Area/10	106191
147	Kustore	Kustore	Kalimandir Area/O2	9940
148	Kustore	Kustore	Khapra Dhowra/O6	23373
149	Kustore	Kustore	Naya Dhowra/O5	34099
150	Kustore	Kustore	Old Simlabahal Office/11	14362
151	Kustore	Kustore	Qtrs. Near 10 Pit Area/O7	32000
152	Kustore	Simlabahal	Bhaga S.E. Rly. Colony/O8	12062
153	Kustore	Simlabahal	Bhalgora Project Complex/O6	49370
154	Kustore	Simlabahal	DAV School Area/O7	15867
155	Kustore	Simlabahal	Ganiban Patti/O4	45369
	JCF/REHAB/P-II/2			
156	Kusunda	Dhansar	Bright Kusunda Colony/O2	28000
157	Kusunda	Dhansar	East Godhur Colony/O1	45637
158	Kusunda	Dhansar	New Delhi Colony/O3	12056
159	Kusunda	E. Bassuriya	Gareria Basti/O1	41286
160	Kusunda	Godhar	3 Pit Area/O3	58437
161	Kusunda	Godhar	Baldar Bastee/O1	2000
162	Kusunda	Gondudih	10 No. Dhowrah/O8	4882
163	Kusunda	Indusrty	Lahabera Bastee/O3	2936
164	Kusunda	Industry	Huchuktand Bastee/O2	2655
165	Kusunda	Industry	KOCP Office & Colony Qtrs./O5	2936
166	Kusunda	Industry	Rise Bhagatdih Colony/O6	6906
167	Kusunda	Khas Kusunda	B Panel Area/O7	14091
168	Kusunda	Khas Kusunda	Colony near KG Section School/11	6011
169	Kusunda	Khas Kusunda	Company Qtr. West of Bhuli Road/12	7808
170	Kusunda	Khas Kusunda	Dharia Jobs Village/O4	1573
171	Kusunda	Khas Kusunda	Gondudih Bastee/O3	12296
172	Kusunda	Khas Kusunda	Harijan Basti/O5	11451
173	Kusunda	Khas Kusunda	Hospital Basti/O8	16345
174	Kusunda	Khas Kusunda	Kharikabad Bastee/ O9	17971
175	Kusunda	Khas Kusunda	Kusunda Station Village/O6	11451
176	Kusunda	Kusunda	Keska Basti Qtrs./O2	21042
177	Lodna	Jealgora	16 No. Dhowra Area/13	32000
178	Lodna	Jealgora	7 Pit Old Hospital Area/10	36000
179	Lodna	Jealgora	Durga Mandir Colony/O4	26800
180	Lodna	Jealgora	Guest House Area/O7	54400
181	Lodna	Jealgora	Jealgora Bastee/O3	26800
182	Lodna	Jealgora	Jealgora Colony/O5	72000
183	Lodna	Lodna	5 No. Colony/29	32000
184	Lodna	Lodna	GM Bunglow & Road Side Bastee/15	48000
185	Lodna	Lodna	Phus Bungla Road side Bastee/10	3200
186	Lodna	Lodna	Phus Bungla Road side colony/16	3200
187	Lodna	Lodna	Puranadih Village/O3	8400
188	Lodna	Lodna	Shalimar Colony/17	16000
189	P-B Area	Balihari 10/12 Pit	60 Dhowra/O3	11500
190	P-B Area	Balihari 10/12 Pit	86 Dhowra/O2	87350
191	P-B Area	Balihari 10/12 Pit	BCCL colony 2/14	11150
192	P-B Area	Balihari 10/12 Pit	Bunglow & Babu Besa/O8	16300
193	P-B Area	Balihari 10/12 Pit	Pit Office/12	20000
194	P-B Area	Balihari 10/12 Pit	Village No. 1 Balihari/O6	5000

195	P-B Area	Balihari 10/12 Pit	Village No.2 Balihari/O5	29700
196	P-B Area	Balihari 10/12 Pit	Villagee No. 3 Balihari/O7	2500
197	P-B Area	Balihari 10/12 Pit	Shakti School/10	144400
198	P-B Area	Bhagaband	Araigoria Basti-3/O3	77000
199	P-B Area	Bhagaband	Kenduadih Bastee (6A)/O6	192600
200	P-B Area	Bhagaband	Kenduadih Bastee (6G)/12	0
201	P-B Area	Bhagaband	Kenduadih Bastee(6)/O6	0
202	P-B Area	Bhagaband	Kenduadih Bastee(6D)/O9	0
203	P-B Area	Bhagaband	Kenduadih Bastee/10	0
204	P-B Area	Bhagaband	Kenduadih Bastee-6F/11	0
205	P-B Area	GopaliChak	17 No. Dhowra/14	44651
206	P-B Area	GopaliChak	2 No. Gopal Colony/12	84651
207	P-B Area	GopaliChak	3 No. Bastee/KK Sec/O4	8372
208	P-B Area	GopaliChak	Marine Colony-1/O1	57874
209	P-B Area	GopaliChak	Marine Colony-2/O2	12093
210	P-B Area	GopaliChak	Sudamdih colony/08	46139
211	P-B Area	Hydro-mining	BC Plant/O7	45440
212	P-B Area	Hydro-mining	Krishna Nagar/O6	9600
213	P-B Area	Hydro-mining	Oranga Patti Birsa Nagar/02	4230
214	P-B Area	Hydro-mining	Station Dhowra/O1	3900
215	P-B Area	Kenduadih	4 Pit Ghansadih Colliery Qtrs./20	11100
216	P-B Area	Kenduadih	Ghansadih/14	46150
217	P-B Area	Kenduadih	Gwala Basti & Kali Mandir/15	4925
218	P-B Area	Kenduadih	Khoira ColonyO/1	51400
219	P-B Area	Kenduadih	Nimtala/11	37700
220	P-B Area	Kenduadih	No:5 Dhowra Bastee/13	40250
221	P-B Area	Pootkee	13 No. Bastee/O2	62156
222	P-B Area	Pootkee	17 No. 10 No. & Gwala Bastee/O1	116370
223	P-B Area	Pootkee	2 No. & JMBH/O3	79628
224	P-B Area	Pootkee	Bowri Basti/O9	110576
225	P-B Area	Pootkee	Prem Nagar/O5	130060
226	P-B Area	Pootkee	Sri Nagar Colony/O7	111696
227	Sijua	Bansdeopur	15 No. Dhowrah/13	1000
228	Sijua	Bansdeopur	4 No. colony/O4	3000
229	Sijua	Bansdeopur	40 No. Dhowra/10	10700
230	Sijua	Bansdeopur	7 No. BSP/O7	12000
231	Sijua	Bansdeopur	Bansudeopur Colliery/O6	6500
232	Sijua	Bansdeopur	New Colony /O3	5000
233	Sijua	Kankanee	5 Pit Area/O1	3500
234	Sijua	Kankanee	7 Pit Area/O3	40000
235	Sijua	Kankanee	Hanuman Nagar/O4	75000
236	Sijua	Kankanee	Loyabad Station/O5	5400
237	Sijua	Kankanee	Railway Quarters/O6	1500
238	Sijua	Kankanee	Sendra 7 Pit/O7	15000
239	Sijua	Loyabad	3 No. Area/O8	5000
240	Sijua	Loyabad	6 Pit Area/10	96000
241	Sijua	Loyabad	Central Hospital/O6	7500
242	Sijua	Loyabad	Coke Plant-1/14	26000
243	Sijua	Loyabad	Coke Plant-2/15	38400
244	Sijua	Loyabad	Idgeh Area/12	12300
245	Sijua	Loyabad	Kankanee Basti/O5	22000
246	Sijua	Loyabad	Madanadih/O3	5000

247	Sijua	Loyabad	New Drift/16	56000
248	Sijua	Loyabad	Pootkee Barrier/19	17600
249	Sijua	Loyabad	Pootkee Colony/20	72000
250	Sijua	Loyabad	Power House-2/17	35000
251	Sijua	Mudidih	6/10 Colony/O2	3350
252	Sijua	Mudidih	22/12 Colony/O5	36900
253	Sijua	Mudidih	Jogta Upper/14	14100
254	Sijua	Mudidih	Kajra Bagan/10	6700
255	Sijua	Sendra Bansjora	10 No. Colony/O5	1000
256	Sijua	Sendra Bansjora	19 No. Colony/19	750
257	Sijua	Sendra Bansjora	21 No. Colony/21	625
258	Sijua	Sendra Bansjora	6 Pit Colony/O4	5110
259	Sijua	Sendra Bansjora	6 Pit Colony/O6	2160
260	Sijua	Sendra Bansjora	6 Pit colony/Past/O9	600
261	Sijua	Sendra Bansjora	Bansjora Village/16	4792
262	Sijua	Sendra Bansjora	OCP Office/O2	13200
263	Sijua	Sendra Bansjora	Office Colony/O6	4600
264	Sijua	Tetulmari	Beldari Bastee/ 11	3000
265	Sijua	Tetulmari	Chandore Bastee /O8	3000
266	Sijua	Tetulmari	Chandore West No.1/17	900
267	Sijua	Tetulmari	Chandore West No.2/18	675
268	Sijua	Tetulmari	Delshi Basti & BCCL Quarters/O1	95890
269	Sijua	Tetulmari	Hutments of RNS/15	2026
270	Sijua	Tetulmari	Malle Dhowrah/O5	16000
271	Sijua	Tetulmari	Naya More Basti/13	2400
272	Sijua	Tetulmari	Nimia Dhowra/O7	836
273	Sijua	Tetulmari	Pondlhdih Bastee/ 10	16200
274	Sijua	Tetulmari	Substation RNS/16	660
275	Sijua	Tetulmari	Workshop/O6	18000
276	W. Jharia	Bhatdih	Belakhnda & Bhatdih Bastee/O5	120400
277	W. Jharia	Bhatdih	Colliery Quarters/O4	400000
278	W. Jharia	Bhatdih	Tentulia & Balakhanda Bastee/O2	76400
279	W. Jharia	Bhurungia	Bhurungia Village/O1	309000
280	W. Jharia	Hantoodih	Hantoodih Village/O2	520600
281	W. Jharia	Lohapatti	Chhatatand/O5	31800
282	W. Jharia	Lohapatti	Jamdiha Bastee/O7	139600
283	W. Jharia	Lohapatti	Kashiatand/O2	64800
284	W. Jharia	Lohapatti	Lohapatti Bastee/O1	65200
285	W. Jharia	Moonidih	Baludih/Dobray Village/O2	386500
286	W. Jharia	Moonidih	Dhobani Bastee/O4	384600
287	W. Jharia	Moonidih	Jatudih Colony & Village/O1	264000
288	W. Jharia	Moonidih	Moonidih Basti/O5	244600
289	W. Jharia	Moonidih	Moonidih Colony/O3	828000
290	W. Jharia	Murulidih (closed)	Mohuda Bastee/O2	145600
291	W. Jharia	Murulidih (Closed)	Murulidih Colliery Qtrs./O3	308000
292	W. Jharia	Murulidih 20/21 Pit	Bulbeazar/O5	76000
293	W. Jharia	Murulidih 20/21 Pit	Chitrutand Basti/O1	27700
294	W. Jharia	Pandugora	Lakhanpur/O2	59600
295	W. Jharia	Pandugora	Padugora/O1	24600
			Sub Total	13650508
Total (Phase-I & Phase-II)				**25695199**

7.10 Action Plan for Rehabilitation & Resettlement

Area wise, Colliery wise, site wise and phase wise no. of houses to be rehabilitated along with their land and indicative fund requirement has been shown in **Table no-7.**

7.11 Pre-Implementation Activities:

Before commencement of actual implementation of resettlement, the following activities are to be completed.

i. Demographic Survey of affected population with details of houses and land including valuation

ii. Identification & Acquisition of land for Phase-I township

iii. Tendering and awarding of work for land survey and township planning

iv. Surveying of land

v. Township planning

vi. Tendering and award of work for construction of houses

The pre-implementation activities will be completed within 2 years period and the estimated cost is Rs. 163.79 . The detail of cost is given in **Table 8**

Table- 8

Fund requirement for Pre implementation Activities

Sl. no	Activities	1st year	2nd year	Total (Rs. Crs)
1	Socio – Economic survey, Valustion survey and other survey for Non-BCCL houses.	0.70	0.71	1.41
2	Land acquisition BCCL & Non BCCL houses for Phase-I (860 ha)	69.42	69.41	138.83
4	Contingency (3%) & supervision charges (5%) for land acquisition	5.55	5.56	11.11
3	Township planning and preparation of Rehabilitation scheme for Phase -I	6.22	6.22	12.44
	Total	**81.89**	**81.90**	**163.79**

7.12 Identification of Resettlement sites & their description:

Total 79159 Nos. of affected houses are proposed to be resettled in Satellite Township with all basic amenities and infra -structural facilities in non-coal bearing areas along the fringe of JCF. In each township, about 6000houses for BCCL and 12500 houses for Non BCCL are proposed to be constructed in different sector. The resettlement sites will be selected

preferably where Govt. land/BCCL land is available. Tentative resettlement mouzas are as follows:

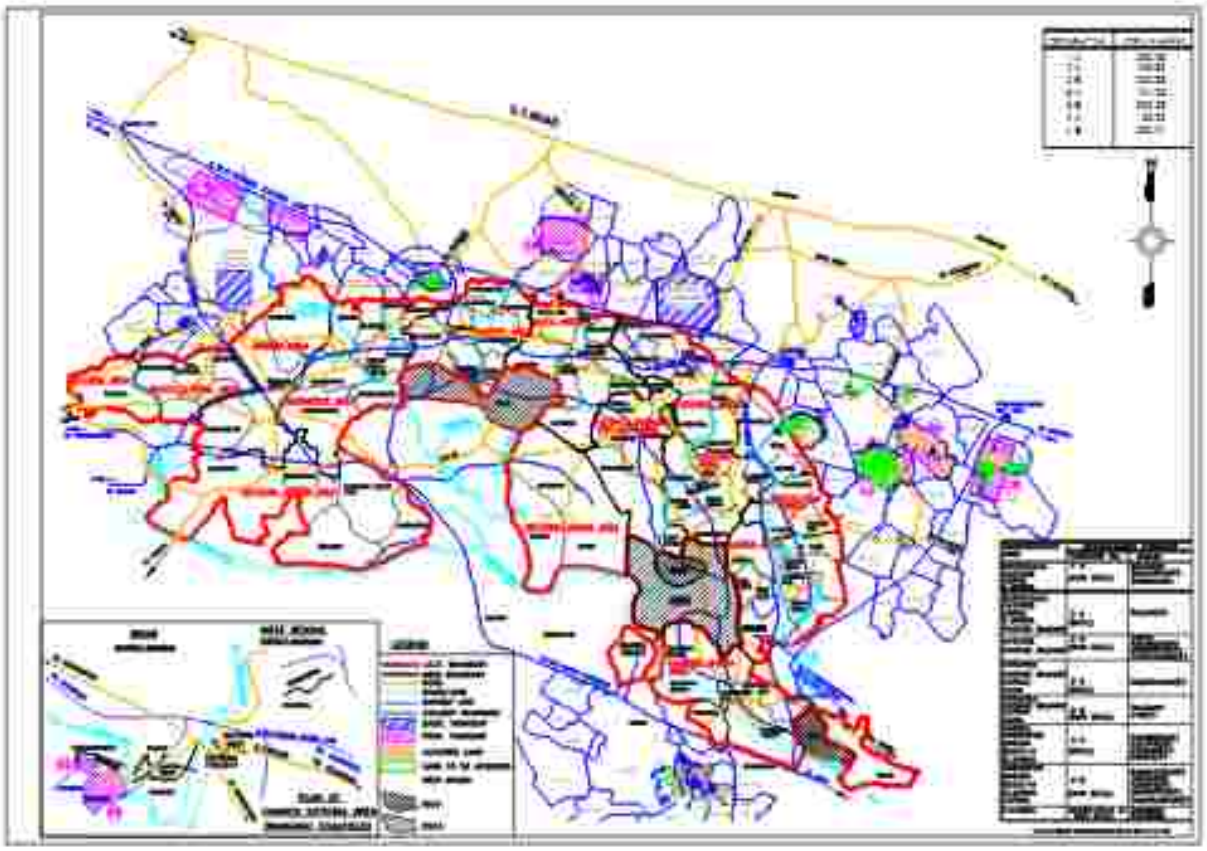
- Belgoira, Amagarha, Shabaigara, Palani, Sapta, Fakiradih, Manoharpur, Nagarikalan, Tilatanr, Pokrabara, Kolipur, Pochari, Darida, Barrakunda, Mahanpur, Dahibari, Pathbari etc.

Resettlement sites should be finalised based on the availability of land during implementation of the project. The tentative satellite townships are shown in Drg. no 4. These sites are tentative and actual location can be decided only after availability of land is finalized by State Govt.

7.13 Location wise shifting from rehabilitation site to Resettlement Sites

Table- 9

Administrative Areas	Resettlement Township	
	Township no	Mouzas
BASTACOLA KUSTORE LODNA E.JHARIA	1A (NON BCCL)	BELGORIA AMAGARHA(P) SABAIGARA
BASTACOLA KUSTORE LODNA E.JHARIA POOTKEE BALIHARI	2A (BCCL)	PALANI (P)
KUSTORE POOTKEE BALIHARI	2B (NON BCCL)	SAPTA FAKIRADIH (P) MOHANPUR (P) CHATKATANR (P)
KUSUNDA POOTKEE BALIHARI KATRAS SIJUA	3A (BCCL)	NAGRIKALAN(P)
KUSUNDA POOTKEE BALIHARI KATRAS SIJUA	3B (NON-BCCL)	TILATANR 216 (P)
KATRAS GOVINDPUR BARORA BLOCK-II W. JHARIA	4A (BCCL)	POKRSERA(P) KOLIPUR(P) POCHARI(P) DARIDA(P)
KATRAS GOVINDPUR BARORA BLOCK-II W. JHARIA	4B (NON-BCCL)	BAMAKUNDA(P) JURSABAD KHARYA(P) MAHANPUR(P) DAMODARPUR(P)
C.V. AREA	5A & 5B (BCCL & NON-BCCL)	DAHIBARI PATHBARI



7.14 Organisation:

It is proposed that rehabilitation & resettlement of BCCL houses will be the responsibility of BCCL whereas the same for Non BCCL houses including the encroachers will be the responsibility of concerned State Govt.

For rehabilitation of BCCL houses, it is proposed to have a separate R&R division headed by an official of Chief General Manager rank at Company HQ The responsibility of the R&R division at Company (HQ) level would be as under

- Identification & Acquisition of land in association with state govt. and surveying for the BCCL houses
- Preparation of tender documents, tendering and award of work for surveying of land and township planning.
- Preparation of town ship plans through external agencies and approval of cost estimates of townships
- Arrangement and disbursement of fund to different implementing agencies
- Monitoring and supervision of various works under implementation

For rehabilitation of Non-BCCL houses (Pvt. & Encroachers), it is proposed that a suitable organisational set up be formed by State Govt. for implementation of rehabilitation plan under the Master Plan

7.15 Indicative Fund Requirement for Rehabilitation Projects:

Total fund requirement for rehabilitation Projects has been estimated at Rs 5297.07 Crs. including fund for pre implementation activities. This also includes 3% contingency and 5% supervision charges. The supervision charges will cover the expenditure (Revenue, furniture & fittings, vehicle, office equipment etc) of separate organization at BCCL and state Govt.

Rehabilitation project is proposed to be implemented in 12 years time (including 2 years of pre-implementation activities). During this period further sites may become endangered which shall be rehabilitated with same R&R package as proposed in the Master Plan. This may require additional fund.

The year wise capital requirement has been shown in **Table -10**

TABLE -10

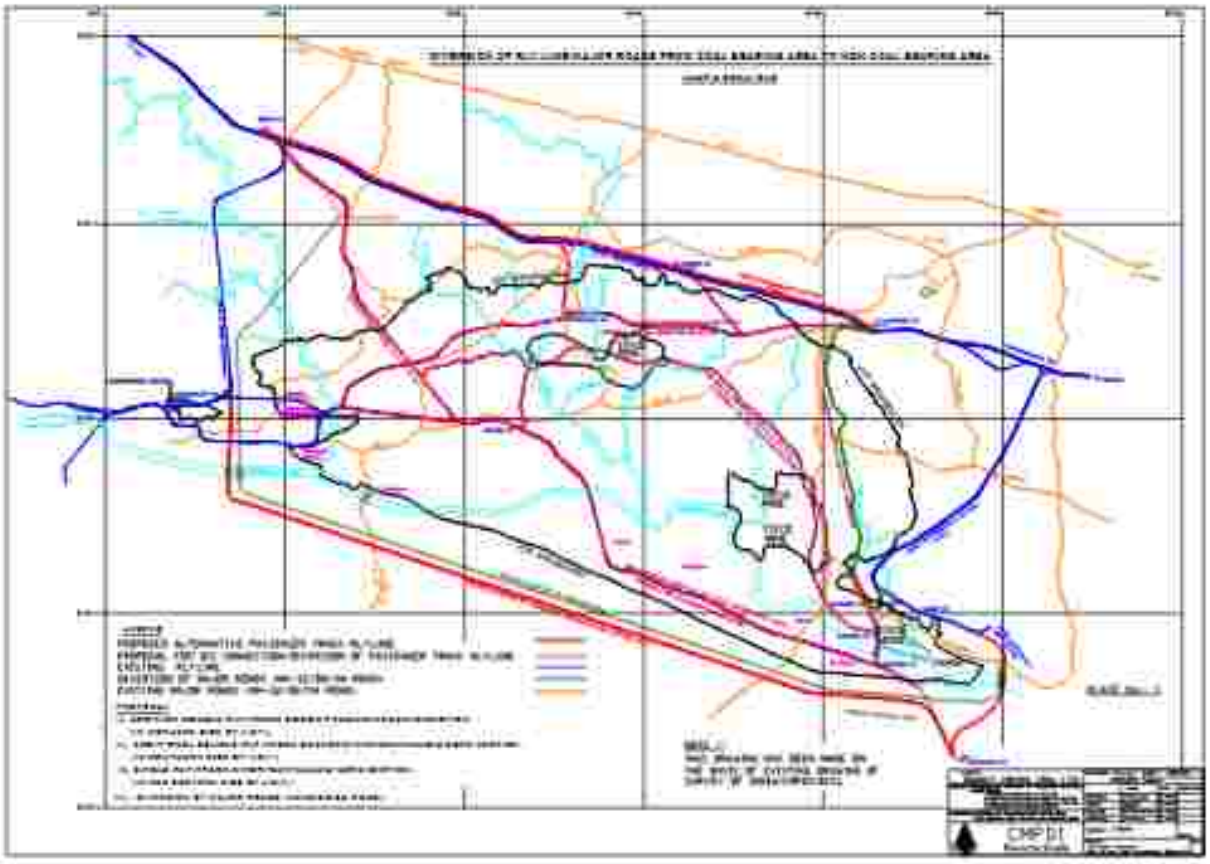
YEAR-WISE INDICATIVE CAPITAL REQUIREMENT FOR REHABILITATION

PHASE	YEAR	INDICATIVE FUND (Rs.Crs)
A) Pre-implementation Phase		
	1st	81.89
	2nd	81.90
Total Pre-Implementation Phase		**163.79**
Implementation Phase		
Phase-I	3rd	448.66
	4th	509.75
	5th	509.75
	6th	515.05
	7th	515.05
B) Sub Total Phase-I		**2498.26**
Phase-II	8th	423.71
	9th	423.71
	10th	423.71
	11th	423.71
	12th	423.71
C) Sub Total Phase-II		**2118.55**
Grand total (A+B+C)		**4780.60**

Phase wise Fund requirement for BCCL and Non BCCL Houses (Rs. Crs)

A) Pre Implementation Activities	
BCCL houses	34.75
Non BCCL houses	129.04
Sub Total (A)	**163.79**
B) Phase-I	
BCCL houses	478.95
Non BCCL houses	2019.32
Sub Total (B)	**2498.27**
C) Phase-II	
BCCL houses	554.75
Non BCCL houses	1563.80
Sub Total (C)	**2118.55**
Grand Total (A+B+C)	**4780.60**
BCCL houses (A+B+C)	1068.45
Non BCCL houses (A+B+C)	3712.15

DIVERSION OF RAILS AND MAJOR ROADS



8.1 Introduction

"BCCL vide letter no. GM(Env)/F-/06/238, dated 22nd April 2006, suggested that diversion of railway lines and NH 32 road passing through coal bearing areas of JCF should also be included in the Master Plan 2006.

The Master Plan envisages dealing with fire, subsidence and rehabilitation in the unstable in-habitated areas only in the leasehold of BCCL. However protection measures against fire affecting the rail and jores have been considered under dealing with fire in this Master Plan.

Diversion of rails and roads passing over the coal bearing areas are affected by fire and subsidence at many places and may further be affected. As the diversion will affect the operation of other coal producing companies like TISCO & SAIL, in addition to other industries operating in the coalfield, private parties, State Govt. and Railway, a joint decision should be taken involving all the above stake holders.

8.2 Brief of Railway lines and Roads proposed for diversion

A number of rail heads passes through JCF. Some of the rail heads are affected by fire at different locations. A brief account of rail heads affected/likely to be by fire in BCCL is as under.

- **Adra- Santhaldih-Bhaga-Gomoh Rly. Line (S.E Rly)**

The above Rly line is affected by active surface & underground fire of Patherdih, Sudamdih and Bhowra collieries between Sudamdih station and Bhowra halt. It is also affected by active fire of Phularitand and Block-II OCP between Kharkharee and Khanoodih station.

XVI seam fire of Pootkee/Gopalichauk Colliery exists on the south side of the above railway line which may affect the line in future.

- **Patherdih-Bhojudih Link Line (S.E Rly) between Patherdih and Sudamdih Stations** (Part of Dhanbad - Patherdih Railway line)

The east ward advance of XIVA/XIV seam fire in the old abandoned quarry of Patherdih Colliery mal affect the line in future.

- **Dhanbad-Chandrapura (DC) Rly line (S.E Rly)**

Dhanbad Chandrapura is likely to be affected by fires of Bassuria and sendra Bansjora collieries in future.

☐Dhanbad-Kusunda-Tetulmari link line (S.E Rly)

The above link line is already affected by fire of East Bassuria colliery and it is likely to be affected by the fires of Bassuria Colliery.

ROAD :

National Highway-32 passing over the coal bearing areas of JCF is affected due to fire of Kenduadih colliery between Kedua and Kirkend and District Board road passing from Jharia to Kendua is endangered due to fire of Alkusa colliery near Kendua Police Station.

8.3 Proposal

The diversion of rail and road requires accurate survey of the alternative routes, assessment of alternative railway sidings will be affected due to diversion, quantification of benefits, detail layout planning for diversion by expert agencies like RITES. The above activities are likely to take about two years time.

Therefore, in this Master Plan, a lump sum provision of Rs. 20.00 Crs as advance action has been kept for surveying and planning only. The detail proposal for diversion may be taken up as a separate Master Plan in future.

9.0 Total Indicative fund requirement for Master Plan

The total indicative capital required to implement the Master Plan, for Dealing with Fires, Subsidence Control of Inhabitated Areas and Rehabilitation of unstable-Uncontrollable subsidence –prone Inhabitated areas is estimated at **Rs. 7112.11** Crores. Year-wise requirement of funds for each type of jobs is shown in **Table –11**

TABLE – 11

YEAR-WISE CAPITAL REQUIREMENT FOR MASTER PLAN

Rs. In Crs.

Phase	Year	Fire Projects	Rehab. Projects	Diversion of Rail/road	Total
Pre-implementation					
	1st	2.69	81.89	10.00	94.58
	2nd	2.24	81.90	10.00	94.14
Sub-total		**4.93**	**163.79**	**20.00**	**188.72**
Implementation period					
Phase -I	3rd	191.52	448.66		640.18
	4th	211.51	509.75		721.26
	5th	267.76	509.75		777.51
	6th	216.36	515.05		731.41
	7th	214.04	515.05		729.09
Sub Total Phase I		**1101.19**	**2498.26**		**3599.45**
Phase-II	8th	262.68	423.71		686.39
	9th	259.11	423.71		682.82
	10th	250.67	423.71		674.38
	11th	252.43	423.71		676.14
	12th	180.50	423.71		604.21
Sub Total Phase -II		**1205.38**	**2118.55**		**3323.45**
Grand Total		**2311.50**	**4780.60**	**20.00**	**7112.11**

10.0 SOURCE OF FUNDING

Committee of Secretaries in its meeting held on 18.03.03 in the committee room of the cabinet secretariat, Rashtrapati Bhawan, New Delhi directed that the Ministry of Coal would examine the extent to which funds could be mobilized by (a) enhancing the cess on coal, and (b) utilising a portion of the profits of BCCL and ECL. Any shortfall would be made good by suitably enhancing the Plan allocation.

Accordingly the following funding arrangement for implementation of Master Plan has been decided by Ministry of Coal

SL. No.	Source	Amount in Rs. Crores / Annum
1	The Coal Cess (CCDA) i.e. Stowing Excise Duty has been increased to Rs. 10/- tonne	120
2	CIL fund as Rs. 6/ tonne	165
3	EMSC provision	30
4	Unspent fund lying with MOC @ Rs. 80.00 Crs. per year for 5 years.	80
	TOTAL	**395**

The above fund of Rs. 395 Crs / year was adequate to implement the activities under Master Plan for a period of 20 years for ECL & BCCL. After considering the recommendations of MOC and Planning Commission by reducing the time period from 20 years to 10 years (excluding 2 years of Pre-Implementation), the corresponding yearly fund requirement for BCCL only would vary from Rs 604.21 Crs to Rs. 777.71 Crs as total fund requirement has been estimated at Rs. 7112.11 Crs.

Accordingly, MOC may take necessary steps to enhance the availability of fund to meet the requirements both for ECL and BCCL for completion of all activities under this Master Plan.

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

(FOR THE MONTH FEBRUARY, 2024)

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 23º46' 29.00'' N 86º 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 23º45'24.48'' N 086º11'59.44''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 23º44'29.42'' N & 86º16'49.96'' E. The sampler was placed at a height of approx. 1.5m above ground level at Safety Office.

ii) Sadariadih (A43): Residential Area

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

ii) Panruabhitha (A44): Residential Area

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

AMBIENT AIR QUALITY DATA

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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	**02/2024**	**Cluster**	**Cluster XV**			**ULR No.**	**TC1012224000000591F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.03.2024**
Project	**Kharkharee CISf Office**		**Sample Ref. No.**	**REM/BCCL/2024/02**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**	
Date of Sampling	05.02.2024		21.02.2024	**Period of Analysis**	05.02.2024 – 15.03.2024	**Zone of Station:**	**Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			1st FN	**2nd FN**				
1	PM_{10}	IS-5182(Part 23):2006, R-2017	89	108	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS5182(Part 24):2019	48	57	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182(Part-6): 2006 , R-2017	**21**	**20**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

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

ANALYSED BY | (Gaurav Kant) ***REVIEWED BY*** | (Amit Raj Mishra) ***HOD's Signature***

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TC-10122

Test Report for Ambient Air Samples

Month & Year	**02/2024**	**Cluster**	**Cluster XV**			**ULR No.**	**TC1012224000000591F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.03.2024**
Project	**Madhuband UGP Office**		**Sample Ref. No.**	**REM/BCCL/2024/02**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**	
Date of Sampling	06.02.2024		21.02.2024	**Period of Analysis**	06.02.2024 – 15.03.2024	**Zone of Station:**	**Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			1st FN	**2nd FN**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	84	69	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	42	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	**29**	**31**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

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

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
HOD's Signature

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Test Report for Ambient Air Samples

Month & Year	**02/2024**	**Cluster**	**Cluster XV**			**ULR No.**	**TC1012224000000591F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.03.2024**
Project	**Block IV Kooridih**		**Sample Ref. No.**	**REM/BCCL/2024/02**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**	
Date of Sampling	07.02.2024		19.02.2024	**Period of Analysis**	07.02.2024 – 15.03.2024	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			1st FN	**2nd FN**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	155	134	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	70	63	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	**28**	**24**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

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

ANALYSED BY | (Gaurav Kant) ***REVIEWED BY*** | (Amit Raj Mishra) ***HOD's Signature***

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Test Report for Ambient Air Samples

Month & Year	**02/2024**	**Cluster**	**Cluster XV**			**ULR No.**	**TC1012224000000591F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.03.2024**
Project	**Lohapatti**		**Sample Ref. No.**	**REM/BCCL/2024/02**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**	
Date of Sampling	06.02.2024		24.02.2024	**Period of Analysis**	06.02.2024 – 15.03.2024	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			1st FN	**2nd FN**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	91	87	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	44	39	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	**32**	**38**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

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

ANALYSED BY	(Gaurav Kant) ***REVIEWED BY***	(Amit Raj Mishra) ***HOD's Signature***

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Test Report for Ambient Air Samples

Month & Year	**02/2024**	**Cluster**	**Cluster XV**			**ULR No.**	**TC1012224000000591F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.03.2024**
Project	**Sadariadih**		**Sample Ref. No.**	**REM/BCCL/2024/02**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**	
Date of Sampling	14.02.2024		27.02.2024	**Period of Analysis**	14.02.2024 – 15.03.2024	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			1st FN	**2nd FN**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	84	74	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	42	37	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	**20**	**18**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

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

,

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
HOD's Signature

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Test Report for Ambient Air Samples

Month & Year	**02/2024**	**Cluster**	**Cluster XV**			**ULR No.**	**TC1012224000000591F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.03.2024**
Project	**Panduabhitha**		**Sample Ref. No.**	**REM/BCCL/2024/02**	**Sampling Method**	**CMPDI/RI-II/LPM 11 , (IS 5182)**	
Date of Sampling	13.02.2024		26.02.2024	**Period of Analysis**	13.02.2024 – 15.03.2024	**Zone of Station:**	**Buffer Zone**

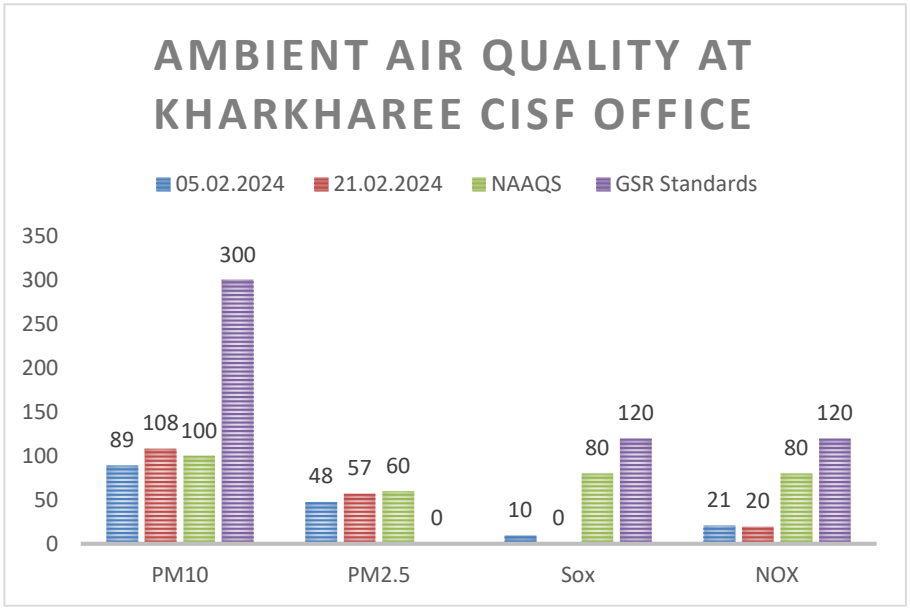
Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			1st FN	**2nd FN**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	66	93	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	33	45	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	**15**	**24**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

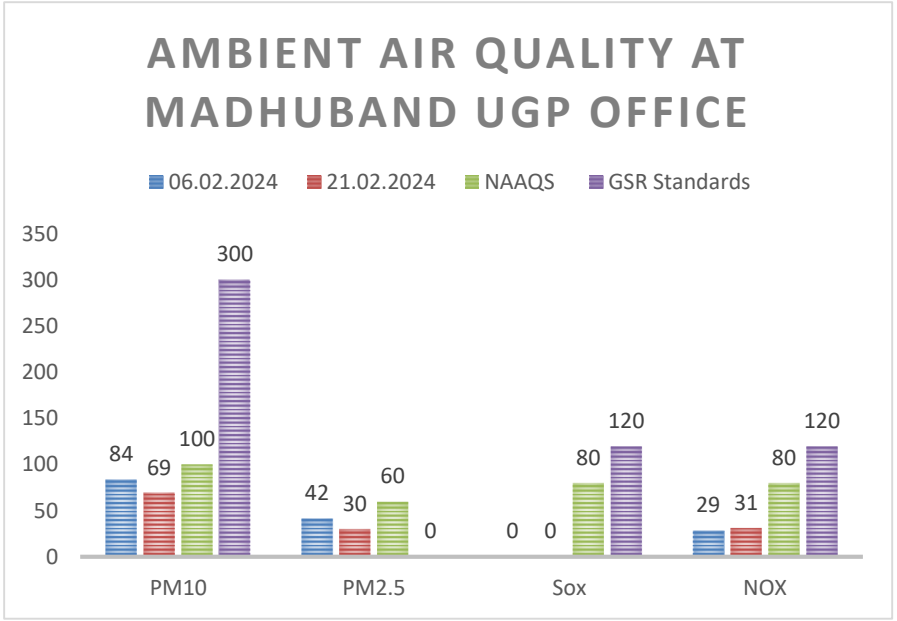
***All units are in µg/m3, 24 hourly Average * LDL indicates Lower Detection Limit,*

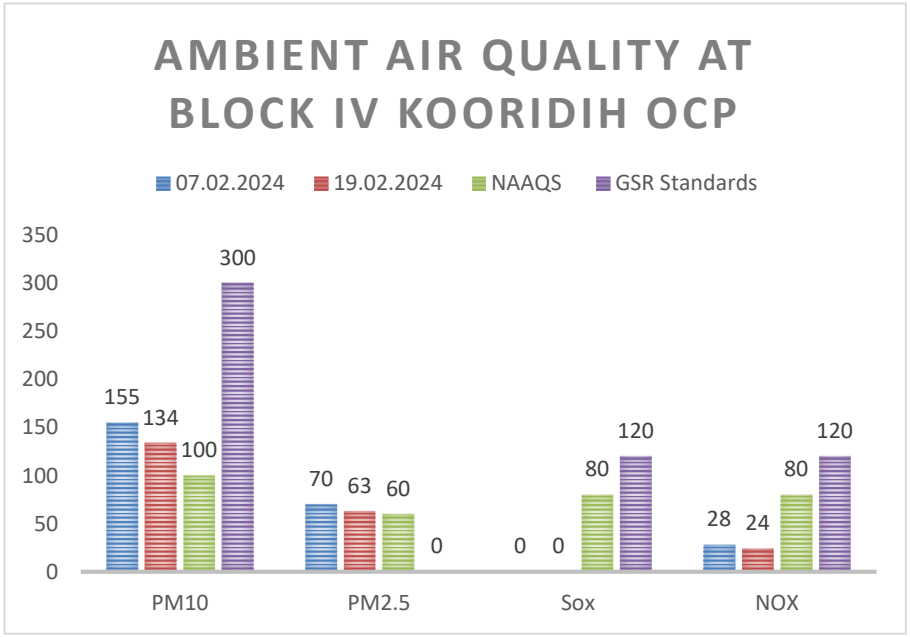
ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Amit Raj Mishra) ***HOD's Signature***

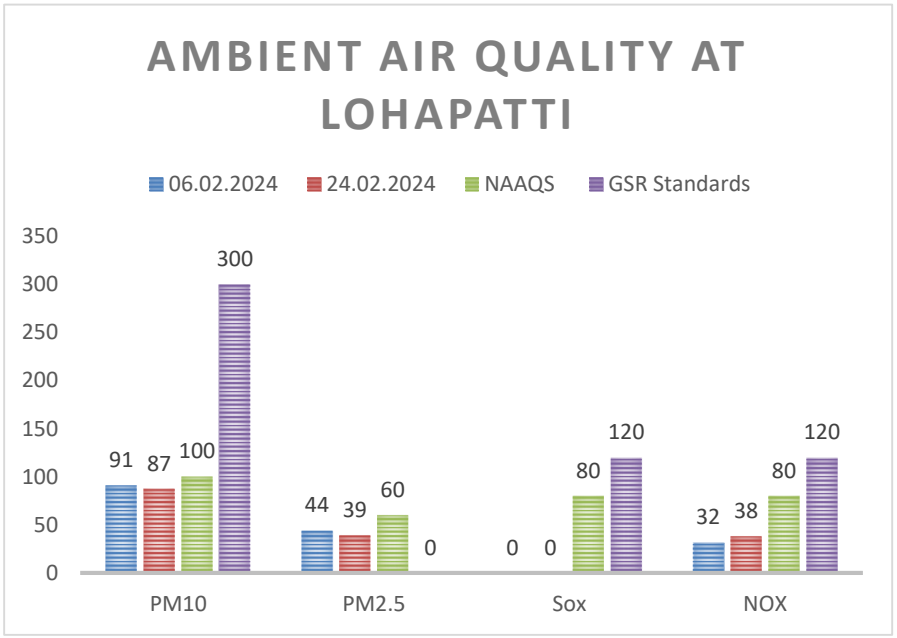
***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

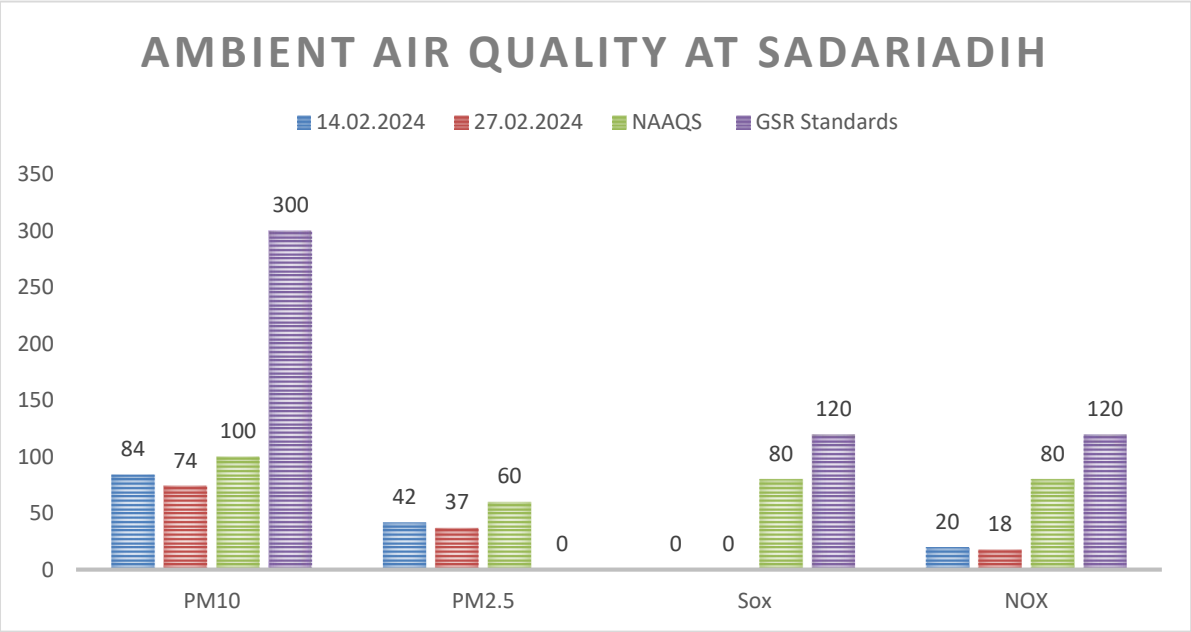
---- End of Report ----

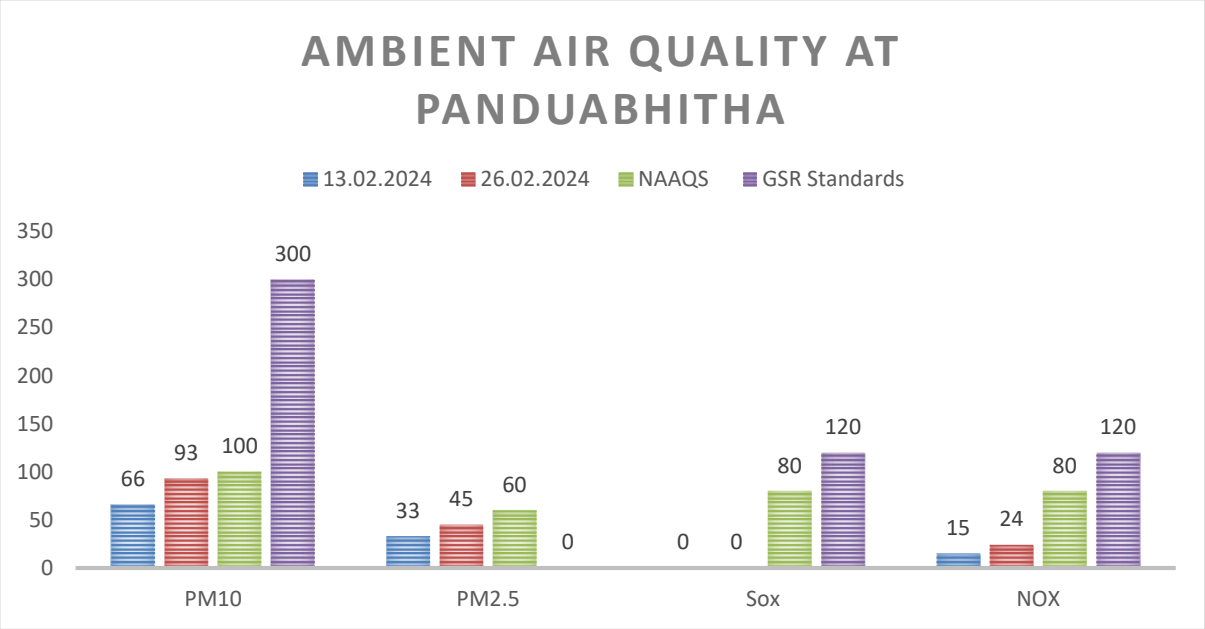

AMBIENT AIR QUALITY AT KHARKHAREE CISF OFFICE
05.02.2024
21.02.2024
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
89
108
100
300
48
57
60
0
10
0
80
120
21
20
80
120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MADHUBAND UGP OFFICE
06.02.2024
21.02.2024
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
84
69
100
300
42
30
60
0
0
0
80
120
29
31
80
120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH OCP
07.02.2024
19.02.2024
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
155
134
100
300
70
63
60
0
0
0
80
120
28
24
80
120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT LOHAPATTI
06.02.2024
24.02.2024
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
91
87
100
300
44
39
60
0
0
0
80
120
32
38
80
120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT SADARIADIH
14.02.2024
27.02.2024
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
84
74
100
300
42
37
60
0
0
0
80
120
20
18
80
120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT PANDUABHITHA
13.02.2024
26.02.2024
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
66
93
100
300
33
45
60
0
0
0
80
120
15
24
80
120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) **Mine Discharge of Kharkharee UGP (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

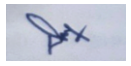
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Test Report for Mine Effluent samples

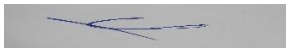
Month & Year	**02/2024**	**Cluster**	**Cluster XV**	**ULR No.**	**TC1012224000000608F**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**				**Date of Issue**	**30.03.2024**
Project		**Sampling Ref. No.**	**REM/BCCL/2024/02**	**Sampling Method**	**IS 3025 (Part-1) CMPDI/RI-II/LPM 13**	
Sampling Stations	**(i)**	**Kharkharee UGP**	**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**		**Period of Analysis**	**04.02.2024 TO 29.02.2024**
			Date of Sampling	*12.02.2024* *26.02.2024*		

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
			First Fortnight	Second Fortnight		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	37	39	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.77	7.79	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<2.0	<2.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	36	32	*250 (Max)*	4

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




ANALYSED BY



(Kumar Vaibhav)
REVIEWED BY



(Amit Raj Mishra)
HOD's Signature

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

---- End of Report ----

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)**

iv) **Lohapatti (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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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

Month & Year	**02/2024**	**Cluster**	**Cluster XV**	**ULR No.**	**TC1012224000000625F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.03.2024**
Project		**Sample Ref. No.**	**REM/BCCL/2024/02**	**Sampling Method**	**CMPDI/RI-II/LPM 22**
Sampling Stations	**i**	**Kharkharee UGP**	**Date of Sampling**	05.02.2024 – 21.02.2024	**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	45.1	46	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	61	60.9					
3		08:00 - 09:00	72.5	72.7					
4		09:00 – 10:00	72.4	72.1					
5		10:00 - 11:00	68.6	67.4					
6		11:00 - 12:00	65.7	65.2					
7		12:00 - 13:00	63.1	64.2					
8		13:00 - 14:00	61.5	60.8					
9		14:00 - 15:00	59.2	58.4					
10		15:00 - 16:00	57.6	57.9					
11		16:00 - 17:00	57.9	58.5					
12		17:00 - 18:00	57.7	58.2					
13		18:00 - 19:00	55	55					
14		19:00 - 20:00	53.2	53.3					
15		20:00 - 21:00	51.2	51.4					
16		21:00 - 22:00	50.5	50.9					
		Leq Day	65.3	65.1					
1	Noise Level dB(A)Leq -Night	22:00-23:00	47.1	44.8	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	44.3	44.7					
3		00:00- 01:00	44.4	44.7					
4		01.00-02.00	42.6	43.8					
5		02.00-03.00	42.2	39					
6		03.00-04.00	41.7	43.1					
7		04.00-05.00	41.5	40.3					
8		05:00-06:00	40.1	38					
		Leq Day	43.5	43.0					

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

Sampling Assistants		(Gaurav Kant)			(Amit Raj Mishra)
	ANALYSED BY		***REVIEWED BY***		***HOD's Signature***

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

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX

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

Month & Year	**02/2024**	**Cluster**	**Cluster XV**			**ULR No.**	**TC1012224000000625F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.03.2024**
Project		**Sample Ref. No.**	**REM/BCCL/2024/02**		**Sampling Method**	**CMPDI/RI-II/LPM 22**	
Sampling Stations	**i**	**Madhuband UGP Office**	**Date of Sampling**	06.02.2024	21.02.2024	**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	42.4	43	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	45.2	44.5					
3		08:00 - 09:00	48.6	49					
4		09:00 – 10:00	49.8	49.6					
5		10:00 - 11:00	49.6	49.7					
6		11:00 - 12:00	49.3	49					
7		12:00 - 13:00	50.3	49.9					
8		13:00 - 14:00	53.7	57.5					
9		14:00 - 15:00	55	55					
10		15:00 - 16:00	55.6	52.1					
11		16:00 - 17:00	48.2	48.3					
12		17:00 - 18:00	47.1	47					
13		18:00 - 19:00	46.6	46.5					
14		19:00 - 20:00	46.4	46					
15		20:00 - 21:00	46.2	45.5					
16		21:00 - 22:00	44.9	45.1					
		Leq Day	50.3	50.5					
1	Noise Level dB(A)Leq -Night	22:00-23:00	43.5	44	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	43.4	44.1					
3		00:00- 01:00	43.3	43.4					
4		01.00-02.00	42.6	43					
5		02.00-03.00	42.2	42.8					
6		03.00-04.00	43.7	44					
7		04.00-05.00	44	44.2					
8		05:00-06:00	44.3	44.1					
		Leq Day	43.4	43.7					

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

Sampling Assistants		(Gaurav Kant)			(Amit Raj Mishra)
	ANALYSED BY	***REVIEWED BY***			***HOD's Signature***

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

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

Month & Year	02/2024	Cluster	Cluster XV				ULR No.	TC1012224000000625F
Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)						Date of Issue	30.03.2024
Project		Sample Ref. No.	REM/BCCL/2024/02		Sampling Method		CMPDI/RI-II/LPM 22	
Sampling Stations	i	Block IV Kooridih OCP	Date of Sampling	07.02.2024	19.02.2024	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	56.4	55	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	60.7	59.6					
3		08:00 - 09:00	61.6	60.6					
4		09:00 – 10:00	65.2	64.4					
5		10:00 - 11:00	64.8	63.7					
6		11:00 - 12:00	66.1	65.5					
7		12:00 - 13:00	65.7	64.4					
8		13:00 - 14:00	66	66.7					
9		14:00 - 15:00	66.4	65.4					
10		15:00 - 16:00	69.5	67.6					
11		16:00 - 17:00	70.2	70					
12		17:00 - 18:00	71.1	70.9					
13		18:00 - 19:00	69.8	67.6					
14		19:00 - 20:00	69.4	68.6					
15		20:00 - 21:00	62.5	61.5					
16		21:00 - 22:00	55.3	53.7					
		Leq Day	66.9	66.1					
1	Noise Level dB(A)Leq -Night	22:00-23:00	53	51.6	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	52.2	49.9					
3		00:00- 01:00	50.4	49.3					
4		01.00-02.00	45.1	45.4					
5		02.00-03.00	44.7	44.9					
6		03.00-04.00	47.9	46.3					
7		04.00-05.00	46	45.3					
8		05:00-06:00	46.3	47.4					
		Leq Day	49.3	48.2					

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

Sampling Assistants	(Gaurav Kant)		(Amit Raj Mishra)
ANALYSED BY	***REVIEWED BY***		***HOD's Signature***

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---- End of Report ----

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

CMPDIL, RI-II
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email: rdri2cmpdi@coalindia.in

Month & Year	**02/2024**	**Cluster**	**Cluster XV**				**ULR No.**	**TC1012224000000625F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**						**Date of Issue**	**30.03.2024**
Project		**Sample Ref. No.**	**REM/BCCL/204/02**		**Sampling Method**		**CMPDI/RI-II/LPM 22**	
Sampling Stations	**i**	**Lohapatti**	**Date of Sampling**	06.02.2024	24.02.2024	**Zone Category of Station:**	**Buffer Zone**	

Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A)) First Fortnight**	**Observed Values (in Leq dB(A)) Second Fortnight**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones**	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	37.7	38.4	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	48.5	47.7					
3		08:00 - 09:00	43.2	48.2					
4		09:00 – 10:00	40.3	42.9					
5		10:00 - 11:00	43.2	44.6					
6		11:00 - 12:00	41.8	47					
7		12:00 - 13:00	42.9	45.5					
8		13:00 - 14:00	44.2	47.2					
9		14:00 - 15:00	43.6	44.9					
10		15:00 - 16:00	46.2	46.6					
11		16:00 - 17:00	46.3	46.4					
12		17:00 - 18:00	46.1	47.2					
13		18:00 - 19:00	46.1	47					
14		19:00 - 20:00	45.5	45.1					
15		20:00 - 21:00	45.4	45.2					
16		21:00 - 22:00	45.2	45.1					
		Leq Day	44.8	46.0					
1	Noise Level dB(A)Leq -Night	22:00-23:00	44.3	44.3	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	44.2	43.7					
3		00:00- 01:00	43.9	43.8					
4		01.00-02.00	43.5	44.4					
5		02.00-03.00	43.4	43.7					
6		03.00-04.00	43.3	43.4					
7		04.00-05.00	42.9	43.5					
8		05:00-06:00	43.7	44					
		Leq Day	43.7	43.9					

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

Sampling Assistants		(Gaurav Kant)			(Amit Raj Mishra)
	ANALYSED BY	***REVIEWED BY***			***HOD's Signature***

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

Category	Pollutant	Time weighted average	Concentration in Ambient Air	Method of Measurement
1	2	3	4	5
III Coal mines located in the coal fields of • Jharia • Raniganj • Bokaro	Suspended Particulate Matter (SPM)	Annual Average * 24 hours **	500 µg/m^3 700 µg/m^3	- High Volume Sampling (Average flow rate not less than 1.1
	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.

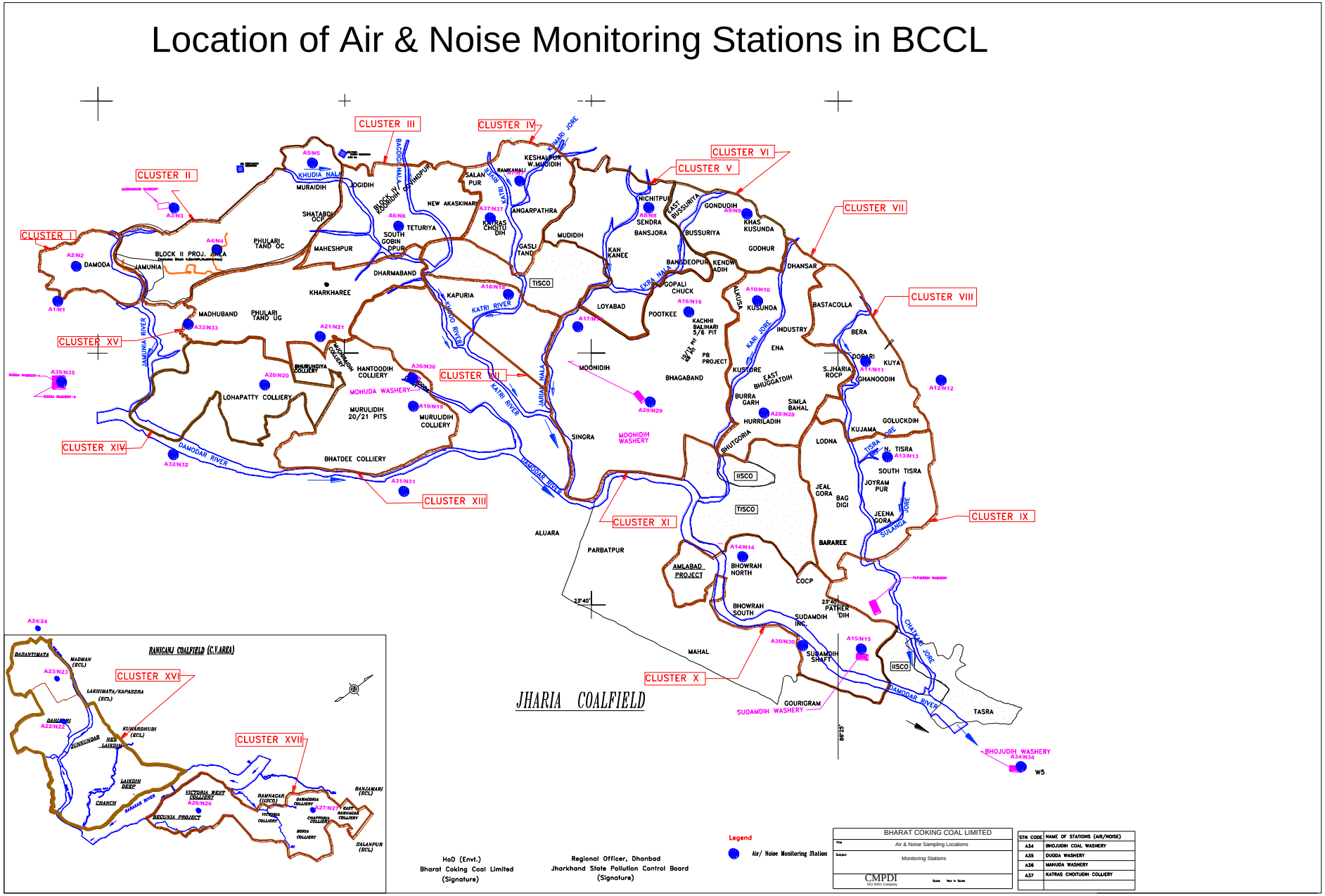
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet 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.

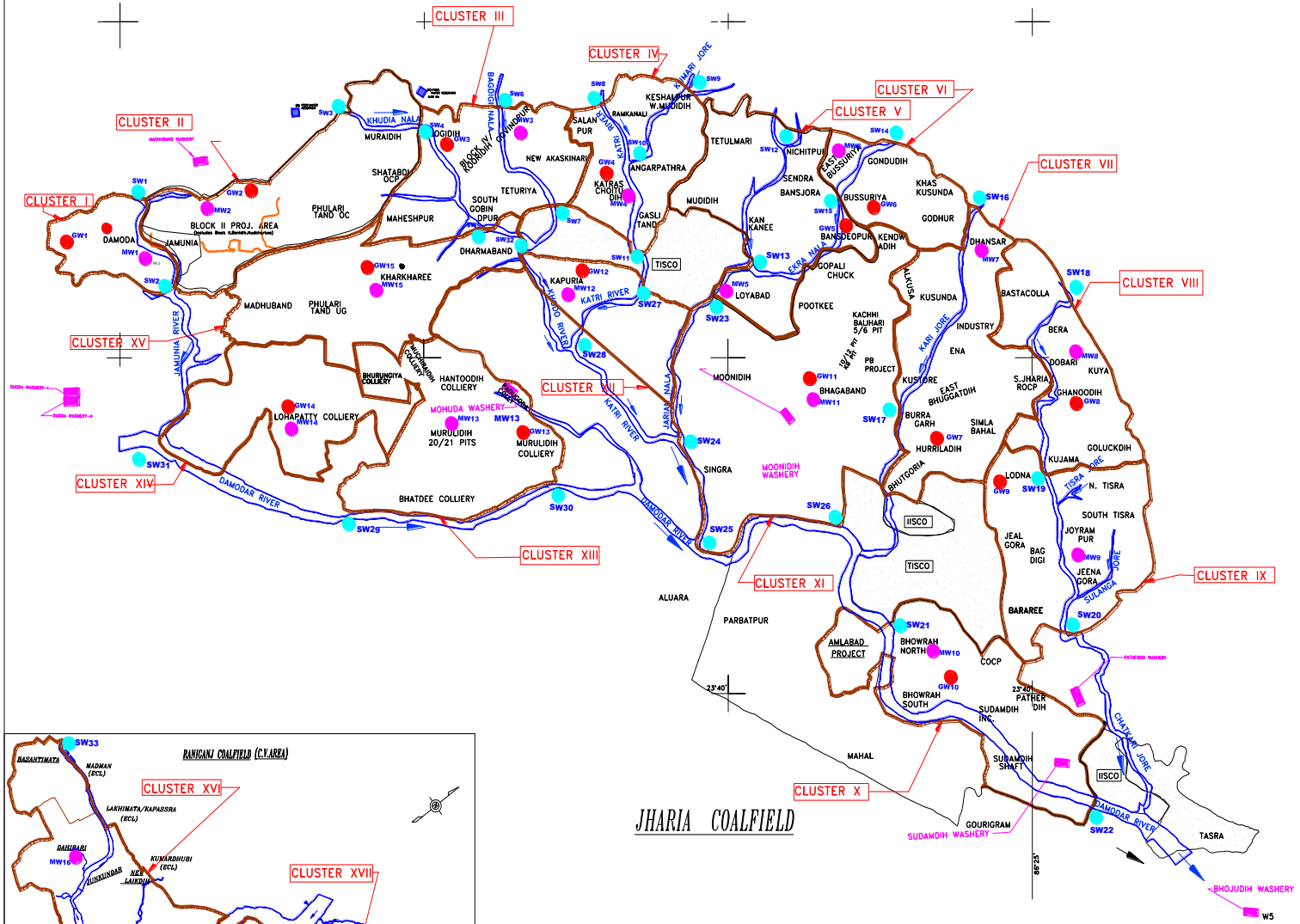
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they JUNE exceed the limits but not on two consecutive days of monitoring.

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

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

(FOR THE Q.E.MARCH 2024)

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. MAR 2024)

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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

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WATER QUALITY REPORT
OF
BHARAT COKING COAL LIMITED
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E. C. no. J-11015/100/2011-IA.II (M) dated 16.12.2013.

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ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

EXECUTIVE SUMMARY

1.0 Introduction

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

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$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.

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	**QUARTER ENDING MARCH 2024**	**Cluster**	**CLUSTERXV**	**ULR No.**	**TC1012224000000697P**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**20.05.2024**
Project	**Kharkharee**	**Sample Ref. No.**	**REM/BCCL/2023-24/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**GW15**	**Date of Sampling**	**12.02.2024**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**12.02.2024** **TO**	**26.03.2024**

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	58	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	90	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method,2023	0.55	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	76	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th Edition, UV-Spectrophotometric Method,2023	32.63	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	7.49	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th Edition, 4500 S , Turbidity Method,2023	156	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	355	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	818	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	457	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,*

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	**QUARTER ENDING MARCH 2024**	**Cluster**	**CLUSTER XV**	**Report No.**	**RI-2/GW/23-24/QE/04**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**20.05.2024**
Project	**Kharkharee**	**Sample Ref. No.**	**REM/BCCL/2023-24/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**GW15**	**Date of Sampling**	**12.02.2024**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**12.02.2024** **TO**	**26.03.2024**

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	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	0.20-10.0	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	0.10-10.0	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,2023	<0.005	0.10-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.19	0.10-10.0	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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SURFACE WATER ANALYSIS TEST REPORT

Month & Year	**QUARTER ENDI NG MAR 2024**	**Cluster**	**XVII**	**ULR No.**	TC10122240000 00731P TC10122240000 00734P
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**20.05.2024**
Project	**Sample Ref. No.**	REM/BCCL/2023-24/SW /	**Sampling Method**	**(IS 3025 , Part-1) CMPDI/RI-II/LPM 13**	
Sampling Stations	**(i) Downstream in khudia Nala(SW32)**	**Date of Sampling**	11.03.2024	**Period of Analysis**	
	(ii) Upstream in Barakar River(SW35)	**Date of Sampling**	11.03.2024	11.03.2024 TO 10.04.2024	

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	2.1	2.5	3	2.00-100.00	2
2	Colour,Hazen Units	APHA 24th Edition , 2120-B-:2023	3	4	10	1-500.0	1
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 Argentometric Method	111	32	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	5.3	6.1	4	1.0-10.0	0.1
6	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method,2023	0.42	0.64	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	3.61	9.09	50	0.5-45.0	0.5
10	pH value	IS 3025, (Part 11) : 1983 R-2023 Electrometric (Ph Meter) method	7.81	7.69	6.5-8.5	1.0-14.0	2
11	Sulphate, mg/l	APHA –24th Edition,4500- S, Turbidity Method,2023	49	32	400	10.0-400.0	10
12	Total Dissolved Solids, mg/l	IS 3025, (Part 16): 1984 R-2023 Gravimetric method	821	546	1500	25.0-10000.0	25
13	Zinc, mg/l	IS 3025(Part 49) : 1994, R : 2019, AAS-Flame Method	<0.1	0.12	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***

(Kumar Vaibhav)

(Amit Raj Mishra)

Analysed by ***REVIEWED BY*** ***AUTHORISED SIGNATORY***

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

C MPDIL, RI-II
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email: rdri2.cmpdi@coalindia.in

Month & Year	QUARTE ENDI NG MAR 2024	Cluster	XVII	Report No.	RI-2/SW/23-24/QE/04
Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)			Date of Issue	20.05.2024
Project	Sample Ref. No.	REM/BCCL/2023-24/SW /	Sampling Method	(IS 3025 , Part-1) CMPDI/RI-II/LPM 13	
Sampling Stations	(i) Downstream in khudia Nala(SW32)	Date of Sampling	11.03.2024	Period of Analysis	
	(ii) Upstream in Barakar River(SW35)	Date of Sampling	11.03.2024	11.03.2024 TO 10.04.2024	

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***

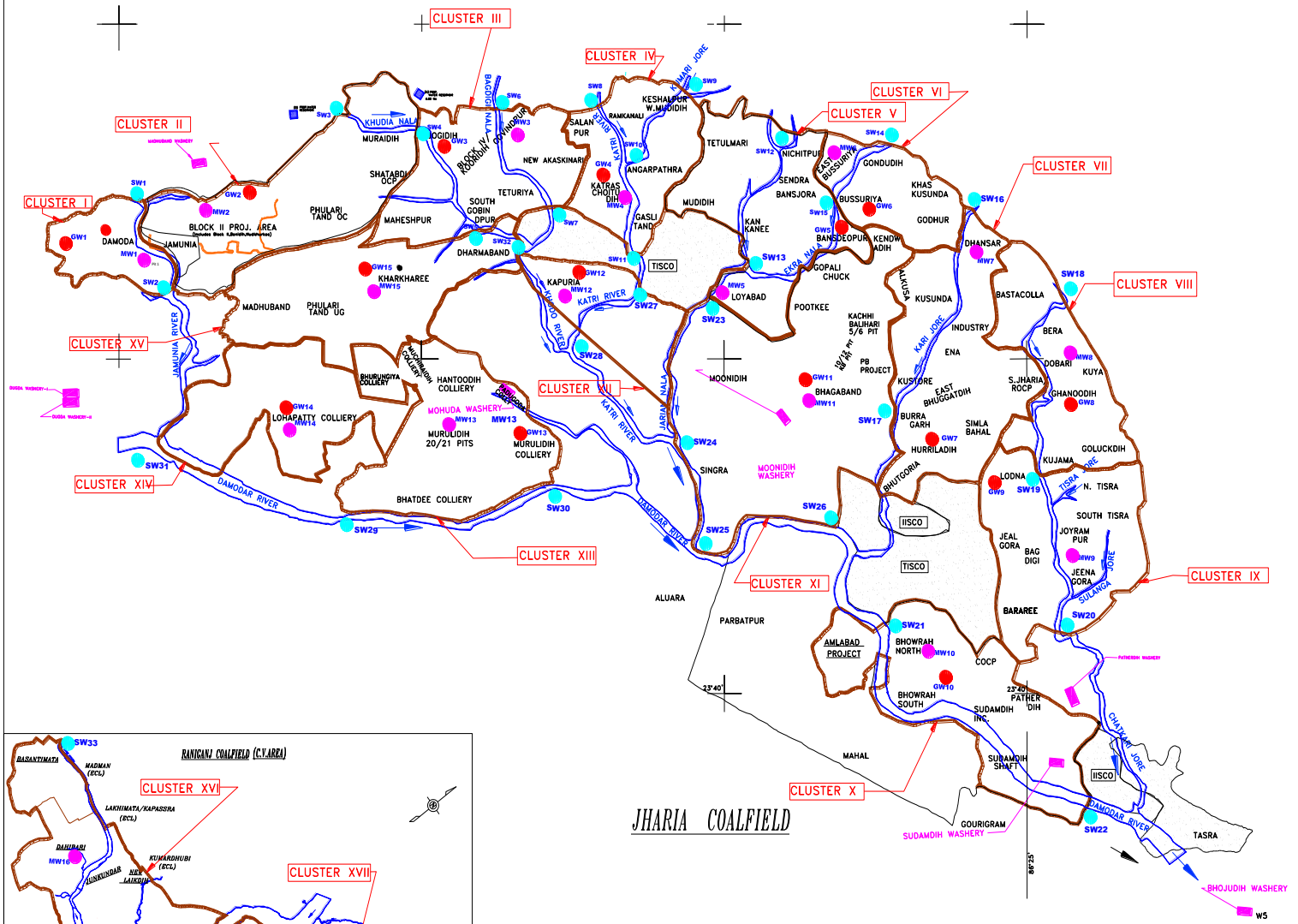
(Kumar Vaibhav) (Amit Raj Mishra)

Analysed by ***REVIEWED BY*** ***AUTHORISED SIGNATORY***

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

---- End of Report ----

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	Patlaban 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)

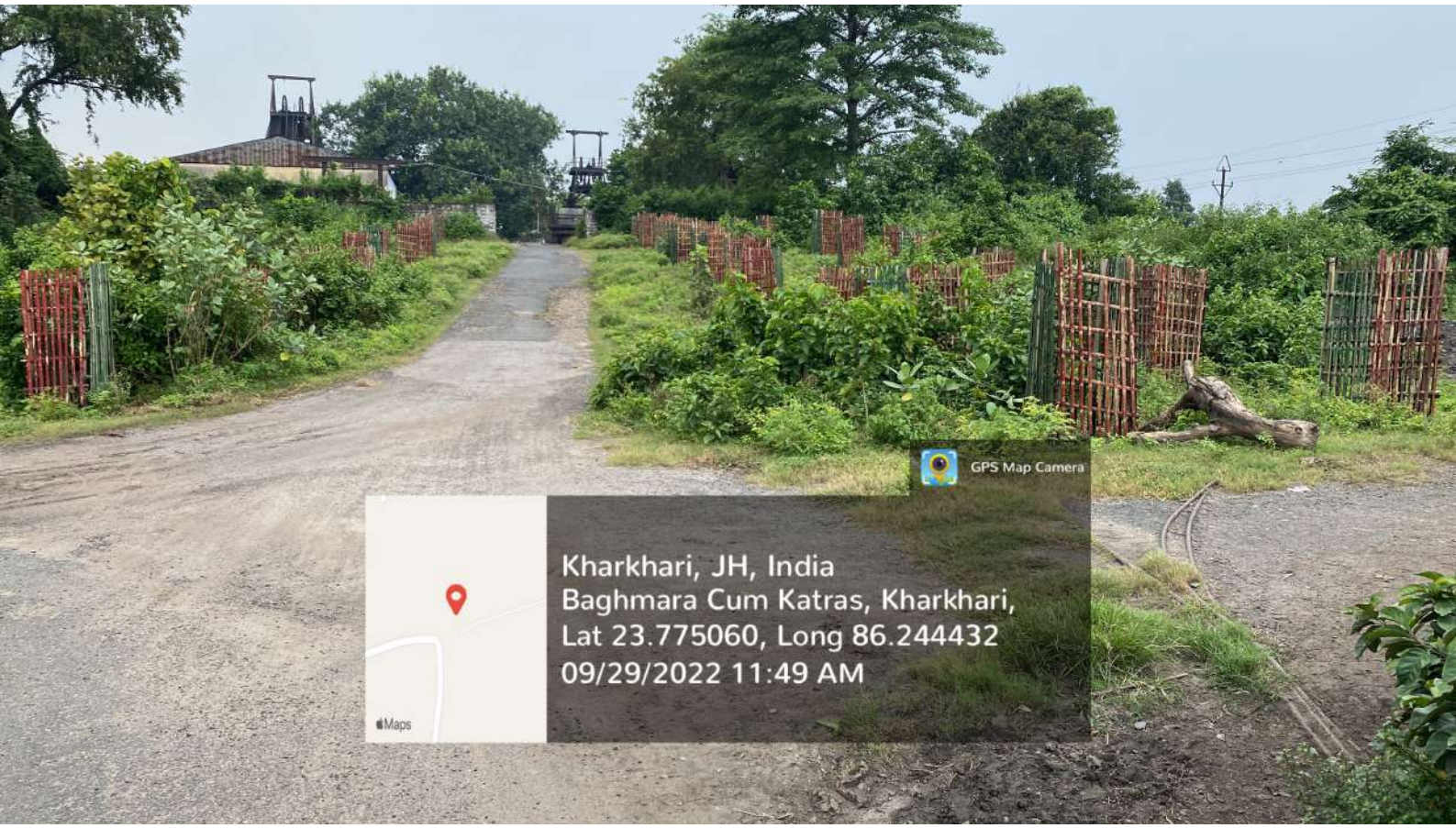
Legend
- Sampling Locations of Surface Water (Upstream/ Downstream)
- Sampling Locations of Mine Water
- Sampling Locations of Ground/ Drinking Water

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








GPS Map Camera
Kharkhari, JH, India
Baghmara Cum Katras, Kharkhari,
Lat 23.775060, Long 86.244432
09/29/2022 11:49 AM
Maps



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

Sponsor

Bharat Coking Coal Limited (BCCL)



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Research Institute, Nagpur

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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.

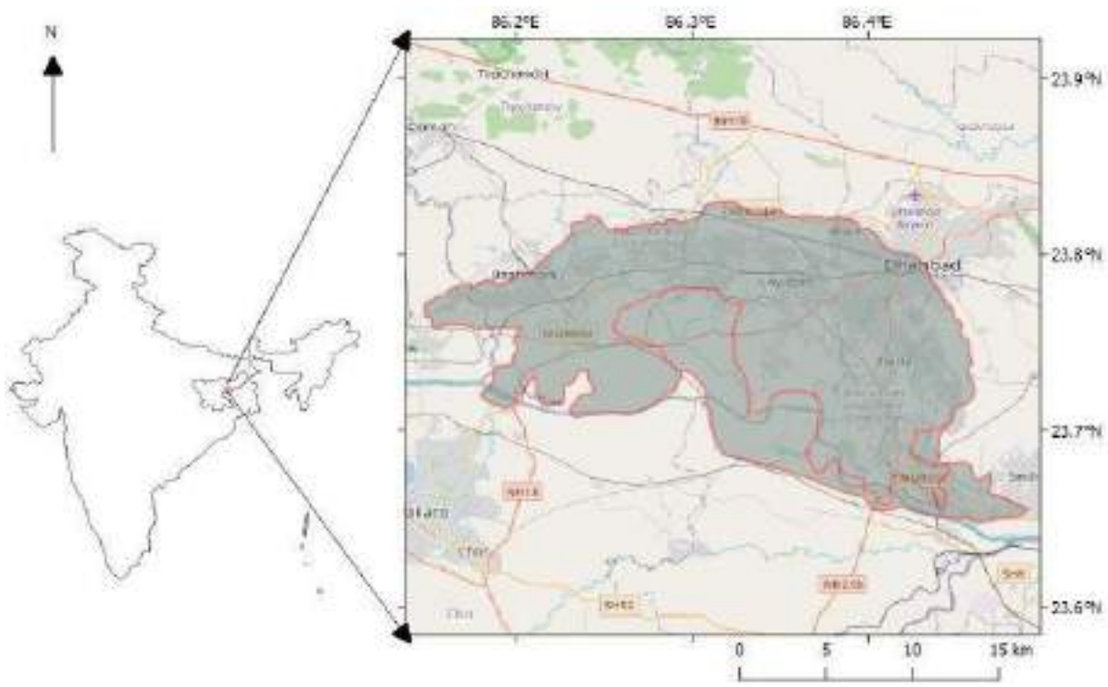


Figure 1.1: Geographical location of Jharia Coalfield in India

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).

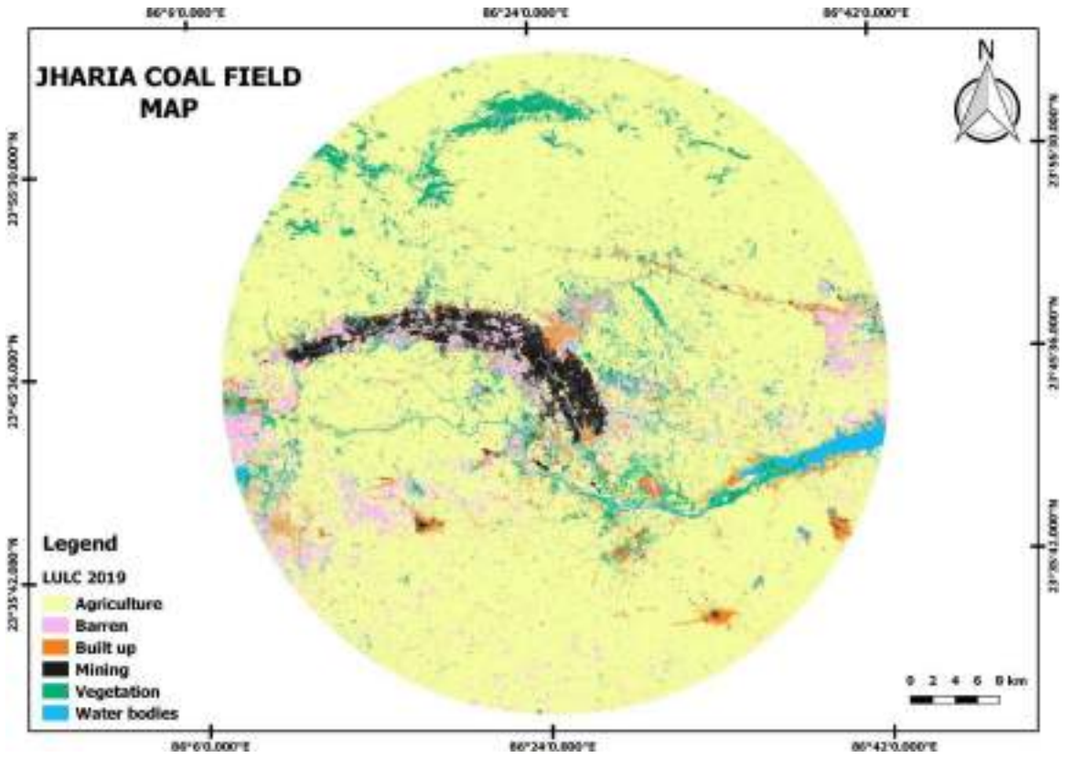


Figure 1.2: Land Use land cover map of Jharia coal field area

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.

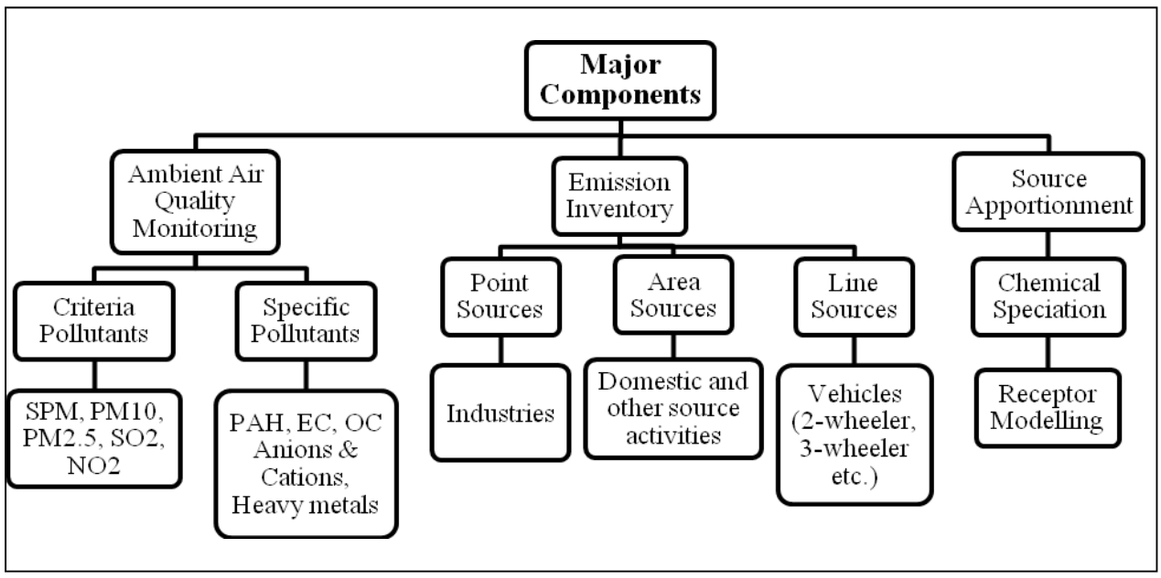


Figure 1.3: Air quality Monitoring & emission source apportionment studies

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%).

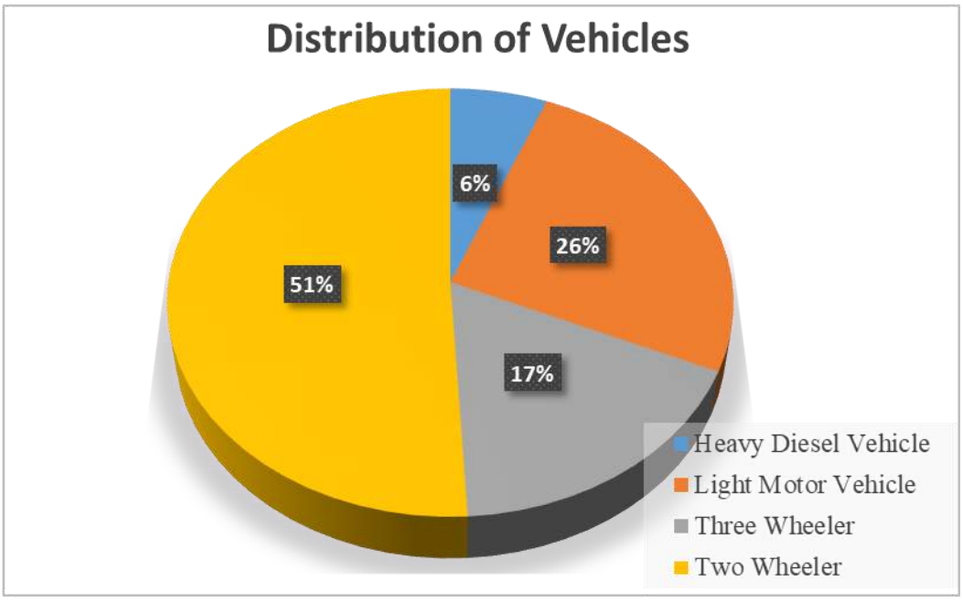


Figure 2.1 Percentage of different types of vehicle surveyed on the road network during the field survey

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

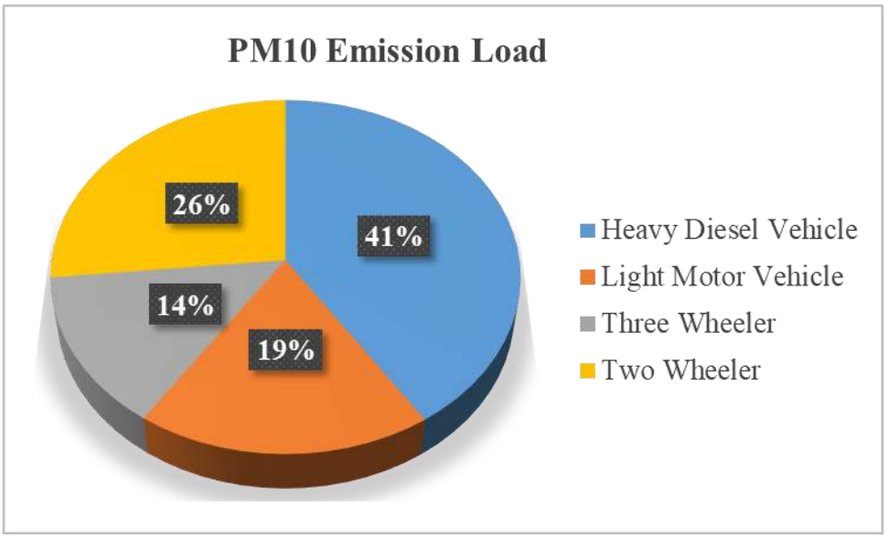


Figure 2.2 PM_{10} emission load for different categories of vehicle

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.

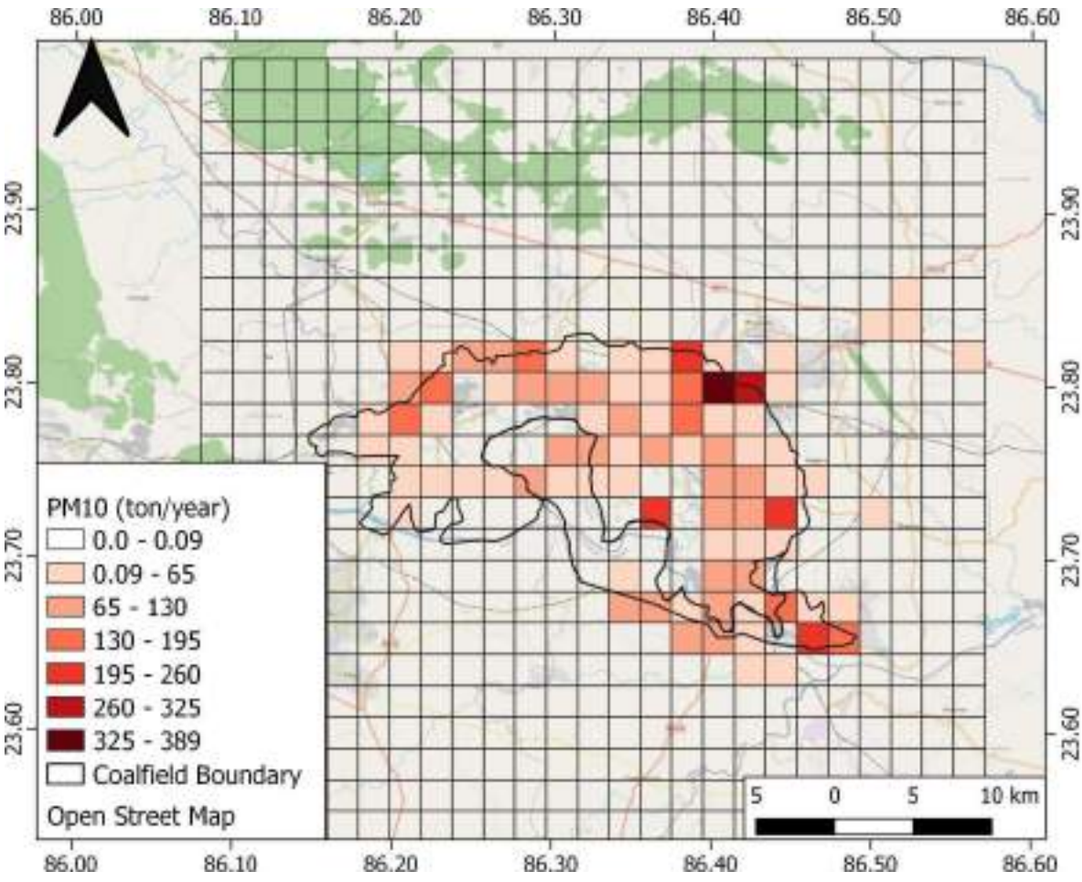


Figure 2.3 Grid-wise emission inventory of PM_{10} in tons/year over the study area

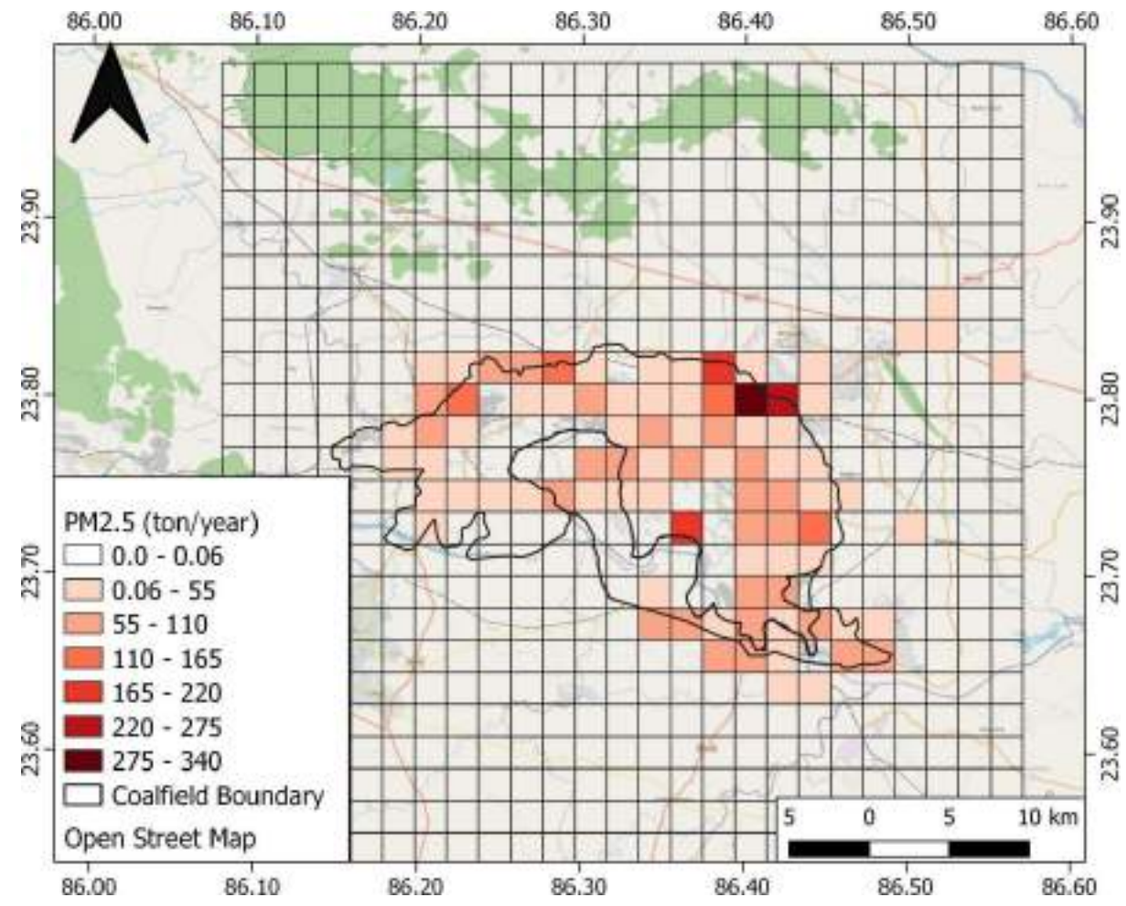
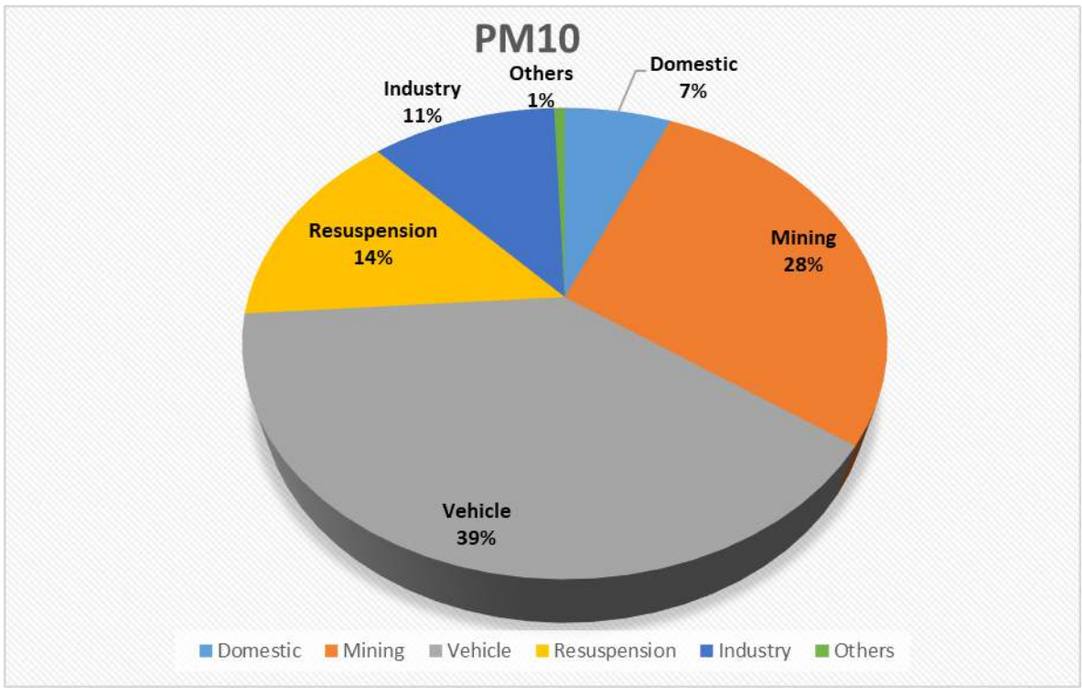


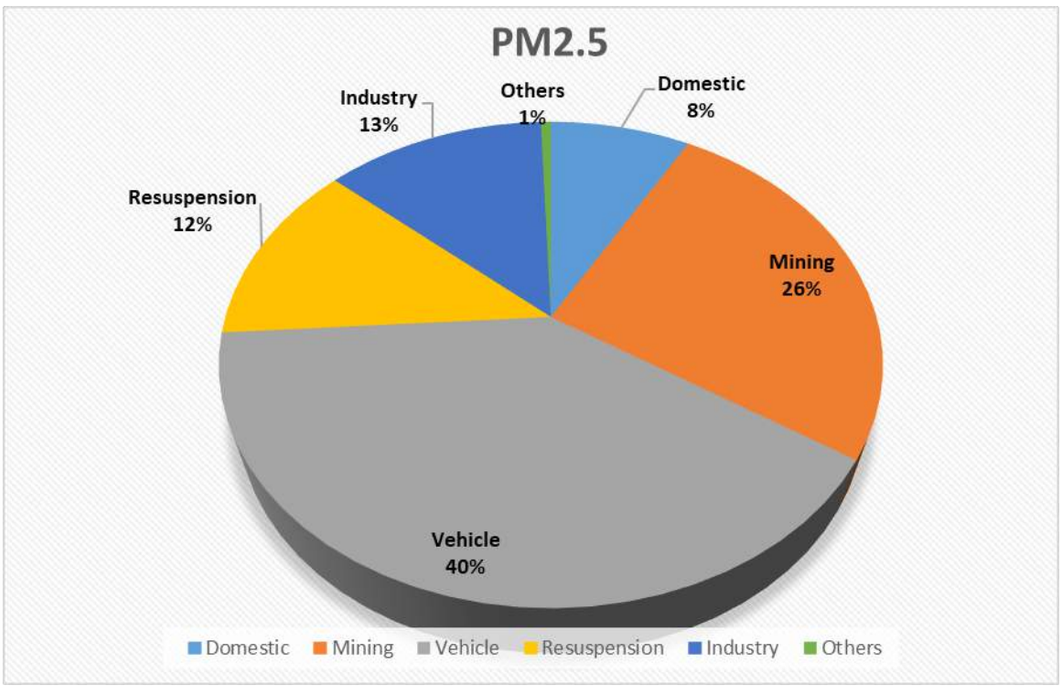
Figure 2.4 Grid-wise emission inventory of PM2.5 in tons/year over the study area

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

References

Automotive Research Association of India (ARAI), CPCB/MoEF. (2007). EF development for Indian vehicles, as a part of ambient air quality monitoring and emission source apportionment studies. AFL/2006-07/IOCL/Emission Factor Project/Final Rep. https //www.cpcb.nic.in/DRAFT 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.

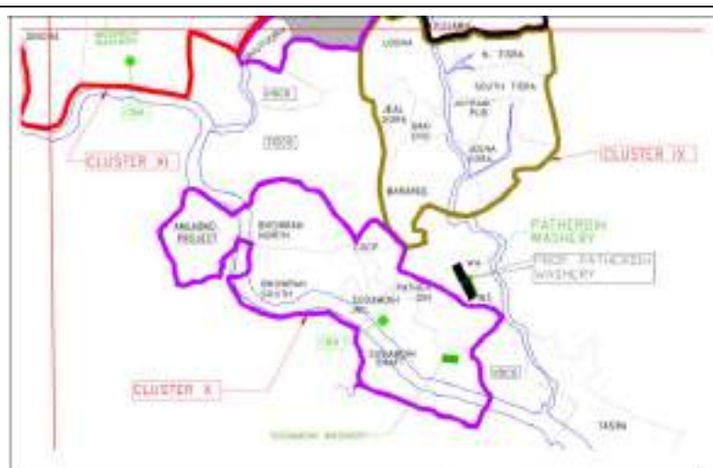
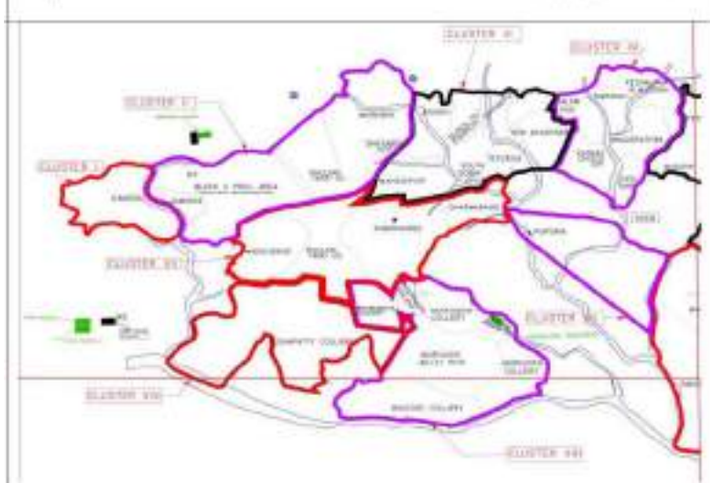
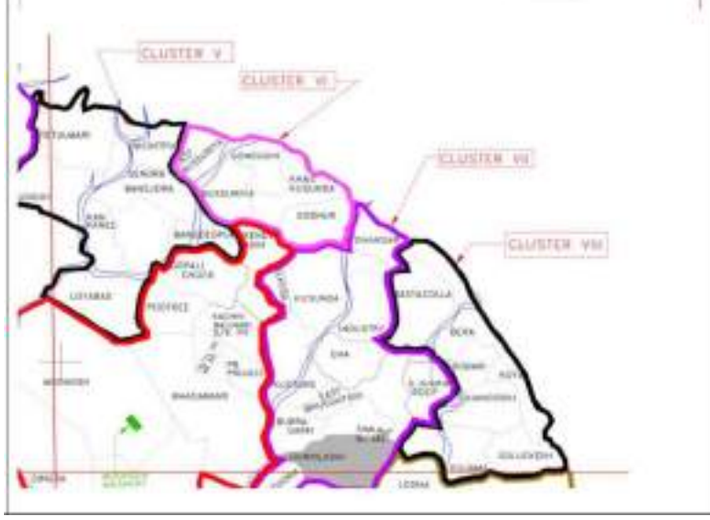
Apoorva Pandey, Chandra Venkataraman, Estimating emissions from the Indian transport sector with on-road fleet composition and traffic volume, Atmospheric Environment, Volume 98, 2014, Pages 123-133, ISSN 1352-2310, https://doi.org/10.1016/j.atmosenv.2014.08.039.

Roy, D., Singh, G., Sinha, S., Park, J., & Seo, Y. C. (2021). Emission inventory of PM10 in Dhanbad/Jharia coalfield (JCF), India: an intricate coal mining sector. *Environment, Development and Sustainability*, *23*(3), 3048-3061. https://doi.org/10.1007/s10668-020-00702-4.

Chapter 3 Air Quality Monitoring and Receptor modelling

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

Table 3.3.1: The details of mine cluster in Jharia Coalfield

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

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

- **Core Zone**

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

- **Buffer Zone**

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

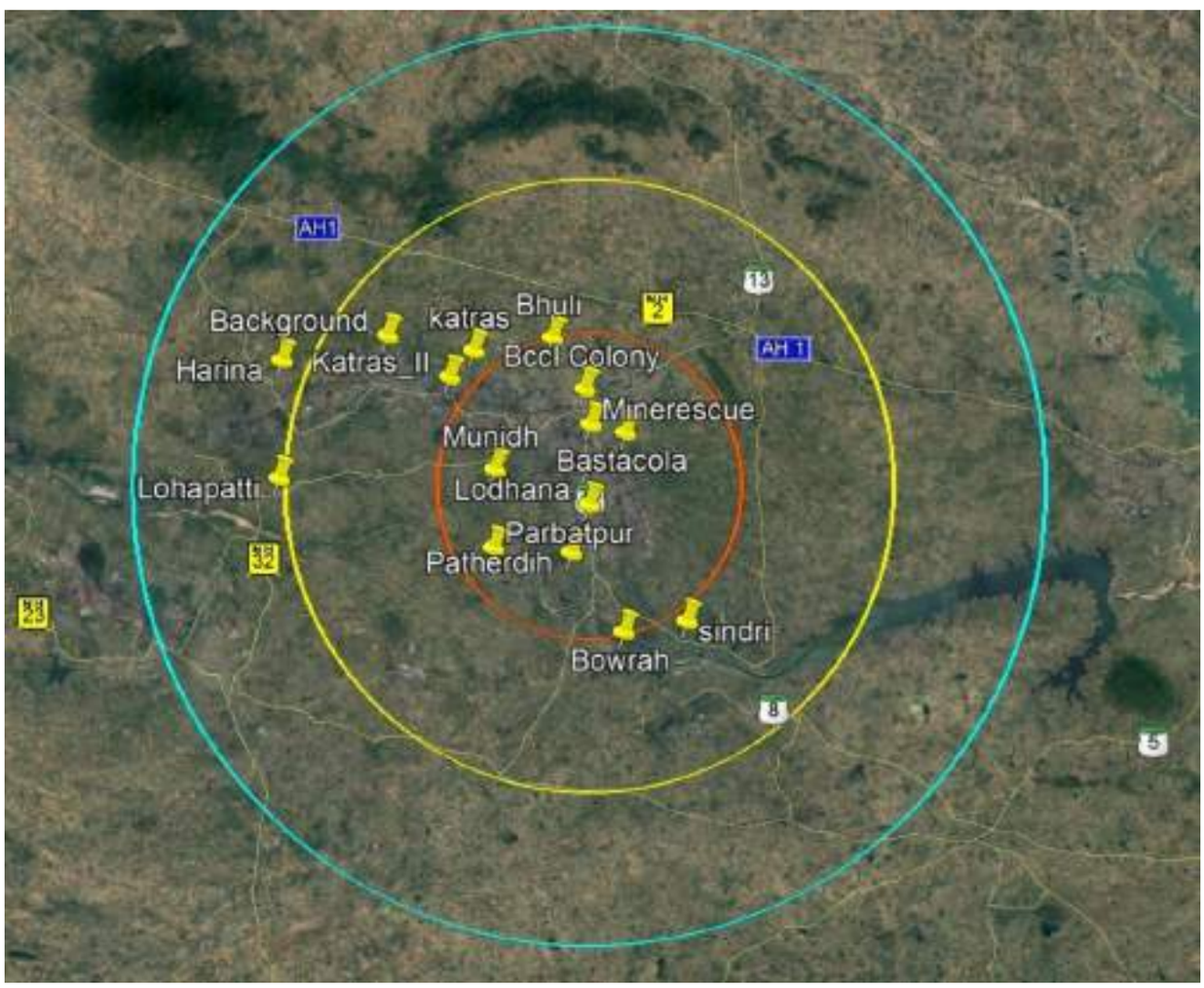


Figure 3.1: Air monitoring sites under 30 km buffer area

3.1. Sampling Method and Schedule

The 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)

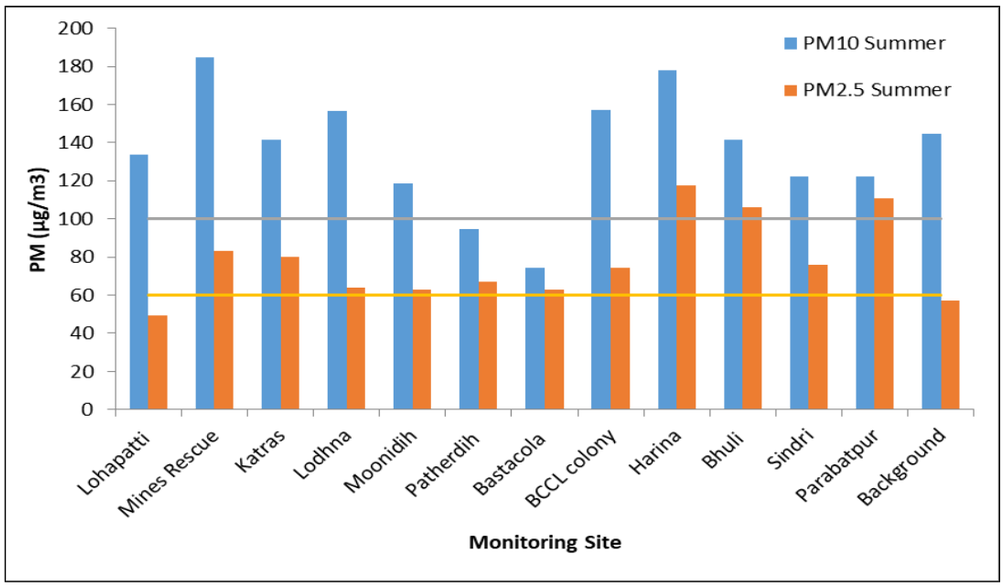


Figure 3.2: Average concentration of PM_{10} and $PM_{2.5}$ in JCF region in summer compared to NAAQS (2009)

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).

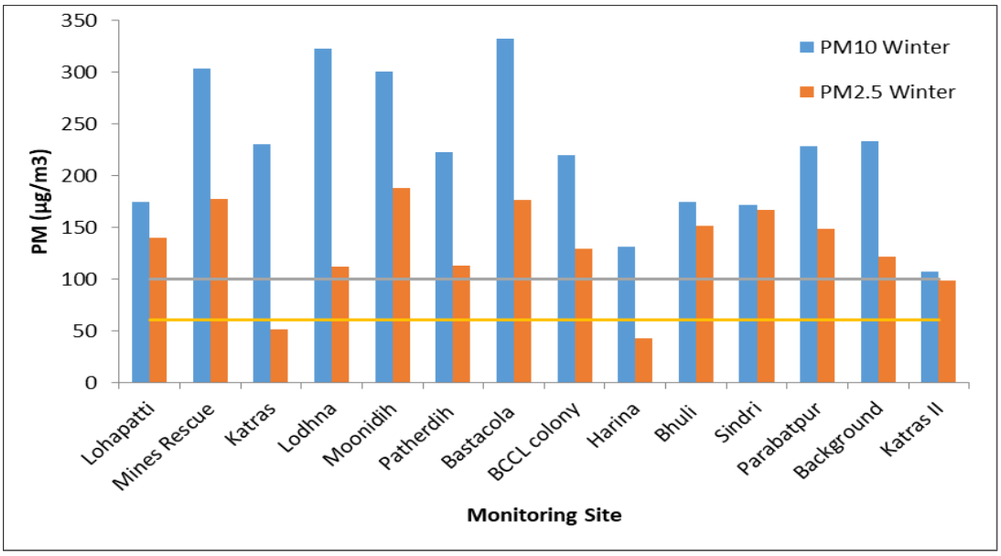


Figure 3.3: Average concentration of PM_{10} and $PM_{2.5}$ in JCF region during Winter compared to NAAQS (2009)

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.

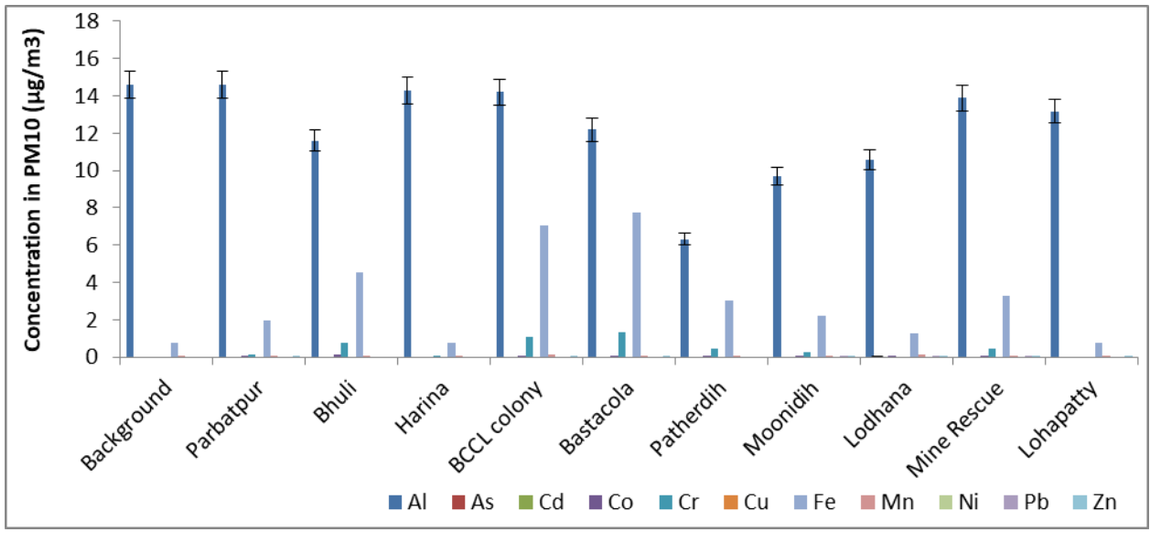


Figure 3.4: Metal concentration of PM_{10} in the summer season

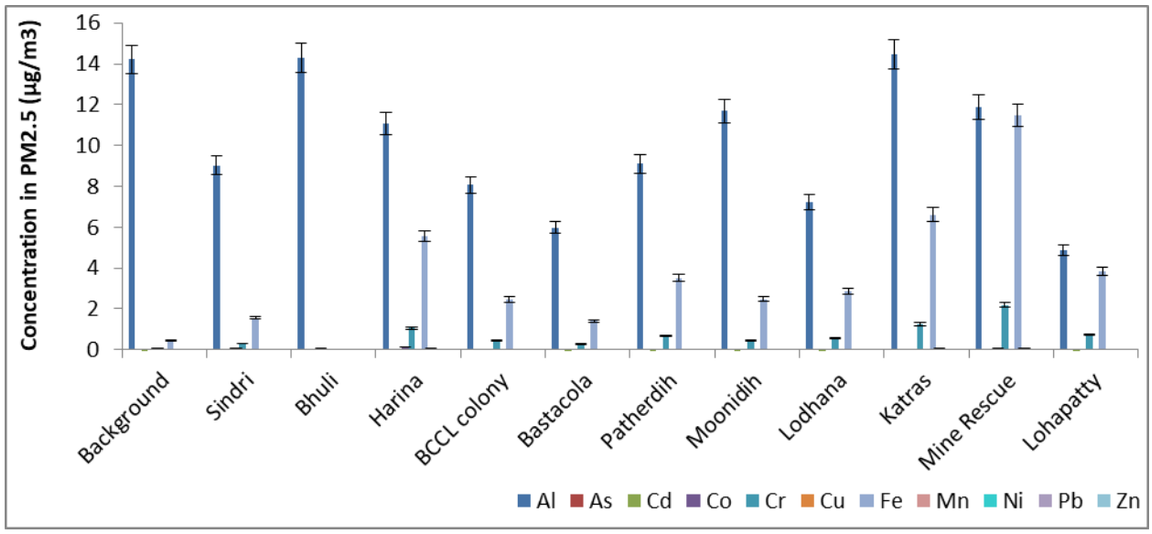


Figure 3.5: Metal concentration of $PM_{2.5}$ in the summer season

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.

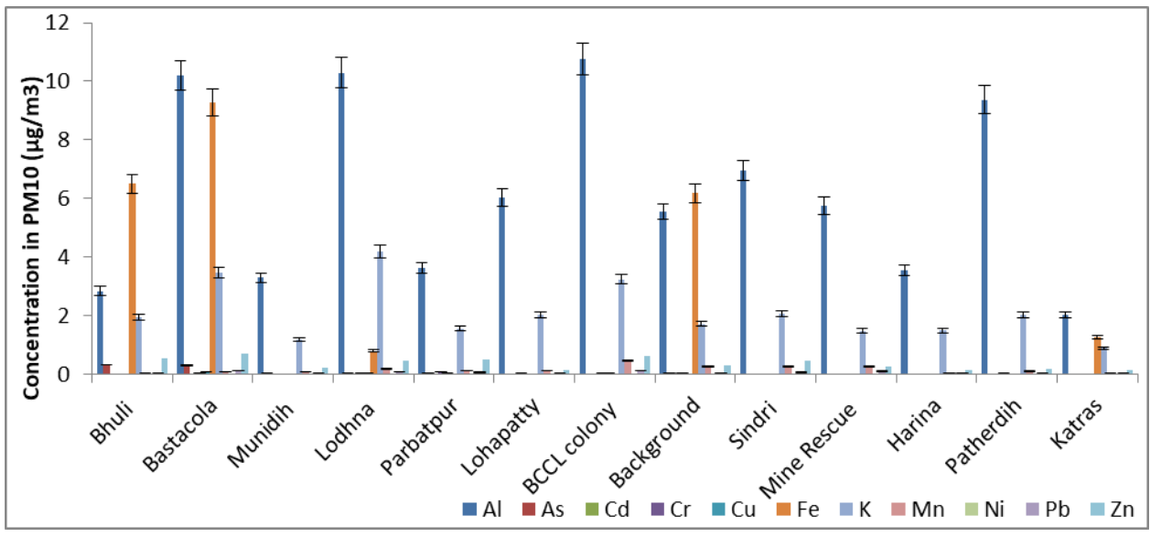


Figure 3.6: Metal concentration of PM_{10} in winter season

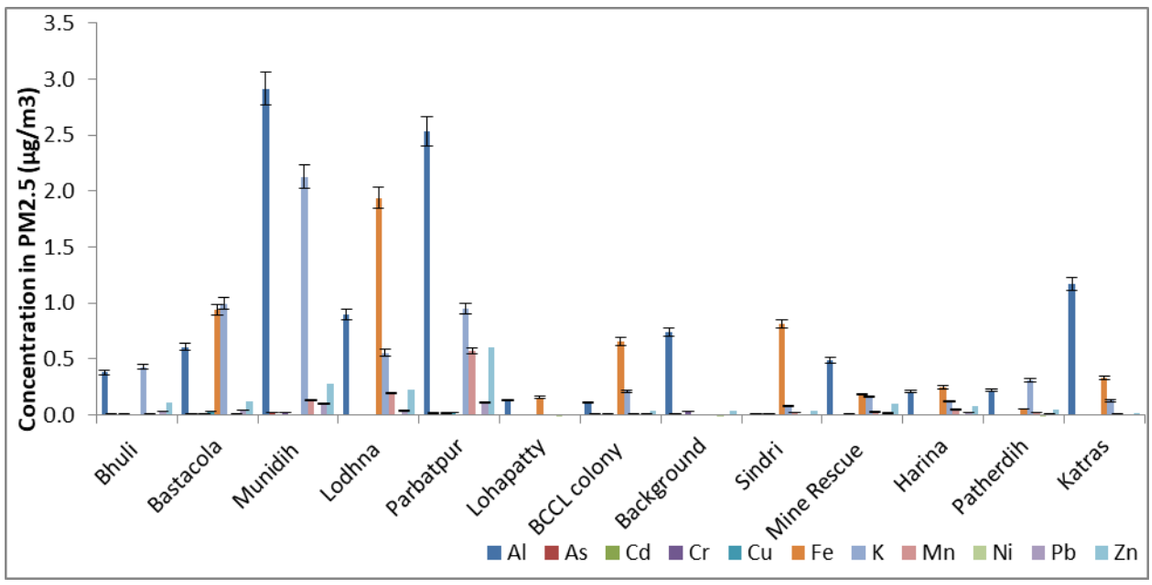


Figure 3.7: Metal concentration of PM 2.5 in winter season

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.

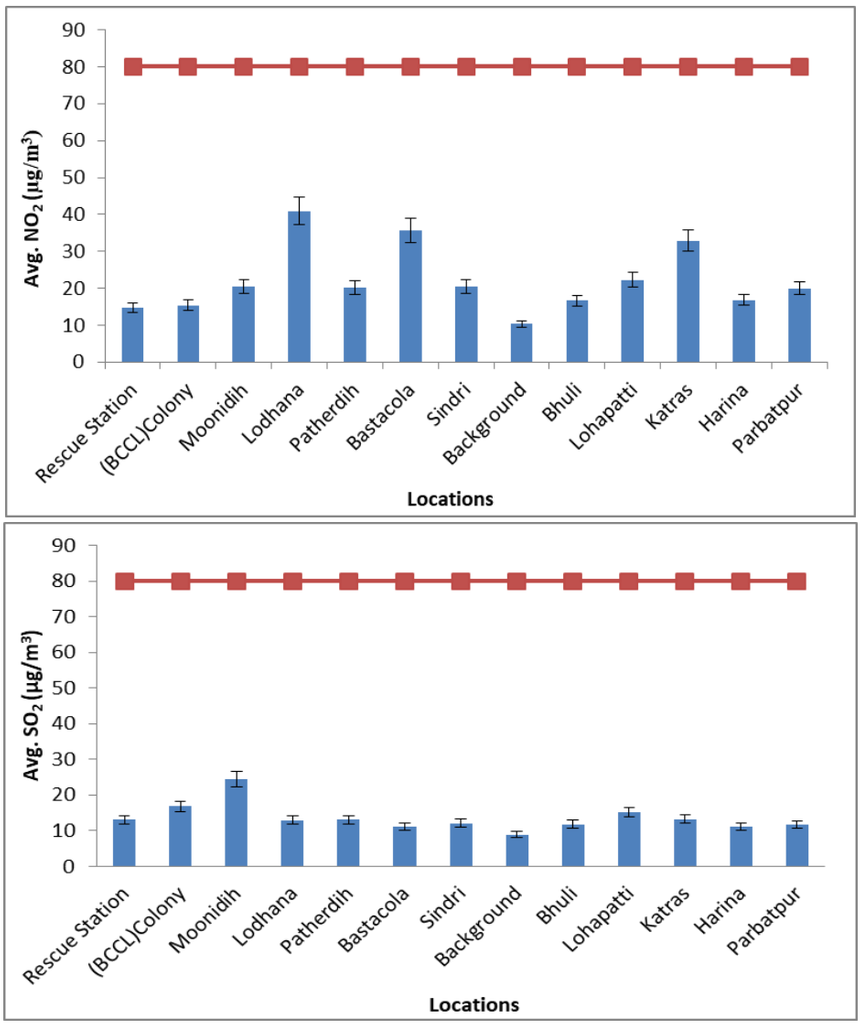


Figure 3.8: NO_2 and SO_2 Concentration of all monitoring sites in summer season

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.

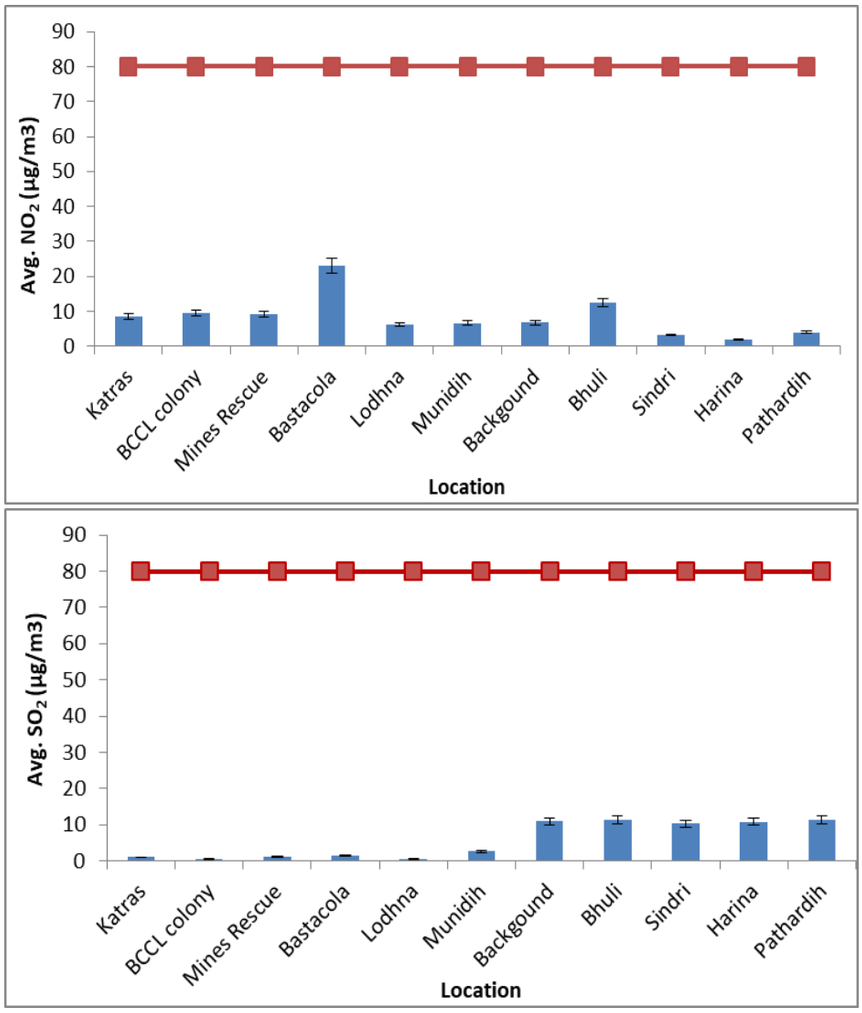


Figure 3.9: NO_2 and SO_2 Concentration of all monitoring sites in Winter season

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).

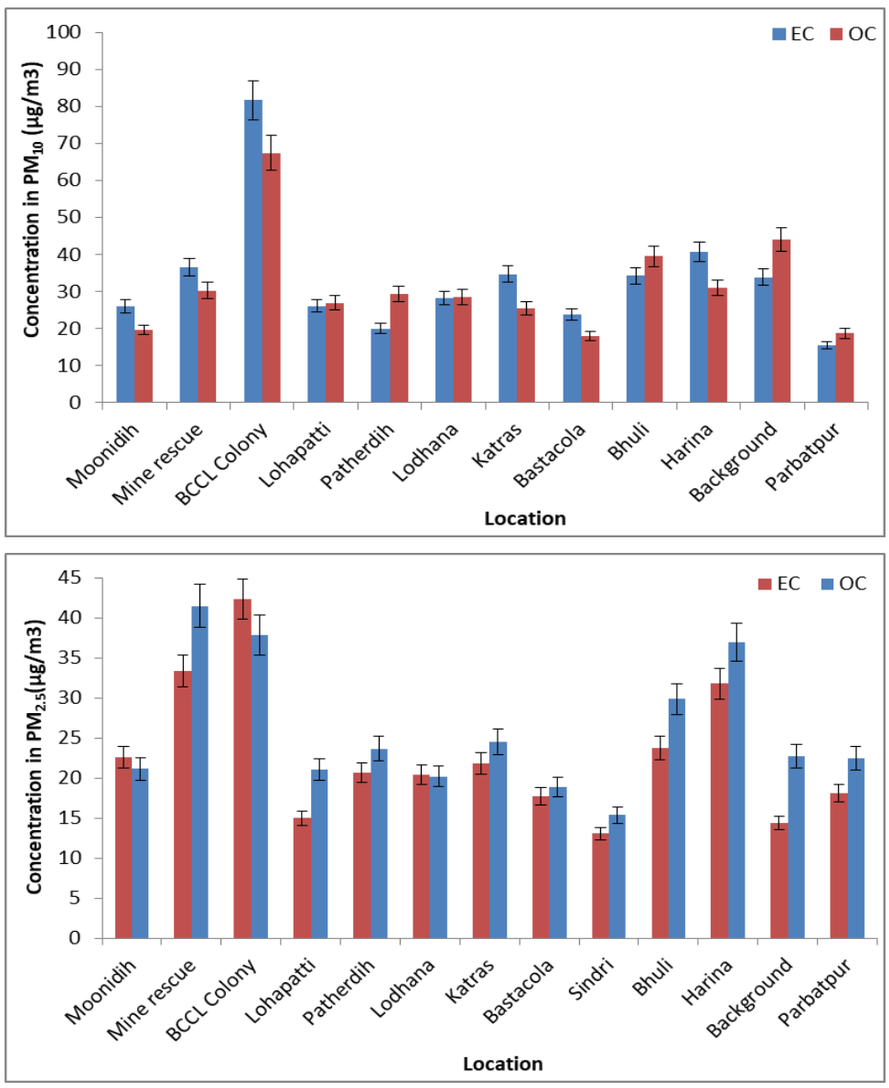


Figure 3.10: EC & OC concentration in PM_{10} and $PM_{2.5}$ in Summer season

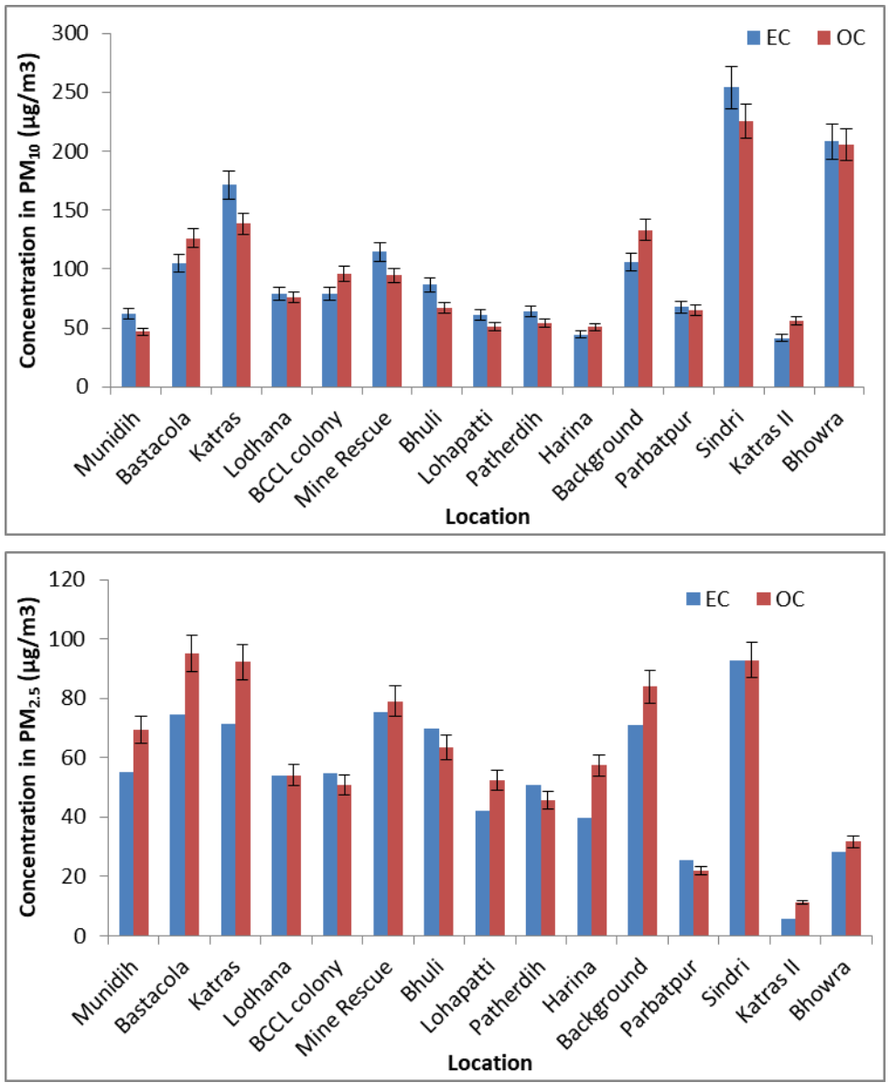


Figure 3.11: EC & OC concentration in PM_{10} and $PM_{2.5}$ in Winter Season

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.

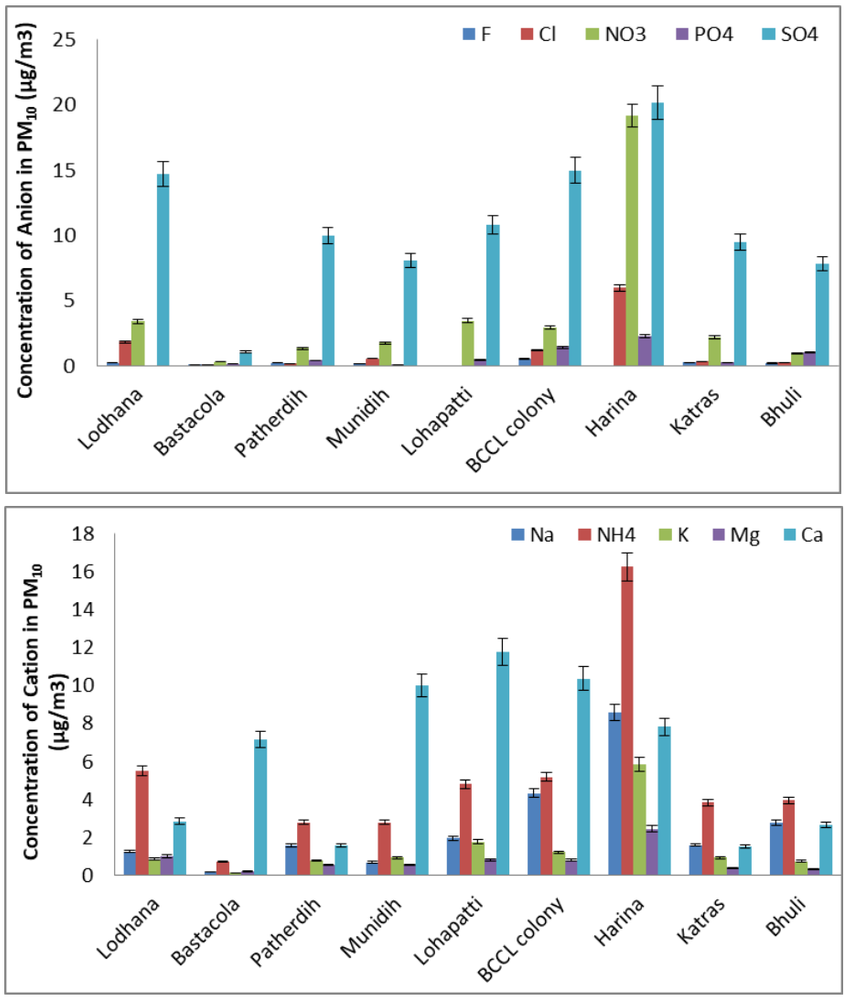


Figure 3.12: Anion and Cation concentration in PM_{10} in summer

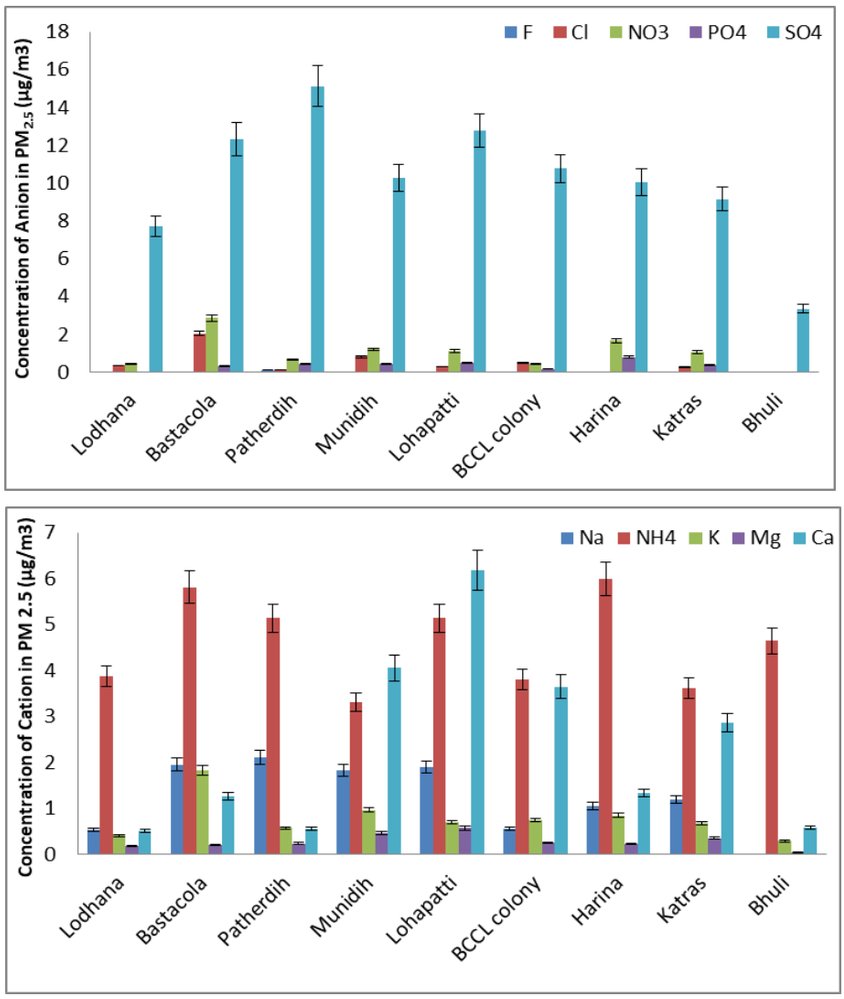


Figure 3.13: Anion and Cation concentration in $PM_{2.5}$ in summer

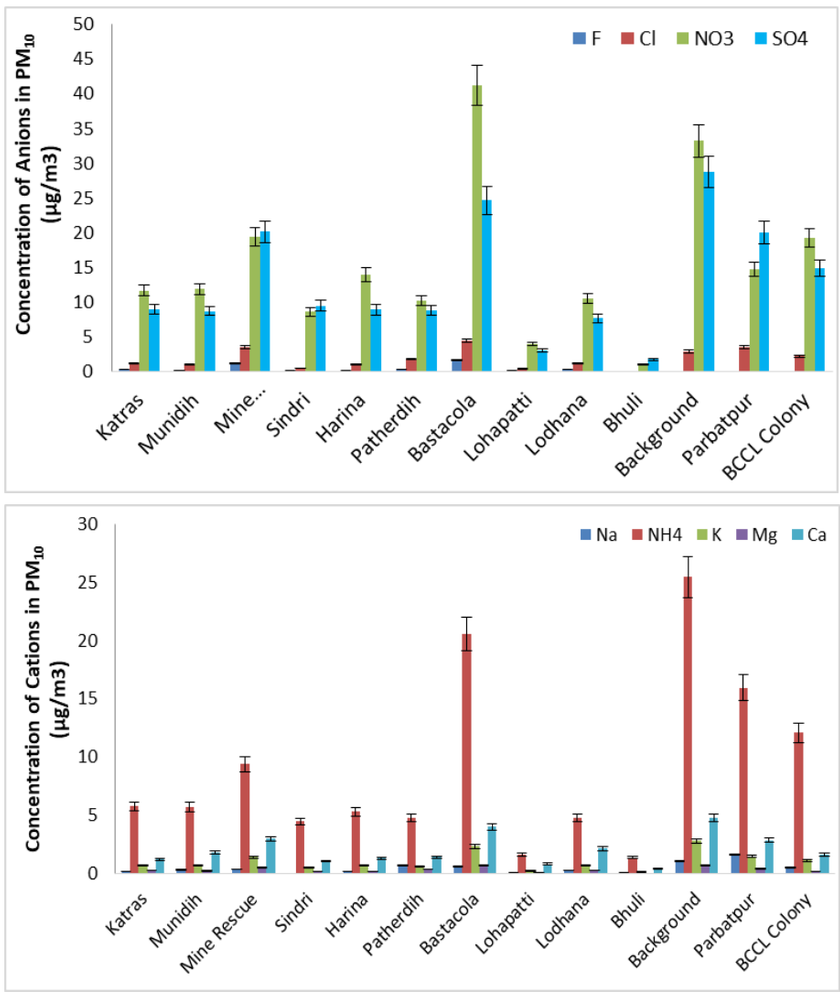


Figure 3.14: Anion and Cation concentration in PM_{10} in winter

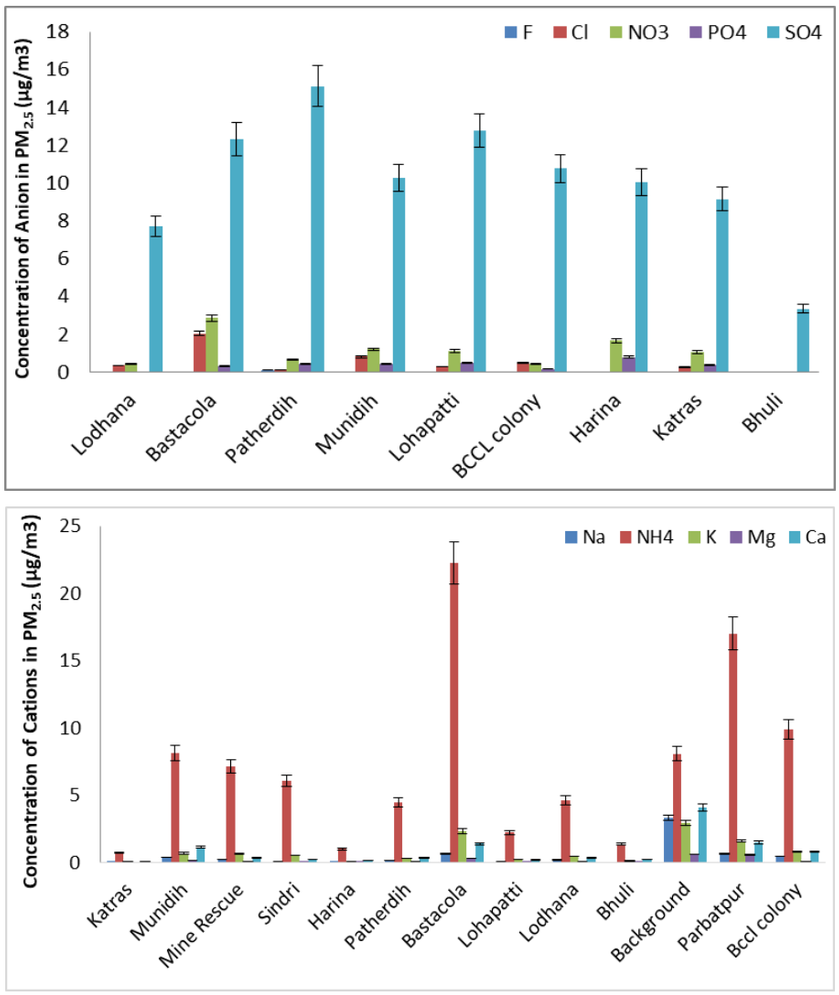


Figure 3.15: Anion and Cation concentration in $PM_{2.5}$ in winter

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:

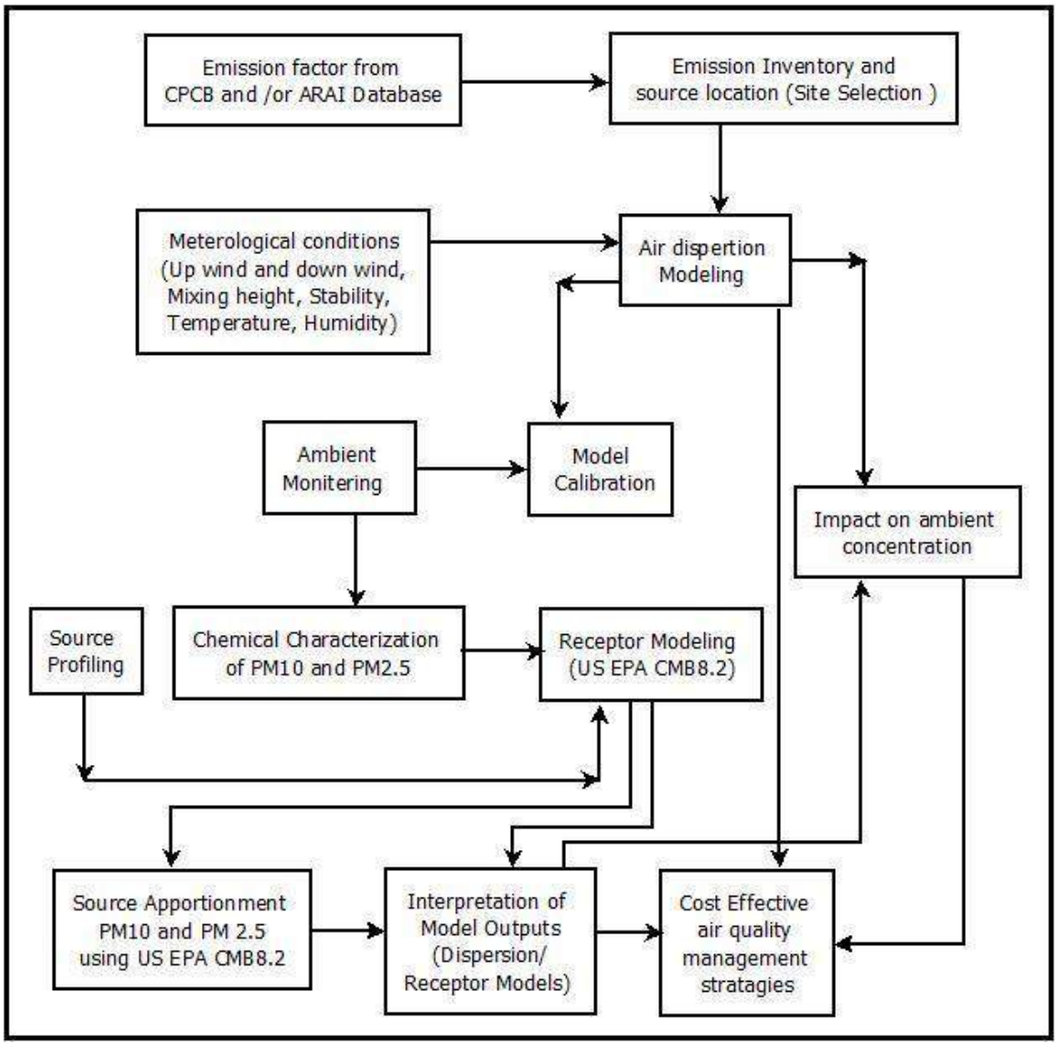


Figure 4.1: General methodology followed in the source apportionment studies

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.).

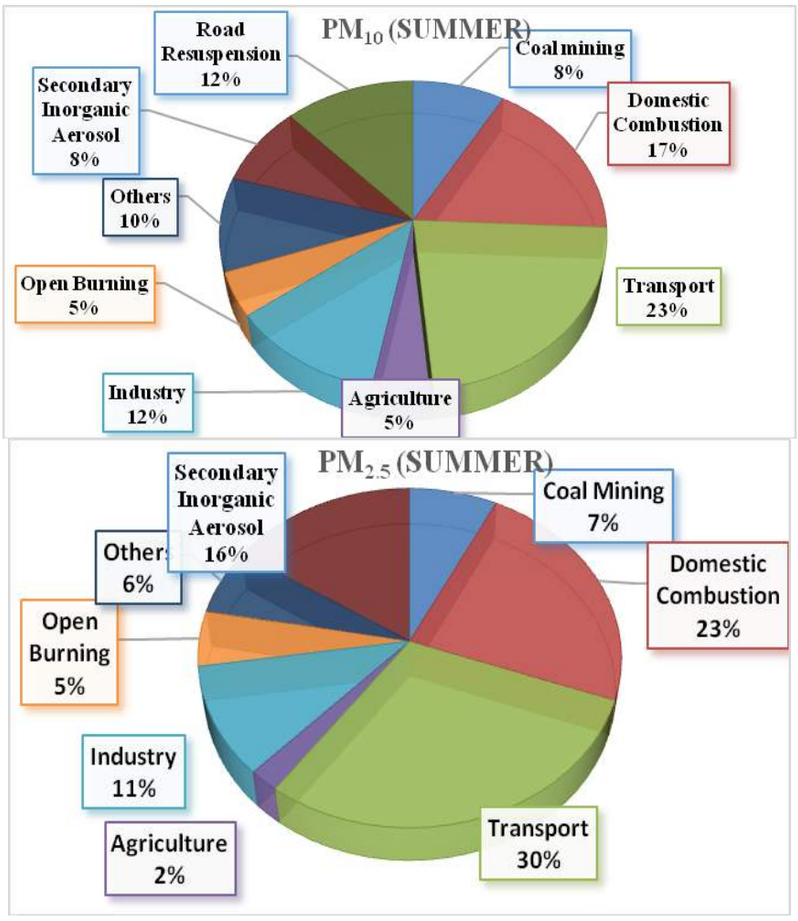


Figure 4.2: Source contribution at receptor locations of PM_{10} and $PM_{2.5}$ in summer

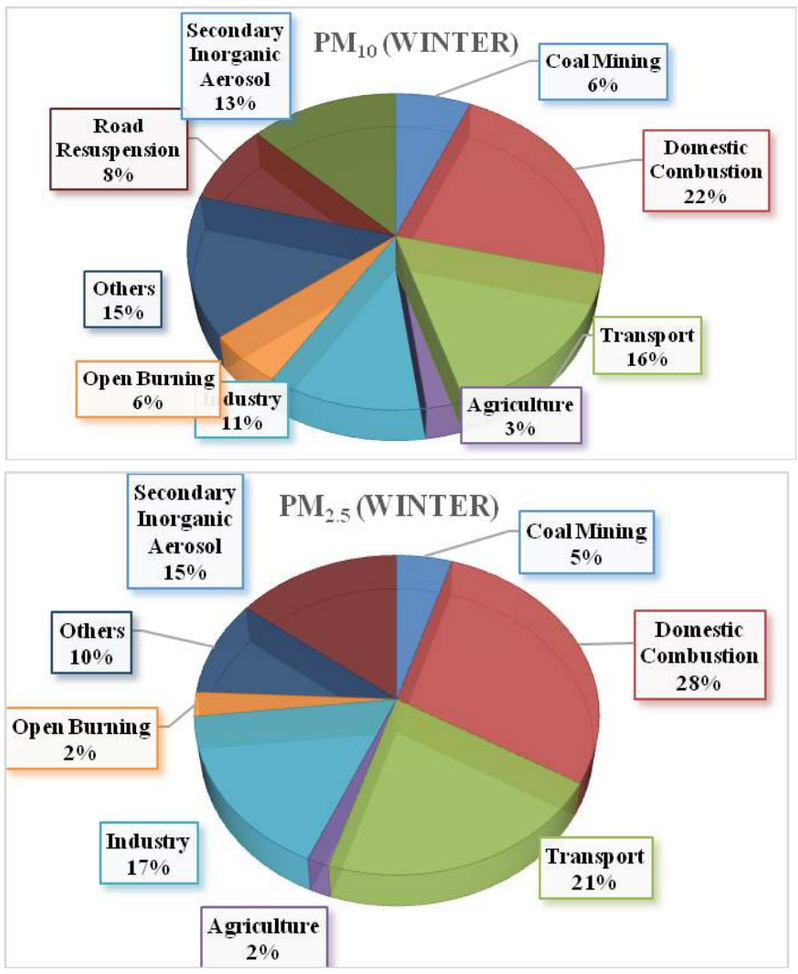


Figure 4.3: Source contribution at receptor locations of PM_{10} and $PM_{2.5}$ in winter

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.

References:

Srishti Jaina, S. K. Sharma, N. Vijayan, T. K. Mandal, Seasonal characteristics of aerosols ($PM_{2.5}$and PM_{10}) and their source apportionment using PMF: A four-year study over Delhi, India. Environmental Pollution 262 (2020) 114337.

G. Kalaiarasan, R. M. Balakrishnan, N. A. Sethunath, S. Manoharan. Source apportionment studies on particulate matter ($PM_{10}$and $PM_{2.5}$) in ambient air of urban Mangalore, India. Journal of Environmental Management 217 (2018) 815e824816.

Source Apportionment of $PM_{2.5}$ & PM_{10} of Delhi NCR for Identification of Major Sources. Report No. ARAI/16-17/DHI-SA-NCR/Final Report August 2018.

Jain, Srishti; Sharma, Sudhir Kumar; Choudhary, Nikki; Masiwal, Renu; Saxena, Mohit; Sharma, Ashima; Mandal, Tuhin Kumar; Gupta, Anshu; Gupta, Naresh Chandra; Sharma, Chhemendra (2017). Chemical characteristics and source apportionment of PM2.5using PCA/APCS, UNMIX, and PMF at an urban site of Delhi, India. Environmental Science and Pollution Research, 24(17), 14637–14656. doi:10.1007/s11356-017-8925-5.

Pipalatkar, P., Khaparde, V.V., Gajghate, D.G., Bawase, M. a, 2014. Source apportionment of PM2.5 using a CMB model for a centrally located Indian city. Aerosol Air Qual. Res. 14, 1089-1099.

Matawle, J.L., Pervez, S., Dewangan, S., Tiwari, S., Bisht, D.S., Pervez, Y.F., 2014. PM2.5 chemical source profiles of emissions resulting from industrial and domestic burning activities in India. Aerosol Air Qual. Res. 14, 2051-2066.

Guttikunda, S.K., Kopakka, R.V., Dasari, P., Gertler, A.W., 2013. Receptor model-based source apportionment of particulate pollution in Hyderabad, India. Environ. Monit. Assess. 185, 5585-5593.

Gummeneni, S., Yusup, Y. Bin, Chavali, M., Samadi, S.Z., 2011. Source apportionment of particulate matter in the ambient air of Hyderabad city, India. Atmos. Res. 101, 752-764.

ARAI, 2010. In: C.P.C.B (Ed.), Air Quality Monitoring and Emission Source Apportionment Study for Pune, India. The Automotive Research Association of India, Pune, India.

CPCB, 2010b. In: C.P.C.B (Ed.), Air Quality Assessment, Emissions Inventory and Source Apportionment Studies for Kanpur City, India. Indian Institute of Technology Kanpur, India.

CPCB, 2010a. In: C.P.C.B (Ed.), Air Quality Assessment, Emissions Inventory and Source Apportionment Studies Mumbai, India. National Environmental Engineering Research Institute, India.

IIT Madras, 2010. In: C.P.C.B (Ed.), Air Quality Monitoring, Emission Inventory and Source Apportionment Study for Chennai, India. Indian Institute of Technology Madras, India.

TERI, 2010. In: C.P.C.B (Ed.), Air Quality Assessment, Emission Inventory and Source Apportionment Study for Bangalore City, India. The Energy and Resources Institute, India.

D. Cesari, G.E. De Benedetto, P. Bonasoni, M. Busetto, A. Dinoi, E. Merico, D. Chirizzi, P. Cristofanelli, A. Donateo, F.M. Grasso, A. Marinoni, Seasonal variability of $PM_{2.5}$ and PM_{10} composition and sources in an urban background site in Southern Italy**.** Sci. Total Environ., 612 (2018), pp. 202-213.

F. Amato, A. Alastuey, A. Karanasiou, F. Lucarelli, S. Nava, G. Calzolai, M. Severi, S. Becagli, L.G. Vorne, C. Colombi, C. Alves, D. Custódio, T. Nunes, M. Cerqueira, C. Pio, K. Eleftheriadis, E. Diapouli, C. Reche, M.C. Minguillón, M.I. Manousakas, T. Maggos, S. Vratolis, R.M. Harrison, X. Querol, AIRUSE-LIFEC: a harmonized PM speciation and source apportionment in five southern European cities. Atmos. Chem. Phys., 16 (2016), pp. 3289-3309.

M.O. Andreae, P. Merlet, Emission of trace gases and aerosols from biomass burning. Glob. Bio Geochem. Cycles, 15 (2001), pp. 955-966.

Li Z, Hopke PK, Husain L, Qureshi S, Dutkiewicz VA, Schwab JJ, Demerjian KL (2004) Sources of fine particle composition in NewYork city. Atmos Environ 38(38):6521–6529.

Seinfeld J H, Pandis S N (2016) Atmospheric chemistry and physics:from air pollution to climate change. John Wiley & Sons.

Kumar AV, Patil RS, Nambi KSV (2001) Source apportionment of suspended particulate matter at two traffic junctions in Mumbai, India. Atmos Environ 35(25):4245–4251.

Sharma SK, Mandal TK, Saxena M, Sharma A, Datta A, Saud T (2014b)Variation of OC, EC, WSIC and trace metals of PM_{10} in Delhi, India. J Atmos Solar-Terres Phy 113:10–22.

Kulshrestha A, Satsangi PG, Masih J, Taneja A (2009) Metal concentration of $PM_{2.5}$and PM_{10} particles and seasonal variations in urban and rural environment of Agra, India. Sci Total Environ 407(24):6196–6204.

Kar S, Maity JP, Samal AC, Santra SC (2010) Metallic components of traffic-induced urban aerosol, their spatial variation, and source apportionment. Environ Monit Asses 168(1–4):561–574.

S.M. Almeida, C.A. Pio, M.C. Freitas, M.A. Reis and M.A. Trancoso. Source apportionment of atmospheric urban aerosol based on weekdays/weekend variability: evaluation of road re-suspended dust contribution. Atmos. Environ., 40 (11) (2006), pp. 2058-2067.

P. Khare and B.P. Baruah. Elemental characterization and source identification of PM2.5 using multivariate analysis at the suburban site of north-east India. Atmos. Res., 98 (1) (2010), pp. 148-162.

V. Shridhar, P.S. Khillare, T. Agarwal and S. Ray. Metallic species in ambient particulate matter at rural and urban location of Delhi. J. Hazard Mater., 175 (1) (2010), pp. 600-607.

D. Cesari, G.E. De Benedetto, P. Bonasoni, M. Busetto, A. Dinoi, E. Merico, D. Chirizzi, P. Cristofanelli, A. Donateo, F.M. Grasso and A. Marinoni. Seasonal variability of $PM_{2.5}$ and PM_{10} composition and sources in an urban background site in Southern Italy. Sci. Total Environ., 612 (2018), pp. 202-213.

S. Jain, S.K. Sharma, T.K. Mandal and M. Saxena. Source apportionment of PM_{10} in Delhi, India using PCA/APCS, UNMIX and PMF. Particuology, 37 (2018), pp. 107-118.

Ram K, Sarin MM (2011) Day–night variability of EC, OC, WSOC and inorganic ions in urban environment of Indo-Gangetic Plain: implications to secondary aerosol formation. Atmos Environ 45(2):460–468.

Sharma SK, Mandal TK, Srivastava MK, Chatterjee A, Jain S, Saxena M, Ghosh SK (2016a) Spatio-temporal variation in chemical characteristics of PM_{10}over Indo-Gangetic Plain of India. Environ Sci PollRes 23(18):18809–18822.

Chapter 5 Dispersion Modelling

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

5.1. Wind data analysis

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

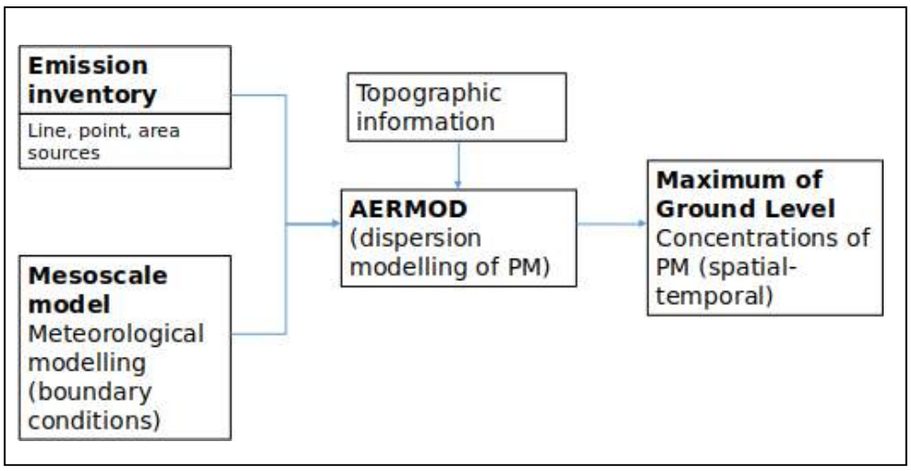


Figure 5.1: Methodology followed in the study.

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

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

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

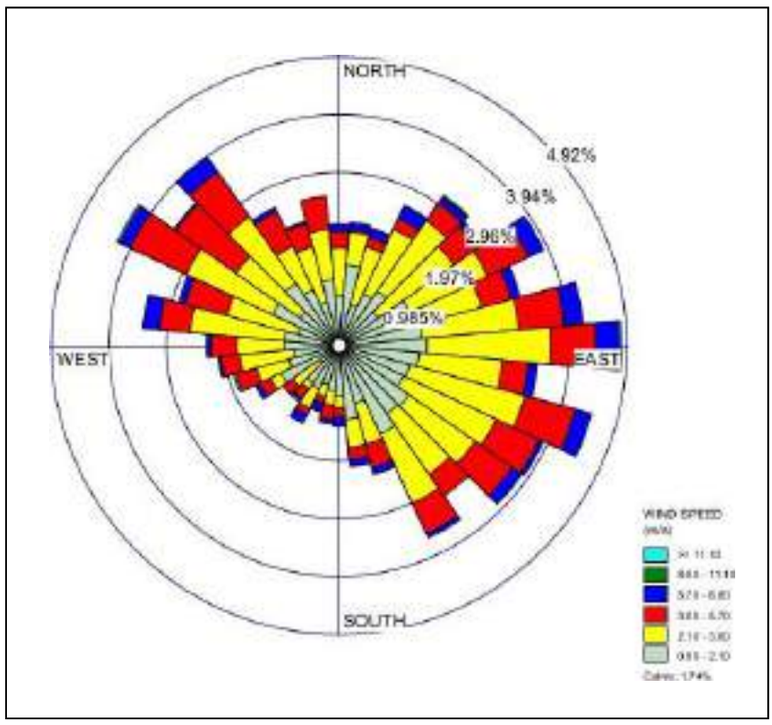


Figure 5.2: Windrose of the study area during March-June, 2019 (wind direction blowing towards the center)

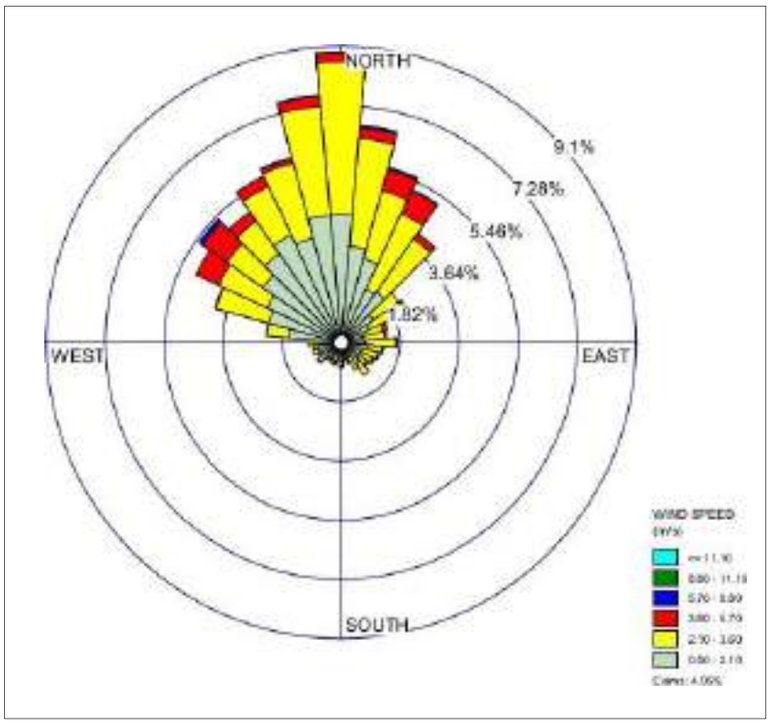


Figure 5.3: Windrose of the study area during November-December 2019 (wind direction blowing towards the centre)

5.2. Dispersion of Particulate matter

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

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

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

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

The wind blowing from different directions in the study area determines the direction of pollution dispersion. The Gaussian plume equation used in the AERMOD model estimates the diffusion and advection of the pollutants concerning the emission rates and meteorology (wind speed, direction and atmospheric stability categories). The model simulated maximum ground level concentration of the particulate matter (PM_{10} and $PM_{2.5}$) in the study area covering the JCF is shown through the isopleths. The isopleths (contours connecting the regions with the same ground level concentration in the context of the present study) of maximum GLC of PM_{10} and $PM_{2.5}$ were observed to form a pattern according to the predominant wind directions flowing in different monitoring seasons. It is observed that the line sources in the study area have contributed the maximum to the surface GLC of PM_{10}, following the open cast mines. The AERMOD model simulated the value of GLC of PM_{10} due to line sources, open cast mines, and all sources are 927, 286, and 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.

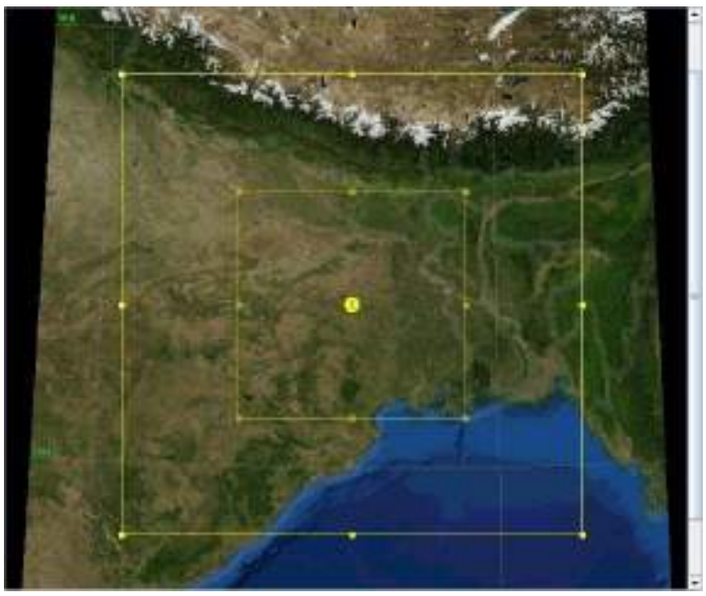


Figure 5.4: AERMOD grid covering the Jharia Coal Fields (JCF). The line, area, and point sources covered in the study are indicated in red color. The UTM coordinates of the left bottom point are x=406111 and y=2603492, and the coordinates of the right top point are x=456248 and y=2653417.

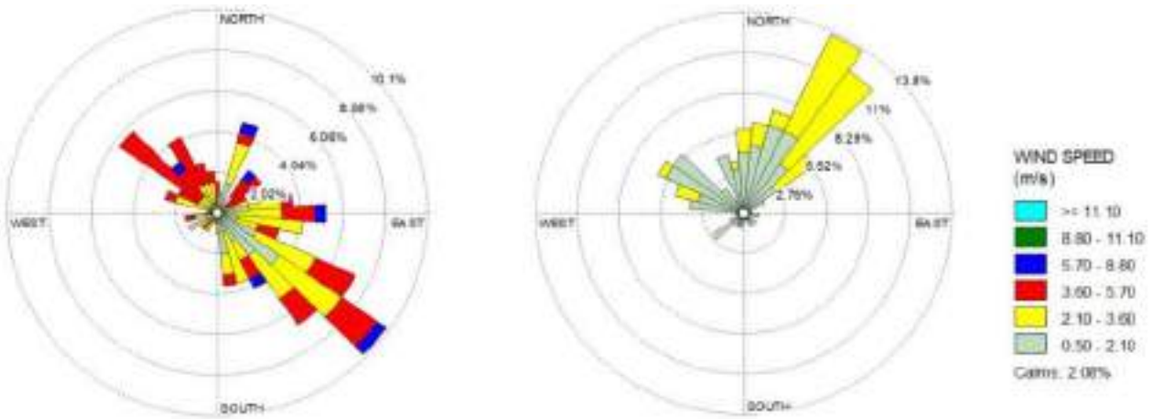
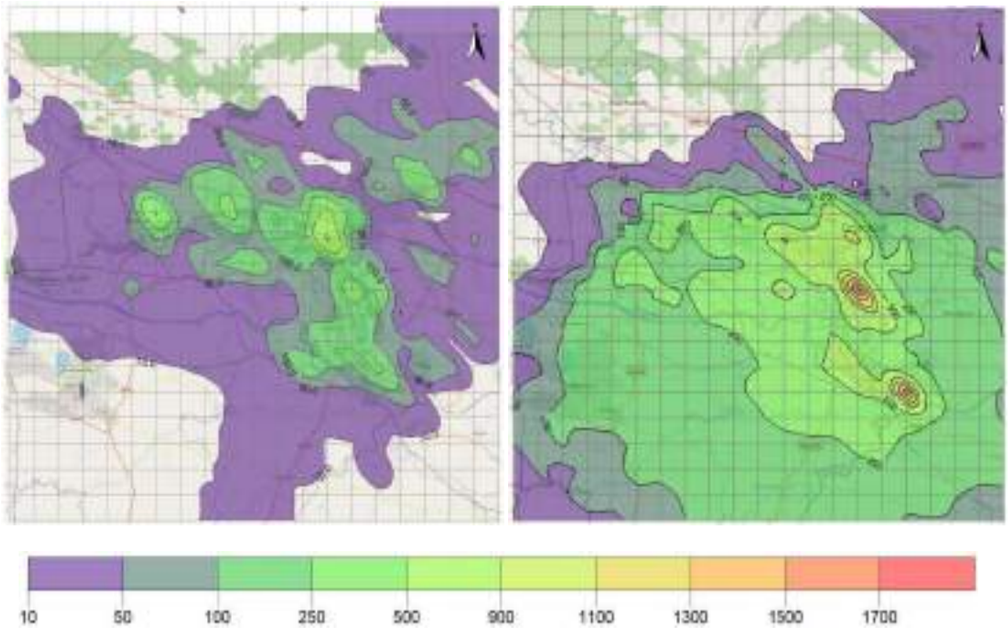
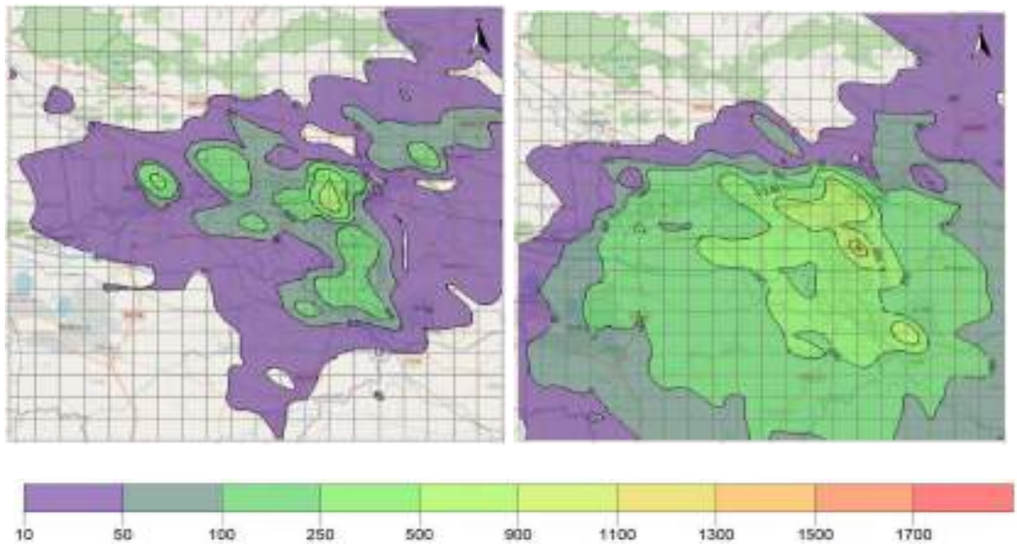


Figure 5.5: Windrose diagram for the summer (left) and winter seasons (right) at Jharia Coal Fields during the sampling period. Wind direction is flowing towards the centre.



(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 :-----

CSR Booklet

Barora Area

Bharat Coking Coal Limited

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1.0 INTRODUCTION

Coal India has adopted CSR as a strategic tool for sustainable growth. For Coal India in the present context, CSR means not only investment of funds for Social Activity but also Integration of Business processes with Social processes. Even much before the issue of CSR became global concern; Coal India was aware of its Corporate Social Responsibility and was fulfilling the aspiration of the Society through well-defined "Community Development Policy" within the periphery of 8 Kms. of the Project sites. This has resulted into a harmonious relationship between Coal India and the peripheral Communities. Coal India has identified land outsee, PAP and those staying within the radius of 25 Kms of the Project as primary beneficiaries. Poor and needy section of the society living in different parts of India is second beneficiaries. For carrying out CSR activities, 80% of the budgeted amount are be spent within the radius of 25 Km of the Project Site/Mines/Area HQ/Company HQ and 20% of the budget to be spent within the States in which operating.

2.0 SCOPE

As per Schedule VII of New Companies Act 2013 the following should be the Scope of Activities under Corporate Social Activities:

1) Eradicating hunger, poverty and malnutrition, promoting healthcare including preventive health care and sanitation and making available safe drinking water.
2) Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly, and differently able and livelihood enhancement projects.
3) Promoting gender equality, empowering women, setting up homes and hostels for women and orphans, setting up old age homes, day care centers and such other facilities for senior citizens and measures for reducing inequalities faced by socially and economically backward groups.
4) Ensuring environmental sustainability, ecological balance, protection of Flora and Fauna, animal welfare, agro-forestry, conservation of natural resources and maintaining quality of soil, air and water.
5) 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 arts and handicrafts.
6) Measures for the benefit of armed forces veterans, war widows and their dependents
7) Training to promote rural sports, nationally recognized sports, Paralympics sports and Olympic Sports.
8) Contribution to the Prime Minister's National Relief Fund or any other fund set up by the Central Government for socio-economic development and relief and welfare of the Scheduled Castes, the Scheduled Tribes, other backward classes, minorities and women.
9) Contributions or funds provided to technology incubators located within academic institutions which are approved by the Central Government.
10) Rural development projects.

3.0 SOURCE OF FUND

The fund for the CSR should be allocated based on 2% of the average net profit of the Company for the three immediate preceding financial years or Rs. 2.00 per tonne of Coal Production of previous year whichever is higher.

4.0 ACTION PLAN FOR CORPORATE SOCIAL RESPONSIBILITY

CSR activities are mainly taken at corporate level.

5.0 STATUS OF CSR ACTIVITIES

5.1 Details of CSR expenditure made at M/s BCCL Level:

FY	Expenditure (In Cr.)
2020-21	6.21
2019-20	6.46
2018-19	1.43
2017-18	2.74

5.2 Details of Civil work ,Medical Camps, CSR Clinics & Awareness Programme under taken at area level:

Civil work

S. N.	Details	Award value (In Lac)	Remarks
1	Construction of PCC road at Gonduadih west under Mohanpur village (from Khalil Mahto home to Primary school).	3.98	25.01.2015 to 24.03.2015 (60 days)
2	Construction of Janaja shed at Ramakunda west under Amtand village	3.15	15.10.2014 to 14.12.2014 (60 days)
3	Construction of 1 no. chhathh ghat at Muraidih colony, Hirak road river side	3.01	15.10.2014 to 14.12.2014 (60 days)
4	Construction of Janaja shed at Muraidih colony near river of Hirak road	0.46	31.03.2014 to 29.04.2014 (30 days)
5	PCC Road jhunu Rajwar House to Tarkeswar Gope House at Bakaspura Village Luti Pahari (Jhunu Tarkeshwar)Road Length:-	2.30	This is benefiting to approx. 200 families in this locality by all-weather connectivity.
6	Making PCC Path from Manoj Matha House to Sahabuddin Ansari house at Ghunghusa Village (Mahato Shahbhuddin)	1.85	This is benefiting to approx. 300 families in this locality by all-weather connectivity
7	Steps for Ghat at sarbandh near hirak chowk under B-II Area	2.67	This will ease in performing rituals by local villages of Dumara ,harina & Bada pandeydih.
8	Cutting of earth from pond at Chaudhary bandh at Harina Basti,under B-II Area	19.22	This is benefiting to approx 5000 persons in this locality. This pond is used for multipurpose like irrigation,water for

			households drinking water for animals etc.it will also maintain the water leval in locality.
9	Drinking Water pipe line works in hadi basti at Bhamkanali.	0.44	This is benefiting to approx. 150 families in this locality
10	Rep/Maint of Hand pump at Bara pandeydih (08 Nos).	0.26	This is benefiting to approx. 500 persons in this locality
11	Development work at rehabilitation site at Bhimkanali.	6.45	This is benefiting to approx. 500 persons in this locality
12	Construction of community hall at Bara Pandeydih Village	11.9	This is benefiting to approx. 1000 persons in this locality
13	Rep. Of Main road & Drain at Bakashpura rehabilitation site.	9.71	This is benefiting to approx. 1500 persons in this locality
14	Engagement of tankers for drinking water supply in nearby villages	1.9	This is benefiting to approx. 2000 families in Viallages like Benidih Baghmara, Luttipahadi, Harina, Kessurgarh, Rathtand, Nudkhurkee,Pinalgarhia,Mandra.
15	Engagement of departmental tankers for drinking water supply in nearby villages as on need base.	-	This is benefiting to approx. 2000 families in Viallages like Benidih Baghmara, Luttipahadi Kessurgarh, Madhuban Etc.

S.N.	Details	Award value (In Lac)	Remarks
1	Construction and maintenance for 5 years of toilets in Government schools in Gumla District under Swachh Vidyalaya Abhiyan. 125 toilets in 69 schools were constructed.	191.67	This is benefiting to approx. 7500 students
2	Construction and maintenance for 5 years of toilets in Government schools in Bokaro District under Swachh Vidyalaya Abhiyan. 179 toilets in 181 schools were constructed.	1702.98	This is benefiting to approx. 10000 students

Health: Medical Camps, CSR Clinics & Awareness Programme:

Medical Camps	Beneficiaries	Amount (in Rs.)
2014-15	5144	58095.75
2015-16	3397	38352.13
2016-17	595	30320.00
2018-19	789	30320.00
2019-20	310	-

CSR Clinic:

Year	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Total no patients	1660	1301	1895	1293	1305	810	910

SN	**Health Awareness Programme**	**Amount (in Rs.)**
1	Nasa Mukti Abhiyan	10000.00
2	Blood Pressure Detection	5000.00
4	Aids Awareness Programme	5000.00
5	Eye Checkup camp	25000.00

5.3 COVID Prevention related Activities (2020-21):

Type	No of beneficiaries	Hand wash	Mask
Hand wash and Mask Distribution	500	450	500
Blood sugar strips	124	NA	NA

6.0 COAL TRANSPORTATION PLAN:

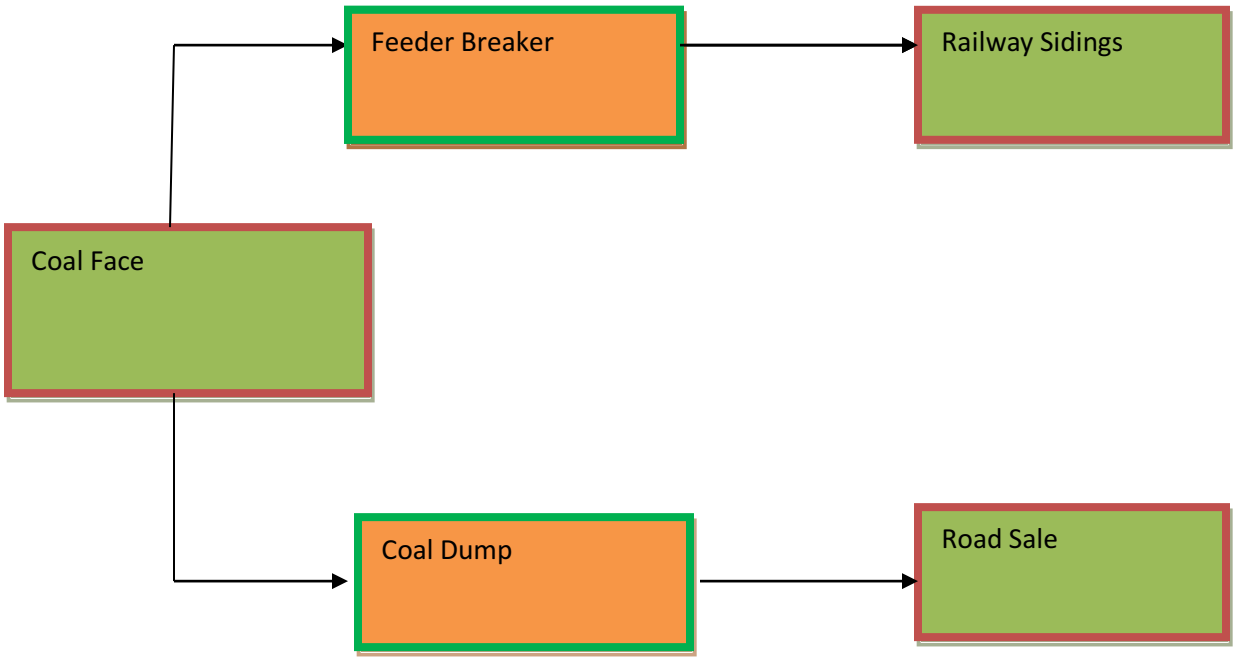


Fig: Coal transportation route

7.0 REHABILITATION AND RESETTLEMENT PLAN:

REHABILITATION AND RESETTLEMENT POLICY OF COAL INDIA LTD 2012.

Preamble

The location and quality of coal reserves, and their distance from major consumers determines to a great extent the selection of mine sites. For reserves that are close to the surface, opencast mining has proven to be the most efficient mining method. Opencast mines require relatively large areas of land. Population growth, particularly in India's eastern region, has made it increasingly difficult for the subsidiary coal companies to acquire the land they need for expanding their operations under the present Resettlement and Rehabilitation policy,2008 of Coal India.

The resettlement and rehabilitation policies followed by the subsidiary companies have evolved over time and undergone numerous changes in response to changing circumstances. As and when the Central or State Governments enact amendments to the Land Acquisition Act, issue new guidelines for resettlement and rehabilitation, as per its requirement Coal India reviews and modifies its resettlement and rehabilitation policy taking into account the changing conditions in coal producing areas.

In addition to compensation for land coal companies provide Rehabilitation and Resettlement (R&R) package for project affected persons to compensate for loss of livelihood. Apart from compensation for house site, house, trees, cow shed, cost of shifting etc., employment is also provided to land oustees. In addition to this, efforts are made to rehabilitate them by construction of houses, building roads, streets, schools, providing water etc. wherever feasible . However, demand for both more land compensation and better R&R package has been raised by project affected persons and has been highlighted in various Parliamentary Committees. Coal Companies often have to face representations and agitations by these land oustees who obstruct the smooth working of existing mines and come in the way of expansion of new projects.

In the past, subsidiaries found it relatively easy to acquire land, if they were able to offer employment. Partly because of this practice, subsidiaries have built up a largely unskilled labour force beyond their needs. This has contributed to the heavy losses and many mines are incurring and has also affected their efficiency and viability. The subsidiaries may still need to hire people in selected locations and continue to give preference to those whose livelihood will be affected by coal mining operations. However, increasingly subsidiaries will need to develop other ways and means to compensate land owners and others adversely affected by their projects and give them the option to choose which method of compensation best suits their needs. Greater emphasis will also need to be given to community requirements like schools, hospitals etc. Only proper resettlement and rehabilitation will elicit the required cooperation of project affected people, and make it possible for Coal India to acquire the land it needs to fulfill the ever increasing demand of coal for the economic development of the Country.

- 1 -

The purpose of the Resettlement and Rehabilitation Policy 2012 is to revise and provide greater flexibility to the basic principles for the resettlement and rehabilitation of people affected by coal mining projects i.e. Project Affect People (PAPs). It attempts to consolidate the different resettlement and rehabilitation practices that are being followed by subsidiaries as per the different State land Acquisition Acts and various decisions of the Coal India Board and to modify the Policy of 2008 so as to give the Board of the subsidiary Companies greater flexibility to deal more effectively with resettlement and rehabilitation issues and determine the rehabilitation packages best suited to local needs in line with this policy. The provisions of the National Rehabilitation and Resettlement Policy, 2007 and the Land Acquisition, Rehabilitation & Resettlement Bill, 2011 have also been kept in mind while framing the policy.

While Coal India's basic philosophy for compensating land-losers and other project-affected people remains substantially unchanged, the revised policy emphasizes the need to cultivate and maintain good relationships with the people affected by Coal India's projects starting as early as possible; it also underscores that the subsidiaries have a responsibility towards the land oustees whose livelihood is often taken away. On the other hand, subsidiaries need to protect themselves more effectively against unjustified claims, redundant manpower and swelling Wage Bills. To this end, the statement proposes that subsidiaries prepare detailed resettlement and rehabilitation action plans (RAPs) that clearly identify, at an early stage, the entitlements of the people affected by coal projects and enables them to exercise a choice between various options. The concept of Annuity in lieu of compensation/employment is also being introduced to mitigate, if not eliminate the ever dependence of Project Affected Families (PAFs) on CIL for provision of employment.

(1) The revised Resettlement & Rehabilitation Policy, 2012 is based on the deliberations of the Inter Ministerial Committee set up vide O.M 490191/2011-PRIW-I dated 01-07-2011 of Ministry of Coal , deliberations of the CMDs meet held on 05/03/2012 at New Delhi and has been approved by the CIL Board in its 279th meeting held on 12th and 13th March, 2012.

(2) **Objectives and general principles of Coal India's Resettlement and Rehabilitation Policy- 2012**

A. To re-visit CIL's existing R&R policy 2008 and evolve a PAP friendly policy by incorporating such provisions of the National Policy and The Draft Land Acquisition, Rehabilitation and Resettlement Bill-2011 as considered suitable in light of the growing difficulties many subsidiaries face in land acquisition.

B. To accord the highest priority for avoiding or minimizing disturbance of the local population while taking decisions to open new mines or expand existing ones too (exploring alternative sites and project designs) and to ensure that wherever people are likely to be adversely affected by a project the subsidiaries will prepare resettlement and rehabilitation action plans for the project.

C. To ensure a humane, participatory, informed consultative and transparent process for land acquisition for coal mining and allied activities with the least disturbance to the owners of the land and other affected families.

D. To provide just and fair compensation to the affected families whose land has been acquired or proposed to be acquired or are affected by such acquisition and make

adequate provisions for loss of livelihood of such affected persons including their rehabilitation and resettlement.

E. To ensure that the cumulative outcome of compulsory acquisition should be that the affected persons become partners in development leading to an improvement in their post acquisition social and economic status and matters connected therewith or incidental thereto.

F. Through the preparation of resettlement and rehabilitation action plans, subsidiaries will safeguard that project-affected people improve or at least regain their former standard of living and earning capacity after a reasonable transition period. The transition period is to be kept to a minimum. However, the involvement of subsidiaries in resettlement and rehabilitation activities may continue until all the actions specified in the rehabilitation plan have been completed.

G. Involuntary resettlement is conceived and executed as a development programme with project-affected people being provided sufficient resources and opportunities to share in a project's benefits. The efforts of subsidiaries are complementary to the Government's schemes in rural development and the concurrence, approvals and support from concerned Government authorities will be sought.

H. In parallel, subsidiaries will work closely with non-governmental organizations of proven repute which are legally constituted and recognized and also have the confidence of the project-affected people, in the preparation and implementation of rehabilitation plans.

I. Corporate Social Responsibility (CSR) : Activities shall be intensified in and around the villages where land is being acquired in accordance with the CSR Policy of Coal India.

J. Actual implementation of R&R package must follow a detailed survey of the project-affected villages to formulate the list of persons/families affected by the project, nature of the affect, the likely loss of income, etc. For this purpose, if necessary, the services of a reputed NGO with an impressive record of integrity and performance may be engaged.

3. SCOPE:

This Policy may be called "Rehabilitation and Resettlement Policy of Coal India Limited-2012". It extends to the Coal India Limited and its subsidiary companies in India. It shall come into force from the date of its approval by the CIL Board and is applicable to all cases in which land is taken after the date of approval by the CIL Board. While implementing the policy it is to be ensured that the provisions of the concerned Acts applicable and Rules mentioned there under shall not be violated.

4. Definitions

(a) "**affected family**" means:

(i) a family whose primary place of residence or other property or source of livelihood is adversely affected by the acquisition of land (including direct negotiation) for a project or involuntary displacement for any other reason; or

(ii) any tenure holder, tenant, lessee or owner of other property, who on account of acquisition of land (including plot in the *abadi* or other property) in the affected area or other wise, has been involuntarily displaced from such land or other property; or

(iii) any agricultural or non-agricultural labourer, landless person (not having homestead land, agricultural land, or either homestead or agricultural land), rural artisan, small trader or self-employed person, who has been residing or engaged in any trade, business, occupation or vocation continuously for a period of not less than three years preceding the date of declaration of the affected area, and who has been deprived of earning his livelihood or alienated wholly or substantially from the main source of his trade, business, occupation or vocation because of the acquisition of land in the affected area or being involuntarily displaced for any other reason.

(b) "***family***" includes a person, his/her spouse, son including minor sons, dependant daughters, minor brothers, unmarried sisters, father, mother residing with him or her and dependent on him/her for their livelihood, and includes "***nuclear family***" consisting of a person, his/her spouse and minor children. Provided that where there are no male dependants, the benefit due to a land loser may devolve on dependent daughter nominated by the land loser.

(c) "land owner" includes any person—

(i) whose name is recorded as the owner of the land or part thereof, in the records of the concerned authority; or

(ii) who is entitled to be granted Patta rights on the land under any law of the State including assigned lands; or

(iii) who has been declared as such by an order of the court or District Collector.

(d) **Displaced person** - means and includes any person who is deprived of his homestead on account of acquisition. Provided that the person/family who does not ordinarily reside in the homestead land acquired for the project can be termed "Displaced" but he will be eligible for compensation only for homestead and not for livelihood.

(e) **Ordinarily resides**" shall mean residing in the homestead / acquired land for a period more than 6 months every year for at least the preceding 5 years.

5. Socio-economic Survey and preparation of RAP.

A baseline socioeconomic survey will be carried out to identify the PAPs who are enlisted to receive benefits in line with Coal India's Resettlement and Rehabilitation Policy. This survey will be conducted within two months of notification under the relevant land acquisition Acts by the subsidiaries with the help of reputed independent institutional agencies, who are well versed with the social matrix of the area.

The basic objective of the socio-economic study will be to generate baseline data on the social and economic status of the population who are likely to lose their means of livelihood or homestead due to the acquisition of the land for the project. The data base will be used to formulate a viable and practical Rehabilitation Action Plan (RAP) for the affected persons in line with their entitlements. Digital Satellite Maps would also be prepared of the project Area freezing the dwelling units and habitations existing at the time of negotiation for Land Acquisition wherever feasible. The RAP will also address the following-

(A) Implementation, Monitoring and Evaluation, Dispute Mechanism

The rehabilitation action plan will address the following:

i) The project design, including an analysis of alternative designs aimed at avoiding or minimizing resettlement;
ii) Socio-economic survey and activities to ensure restoration of incomes of PAPs in line with Coal India's Resettlement and Rehabilitation Policy;
iii) Description of the institutional and other mechanisms for provision of entitlements;
iv) Time table for the acquisition and preparation of the resettlement site(s);
v) The cost and budgets for the resettlement and rehabilitation of PAFs;
vi) Project-specific arrangements to deal with grievances of PAFs; and
vii) Time tables, benchmarks and arrangements for monitoring the resettlement and rehabilitation effort.

The RAP will be formulated in consultation with PAPs and State government.

(B). Environment Impact Assessment (EIA) will be conducted as per any law, rule and regulation of the locality in which the land has been acquired

6. Eligibility Criteria -

(A) Eligibility Criteria for Economic Rehabilitation Benefits

This benefit shall accrue only to Entitled Project Affected Person. Entitled Project Affected Person shall be one from the following categories.

(i) Persons from whom land is acquired including tribals cultivating land under traditional rights.
(ii) Persons whose homestead is acquired.
(iii) Sharecroppers, land lessees , tenants & day labourers.
(iv) Tribal dependent on forest produce as certified by the District Forest Officer/Revenue Authorities.

(B) Eligibility Criteria for Resettlement Benefits

1. Only a 'Displaced' family / person shall be eligible for resettlement benefits.

2. A family/person shall be termed 'displaced' and hence eligible for resettlement benefits if such family/person has been a permanent resident and ordinarily residing in the project area on the date of publication of notification U/S 9 of CBA(A&D) 1957 / U/S 11 of LA Act, 1894/ Or both/ on the date of the land vested with the State/ Central government as the case may be

and

(a) on account of acquisition of his/her homestead land / structure is displaced from such areas

or

(b) He/she is a homesteadless or landless family/person who has been/is required to be displaced.

7 .Census & Identification of displaced families:

1. Within two months of publication of notice U/S 4(1) of the Land Acquisition Act or U/S 7(1) of CBA (A D) Act 1957 for acquisition of land for the project a census would be undertaken in the manner to be decided by the Collector / project authority for identification of displaced families and for preparing their socio-economic profile and list of eligible persons for the purpose of receiving Rehabilitation & Resettlement Benefits.

2. A photo identity card to each Entitled Project Affected Person shall be issued under the signature of the Collector / project authority concerned indicating the following particulars:

(a) Name of the village/GP/PS :
(b) Name, Father's name and address of the head of the family
(c)Category of entitlement :
(d)Whether S.C./S.T./O.B.C./General :
(e)Age,Sex,educational qualification of the members of the family :

8. Types of Compensation and Rehabilitation Entitlement

Option to the land losers regarding Rehabilitation & Resettlement Benefit - The land losers shall have the option for Rehabilitation and Resettlement benefits in accordance with the awards for each affected family in terms of the entitlements passed by the Concerned Collector of the State or as per this Policy with the consent of the concerned Collector.

8.1 Eligibility and Compensation

The table below shows the compensation and rehabilitation benefits will be offered by the subsidiaries for each Project Affected Person or family, affected by one of their projects. Evidence to the effect that a person is a legitimate PAP will need to be provided in the form of a written legal document, or reference to a record, such as a revenue officer certificate, electoral roll, ration card or school record.

Category of Persons affected by the Project	*Compensation and Rehabilitation entitlement option*
	Provisions
(i) Persons (including tribals cultivating land under traditional rights) from whom land is acquired	All land owners with titles will receive monetary compensation for the land acquired from them. The value of the land is determined on the basis of prevailing legal norms. *In respect of tribals cultivating land under traditional rights, authentication of land held under traditional rights by state authorities will be necessary.* In addition to above the following shall apply.

Category of Persons affected by the Project	*Compensation and Rehabilitation entitlement option*
	Provisions
	A). Land Compensation - Land compensation shall be paid as per the provisions of the concerned Act or State Govt. notification. Where no notification of the State Govt. is available the concerned subsidiary Board may decide on the rate of compensation keeping in view the compensation provided by the neighboring states. Authentication of land held under traditional rights by state authorities will be necessary. In addition to above Solatium will be paid as per provisions of the concerned Act / as imposed by the Concerned State Govt. Escalation of land compensation – Escalation will be paid as per provisions of the concerned Act / as imposed by the Concerned State Govt. or Escalation at the rate of 12% per anum for a maximum period of three years. **(B): Employment provision:** Apart from payment of the land compensation, employment may be given in the following manner – **1)** The maximum total number of employments that may by provided to the land losers would be limited to the total no. of acres of land acquired divided by two. However employments will be released in proportion to the land possessed. **2)** For every two acres of land one employment can be considered; 3) Subsidiaries of CIL may give an option to the Land losers having less than two acres of land to club together their land to the extent of two acres and nominate one of the land losers among the groups or their dependent for employment under package deal or employment under Descending order system by preparing the list of eligible land oustees in the descending order of land lost subject to the cut off equivalent to the total number of permissible employments or any other method with the approval of the respective Board of the subsidiary. **4)** The land loser must be a domiciled resident/Mool Niwasi and the certificate to this effect shall be issued by the concerned State Authority **5)** The modalities for offering employment shall be such as may be approved by the Board of the Subsidiary companies as per the unique conditions of the subsidiary provided that - **a)** The initial employment shall be given with pay of Category-I pay scale of NCWA, with training period of 6 months. b) In the seniority list, the seniority of the appointee should be reflected in appropriate manner in order to keep the senior most as senior. **c)** The land loser trainees shall be posted as per requirement, including underground duties.

Category of Persons affected by the Project	*Compensation and Rehabilitation entitlement option*
	Provisions
	(C): Lumpsum Monetary Compensation – 1. All the land losers who are not eligible for employment as above shall be entitled to receive monetary compensation in lieu of employment at the rate of Rs.5,00,000/- (Five Lakhs) for each acre of land on pro-rata basis . 2. Land losers who are offered employment as per principle specified in point No (8.(i)B) above will have the option either to opt for employment or to forego employment and opt for monetary compensation at the rate of Rs.5,00,000/- (Five lakhs) for each acre of land on pro-rata basis with minimum of Rs. 50,000 (Fifty thousands) provided that the employment thus surrendered shall not be available for offer to any other person and will stand lapsed from the total sanctioned number of employments as specified in point No.(8.(i)B1). 3. The Land losers who have clubbed their land in Package Deal can claim employment for only one land loser of the clubbed two acres of land and remaining land losers of the package cannot claim either employment or lump sum monetary compensation in lieu of the land contributed by them. 4. Annuity – All land losers who are entitled to get lump sum monetary compensation may opt for payment of compensation amount in the form of annuity made payable to the land losers monthly, annually or at such intervals (not less than one year) as may be opted for by him. The annuity be paid for a maximum period extending to 60 years of age or the life of the project for which the land has been acquired, whichever is earlier. **Note:** *A person receiving a job forgoes all claims to above compensation and a person receiving above compensation forgoes all claims to employment.*
(ii) Person whose homestead is acquired	I. Compensation for homestead shall be paid as per the standard valuation method of the L.A Act. of the concerned State Govt. II. One time lump sum payment of Rs.3,00,000/- (three lakhs),shall be paid in lieu of alternate House site, Assistance in designing Shifting Allowance,compensation for construction of cattle shed , Monetary compensation for construction of work shed etc.The compensation shall be paid to displaced persons only after vacation and demolition of the homestead/ work shed etc. III. Subsistence allowance :Each affected displaced family will get subsistence allowance at the rate of 25 days (Minimum Agricultural Wage) per month for one year.

Category of Persons affected by the Project	*Compensation and Rehabilitation entitlement option*
	Provisions
(iii)Sharecroppers, land lessees, tenants and day labourers	The subsidiary will assist PAP to take-up non farm self employment through petty contracts or formation of cooperatives. If such co-operatives will not be entitled for awarding work as per Manual for lack of experience, the said co-operative will be facilitated by awarding small jobs to acquire experience after relaxation of the provisions of the Manual pertaining to experience with approval of the Subsidiary Boards. Subsequent jobs may be awarded after getting report of the timely completion / quality / of the awarded jobs from the concerned Department or contractors. Contractors will also be persuaded to give job to eligible PAPs on a preferential basis, where feasible as per terms of contract.
(iv)Landless tribals, Tribal dependent on forest produce	The subsidiary will assist PAP to establish non farm self employment through the provision of infrastructure, petty contracts or formation of cooperatives and encourage provisions of Jobs with contractors. Contractors will be persuaded to give jobs to eligible PAPs on preferential basis, where feasible. - In addition, the subsidiaries will shift the tribal community as a unit and provide facilities to meet the specific needs of the tribal community that will allow them to maintain their unique cultural identity. - Tribal affected family will be given one time financial assistance of 500 days of MAW for loss of customary right or usages of forest produce. Loss of customary rights needs to be authenticated by the district authority. - Tribal affected families resettled out of the district shall be given 25% higher rehabilitation and resettlement benefit.

9. Resettlement & Rehabilitation Committee - A Committee will be constituted at project Level under the chairmanship of the Collector to be called the Rehabilitation and Resettlement Committee with the following objectives to monitor and review the progress of implementation of the Rehabilitation and Resettlement scheme and to carry out post-implementation social audits in consultation with the village panchayat in rural areas and municipality in urban areas in the manner will be decided by the concerned State Govt.

I. To approve the list of land losers and other PAPs;
II. To approve the list of persons eligible to be offered employment as per R&R Policy.
III. To approve the detailed Rehabilitation Plan for the project in consultation with the displaced persons and Gram Sabhas.
IV. To expedite issue of domicile certificates and other necessary documentation required for State Authorities;
V. To monitor and review the progress of the Rehabilitation Scheme, grant of benefits and handing over of possession of land in a smooth manner;
VI. To facilitate the land acquisition process in any other manner as may be required including resolution of disputes;
VII. To carry out post implementation social audit in consultation with the authorities.

10. Community facilities - The subsidiary will provide at the resettlement site a school, road with street light, pucca drain, pond, dugwell and/or tubewell for drinking water supply, community center, place of worship, dispensary, grazing land for cattle and play ground. Similar infrastructural facility, if necessary, will be extended to the host locality. The community facilities and services would be available to all residents of the area, including PAPs and the host population.

The approach for operation of community facilities would be flexible and all efforts will be made to involve the State and local self Government / Panchayat for operating the facilities. To achieve this, subsidiaries will pursue with these agencies to ensure the same. The planning of the community facilities and their construction should be undertaken in consultation with the affected community.

11. Corporate Social Responsibilities - This should be as per Company's Corporate Social Responsibility (CSR) Policy.

12. Monitoring and Evaluation Mechanism.

The RAP will be monitored and evaluated periodically after the completion of the land acquisition process.

I. The resettlement and rehabilitation activities are the responsibility of a separate group, both at the projects and corporate level, which will be constituted for planning, implementation, monitoring and evaluation of the Rehabilitation Action Plan. At the corporate level the group will be headed by a senior manager, whereas at the project, an executive of the rank of manager will head the group. The project group should have at least one member with social science qualification / experience and skills.

II. The project group will closely interact with the state authorities during the implementation of the RAP. Although the subsidiaries will develop the plots and infrastructural facilities in the resettlement colony and actively implement the RAP, assistance of State authorities will be taken for administrative services such as allotment of land. Implementation will be planned, monitored and corrective measures will be incorporated in the RAP, if needed. In addition to the State Government, the PAPs, the village leaders including the Pradhans and NGOs will be consulted and associated with the implementation of the RAP

III. The Resettlement and Rehabilitation Cell at the corporate level will evaluate the implementation of the RAP after its completion.

13. **Flexibility to the Subsidiary Companies** – The Subsidiary Companies Boards have been authorised to approve necessary modifications in the R&R Policy with reference to unique conditions prevailing at the concerned Subsidiaries as the policy is not exhaustive.

(The above list is only indicative and not exhaustive)

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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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).

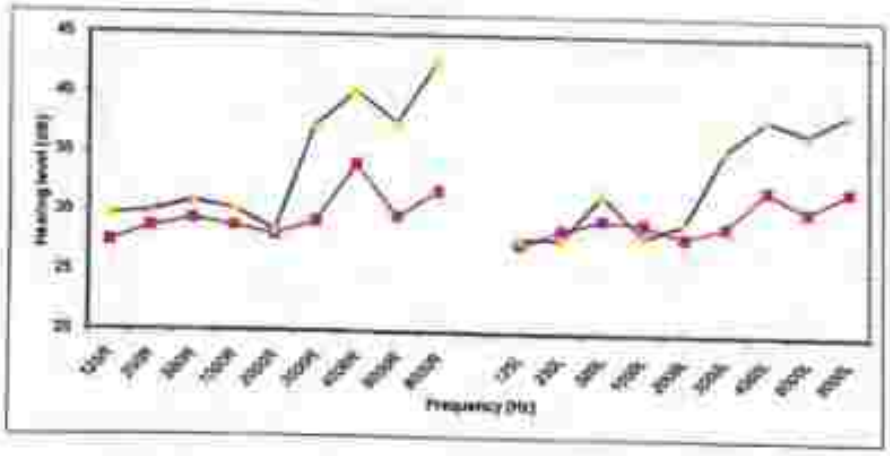
Table 14: Ophthalmological findings of study subjects

	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

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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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REFERENCES:

1. Finkelman RB.1995. Modes of occurrence of environmentally-sensitive trace elements in coal. In: Environmental Aspects of Trace Elements (Swaine DJ, Goodarzi F, eds). Boston: Kluwer Academic Publishers, 24–50.
2. "Coal & Lignite - Indian Minerals year book - 2011". Indian Bureau of Mines, Government of India. October 2012. Retrieved 26 December 2013
3. Castranova V, Vallyathan V. Silicosis and coal workers' pneumoconiosis. Environ Health Perspect 2000; 108(suppl 4):675–684.
4. Demchak J, Skousen J, McDonald LM. Longevity of acid discharges from underground mines located above the regional water table. J Environ Qual. 2004; 33:656–668.
5. Attfield MD, Kuempel ED. Pneumoconiosis, coalmine dust and the PFR. Ann Occup Hyg 2003; 47:525–529.
6. Ruckley VA, Gauld SJ, Chapman JS, Davis JM, Douglas AN, Fernie JM, et al. Emphysema and dust exposure in a group of coal workers. Am Rev Respir Dis. 1984; 129:528–532.
7. Soutar CA, Hurley JF, Miller BG, Cowie HA, Buchanan D. Dust concentrations and respiratory risks in coalminers: key risk estimates from the British Pneumoconiosis Field Research. Occup Environ Med. 2004; 61:477–481.
8. Rom WN. Basic mechanisms leading to focal emphysema in coal workers' pneumoconiosis. Environ Res 1990; 53:16–28.
9. Rom WN. Relationship of inflammatory cell cytokines to disease severity in individuals with occupational inorganic dust exposure. Am J Ind Med 1991; 19:15–27.
10. Brown GM, Donaldson K. Inflammatory responses in lungs of rats inhaling coalmine dust: enhanced proteolysis of fibronectin by bronchoalveolar leukocytes. Br J Ind Med 1989; 46:866–72.

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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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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.

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Prof. B. Venkatesh Kumar
Director
National Corporate Social Responsibility Hub
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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

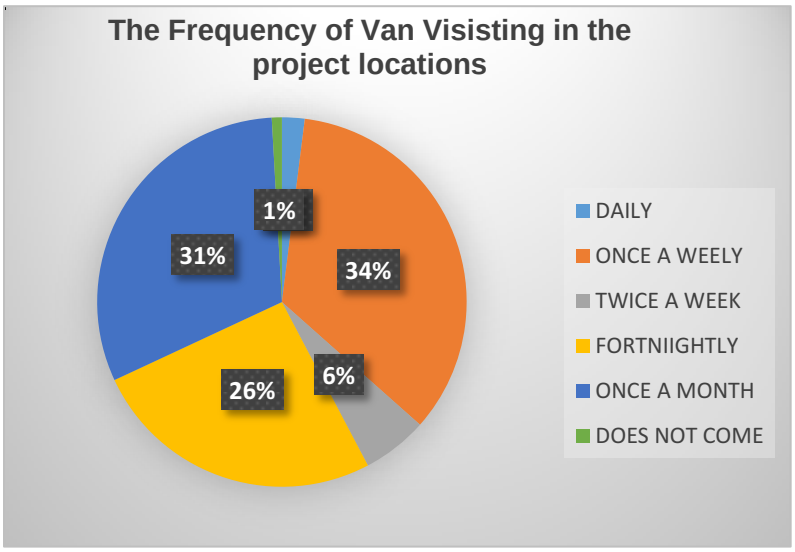


Figure 1 – Frequency of Van Visiting in the project locations

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.

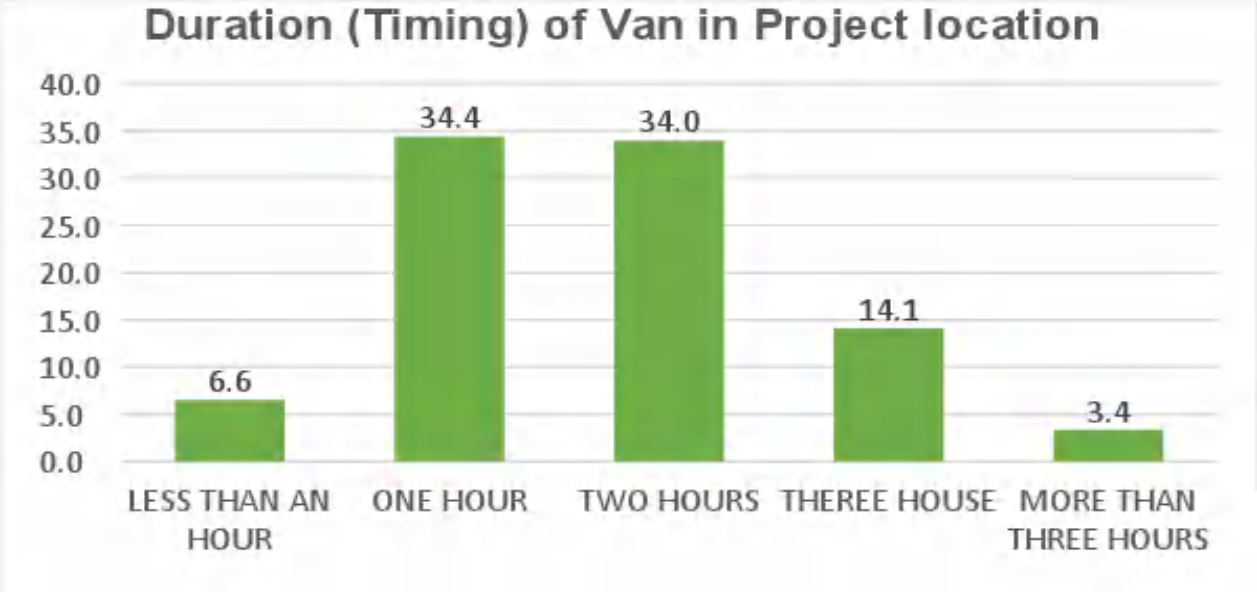


Figure 2 – Duration (Timing) of Van in project location

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

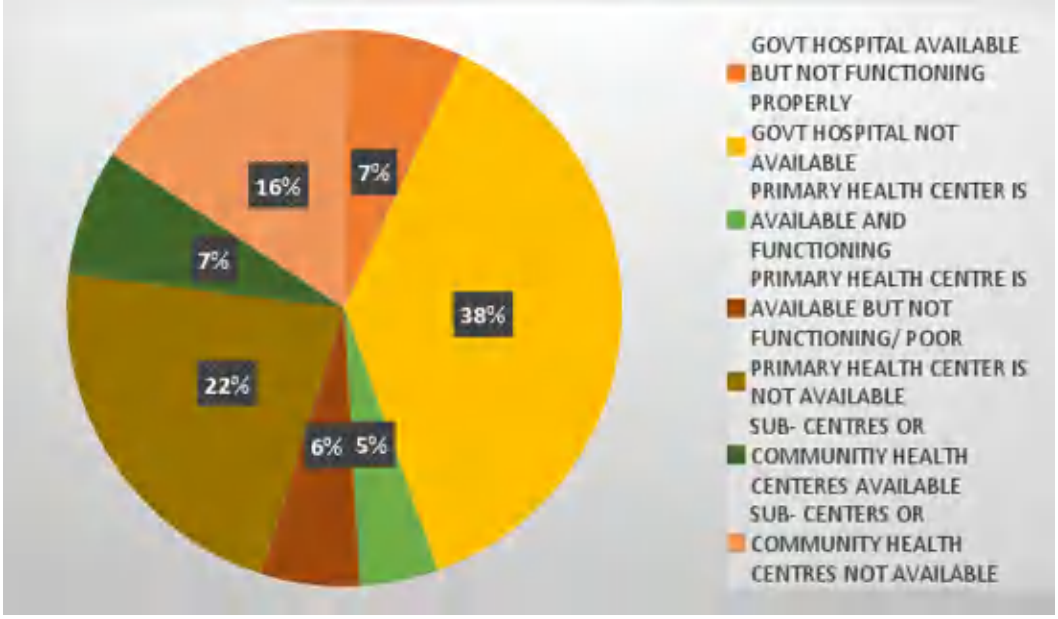


Figure 3 – Availability of health services

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.

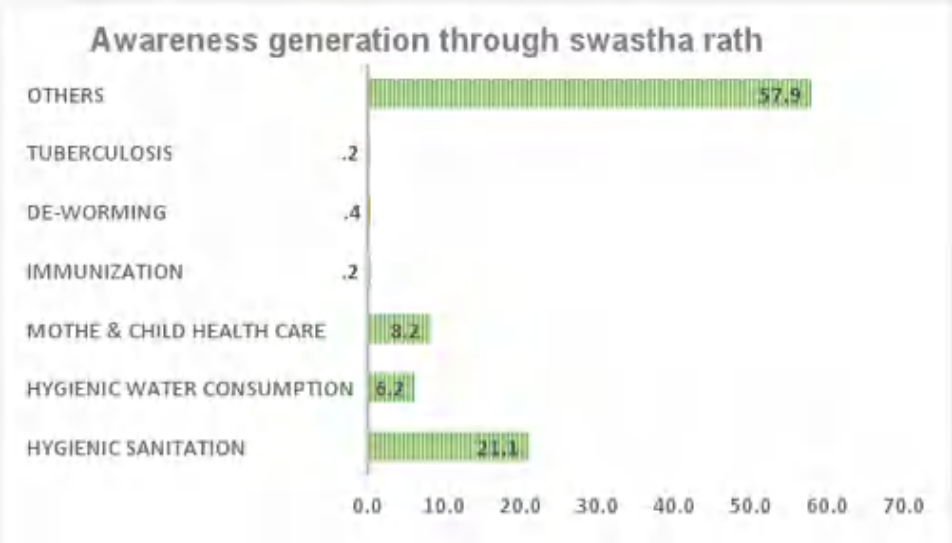


Figure 4 – Awareness generation through swastha Rath

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

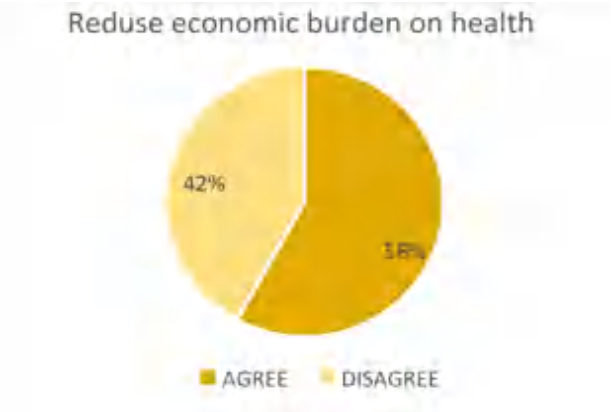


Figure 5 – Reduction in economic burden on health

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

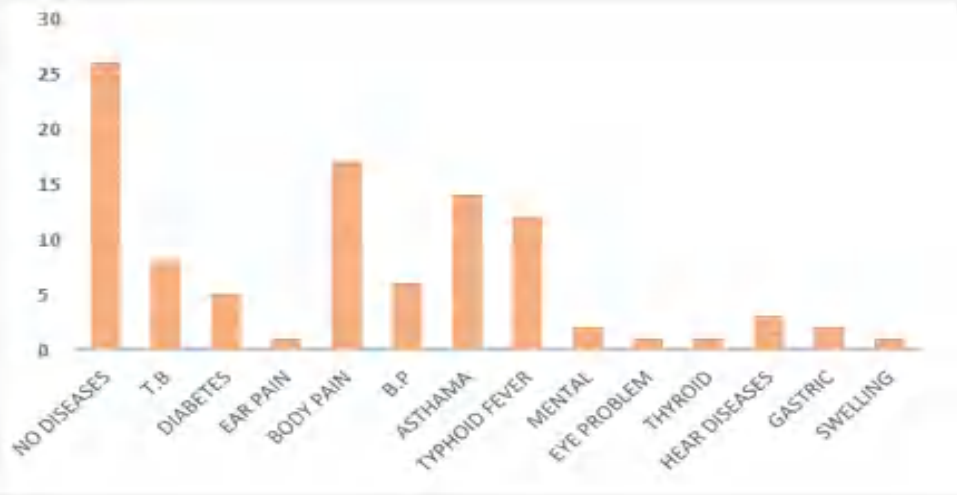


Figure 6 – Major ailments in the families

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

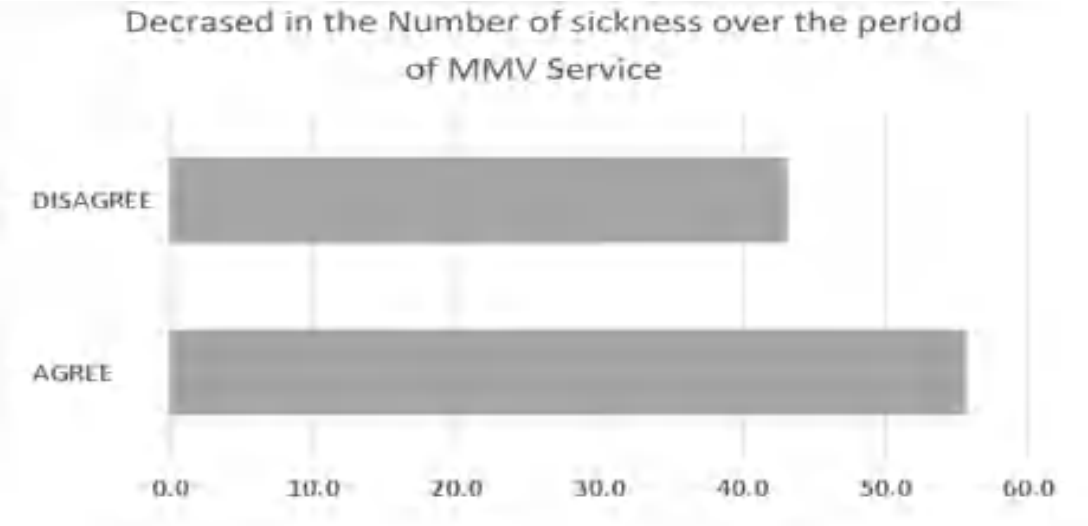


Figure 7 – Decrease in number of sicknesses over the period of MMV service

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

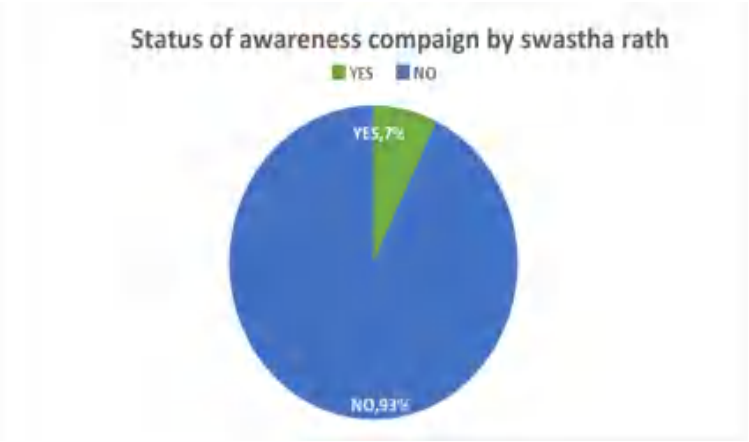


Figure 8 – Status of awareness campaign by Swastha Rath

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

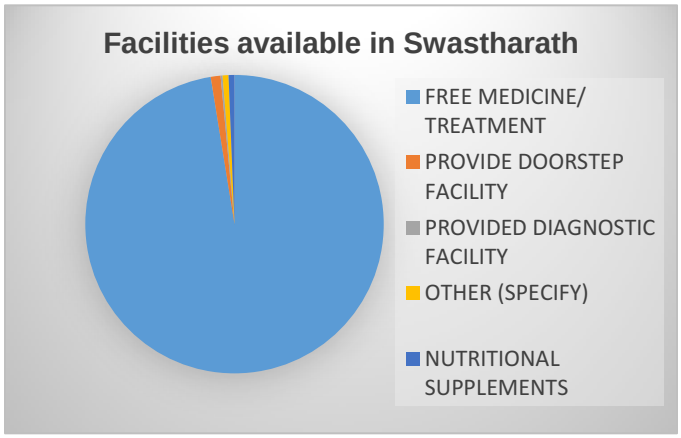


Figure 9 – Facilities available in Swastha Rath

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

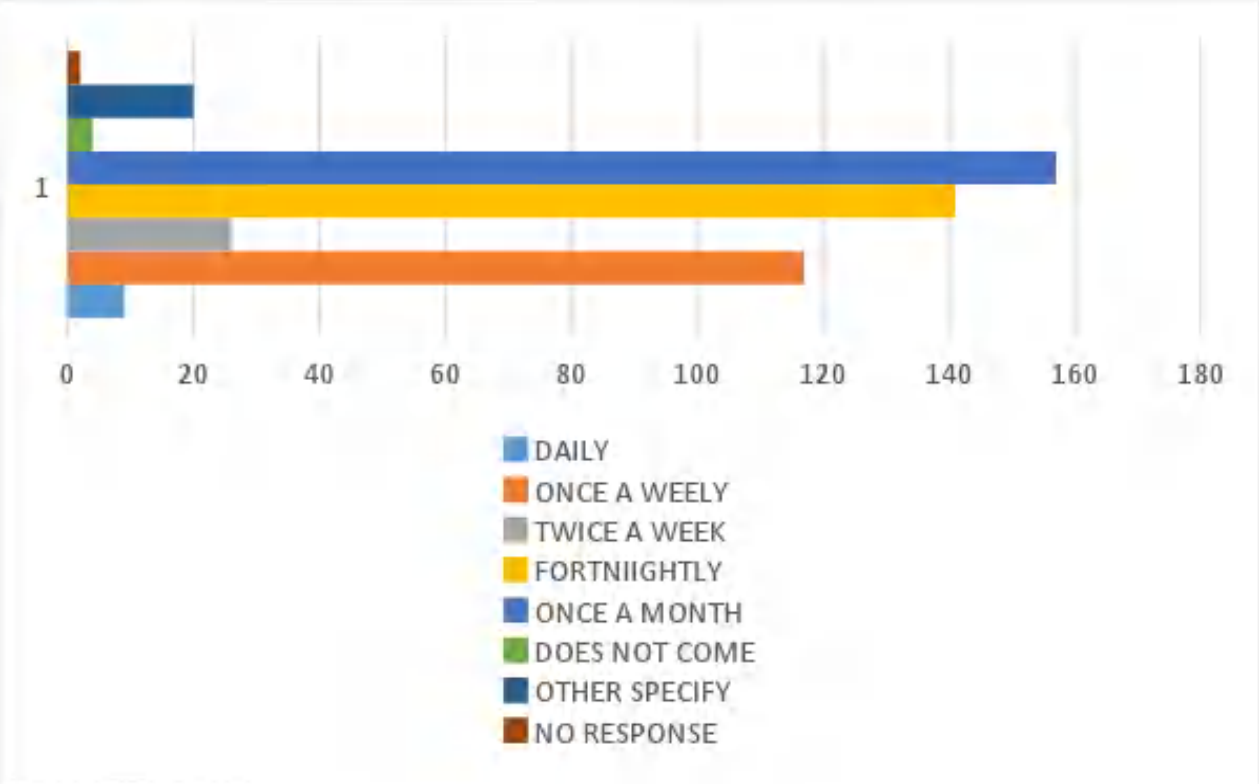


Figure 10 – Frequency of Swastha Rath

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.

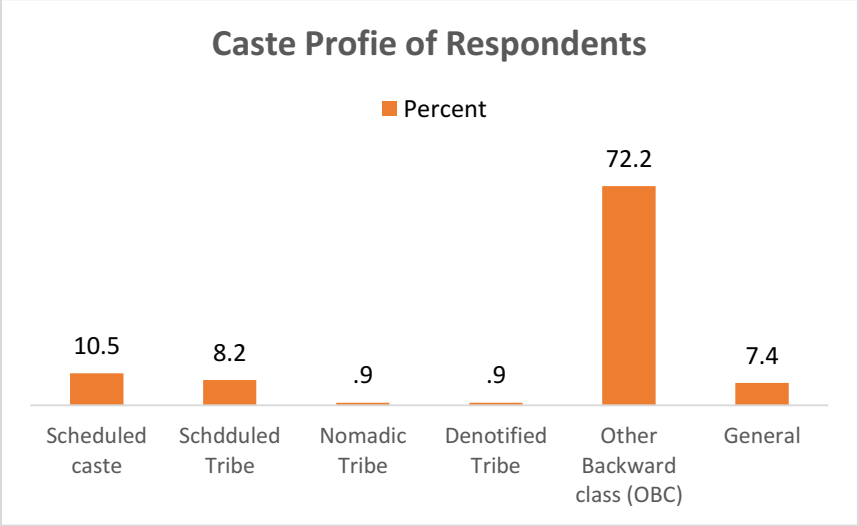


Figure 11 – Caste profile of respondents

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.

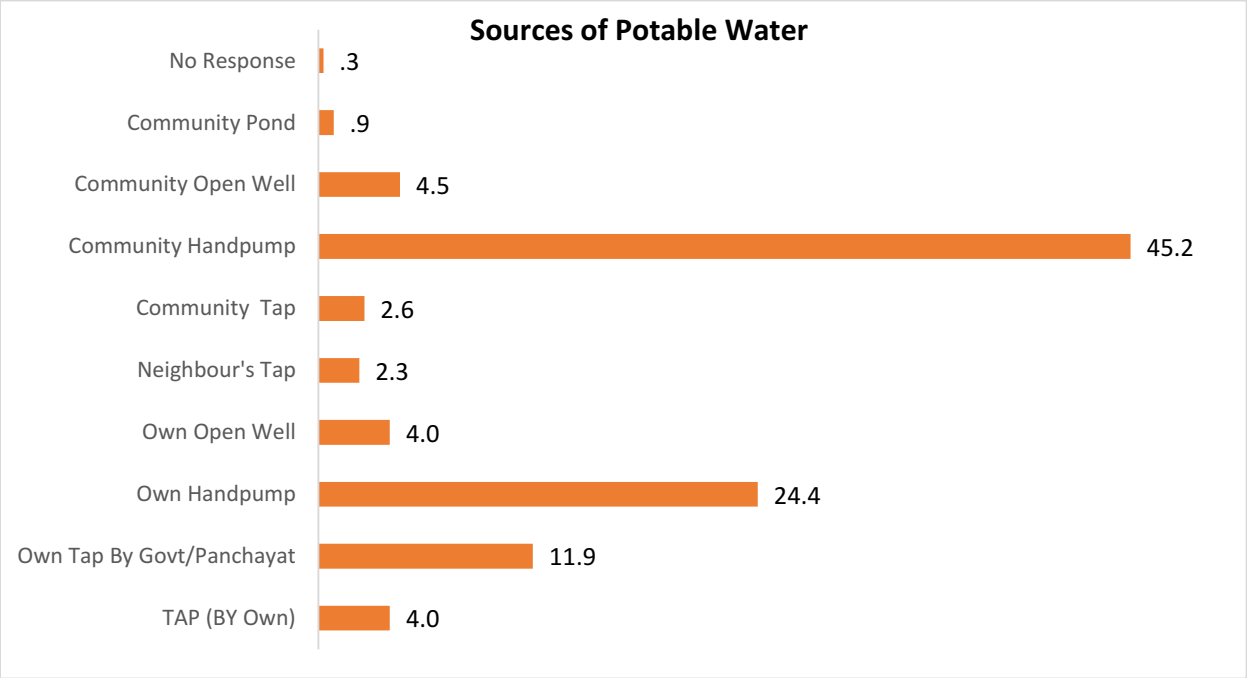


Figure 12 – Sources of potable water

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.



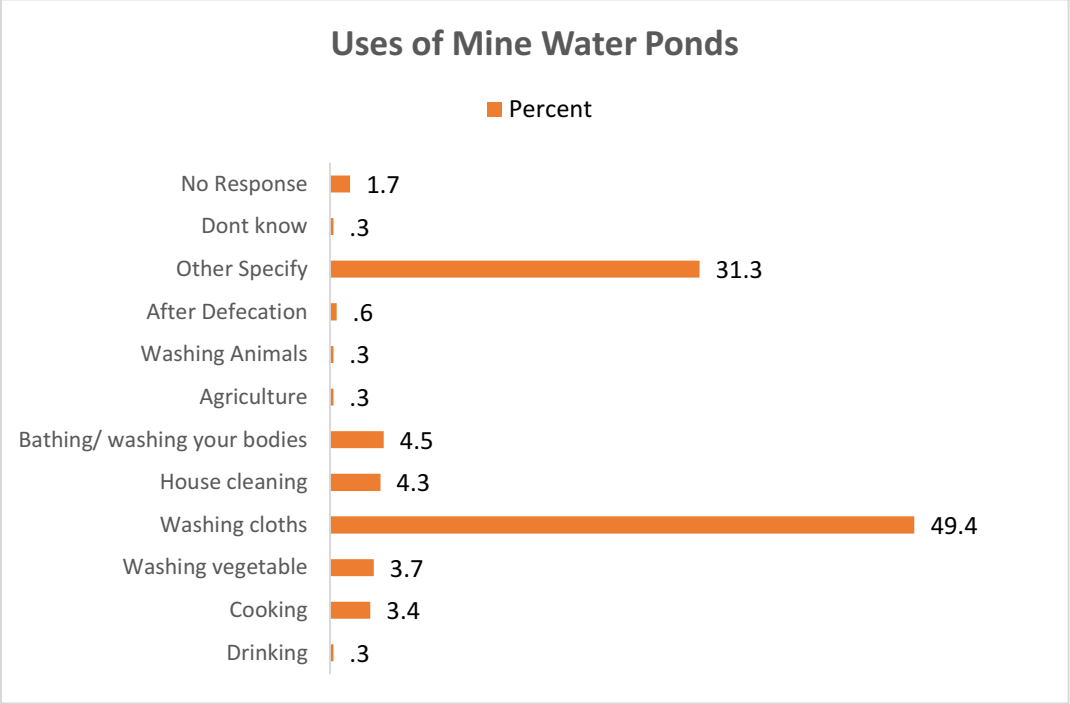


Figure 13 – Uses of mine water ponds

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).

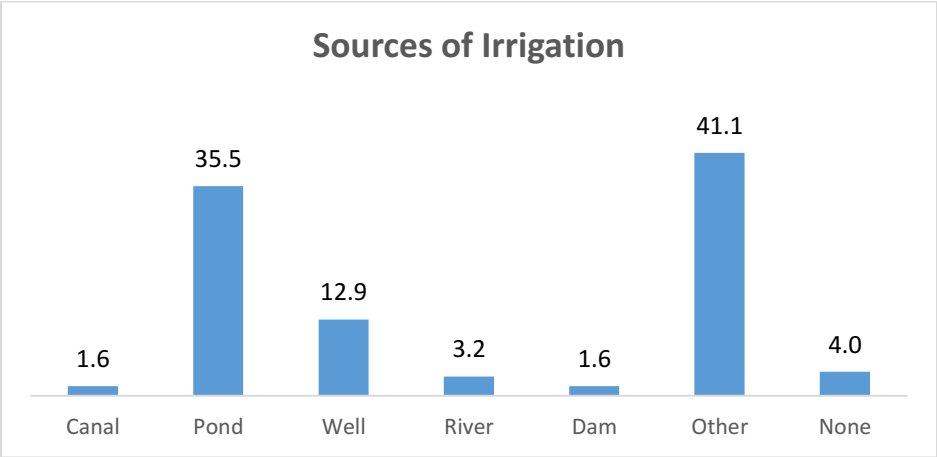


Figure 14 – Sources of irrigation

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*.

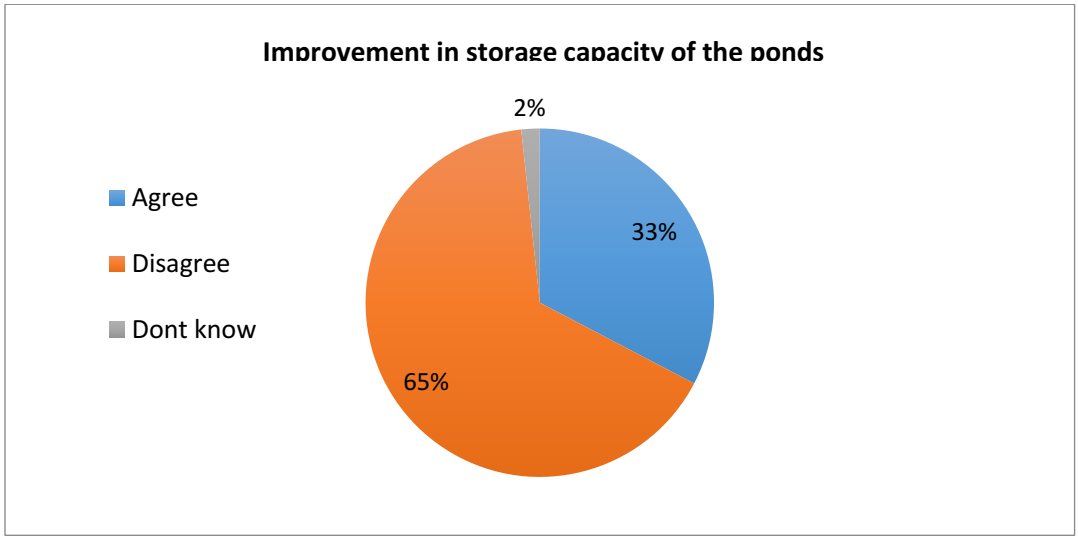


Figure 15 – Improvement in storage capacity of the ponds

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.

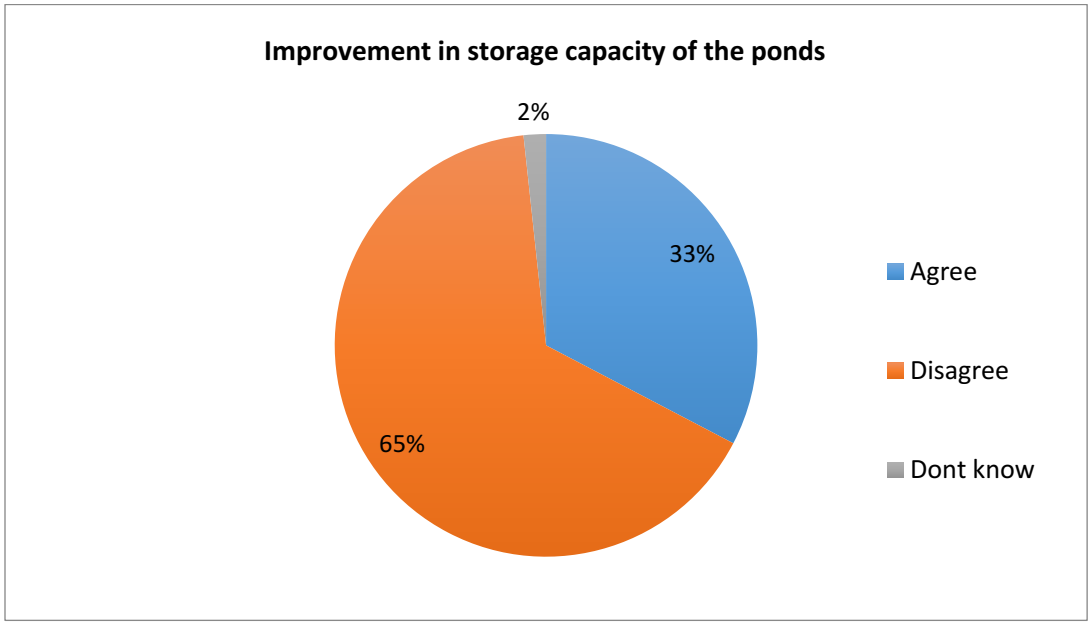


Figure 16 - Improvement in storage capacity of the ponds

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.

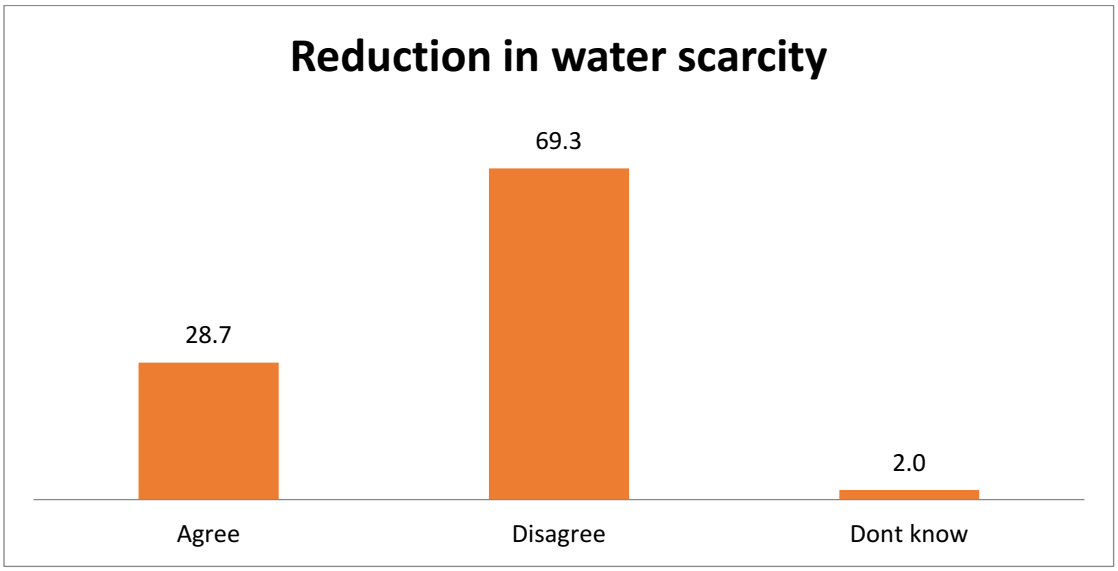


Figure 17 – Reduction in water scarcity

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.

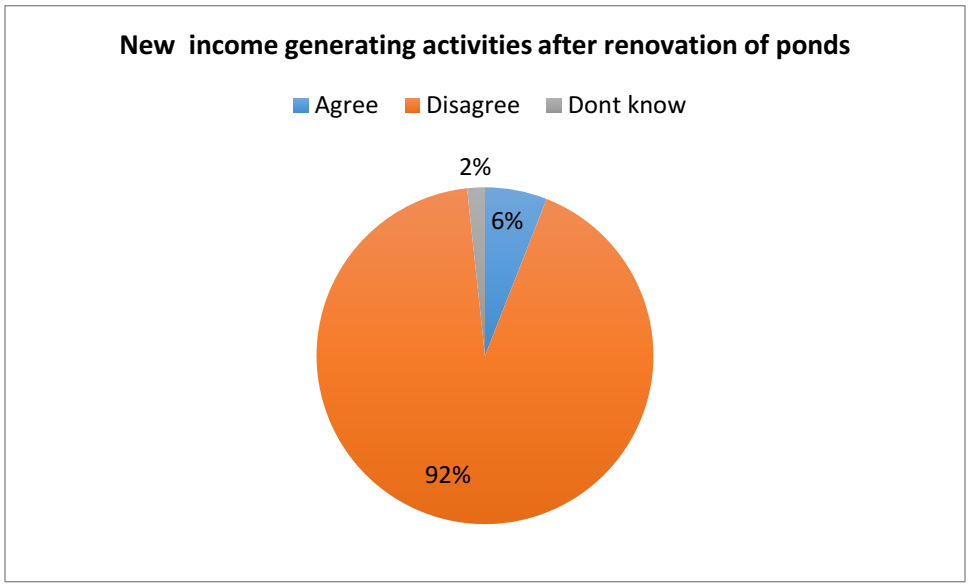


Figure 18 - New income generating activities after renovation of ponds

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.

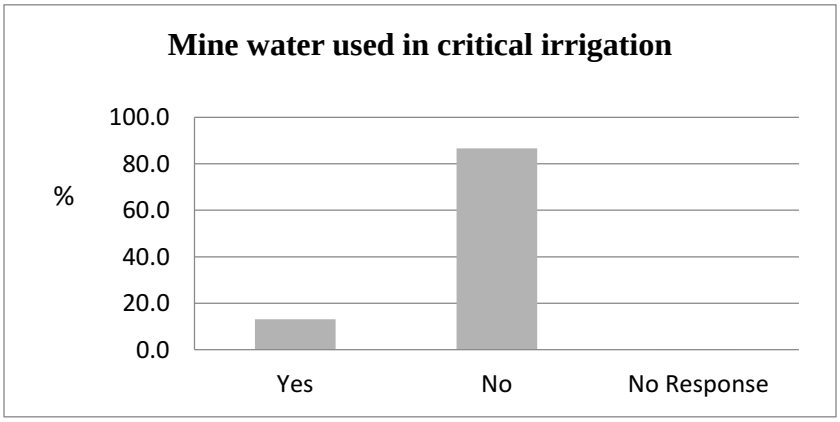


Figure 19 – Mine water used in critical irrigation

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.

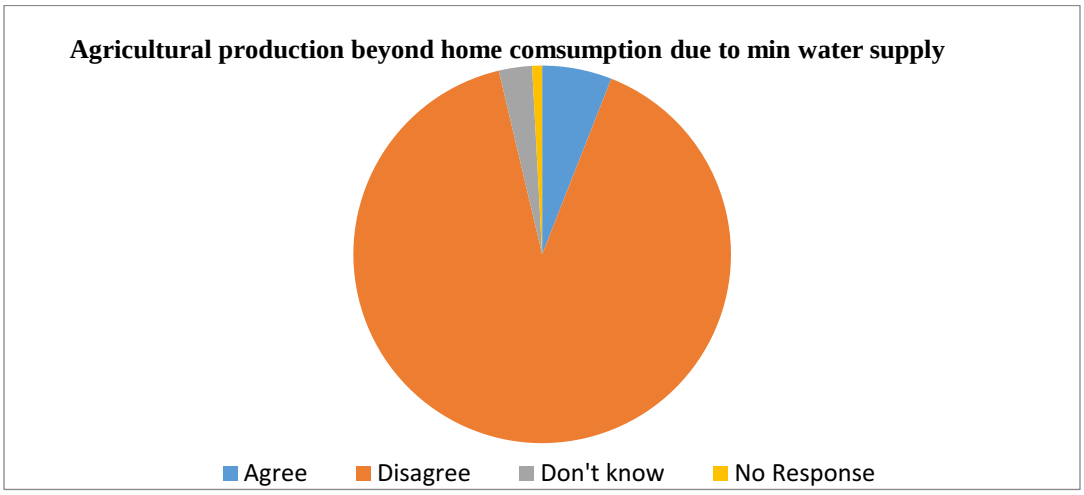


Figure 20 - Agricultural production beyond home consumption due to min water supply

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.

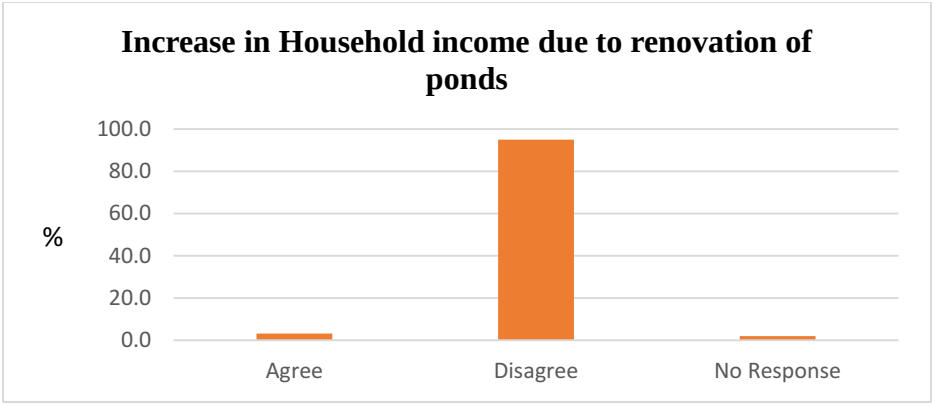


Figure 21 - Increase in Household income due to renovation of ponds

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.



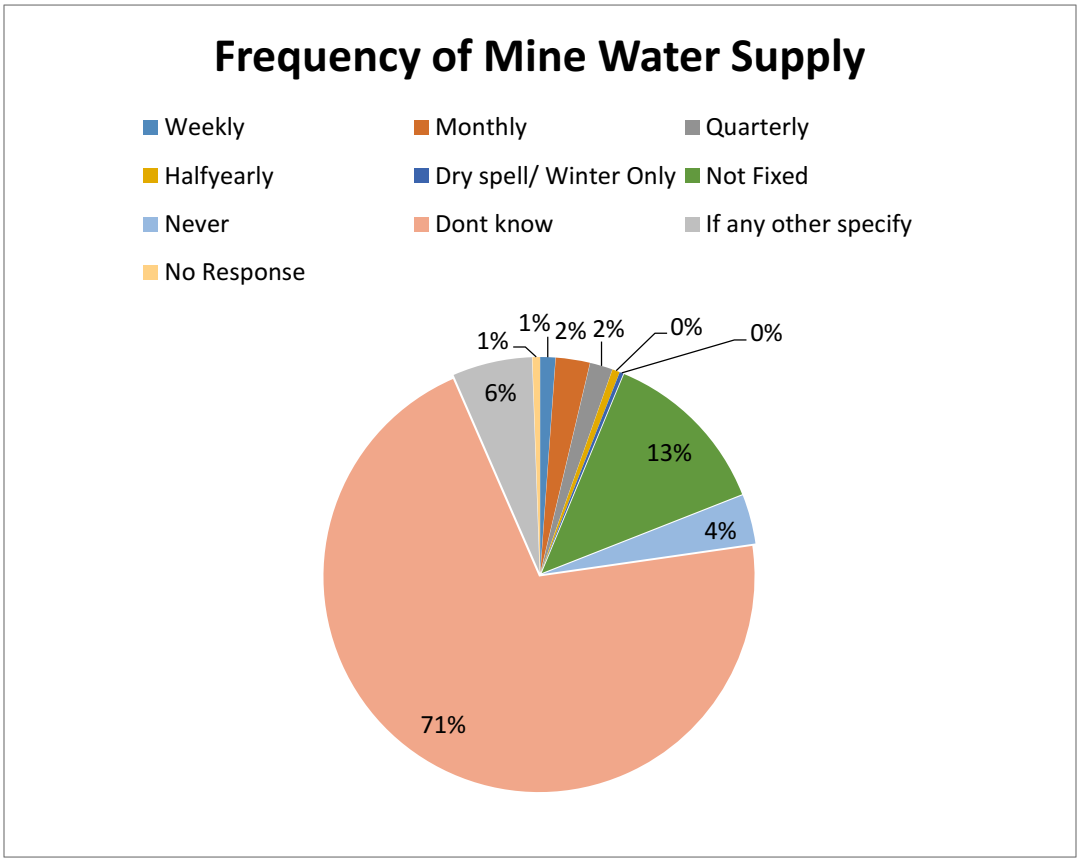


Figure 22 – Frequency of mine water supply

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 – 2023-24)

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

JHARIA COALFIELD AND RANIGANJ COALFIELD (PART)

For
(BHARAT COKING COAL LIMITED)

(A Subsidiary of Coal India Limited)

KOYLA BHAWAN (DHANBAD)

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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: 1264.10 mm Rainfall data given in **Annexure-IV**.
5	Geological Formations	Gondwana Formation (Talchir Formation, Barakar Formation, Barren Measure Formation & Raniganj Formation)
6	Aquifer System	Unconfined/Phreatic Aquifer – thickness 25 m (Avg.) Semi-confined to confined Aquifer – thickness from 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 140 nos. of monitoring stations 48 nos located within core mining area and rest comes within Buffers zone. 44 Nos. of Groundwater monitoring well (Dug Wells) network established by CMPDI to record groundwater level data in and around the Core Zone of JCF and 4 Nos. of Groundwater monitoring well (Dug Wells) in RCF (CV Area).
9	Groundwater Levels Below Ground Level (bgl)	JCF area: Pre-monsoon – 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 (GWRA-2022)

GROUNDWATER LEVEL & QUALITY REPORT FOR CLUSTER OF MINES OF BCCL

1.0 INTRODUCTION

1.1 LOCATION DETAILS AND BRIEF ABOUT THE PROJECT

The 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 15 Cluster of mines. The data collected shall be submitted to the MoEF&CC, CPCB & SPCB within stipulated timeframe. The work is being done yearly and required to be continued as per the specific condition mentioned invariably in Environmental Condition (EC) for all of the Clusters of BCCL.

1.3 SCOPE OF THE STUDY:

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

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

File No. 08HBDD/JRRI/BCCL/ENV/0003/2018-BD Divn.-CMPDI (Computer No. 68378)
Receipt No : 188686/2018/O/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).

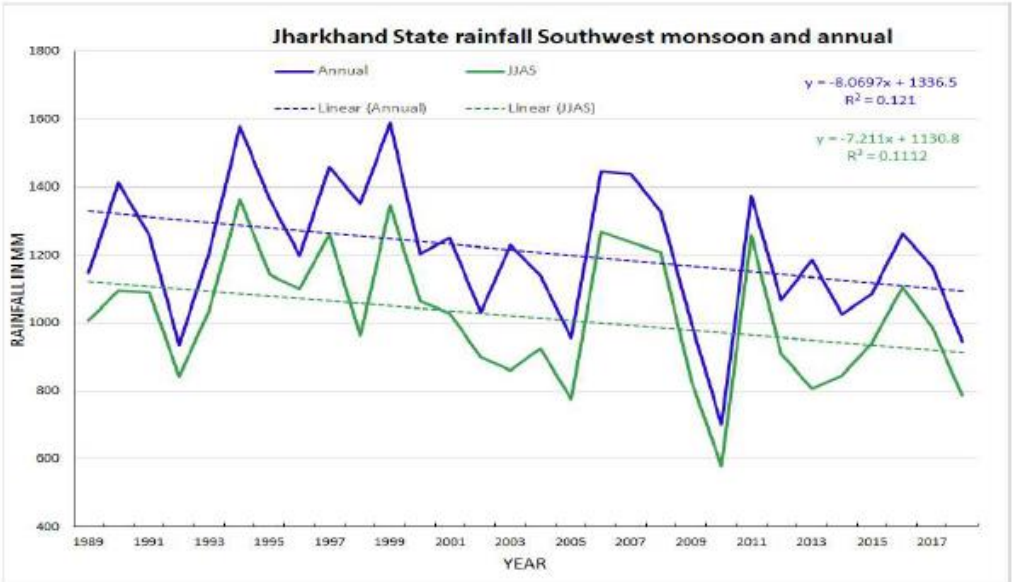


Fig-1.

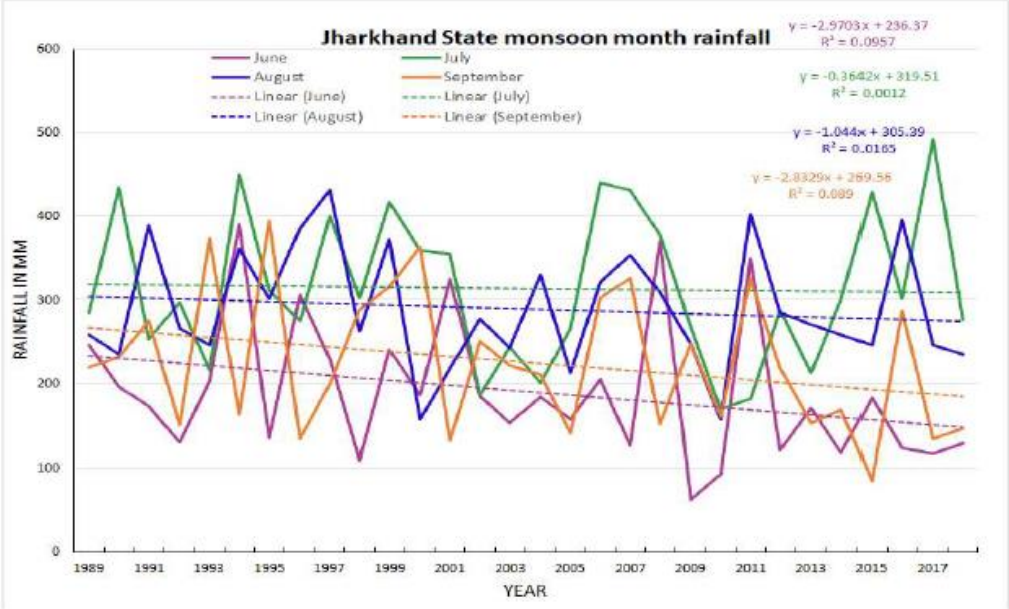


Fig-2.

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 140 monitoring stations out of which 48 located within core zone and rest falls in Buffer zone. Total 44 nos. dug well within JCF and 04 nos. dug well within RCF (part) area (Details of the Hydrograph stations & water level given in **Annexure-V, VA** & **VB**) spread over the entire BCCL leasehold area, **Plate-I**. Water level data collection in all monitoring stations has been done on quarterly basis (May'23, Aug'23, Nov'23 and Jan'24).

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 2023 (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
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

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-2023-24]*	
		Pre-monsoon (May'23)	*Post-monsoon (Nov'23)*
Sedimentary (Gondwana Formation / Core Zone)	Non-mining	3.0-12.0	1.0-8.0
	Mining	1.0-10.0	0.50-6.50
Metamorphics (Hard rock)	Peripheral part of the Coalfield	3.0-12.0	1.0-8.0

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

Table – 6: Average hydraulic gradient

Sl. No	*Formation*	*Area*	*Average hydraulic gradient*
1	Sedimentary (Gondwana Formation / Core Zone)	Non-Mining	1.0×10^{-3} to 2×10^{-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.

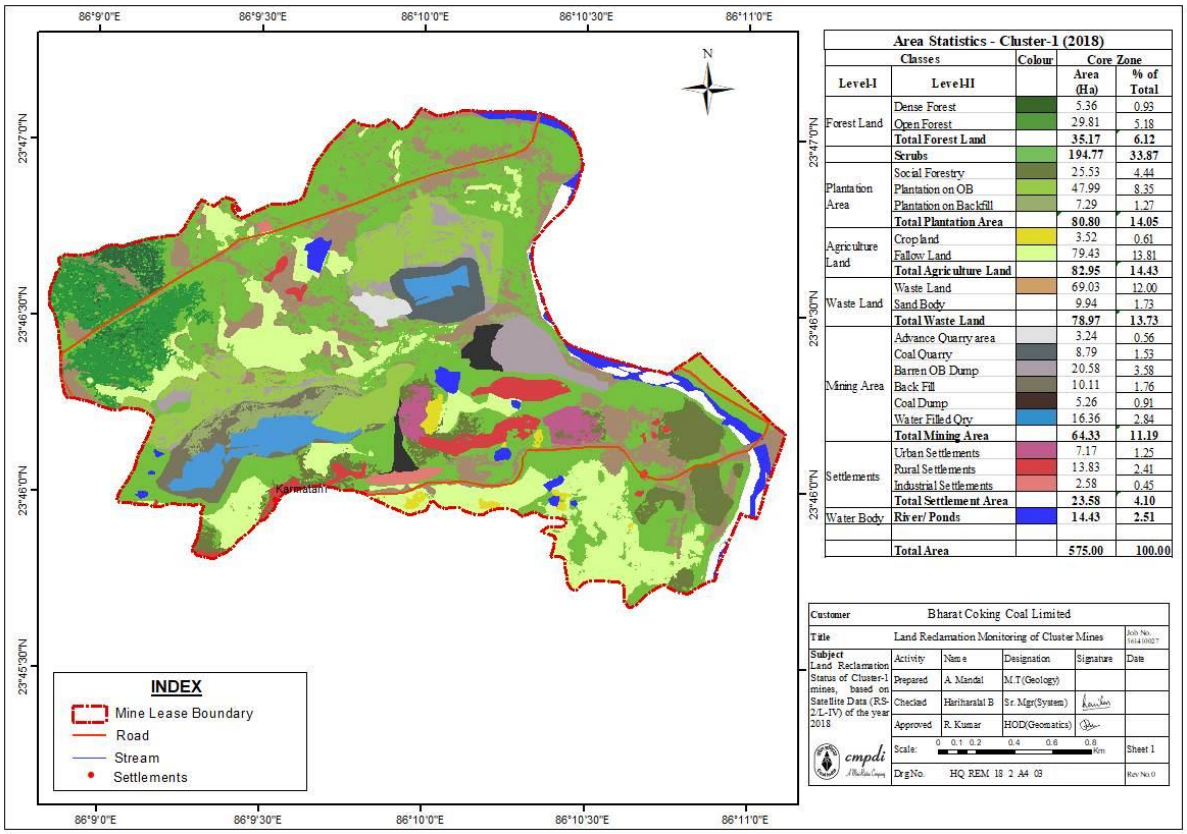
Monitoring stations (**B015, B051 and B053**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl 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	B015	Bera Basti	3.20	0.80	1.00	2.72	3.67	0.45	1.02	2.30	1.46	0.25	0.35	1.01
2	B051	Taranga	5.20	2.51	4.45	4.95	5.06	0.00	4.57	2.87	5.70	0.90	1.00	4.88
3	B053	Karmatanr	2.62	1.33	1.13	1.66	4.42	1.78	3.54	1.68	4.85	1.52	1.87	2.87
Average WL (bgl)			3.67	1.55	2.19	3.11	4.38	0.74	3.04	2.28	4.00	0.89	1.07	2.92

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.46 m Max –5.70 m
Post-monsoon GW Level (m): Min – 0.35 m Max – 4.57 m

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



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

B. GROUND WATER LEVEL OF CLUSTER-II

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

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

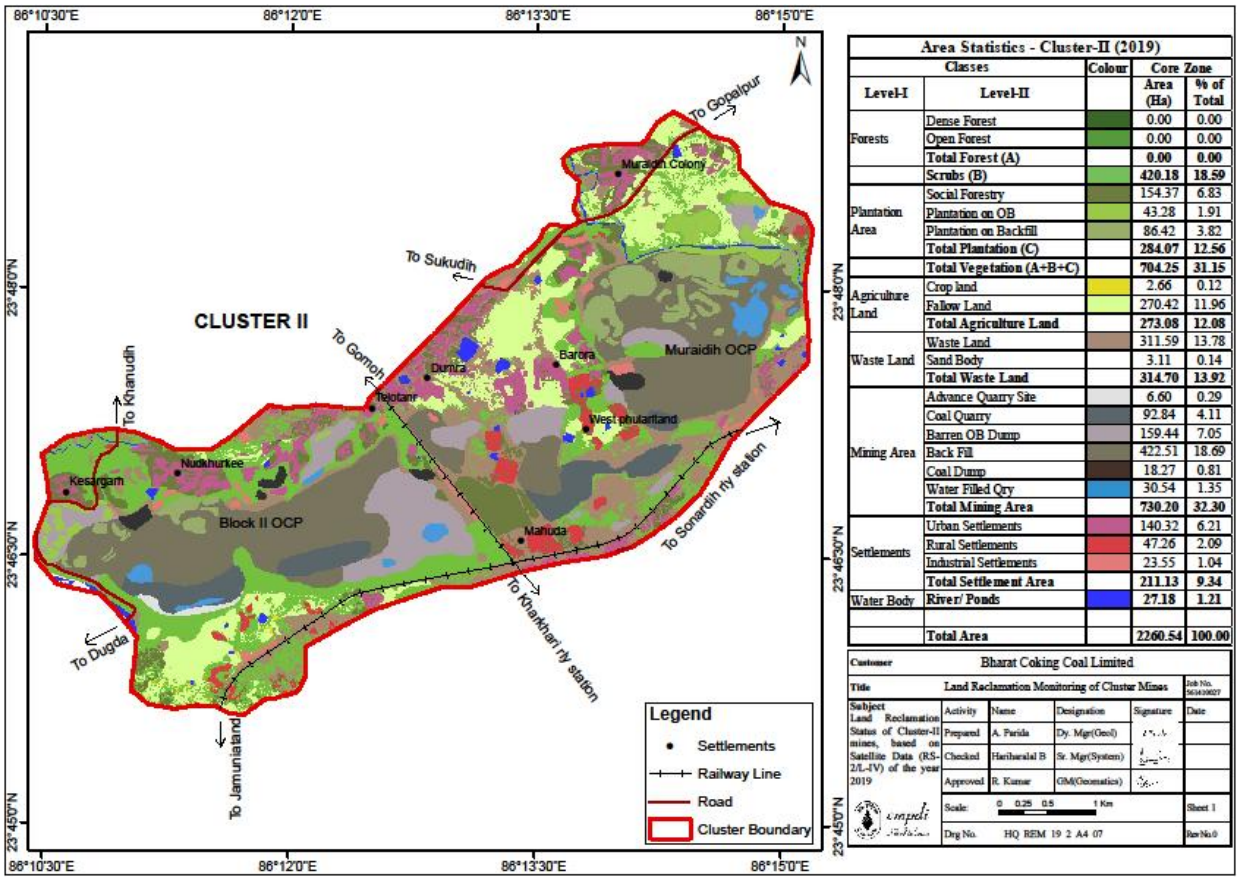
Monitoring stations (**B001, B059, B060 and B062**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl 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	B001	Muraidih	3.22	1.25	2.45	2.70	2.10	1.65	1.81	2.73	2.58	0.58	1.91	2.03
2	B059	Khodovaly	1.88	0.50	0.70	1.12	4.50	0.44	1.14	1.04	5.49	0.30	0.90	0.95
3	B060	Bahiyardih	10.73	5.31	5.73	9.51	10.53	1.08	5.80	9.38	11.26	1.33	2.23	6.53
4	B062	Sadiyardih	4.80	2.35	3.10	4.00	6.45	1.77	4.91	5.15	6.87	1.35	4.50	4.60
Average WL (bgl)			5.16	2.35	3.00	4.33	5.90	1.24	3.42	4.58	6.55	0.89	2.39	3.53

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.88m Max – 11.26 m
Post-monsoon GW Level (m): Min – 0.70 m Max – 5.80 m

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



Area Statistics - Cluster-II (2019)

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)		**420.18**	**18.59**
Plantation Area	Social Forestry		154.37	6.83
	Plantation on OB		43.28	1.91
	Plantation on Backfill		86.42	3.82
	Total Plantation (C)		**284.07**	**12.56**
	Total Vegetation (A+B+C)		**704.25**	**31.15**
Agriculture Land	Crop land		2.66	0.12
	Fallow Land		270.42	11.96
	Total Agriculture Land		**273.08**	**12.08**
Waste Land	Waste Land		311.59	13.78
	Sand Body		3.11	0.14
	Total Waste Land		**314.70**	**13.92**
Mining Area	Advance Quarry Site		6.60	0.29
	Coal Quarry		92.84	4.11
	Barren OB Dump		159.44	7.05
	Back Fill		422.51	18.69
	Coal Dump		18.27	0.81
	Water Filled Qry		30.54	1.35
	Total Mining Area		**730.20**	**32.30**
Settlements	Urban Settlements		140.32	6.21
	Rural Settlements		47.26	2.09
	Industrial Settlements		23.55	1.04
	Total Settlement Area		**211.13**	**9.34**
Water Body	**River/ Ponds**		**27.18**	**1.21**
	Total Area		**2260.54**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 56161002027
Subject: Land Reclamation Status of Cluster-II mines, based on Satellite Data (RS-2/L-IV) of the year 2019	Activity	Name	Designation	Signature	Date
	Prepared	A. Parida	Dy. Mgr(Geol)		
	Checked	Hariharalal B	Sr. Mgr(System)		
	Approved	R. Kumar	GM(Geomatics)		
	Scale:	0 0.25 0.5 1 Km			Sheet 1
	Drg No.	HQ REM 19 2 A4 07			Rev No: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.

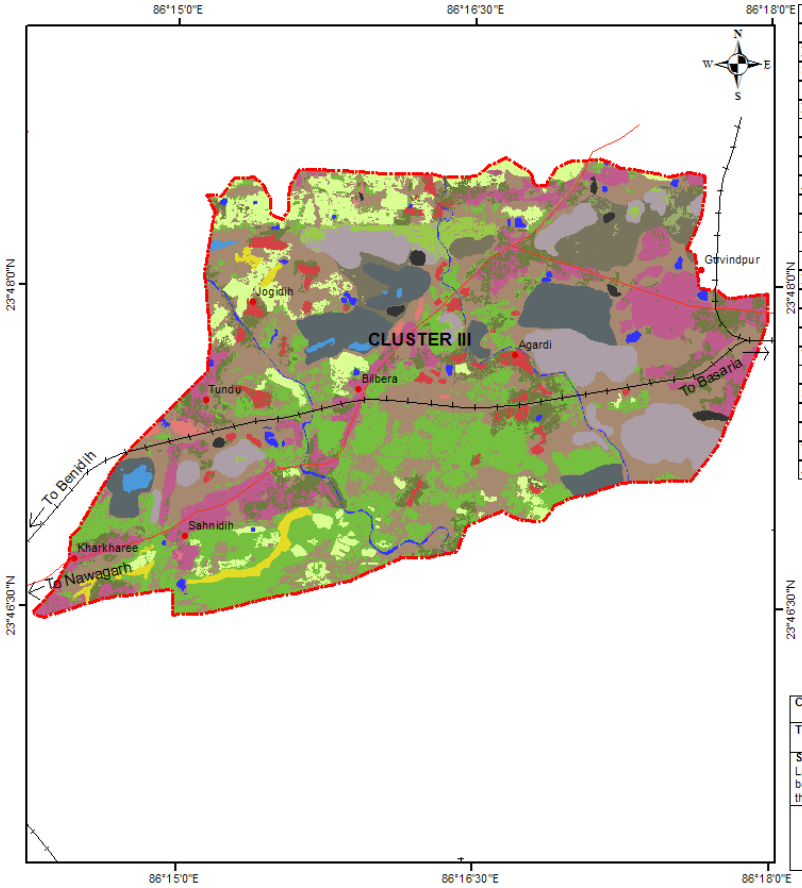
Monitoring stations (**A025, A029, B014 and B060**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2023-24				2022-23				2021-22			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A025	Sinidih	2.93	1.09	2.60	2.70	3.31	1.33	2.08	2.51	5.78	1.73	2.43	2.53
2	A029	Dharmaband	5.60	2.10	3.20	4.08	4.60	1.20	1.15	1.12	6.49	2.90	5.90	6.65
3	B014	Mathadih	2.84	1.12	2.34	2.42	3.24	0.09	2.60	2.55	2.84	0.24	2.04	2.10
4	B060	Sonardih	10.73	5.31	5.73	9.51	10.53	1.08	5.80	9.38	11.26	1.33	2.23	6.53
Average WL (bgl)			5.53	2.41	3.47	4.68	5.42	0.93	2.91	3.89	6.59	1.55	3.15	4.45

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.84 m Max – 11.26 m
Post-monsoon GW Level (m): Min – 1.15 m Max – 5.90 m

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



Area Statistics of Cluster III				
Class		Color	Area	
Level I	Level II		Hect	%of Total
Scrubs	Scrubs (A)		300.05	19.33
	Social Forestry		128.07	8.25
Plantations	Plantation on OB Dump		21.11	1.36
	Plantation on Backfill		3.89	0.25
	Total Plantation (B)		**153.07**	**9.86**
	Total Vegetation (A+B)		**453.12**	**29.19**
Agricultural Land	Fallow Land		110.04	7.09
	Crop Land		17.05	1.10
	Total Agricultural Land		**127.09**	**8.19**
	Coal Quarry		93.24	6.00
	Coal Dump		7.64	0.49
Mining Area	Barren OB Dump		126.20	8.13
	Area Under Backfilling		55.87	3.60
	Water Filled Quarry		8.26	0.53
	Total Mining Area		**291.21**	**18.75**
Waste Lands	Waste Land		461.92	29.75
	Industrial		6.05	0.39
Settlement	Urban		164.97	10.62
	Rural		30.69	1.98
	Total Settlements		**201.71**	**12.99**
Water Bodies	Rivers, Lakes, Nalas etc.		17.48	1.13
All Total			1552.53	100.00

Legend
- Settlements
- Railway Line
- Road
- Cluster III Boundary

Customer	BHARAT COKING COAL LIMITED				
Title	Land Reclamation Monitoring of Clusters				Job No. 30141002
Subject	Activity	Name	Desig	Sign	Date
Land Reclamation Monitoring of Cluster III based on Satellite Data (IRS-R2/LISS-IV) of the year 2017.	Prepared	A. Panda	AM (Geo)		
	Checked	R. Kumar	HOD(Geom)		
	Approved	R. Kumar	HOD(Geom)		
cmpdi A Mini Ratna Company	Scale 540 270 0 540 M				Sheet
	Drg No. HQ REM 4 A4 17 01				

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.

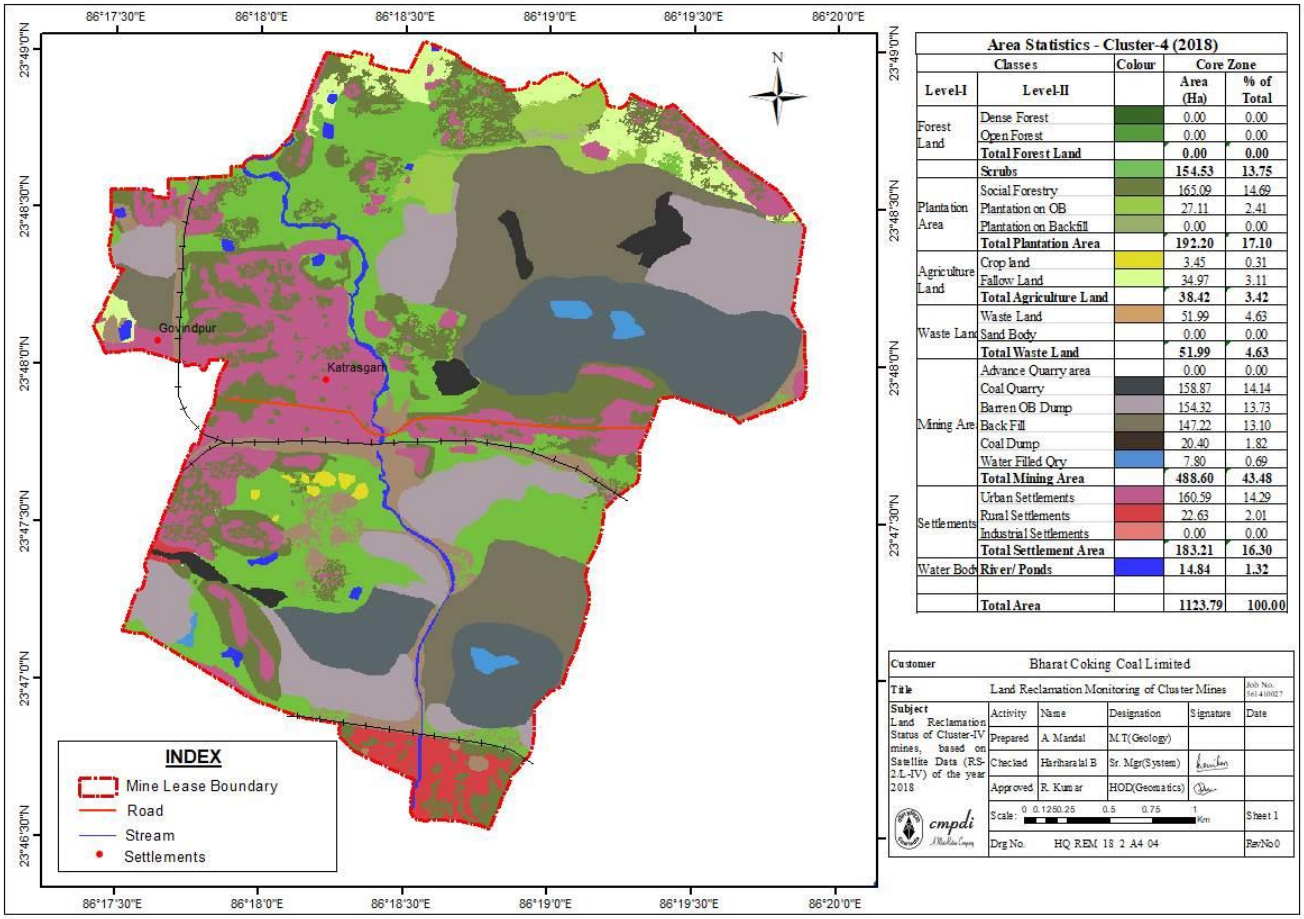
Monitoring stations (**A026, A028 and B065**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2023-24				2022-23				2021-22			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A026	Malkhera	8.40	3.87	3.83	5.50	6.42	2.83	4.31	3.62	6.70	2.10	2.73	3.63
2	A028	Lakarka	3.45	3.13	3.35	3.40	4.23	2.85	3.30	3.57	6.23	0.53	3.75	4.47
3	B065	Jhinjipahari	8.45	1.95	2.35	4.93	7.45	0.50	2.27	3.45	9.03	0.45	1.42	2.80
Average WL (bgl)			6.77	2.98	3.18	4.61	6.03	2.06	3.29	3.55	7.32	1.03	2.63	3.63

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.45 m Max – 9.03 m
Post-monsoon GW Level (m): Min – 1.42 m Max – 4.31 m

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



Area Statistics - Cluster-4 (2018)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest Land	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest Land		**0.00**	**0.00**
	Scrubs		**154.53**	**13.75**
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		**192.20**	**17.10**
Agriculture Land	Crop land		3.45	0.31
	Fallow Land		34.97	3.11
	Total Agriculture Land		**38.42**	**3.42**
Waste Land	Waste Land		51.99	4.63
	Sand Body		0.00	0.00
	Total Waste Land		**51.99**	**4.63**
Mining Are	Advance Quarry area		0.00	0.00
	Coal Quarry		158.87	14.14
	Barren OB Dump		154.32	13.73
	Back Fill		147.22	13.10
	Coal Dump		20.40	1.82
	Water Filled Qry		7.80	0.69
	Total Mining Area		**488.60**	**43.48**
Settlements	Urban Settlements		160.59	14.29
	Rural Settlements		22.63	2.01
	Industrial Settlements		0.00	0.00
	Total Settlement Area		**183.21**	**16.30**
Water Body	**River/ Ponds**		**14.84**	**1.32**
	Total Area		**1123.79**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Rob No. 5614100027
Subject: Land Reclamation Status of Cluster-IV mines, based on Satellite Data (RS-2/L-IV) of the year 2018	Activity	Name	Designation	Signature	Date
	Prepared	A. Mandal	M.T(Geology)		
	Checked	Hariharalal B	Sr. Mgr(System)		
	Approved	R. Kumar	HOD(Geomatics)		
cmpdi	Scale: 0 0.125 0.25 0.5 0.75 1 Km				Sheet 1
	Drg No. HQ/REM/18/2/A4/04				RevNo 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.

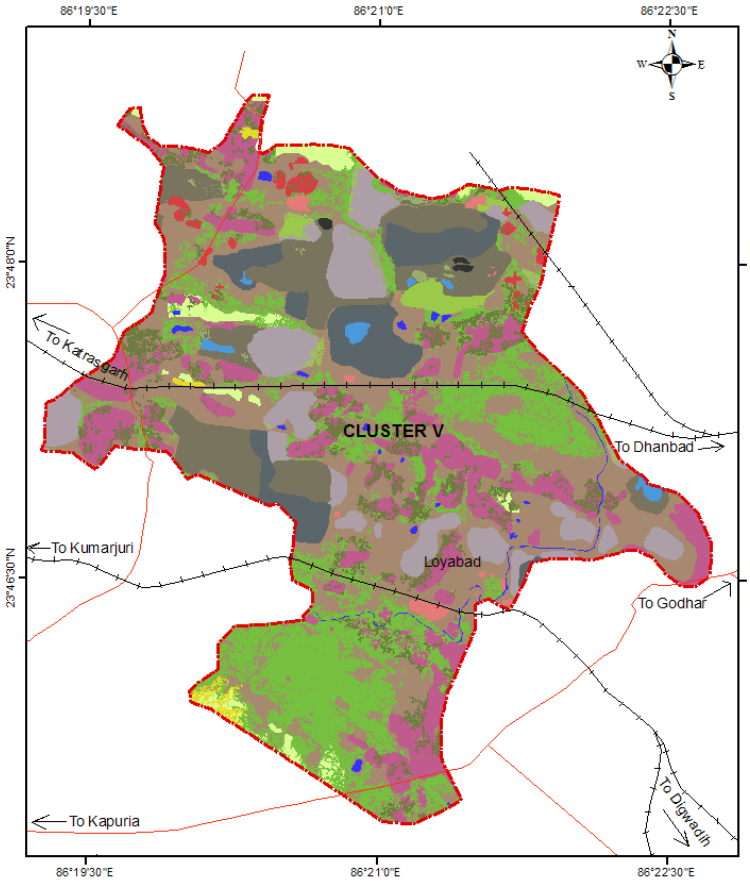
Monitoring stations (**A016 and A027**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2023-24				2022-23				2021-22			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A016	Ekra	5.55	1.35	3.52	4.30	5.80	1.35	3.08	2.99	3.45	1.90	2.00	3.00
2	A027	Tetulmari	1.70	0.55	1.60	1.80	1.90	0.10	1.33	1.50	1.67	0.80	0.90	1.13
Average WL (bgl)			3.63	0.95	2.56	3.05	3.85	0.73	2.21	2.25	2.56	1.35	1.45	2.07

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.67 m Max – 5.80 m
Post-monsoon GW Level (m): Min – 0.90 m Max – 3.52 m

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



Area Statistics of Cluster V				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		344.78	19.99
	Social Forestry		105.29	6.10
Plantations	Plantation on OB Dump		23.85	1.38
	Plantation on Backfill		7.19	0.42
	Total Plantation (B)		136.33	7.90
	Total Vegetation (A+B)		481.11	27.89
Agricultural Land	Crop Land		8.41	0.49
	Fallow Land		37.74	2.19
	Total Agricultural Land		46.15	2.68
	Coal Quarry		102.79	5.96
	Coal Dump		2.55	0.15
Mining Area	Barren OB Dump		151.20	8.77
	Area Under Backfilling		162.09	9.40
	Water Filled Quarry		9.45	0.55
	Total Mining Area		428.08	24.83
Waste Lands	Waste Land		517.23	29.99
	Industrial		10.46	0.61
Settlement	Rural		13.78	0.80
	Urban		217.50	12.61
	Total Settlements		241.74	14.02
Water Bodies	Rivers, Lakes, Nalas etc.		10.21	0.59
All Total			1724.52	100.00

Legend

- Road
- Railway Line
- Cluster V Boundary

Customer: BHARAT COKING COAL LIMITED

Title: Land Reclamation Monitoring of Clusters — Job No. 5014410027

Subject: Land Reclamation Status of Cluster V based on Satellite Data (IRS-R2/LISS-IV) of the year 2017.

Activity	Name	Desig	Sign	Date
Prepared	A. Panda	AM (Geo)		
Checked	R. Kumar	HOD(Geom)		
Approved	R. Kumar	HOD(Geom)		

cmpdi — A Mini Ratna Company

Scale: 460 230 0 460 Meters — Sheet

Drg No. HQ REM 4 A4 17 01 — Revn.

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.

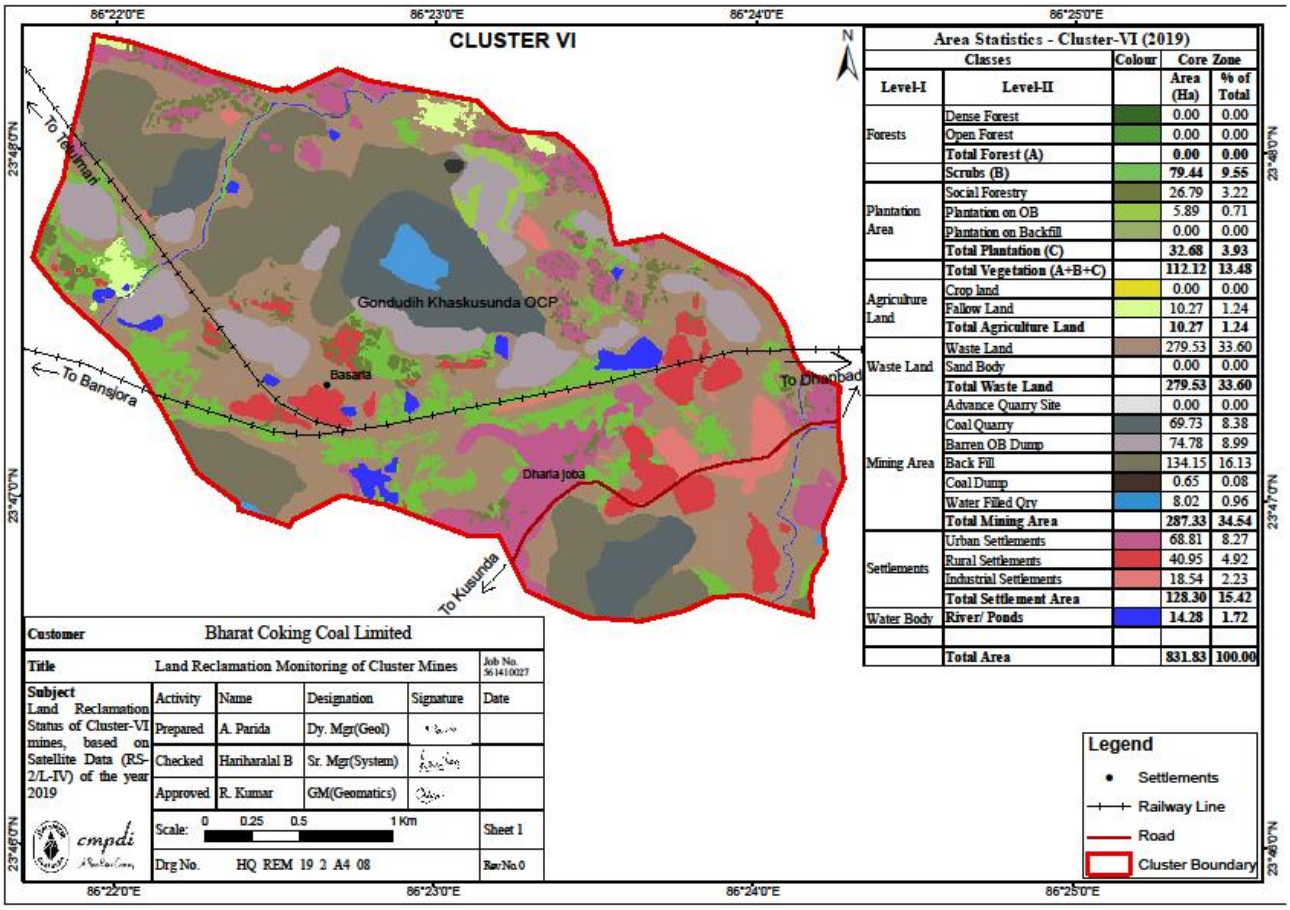
Monitoring stations (**D025, D030 and D034**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2023-24				2022-23				2021-22			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D025	Godhur	4.40	1.80	3.40	4.20	11.9	2.58	4.70	5.30	10.50	2.90	3.80	4.40
2	D030	Borkiboa	4.08	2.10	2.20	3.44	4.37	1.80	2.29	4.15	4.23	0.60	0.84	1.80
3	D034	Kusunda	3.80	1.80	2.50	2.89	5.00	2.15	3.15	3.22	3.78	2.05	2.90	2.95
Average WL (bgl)			4.09	1.90	2.70	3.51	7.09	2.18	3.38	4.22	6.17	1.85	2.51	3.05

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.78 m Max – 11.90 m
Post-monsoon GW Level (m): Min – 0.84m Max – 4.70 m

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



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

G. GROUND WATER LEVEL OF CLUSTER-VII

Cluster-VII consists of fourteen mines within Kusunda Area, Bastacolla Area and PB Area, B.C.C.L, Jharia Coalfield. Coal mines namely Dhansar UG, Dhansar OCP, Kusunda OCP and Viswakarma OCP (proposed) are under the administrative control of Kusunda Area and Industry UG (closed), Alkusa UG, Ena OCP, S.Jharia/Rajapur OCP, Burragarh UG, Simlabahal UG, 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.

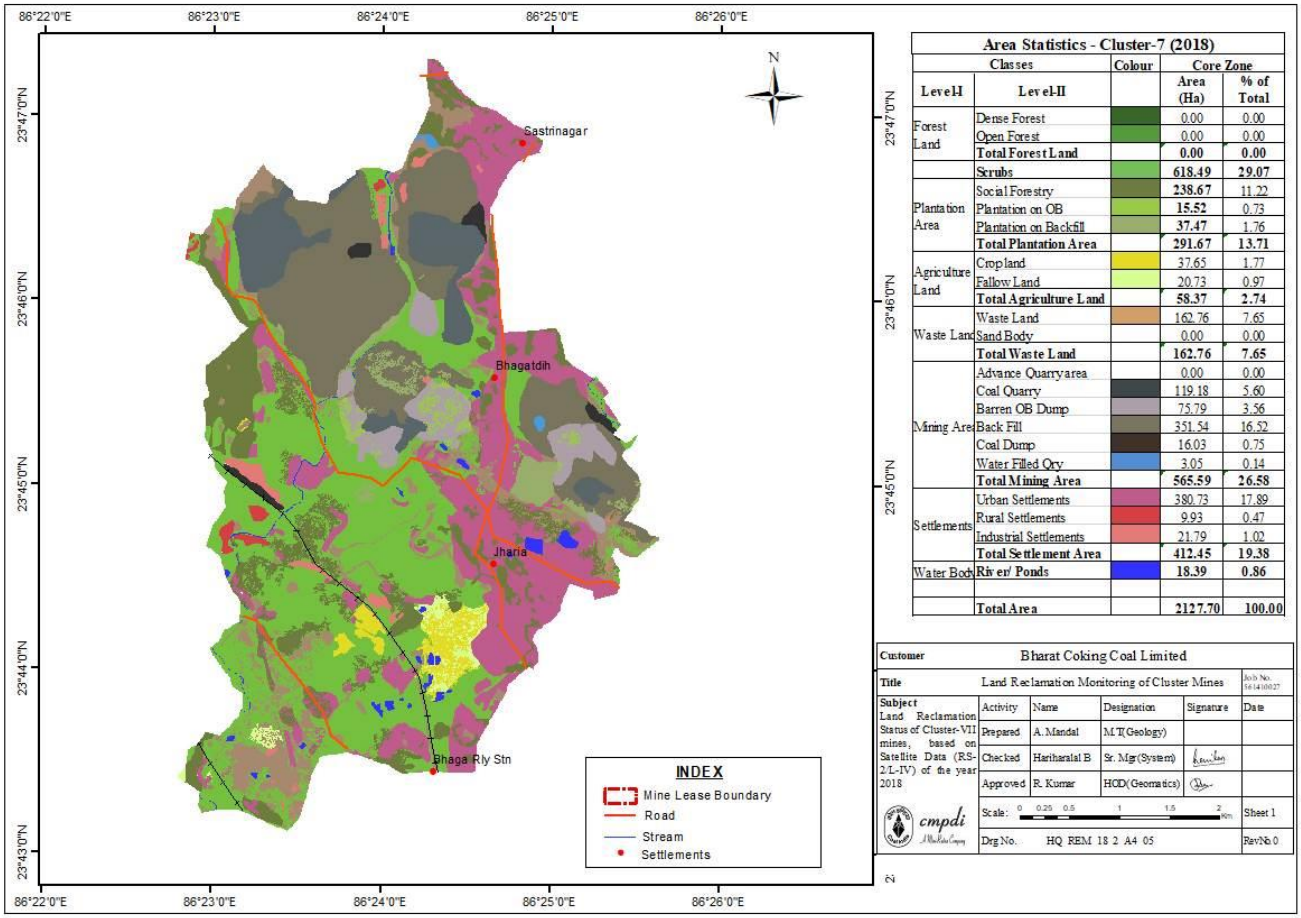
Monitoring stations (**D003, D034, D047 and D080**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2023-24				2022-23				2021-22			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D003	Dhansar	3.15	1.22	1.85	2.28	5.96	0.55	1.32	1.34	3.41	0.80	0.85	1.30
2	D034	Kusunda	3.80	1.80	2.50	2.89	5.00	2.15	3.15	3.22	3.78	2.05	2.90	2.95
3	D047	Parastanr	4.45	2.57	3.27	3.85	6.55	5.32	5.85	11.40	4.05	3.22	2.45	4.88
4	D080	Bastacolla	4.75	1.75	2.60	3.42	3.30	2.40	3.08	1.80	7.10	2.17	2.55	3.10
Average WL (bgl)			4.04	1.84	2.56	3.11	5.20	2.61	3.35	4.44	4.59	2.06	2.19	3.06

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.15 m Max – 7.10 m
Post-monsoon GW Level (m): Min – 0.85 m Max – 5.85 m

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



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

H. GROUND WATER LEVEL OF CLUSTER-VIII

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

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

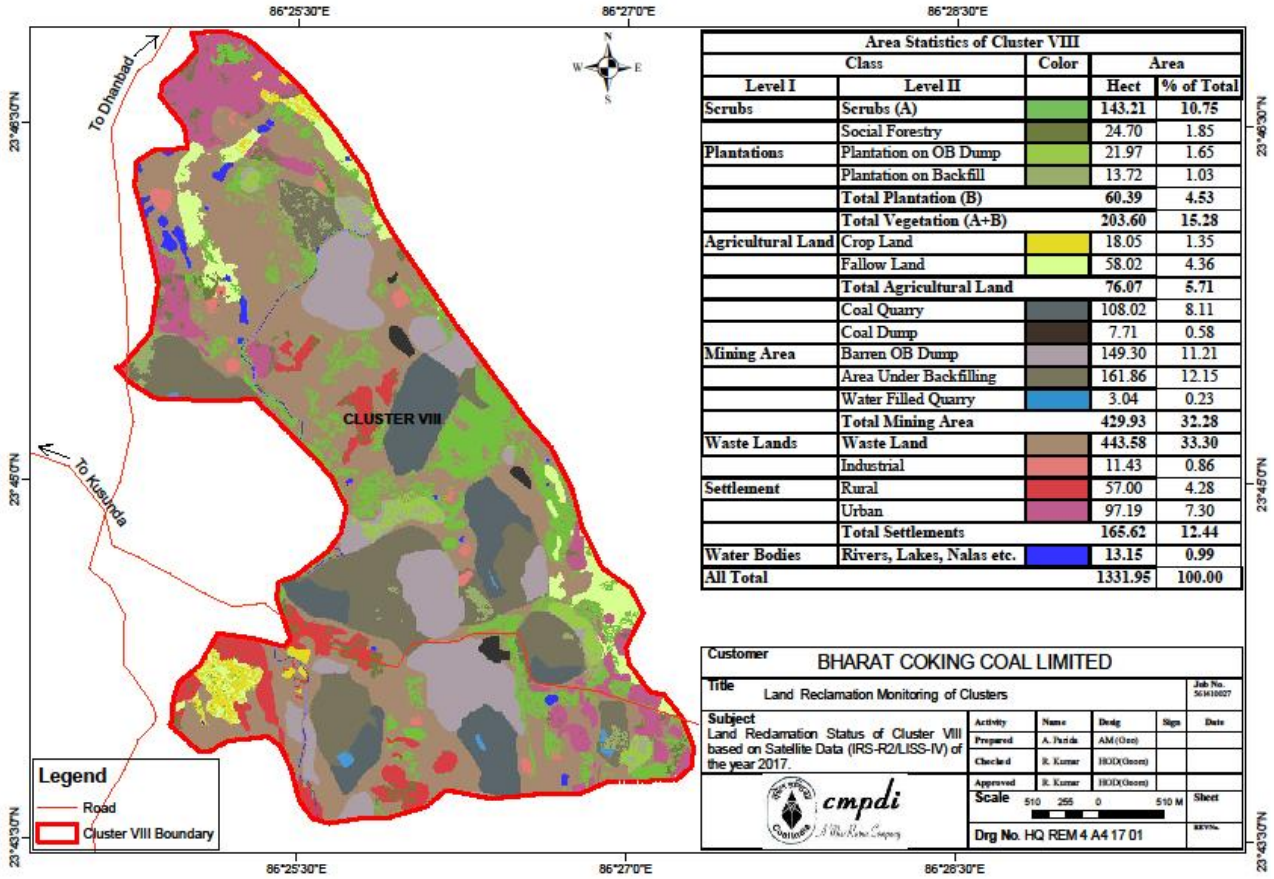
Monitoring stations (**D008 and D039**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2023-24				2022-23				2021-22			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D008	Alokdiha	7.70	4.42	4.82	6.75	6.32	4.25	5.42	6.34	4.55	1.85	2.27	3.20
2	D039	Tilaboni	8.52	2.52	3.28	5.75	7.50	1.85	3.05	1.75	10.70	4.60	5.10	8.15
Average WL (bgl)			8.11	3.47	4.05	6.25	6.91	3.05	4.24	4.05	7.63	3.23	3.69	5.68

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 4.55 m Max – 10.70 m
Post-monsoon GW Level (m): Min – 2.27 m Max – 5.42 m

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



Area Statistics of Cluster VIII				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		143.21	10.75
	Social Forestry		24.70	1.85
Plantations	Plantation on OB Dump		21.97	1.65
	Plantation on Backfill		13.72	1.03
	Total Plantation (B)		60.39	4.53
	Total Vegetation (A+B)		203.60	15.28
Agricultural Land	Crop Land		18.05	1.35
	Fallow Land		58.02	4.36
	Total Agricultural Land		76.07	5.71
	Coal Quarry		108.02	8.11
	Coal Dump		7.71	0.58
Mining Area	Barren OB Dump		149.30	11.21
	Area Under Backfilling		161.86	12.15
	Water Filled Quarry		3.04	0.23
	Total Mining Area		429.93	32.28
Waste Lands	Waste Land		443.58	33.30
	Industrial		11.43	0.86
Settlement	Rural		57.00	4.28
	Urban		97.19	7.30
	Total Settlements		165.62	12.44
Water Bodies	Rivers, Lakes, Nalas etc.		13.15	0.99
All Total			1331.95	100.00

Customer: BHARAT COKING COAL LIMITED
Title: Land Reclamation Monitoring of Clusters
Subject: Land Reclamation Status of Cluster VIII based on Satellite Data (IRS-R2/LISS-IV) of the year 2017.
Prepared: A. Patrik, AM (Geo)
Checked: R. Kumar, HOD(Geom)
Approved: R. Kumar, HOD(Geom)
Scale: 510 255 0 510 M
Drg No. HQ REM 4 A4 17 01
cmpdi

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.

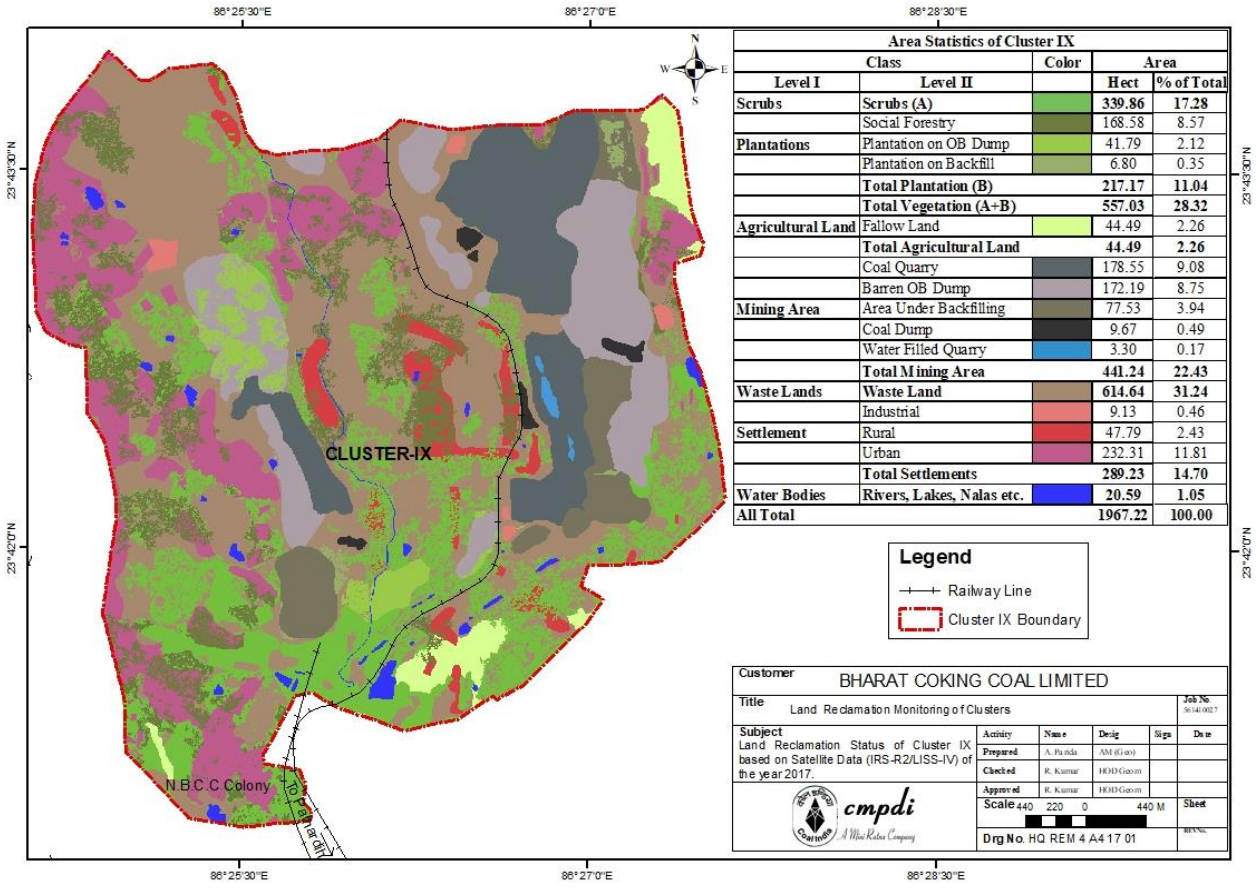
Monitoring stations (**D005, D007, D039 and D074**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2023-24				2022-23				2021-22			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D005	Jiyalgora	8.20	4.08	5.90	6.54	8.40	3.36	7.01	8.95	7.28	3.35	4.00	6.40
2	D007	Golden Pahari	9.03	1.88	3.64	5.18	9.03	2.17	5.67	6.57	6.08	2.38	2.63	3.88
3	D039	Tilaboni	8.52	2.52	3.28	5.75	7.50	1.85	3.05	1.75	10.70	4.60	5.10	8.15
4	D074	BhulanBararee	4.57	3.10	3.54	4.09	6.17	3.20	5.77	7.90	6.93	3.20	2.90	3.70
Average WL (bgl)			7.58	2.90	4.09	5.39	7.78	2.65	5.38	6.29	7.75	3.38	3.66	5.53

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 4.57 m Max – 10.70 m
Post-monsoon GW Level (m): Min – 2.63 m Max – 7.01 m

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



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

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.

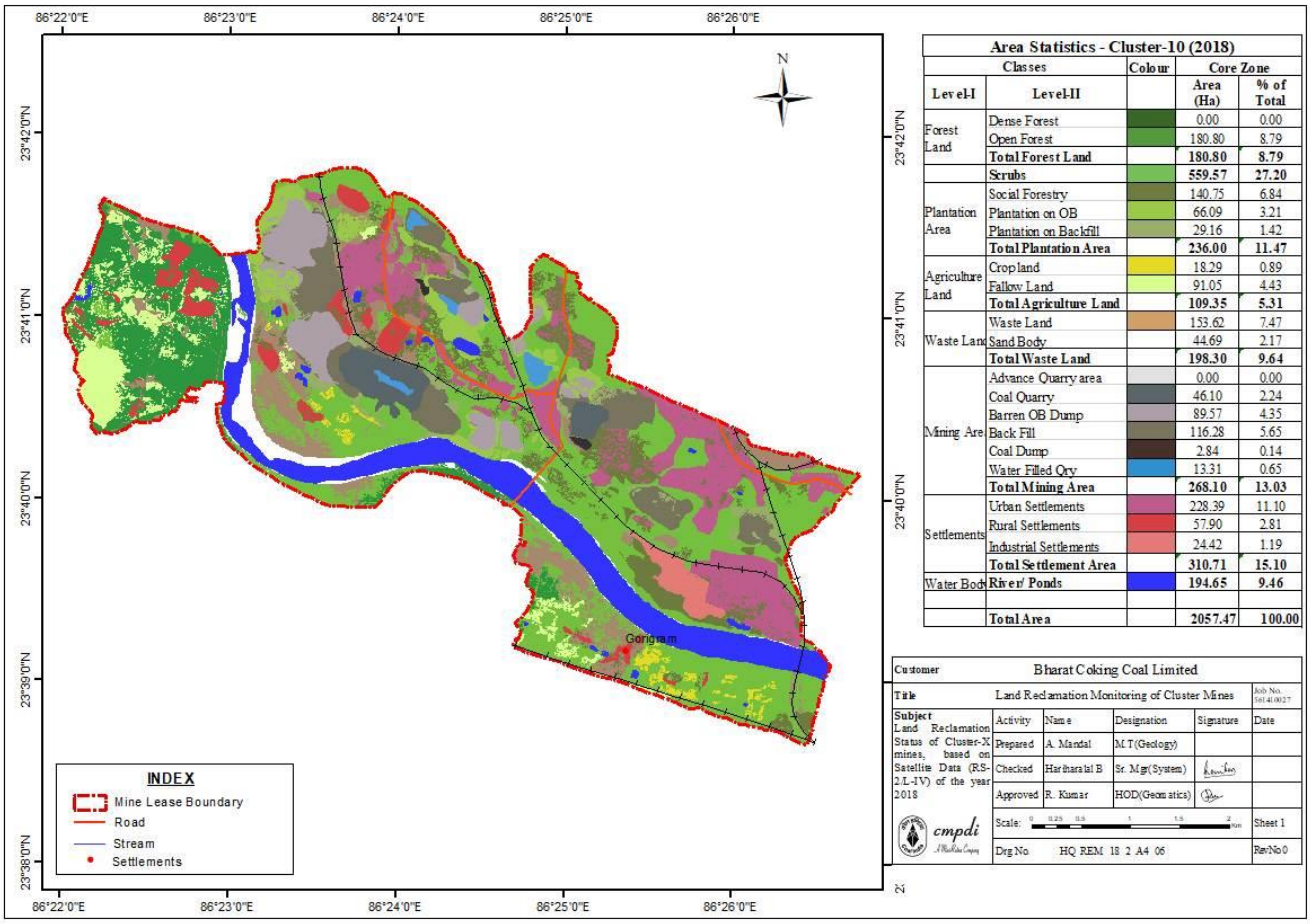
Monitoring stations (**A019, D035, D036 and D077**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24, the Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2023-24				2022-23				2021-22			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A019	Bhowrah	2.90	2.10	2.60	2.73	4.10	1.82	2.54	1.79	3.30	1.95	1.90	2.20
2	D035	Patherdih	5.23	3.45	3.90	4.10	6.10	3.70	4.68	5.50	6.60	2.70	2.90	4.30
3	D036	Sudamdih	1.85	0.50	0.60	1.00	3.25	0.15	0.60	1.44	2.02	0.45	0.55	0.55
4	D077	Amlabad	5.98	3.90	3.93	5.07	6.50	3.40	4.70	6.00	5.98	2.60	4.69	5.60
Average WL (bgl)			3.99	2.49	2.76	3.23	4.99	2.27	3.13	3.68	4.48	1.93	2.51	3.16

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.85 m Max – 6.60 m
Post-monsoon GW Level (m): Min – 0.55 m Max – 4.70 m

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



Area Statistics - Cluster-10 (2018)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest Land	Dense Forest		0.00	0.00
	Open Forest		180.80	8.79
	Total Forest Land		**180.80**	**8.79**
	Scrubs		**559.57**	**27.20**
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		**236.00**	**11.47**
Agriculture Land	Crop land		18.29	0.89
	Fallow Land		91.05	4.43
	Total Agriculture Land		**109.35**	**5.31**
Waste Land	Waste Land		153.62	7.47
	Sand Body		44.69	2.17
	Total Waste Land		**198.30**	**9.64**
Mining Are	Advance Quarry area		0.00	0.00
	Coal Quarry		46.10	2.24
	Barren OB Dump		89.57	4.35
	Back Fill		116.28	5.65
	Coal Dump		2.84	0.14
	Water Filled Qry		13.31	0.65
	Total Mining Area		**268.10**	**13.03**
Settlements	Urban Settlements		228.39	11.10
	Rural Settlements		57.90	2.81
	Industrial Settlements		24.42	1.19
	Total Settlement Area		**310.71**	**15.10**
Water Body	River/ Ponds		194.65	9.46
	Total Area		**2057.47**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 5614/0027
Subject: Land Reclamation Status of Cluster-X mines, based on Satellite Data (RS-2/L-IV) of the year 2018	Activity	Name	Designation	Signature	Date
	Prepared	A. Mandal	M.T(Geology)		
	Checked	Hariharalal B	Sr. Mgr(System)		
	Approved	R. Kumar	HOD(Geomatics)		
cmpdi	Scale: 0 0.25 0.5 1 1.5 2 Km				Sheet 1
	Drg No HQ REM 18 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	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.

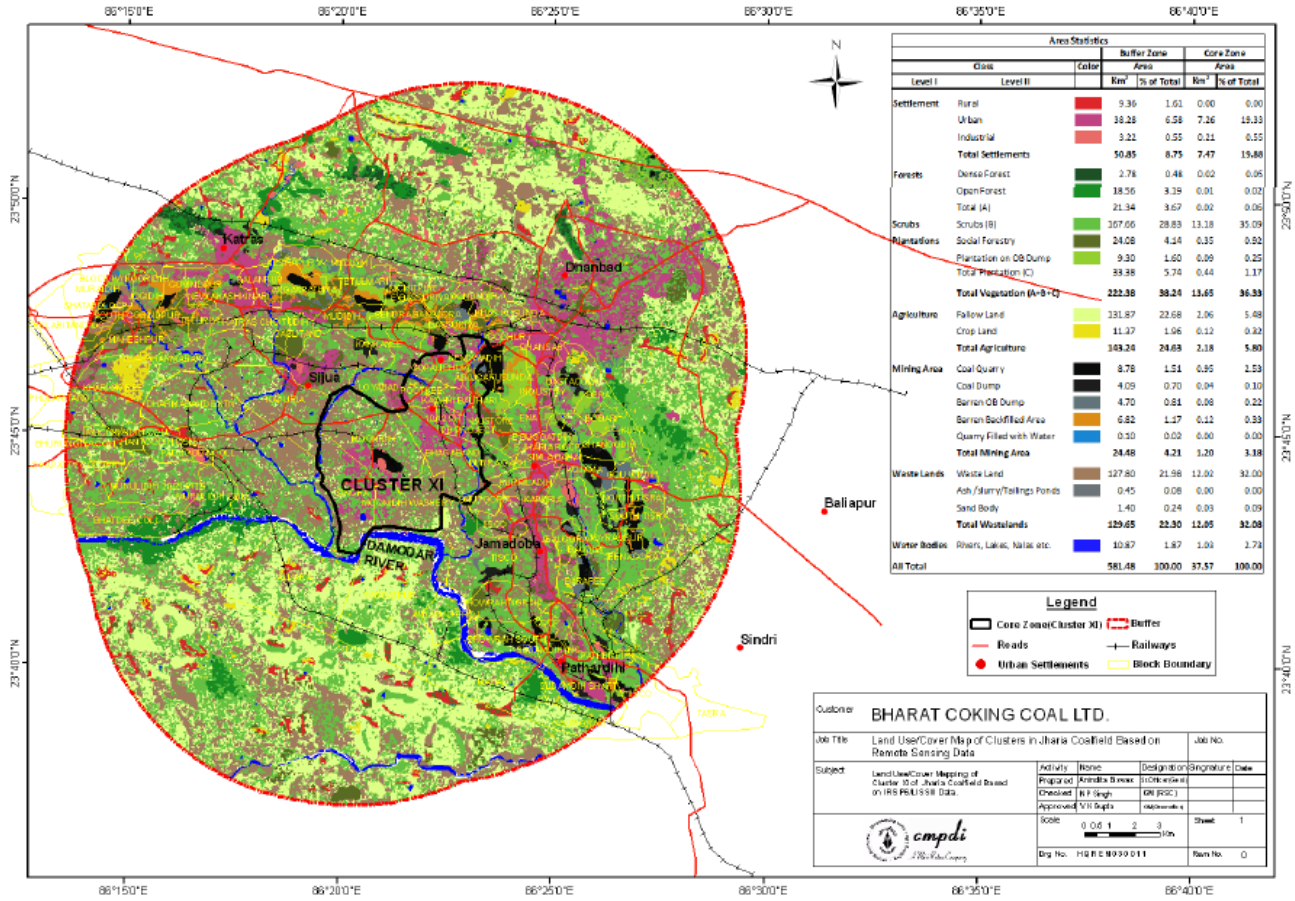
Monitoring stations (**A017, A020 and A032**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2023-24				2022-23				2021-22			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A017	Kachi Balihari	2.41	1.78	2.19	2.57	2.62	2.06	2.59	2.64	3.36	1.62	2.37	2.54
2	A020	Gorbudih	8.02	4.05	4.20	7.27	5.59	3.18	3.54	5.27	5.47	1.47	2.02	3.07
3	A032	Baludih	3.83	0.95	1.60	2.09	2.25	0.65	1.75	2.79	2.35	0.73	0.96	1.50
Average WL (bgl)			4.75	2.26	2.66	3.98	3.49	1.96	2.63	3.57	3.73	1.27	1.78	2.37

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.25m Max – 8.02 m
Post-monsoon GW Level (m): Min – 0.96 m Max – 4.20 m

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



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

L. GROUND WATER LEVEL OF CLUSTER-XIII

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

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

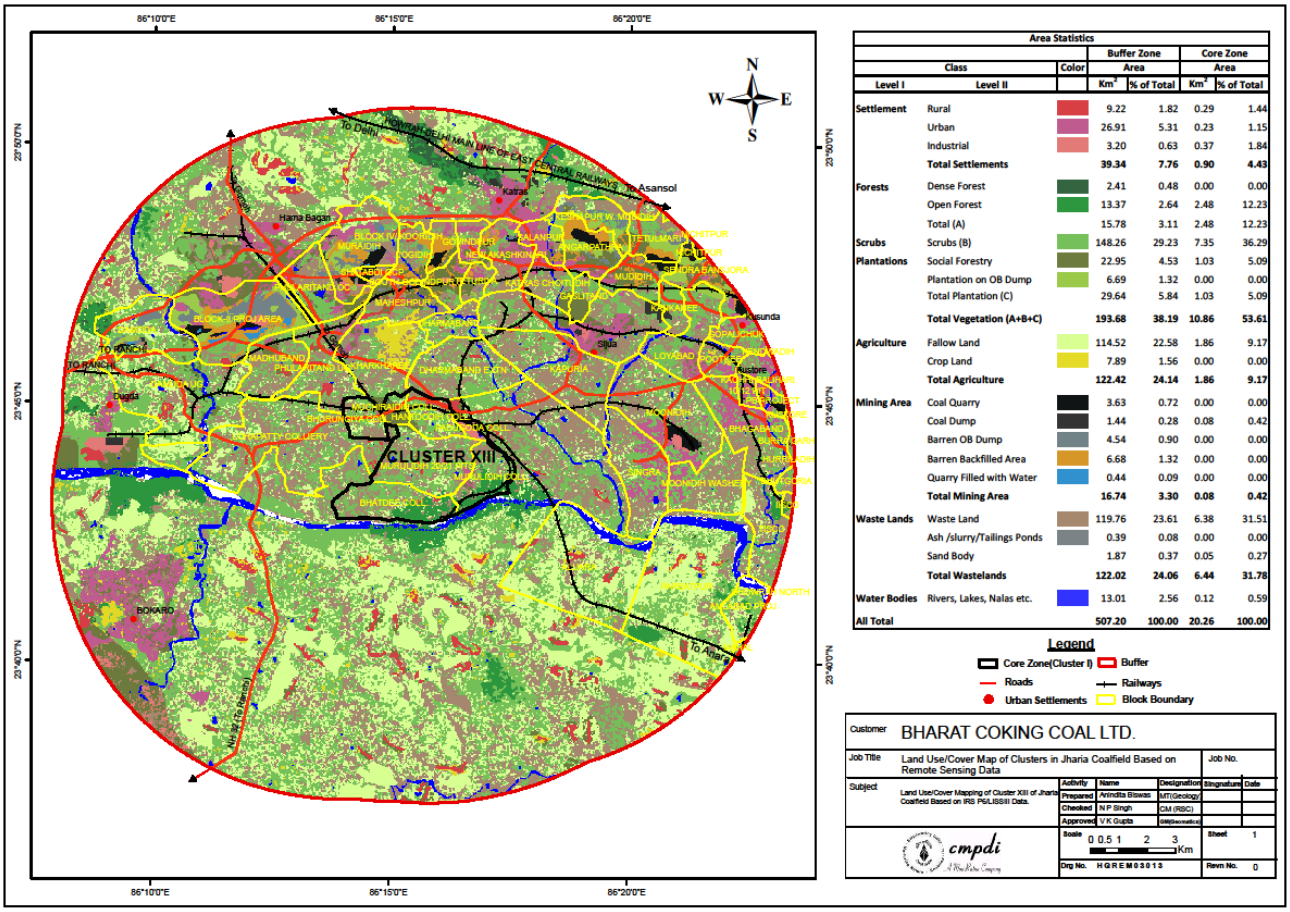
Monitoring stations (**A023, A034 and B048**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2023-24				2022-23				2021-22			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A023	Machhayara	9.00	5.10	5.71	7.90	7.97	1.14	4.79	6.67	9.52	1.87	2.82	4.82
2	A034	Mahuda vil.	6.54	2.98	4.01	4.85	8.20	3.65	6.35	6.95	5.20	1.83	3.55	
3	B048	Mahuda	6.13	4.55	5.05	5.57	6.85	0.65	6.25	5.80	7.23	2.28	6.05	6.60
Average WL (bgl)			7.22	4.21	4.92	6.11	7.67	1.81	5.80	6.47	7.32	1.99	4.14	5.71

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 5.20 m Max – 9.52 m
Post-monsoon GW Level (m): Min – 2.82 m Max – 6.35 m

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



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

M. GROUND WATER LEVEL OF CLUSTER-XIV

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

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

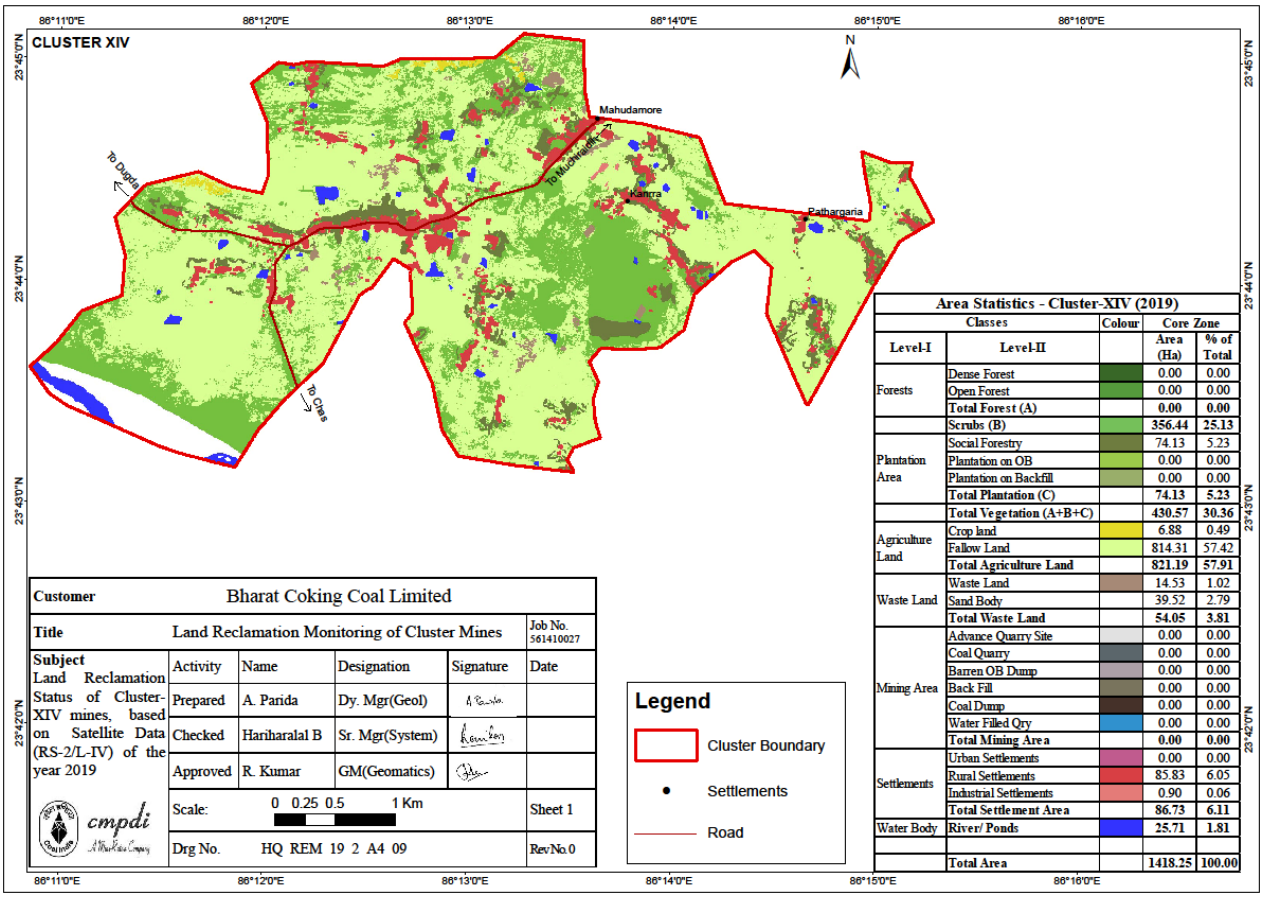
Monitoring stations (**B024 and B067**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

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 – 8.95 m
Post-monsoon GW Level (m): Min – 2.08 m Max – 6.30 m

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



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

N. GROUND WATER LEVEL OF CLUSTER-XV

Mines 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.

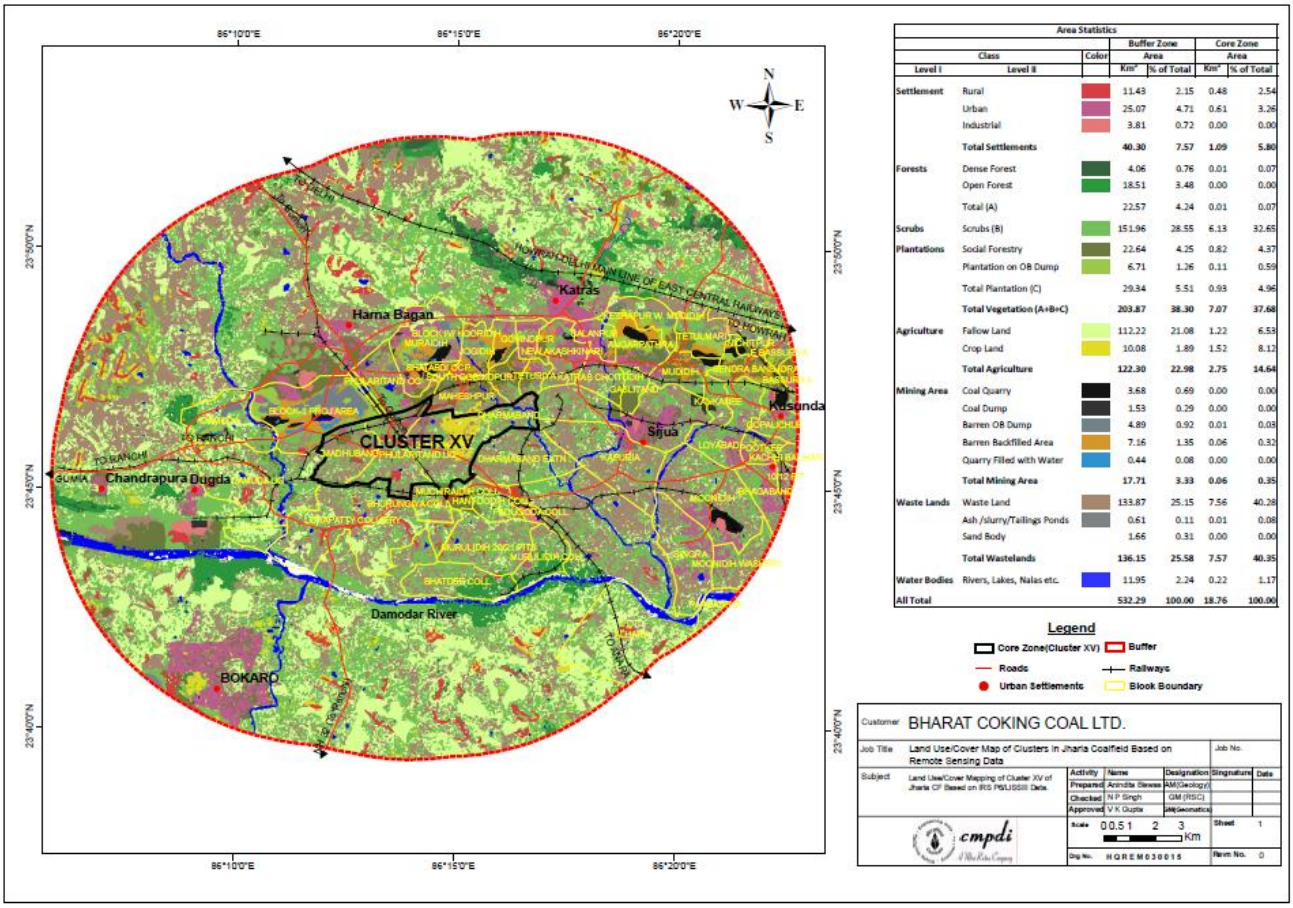
Monitoring stations (**A024, B032 and B062**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2023-24				2022-23				2021-22			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A024	Pipratanr	5.38	3.60	3.90	5.00	7.28	2.55	4.33	5.32	10.13		2.78	4.55
2	B032	Madhuband	5.35	3.93	3.60	5.42	4.15	0.70	2.56	4.15	5.60	1.34	1.70	2.30
3	B062	Sadiyardih	4.80	2.35	3.10	4.00	6.45	1.77	4.91	5.15	6.87	1.35	4.50	4.60
Average WL (bgl)			5.18	3.29	3.53	4.81	5.96	1.67	3.93	4.87	7.53	1.35	2.99	3.82

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 4.15 m Max – 10.13 m
Post-monsoon GW Level (m): Min – 1.70 m Max – 4.91 m

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



Area Statistics

Class		Color	Buffer Zone Area Km²	Buffer Zone Area % of Total	Core Zone Area Km²	Core Zone Area % of Total
Level I	Level II					
Settlement	Rural		11.43	2.15	0.48	2.54
	Urban		25.07	4.71	0.61	3.26
	Industrial		3.81	0.72	0.00	0.00
	Total Settlements		**40.30**	**7.57**	**1.09**	**5.80**
Forests	Dense Forest		4.06	0.76	0.01	0.07
	Open Forest		18.51	3.48	0.00	0.00
	Total (A)		22.57	4.24	0.01	0.07
Scrubs	Scrubs (B)		151.96	28.55	6.13	32.65
Plantations	Social Forestry		22.64	4.25	0.82	4.37
	Plantation on OB Dump		6.71	1.26	0.11	0.59
	Total Plantation (C)		29.34	5.51	0.93	4.96
	Total Vegetation (A+B+C)		**203.87**	**38.30**	**7.07**	**37.68**
Agriculture	Fallow Land		112.22	21.08	1.22	6.53
	Crop Land		10.08	1.89	1.52	8.12
	Total Agriculture		**122.30**	**22.98**	**2.75**	**14.64**
Mining Area	Coal Quarry		3.68	0.69	0.00	0.00
	Coal Dump		1.53	0.29	0.00	0.00
	Barren OB Dump		4.89	0.92	0.01	0.03
	Barren Backfilled Area		7.16	1.35	0.06	0.32
	Quarry Filled with Water		0.44	0.08	0.00	0.00
	Total Mining Area		**17.71**	**3.33**	**0.06**	**0.35**
Waste Lands	Waste Land		133.87	25.15	7.56	40.28
	Ash /slurry/Tailings Ponds		0.61	0.11	0.01	0.08
	Sand Body		1.66	0.31	0.00	0.00
	Total Wastelands		**136.15**	**25.58**	**7.57**	**40.35**
Water Bodies	Rivers, Lakes, Nalas etc.		11.95	2.24	0.22	1.17
All Total			532.29	100.00	18.76	100.00

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. GROUN D 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.

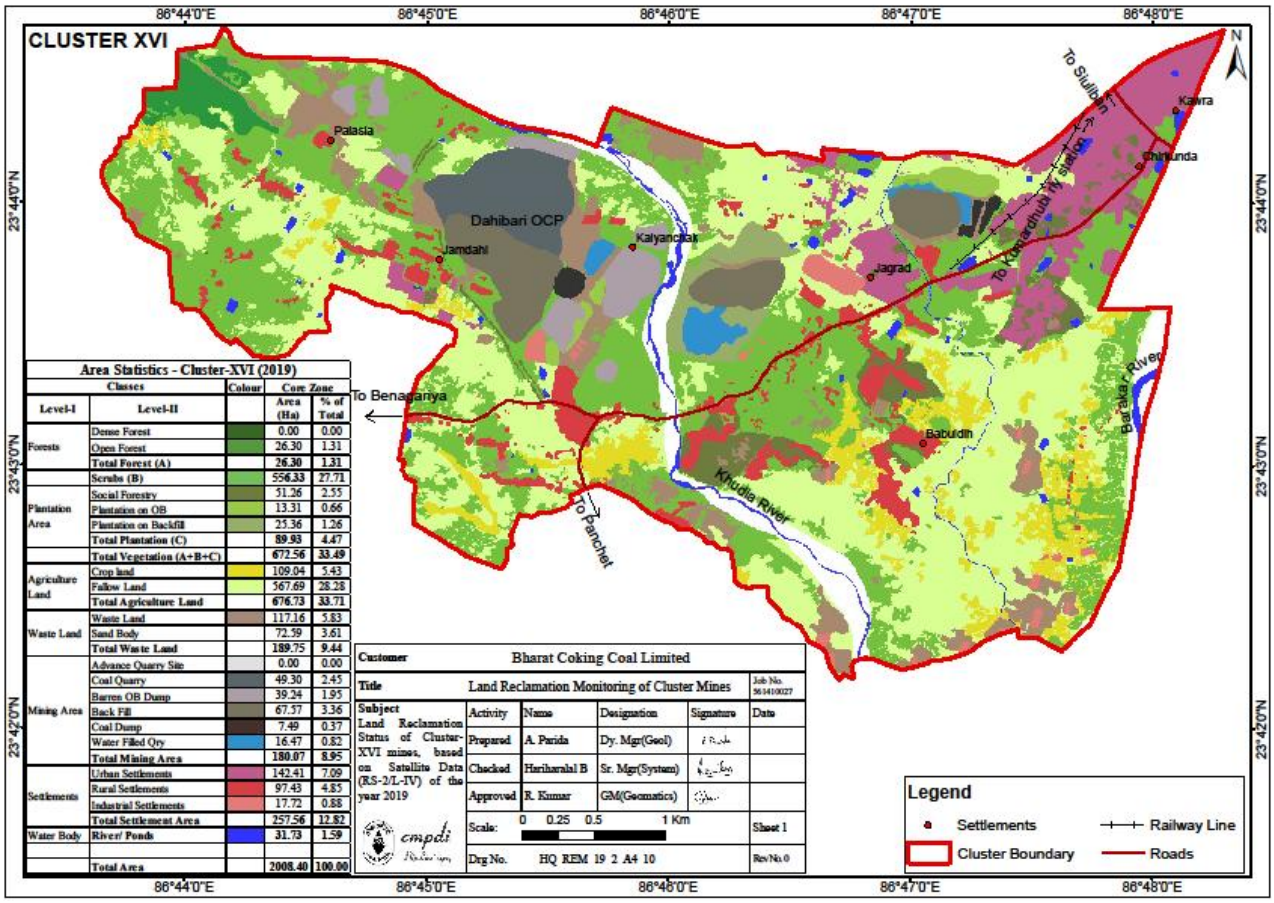
Monitoring stations (**DB022, DB023, DB024 & DB025**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'23, August'23, and Nov'23 and January'24. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2023-24				2022-23				2021-22			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	DB022	Dahibari, Basti	4.25	2.07	2.43	3.31	3.72	1.47	1.99	1.58	3.83	1.55	2.05	1.57
2	DB023	Dahibari OC	4.8	2.61	2.94	4.24	3.56	1.71	2.60	2.40	3.67	1.05	2.68	1.70
3	DB024	Dahibari	8.25	3.5	4.18	6.87	7.08		3.91		7.30	4.20	2.85	5.80
4	DB025	Basantimata	5.15	2.6	2.9	3.17	4.89		2.81		5.04	1.01	2.90	2.63
Average WL (bgl)			5.61	2.70	3.11	4.40	4.81	1.59	2.83	1.99	4.96	1.95	2.62	2.93

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 – 4.18 m

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



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

4.0 GROUND WATER LEVEL SCENARIO

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

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

Sl. No.	Cluster of BCCL	No. of Monitoring Wells	Water level Below ground level (May, Aug, Nov'23 & Jan'24)	Avg. Fluctuation (in meters) during 2023	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	4 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

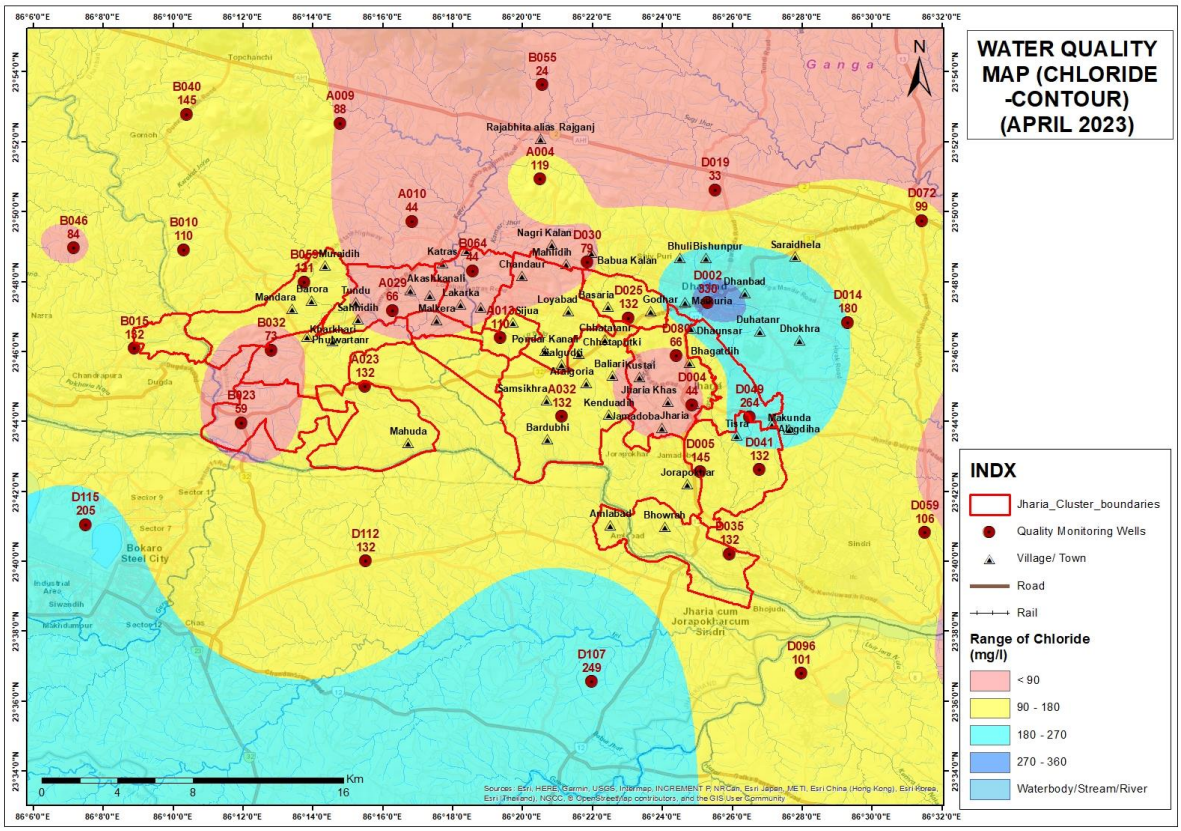
6.0 GROUND WATER QUALITY

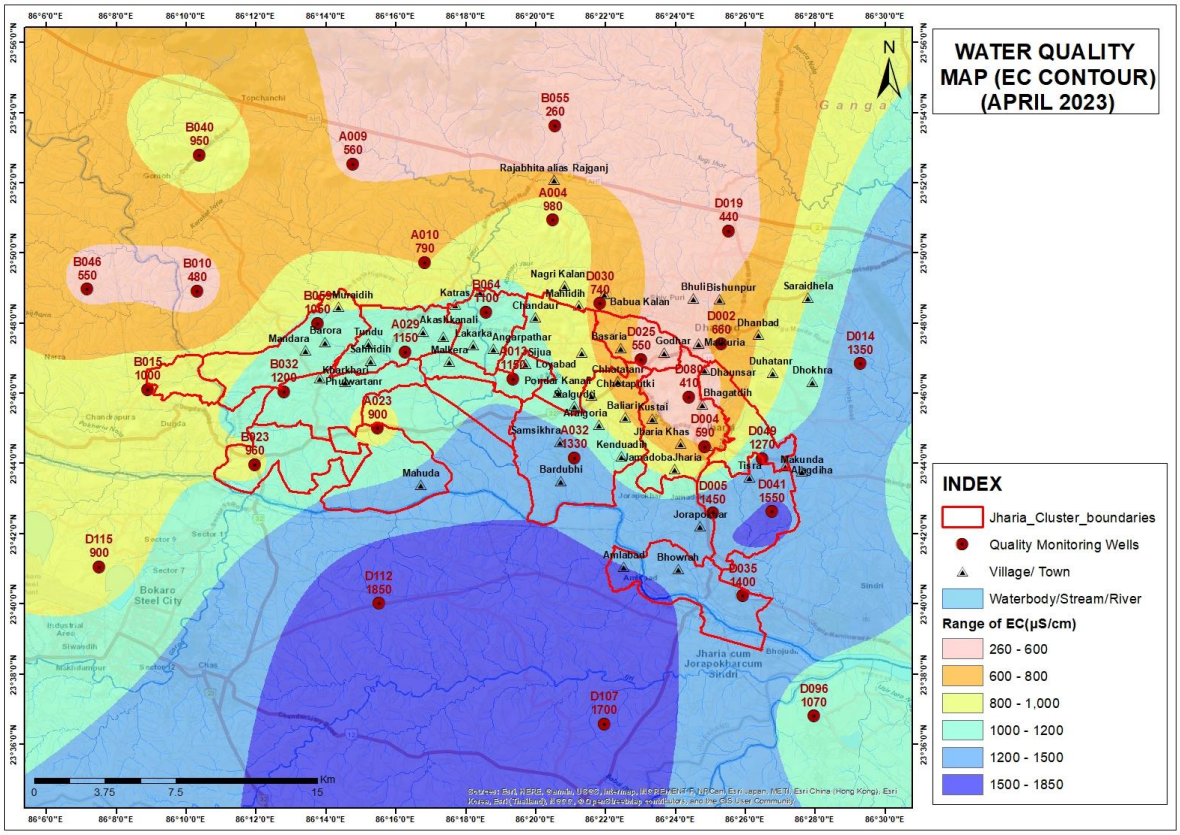
The ground water samples of the study area (15 nos. of Cluster of mines, BCCL) were collected from dug wells and analyzed. Thirty-five ground water samples were analyzed during the month of April and May'2023 at CMPDI, RI-II, Dhanbad. The water sampling details is given in **Annexure–V** and Water sample locations are shown in **Plate-II**. The water quality data is presented in **Annexure–VII.**

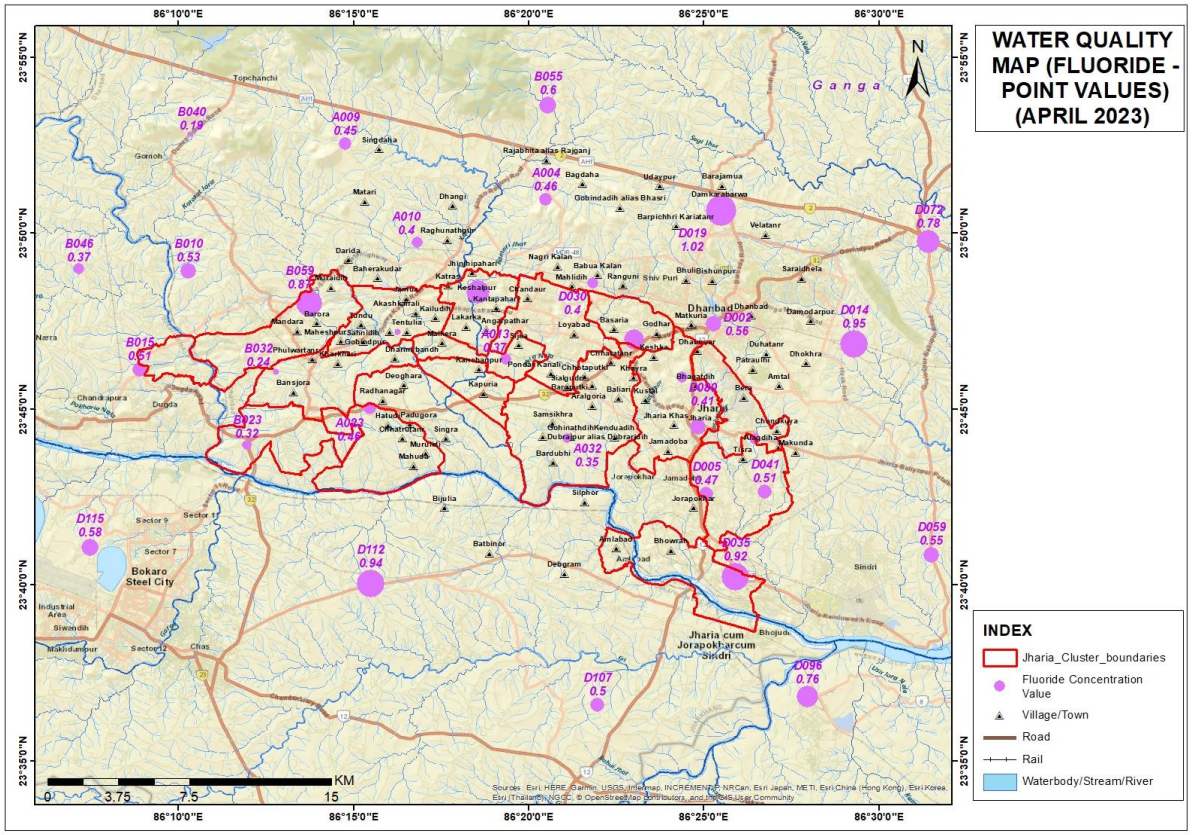
The study of the variations in water quality parameters is described below:

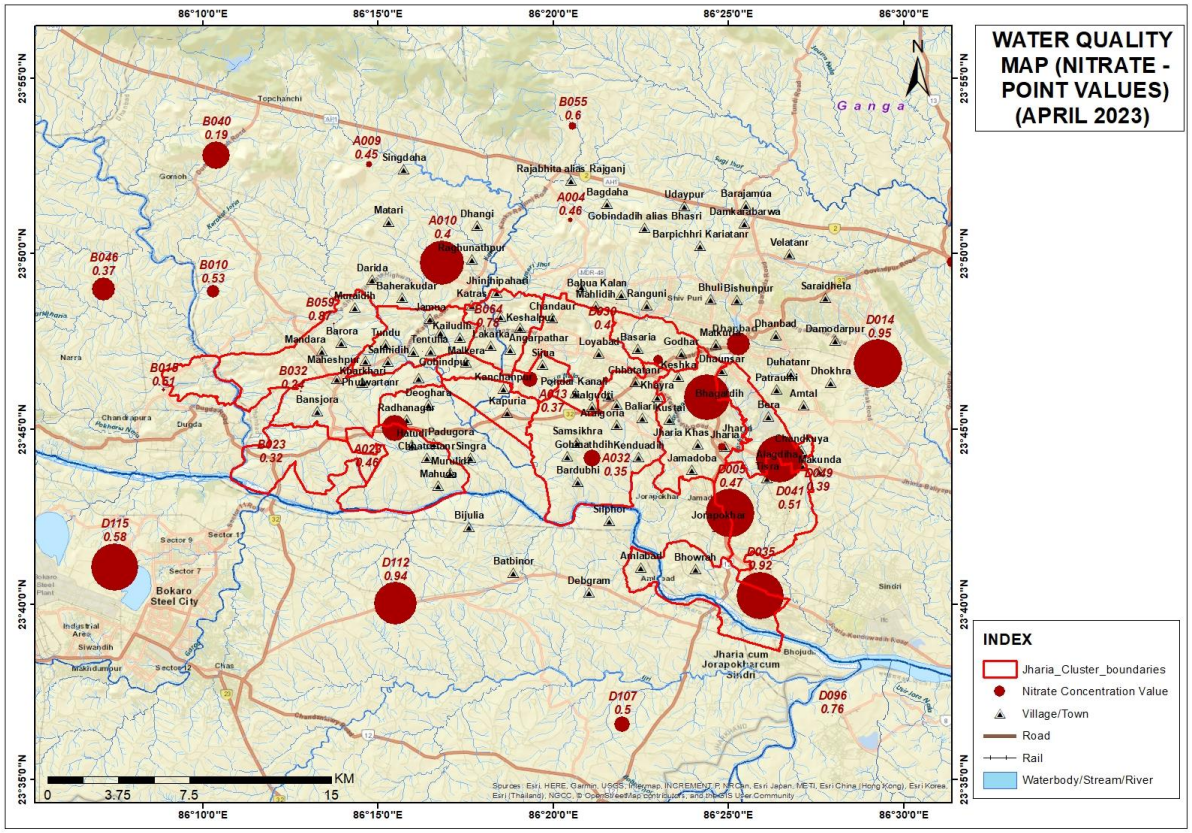
The pH of the groundwater samples varies between 7.63 (D-112) to 8.62 (B-64), the pH is within the IS 10500:2012 limit of drinking water standard.

The concentration of calcium in the water samples varies 21 (B-55) to 190 mg/l (D-107) and is above the permissible limit (75 mg/l) of drinking water standards. The sulphate ranges between 40 (B-55) to 659 mg/l (D-35) and the value of sulphate in water sample are above the permissible limit (200 mg/l). The Iron, Manganese, Zinc and Chromium concentration in the water samples found to be below the upper IS 10500:2012 limits for drinking water.


WATER QUALITY MAP (CHLORIDE -CONTOUR) (APRIL 2023)
INDX
Jharia_Cluster_boundaries
Quality Monitoring Wells
Village/ Town
Road
Rail
Range of Chloride (mg/l)
< 90
90 - 180
180 - 270
270 - 360
Waterbody/Stream/River
B055 24
B040 145
A009 88
Rajabhita alias Rajganj A004 119
D019 33
D072 99
A010 44
B046 84
B010 110
B064 54
D030 79
D002 330
D014 180
B059 111
A029 66
D025 132
B015 152
B032 73
A012 110
D080 66
D049 264
A023 132
B023 59
A032 132
D004 44
D005 145
D041 132
D115 205
D112 132
D059 106
D035 132
D107 249
D096 101
Bokaro Steel City
Jharia cum Jorapokharcum Sindri
Mahuda
Bardubhi
Jorapokhar
Amlabad
Bhowrah
Nagri Kalan
Babua Kalan
Bhuli Bishunpur
Saraidhela
Dhanbad
Mouria
Duhatanr
Dhokhra
Godhar
Dhaunsar
Bhagatdih
Baliari Kustai
Kenduadih
Jharia Khas
Jamadoba
Tisra
Makunda
Alagdiha
Loyabad
Sijua
Powdar Kanan
Chhotapatki
Chhotajani
Barora
Tundu
Sahnidih
Malkera
Lakarka
Akash Kanali
Katras
Chandaur
Mandara
Khorkhari
Phulwartanr
Samsikhra
Kalgudig
Angoria
Muraidih
Ganga
Topchanchi
Maithon
Chandrapura
Dugda
Sindri
Sector 9
Sector 7
Sector 12
Industrial Area
Siwandih
Maldumpur
Chas
Km
0 4 8 16


WATER QUALITY MAP (EC CONTOUR) (APRIL 2023)
INDEX
Jharia_Cluster_boundaries
Quality Monitoring Wells
Village/ Town
Waterbody/Stream/River
Range of EC(µS/cm)
260 - 600
600 - 800
800 - 1,000
1000 - 1200
1200 - 1500
1500 - 1850
B055 260
B040 950
A009 560
Rajabhita alias Rajganj A004 980
D019 440
A010 790
B046 550
B010 480
B064 1100
D030 740
D002 660
D014 1350
B059 1050
A029 1150
D025 550
B015 1000
B032 1200
A012 1150
D080 410
D049 1270
A023 900
B023 960
A032 1330
D004 590
D005 1450
D041 1550
D115 900
D112 1850
D035 1400
D107 1700
D096 1070
Bokaro Steel City
Jharia cum Jorapokharcum Sindri
Mahuda
Bardubhi
Jorapokhar
Amlabad
Bhowrah
Nagri Kalan
Babua Kalan
Bhuli Bishunpur
Saraidhela
Dhanbad
Mouria
Duhatanr
Dhokhra
Godhar
Dhaunsar
Bhagatdih
Baliari Kustai
Kenduadih
Jharia Khas
Jamadoba
Tisra
Makunda
Alagdiha
Loyabad
Sijua
Powdar Kanan
Chhotapatki
Chhotajani
Barora
Tundu
Sahnidih
Malkera
Lakarka
Angorpathar
Akash Kanali
Katras
Chandaur
Mandara
Khorkhari
Phulwartanr
Samsikhra
Kalgudig
Angoria
Muraidih
Ganga
Topchanchi
Maithon
Chandrapura
Dugda
Sindri
Sector 9
Sector 7
Sector 12
Industrial Area
Siwandih
Maldumpur
Chas
Km
0 3.75 7.5 15


WATER QUALITY MAP (FLUORIDE - POINT VALUES) (APRIL 2023)
INDEX
Jharia_Cluster_boundaries
Fluoride Concentration Value
Village/Town
Road
Rail
Waterbody/Stream/River
Ganga
Bokaro Steel City
Jharia cum Jorapokharcum Sindri
KM


WATER QUALITY MAP (NITRATE - POINT VALUES) (APRIL 2023)
INDEX
Jharia_Cluster_boundaries
Nitrate Concentration Value
Village/Town
Road
Rail
Waterbody/Stream/River
Ganga
Bokaro Steel City
Jharia cum Jorapokharcum Sindri
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 76.30% (as per 2017 GWRA). The highest stage of development is in Jharia Block (127.0%) & Dhanbad Block (107.50%) and lowest stage of development is in Chirkunda Block (35.5%) as per GWRA-2013. The Gondwana sandstones in general, known to constitute good aquifers at many places. However, the yield potential of the area adjoining to active mines in the coal belt is poor. The active mines often act as groundwater "sinks". In contrast, the water-logged abandoned mines and pits act as potential sources of groundwater. As per the assessment by Central Ground Water Board (CGWB), Patna in 2022, Block wise data of Dhanbad District given below:

Table–9A: Block wise Stage of Groundwater development

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

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

Table–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) 2023-24		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	Bermo (SOD: Over-exploited)	2173 (2065+108)	NIL	2112 (1698+414)	61	3.67	2.19	YES	YES	Recharge structure needed
Cluster-II	Baghmara (SOD: Safe)	8350	Jamunia river	6737 (2755+3982)	1613	5.16	3.00	NO	NO	Excess mine water needed to be utilized
Cluster-III		12760 (10960+1800)	NIL	8946 (7849+1097)	3814	5.53	3.47	NO	NO	
Cluster-IV		5900	MADA	5100 (3605+1495)	800	6.77	3.18	NO	NO	
Cluster-V		12690 (11025+1665)	MADA	11063 (5710+5353)	1897	3.63	2.56	YES	YES	
Cluster-VI	Dhanbad (SOD: Semi-critical)	4150	MADA	4150 (1664+2486)	0.0	4.09	2.70	YES	NO	--
Cluster-VII		21565	MADA	20826 (17596+3230)	739	4.04	2.56	YES	YES	Excess mine water needed to be utilized water
Cluster-VIII	Jharia / Dhanbad Urban (SOD: Critical)	9320	MADA	5294 (3730+1564)	4026	8.11	4.05	NO	NO	
Cluster-IX		12980	MADA	9358 (4549+4809)	3622	7.58	4.09	NO	NO	
Cluster-X		11825	Damodar river	6201 (4255+1946)	5624	3.99	2.76	YES	NO	
Cluster-XI	Dhanbad (SOD: Critical)	24960	MADA & DVC	19425 (14015+5410)	5535	4.75	2.66	NO	NO	
Cluster-XIII	Baghmara (SOD: Safe)	750	Damodar river	692	58.0	7.22	4.92	NO	NO	--
Cluster-XIV		943	NA	668	275	6.34	4.28	NO	NO	--
Cluster-XV		6200	NA	5941 (4600+1341)	259	5.18	3.53	NO	NO	--
Cluster-XVI	Chirkunda (SOD: Safe)	1910	DVC (Barakar river)	1730 (1380+350)	180	5.61	3.11	NO	NO	--

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 x 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.

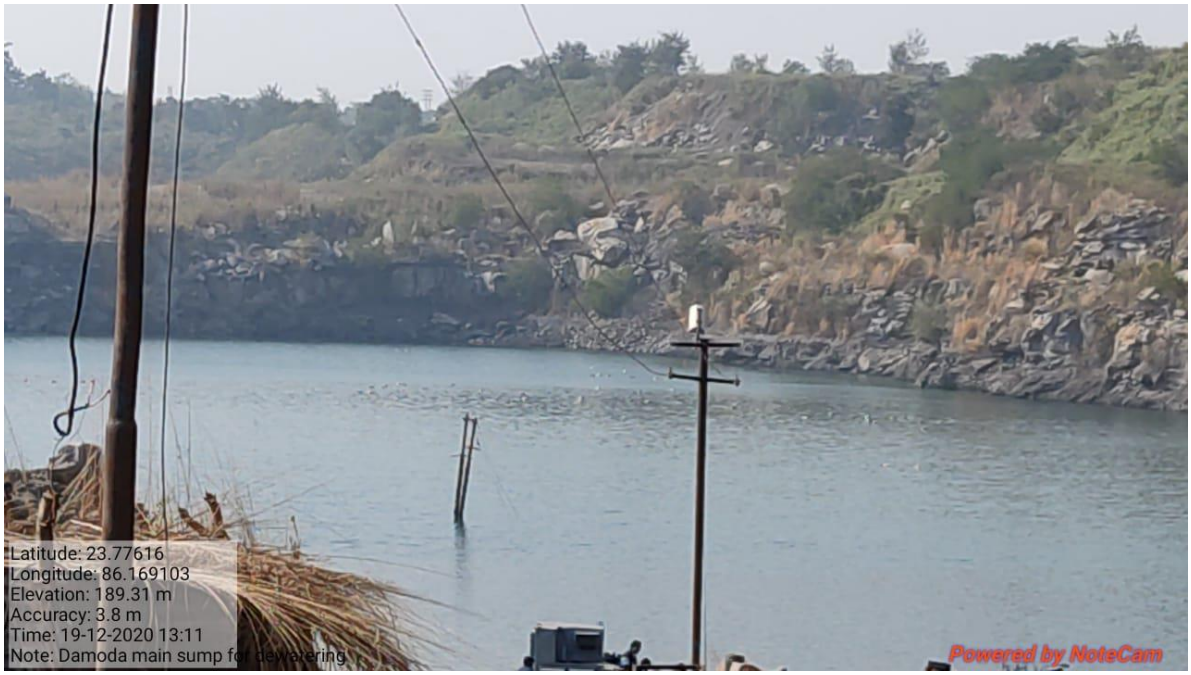


RECHARGE POND / ABANDONDED IN THE JCF MINE AREA



RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

Fig-13 to 14.



RECHARGE POND / ABANDONDED IN THE JCF MINE AREA



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

List of Ramsar Sites in India

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

Annexure – IV

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

Year	January	February	March	April	May	June	July	August	Sep	Oct	Nov	Dec	Annual
1994	26.5	20.0	3.3	23.5	4.5	289.5	245.5	240.0	134.0	40.5	0.0	0.0	1027.3
1995	15.0	18.3	20.0	0.0	34.5	122.0	140.1	257.0	446.0	0.0	34.0	5.5	1092.4
1996	12.5	12.5	5.2	0.0	0.0	210.5	138.5	400.0	214.0	24.0	0.0	0.0	1017.2
1997	10.5	17.5	2.8	63.5	41.5	231.5	599.3	621.1	196.8	16.5	34.0	16.0	1851.0
1998	20.5	21.0	160.0	18.0	40.0	80.0	347.0	409.0	123.0	120.5	11.0	0.0	1350.0
1999	0.0	0.0	0.0	0.0	64.0	150.0	511.0	336.0	510.5	124.0	0.0	0.0	1695.5
2000	2.0	15.0	0.0	20.0	68.0	452.5	270.5	89.0	234.5	-	0.0	0.0	1151.5
2001	0.0	0.0	34.0	13.0	104.0	448.7	552.5	121.0	107.0	126.5	0.0	0.0	1506.7
2002	12.0	10.0	26.0	0.0	32.5	185.0	150.0	125.5	310.0	64.0	0.0	0.0	915.0
2003	6.0	58.5	38.5	40.0	24.0	-	366.1	279.0	145.1	151.6	0.0	2.3	1111.1
2004	18.45	2.13	1.55	53.93	9.53	95.95	408.57	261.07	174.01	63.01	51.10	12.85	1152.15
2005	44.49	23.11	26.16	17.90	28.95	272.26	388.86	158.86	69.03	117.63	0.09	1.67	1149.01
2006	0.00	0.00	3.11	12.64	86.68	113.20	505.72	316.06	339.51	9.80	3.73	0.00	1390.45
2007	0.00	58.69	35.76	21.08	25.33	139.60	666.30	416.85	363.93	43.63	1.57	0.00	1772.74
2008	16.44	1.96	6.27	6.78	37.26	180.58	422.25	275.33	198.31	27.64	0.00	0.00	1172.82
2009	0.00	0.26	5.81	0.19	105.82	78.32	232.20	370.39	429.16	68.56	11.31	0.98	1303.00
2010	0.59	19.64	7.62	38.24	93.72	146.68	157.31	198.97	239.75	78.76	5.26	40.53	1027.07
2011	0.00	1.60	18.25	12.81	102.58	294.61	174.35	445.43	214.88	30.35	0.69	0.00	1295.55
2012	18.45	2.13	1.55	53.93	9.53	95.95	408.57	261.07	174.01	63.01	51.10	12.85	1152.15
2013	0.07	17.62	0.79	15.24	105.51	176.77	170.14	276.70	135.76	304.46	0.00	0.00	1203.06
2014	9.27	35.71	21.21	8.16	62.77	112.58	283.73	223.38	214.48	30.30	0.00	0.00	1001.59
2015	12.06	3.33	26.71	45.73	32.91	162.96	385.21	239.38	71.34	15.62	0.00	0.61	995.86
2016	6.16	17.59	1.73	1.33	73.90	197.34	248.86	395.33	424.81	30.45	0.00	0.00	1397.50
2017	5.12	0.00	34.96	59.89	81.01	141.66	502.58	168.84	111.95	274.18	0.64	4.12	1384.95
2018	0.00	0.06	2.90	159.52	31.22	202.84	344.59	211.91	153.63	16.31	0.04	20.99	1144.01
2019	0.00	25.18	7.24	46.99	109.43	109.11	292.02	234.65	327.95	199.63	0.10	5.13	1357.43
2020	21.14	5.94	74.96	27.94	71.32	218.12	187.01	258.74	196.87	52.23	1.23	0.00	1115.50

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

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	DB010	86.8561	23.7085
B038	86.2135	23.8834	DB012	86.8713	23.7638
B040	86.1731	23.8799	DB013	86.8687	23.7814
B041	86.1611	23.9121	DB018	86.7915	23.7394
B043	86.2420	23.8949	DB019	86.7483	23.7194
B044	86.1276	23.8735	DB002	86.7794	23.7500
B046	86.1195	23.8163	DB022	86.7571	23.7237
B047	86.1233	23.7702	DB023	86.7514	23.7291

B048	86.2783	23.7259	DB024	86.7509	23.7309
B051	86.1521	23.7941	DB025	86.7399	23.7337
B053	86.1636	23.7683	DB026	86.7500	23.7194
B054	86.3639	23.8660	DB027	86.7232	23.7298
B055	86.3427	23.8940	DB028	86.6836	23.7472
B057	86.2860	23.8738	DB029	86.6548	23.7462
B059	86.2293	23.8000	DB003	86.7638	23.6555
B060	86.2541	23.8059	DB030	86.6654	23.7950
B062	86.1929	23.7628	DB031	86.6980	23.7884
B065	86.3076	23.8083	DB033	86.8126	23.7645
B067	86.2325	23.7233	DB034	86.7877	23.7785
B068	86.0873	23.7225	DB036	86.7546	23.7980
B071	86.0799	23.8088	DB038	86.7361	23.8346
D003	86.4149	23.7804	DB039	86.7150	23.7996
D005	86.4180	23.7098	DB004	86.8062	23.6541
D007	86.4574	23.7220	DB047	86.7509	23.7557
D008	86.1915	23.8340	DB005	86.8216	23.6785
D010	86.4947	23.7252	DB008	86.81519	23.73067
D012	86.4484	23.7771	DB009	86.8135	23.7354
D014	86.4884	23.7808	K010	86.9157	23.7059
D018	86.4317	23.8189	K012	86.9277	23.7267
D019	86.4253	23.8440	K015	86.9103	23.8177
D020	86.4023	23.8527	K020	86.8824	23.8514
D022	86.4021	23.8015	K021	86.9277	23.7267
D025	86.3837	23.7828	K026	86.8808	23.7414
D028	86.4016	23.8223	K030	86.8472	23.7396

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	Siulibari	0.6	1.8	13.88		Govt	Domestic
DB012	Puapur	0.85	1.8	9.6		Govt	Domestic
DB013	Sarbari	0.5	2	7.85		Govt	Domestic
DB018	Parbelia	0.75	1.6	7		Govt	Domestic
DB019	Chungei	0.73	1.8	6.45	BM	Govt	Domestic
DB002	Barakar	0.42	1.8	9.63	Barakar	Govt	Domestic
DB022	Kulti College	0.9	1.85	16.25	Raniganj	Govt	Domestic
DB023	Sabanpur	0.67	1.42	5.75	BM	Govt	Domestic
DB-24	Dendua More	0.58	2	12.8	Barakar	Govt	Domestic
DB025	Saraspahari	0.65	3	16.3		Govt	Domestic
DB026	Luchibad	0.7	4	9.8		DVC	Domestic
DB027	Dahibari	0.67	2.4	10.65		Govt	Domestic
DB028	Dahibari	0.7	2.3	8	Barakar	BCCL	Domestic
DB029	Dahibari	0.6	3.6	13.7	Barakar	BCCL	Domestic
DB003	Palasya	0.37	1.55	5.25		Govt	Domestic
DB030	Patlabari	0.6	3.1	10.55		Govt	Domestic
DB031	Ledaharia	0.6	1.2	8.84		Govt	Domestic

DB003	Patharkua	0.7	2	9.2		Kajal Chatterjee	Domestic
DB034	Kelyasol	0.6	3.6	11.6		Govt	Domestic
DB036	Ramkanali	0.55	2.4	8		Chhotka Marandi	Domestic
DB038	Nirsa	0.55	3.8	7.8		Govt	Domestic
DB039	Barajor/Amkura	0.65	3	6.9		Forest Dept.	Domestic
DB004	Tetuldanga	0.62	2.22	8.98	Talcher	DVC	Domestic
DB047	Madanpur	0.65	3.2	8.3		Govt	Irrigation
DB005	Lukuidih	0.48	3.2	7.8		Govt	Domestic
DB008	Pandra	0.8	2.2	5.75		Govt	Domestic
DB009	Mugma	0.68	3	19.25		Govt	Domestic
K010	Phatepur	0.8	2.02	28.3		Govt	Domestic
K012	Ethora	0.81	2	15.9		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		Govt	Domestic
K030	Kulti Station	0.31	0.75	4.25		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

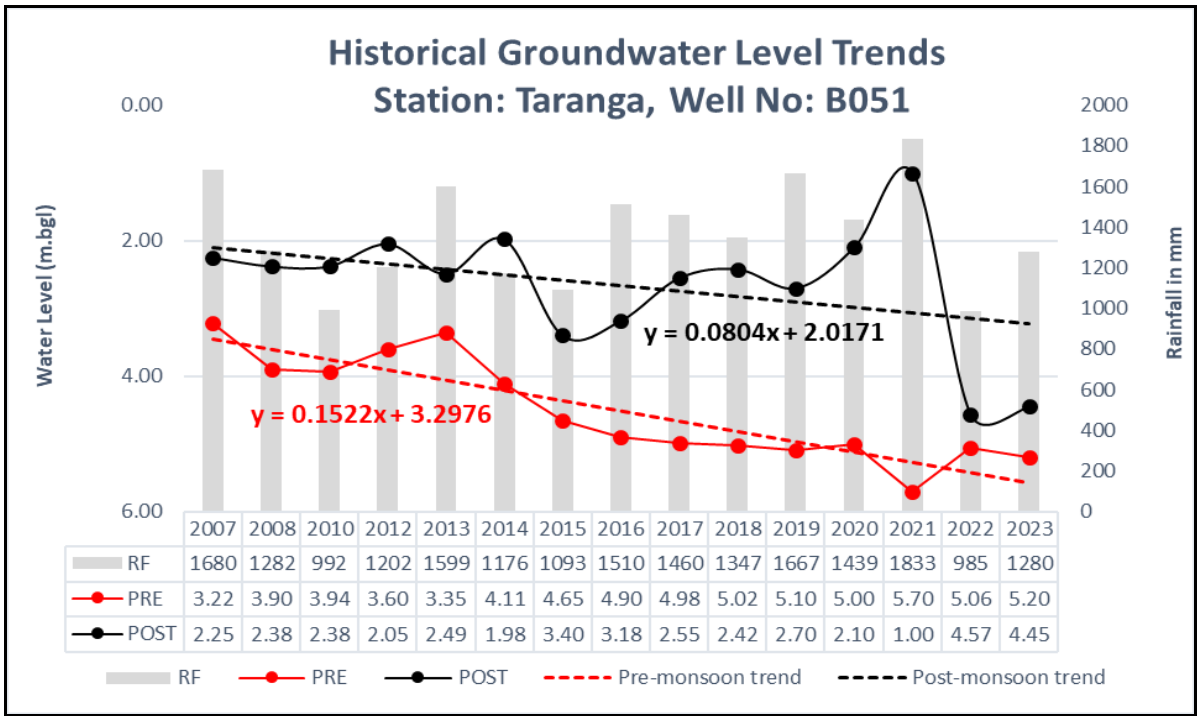
Historical Water Level data of Hydrograph Stations

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

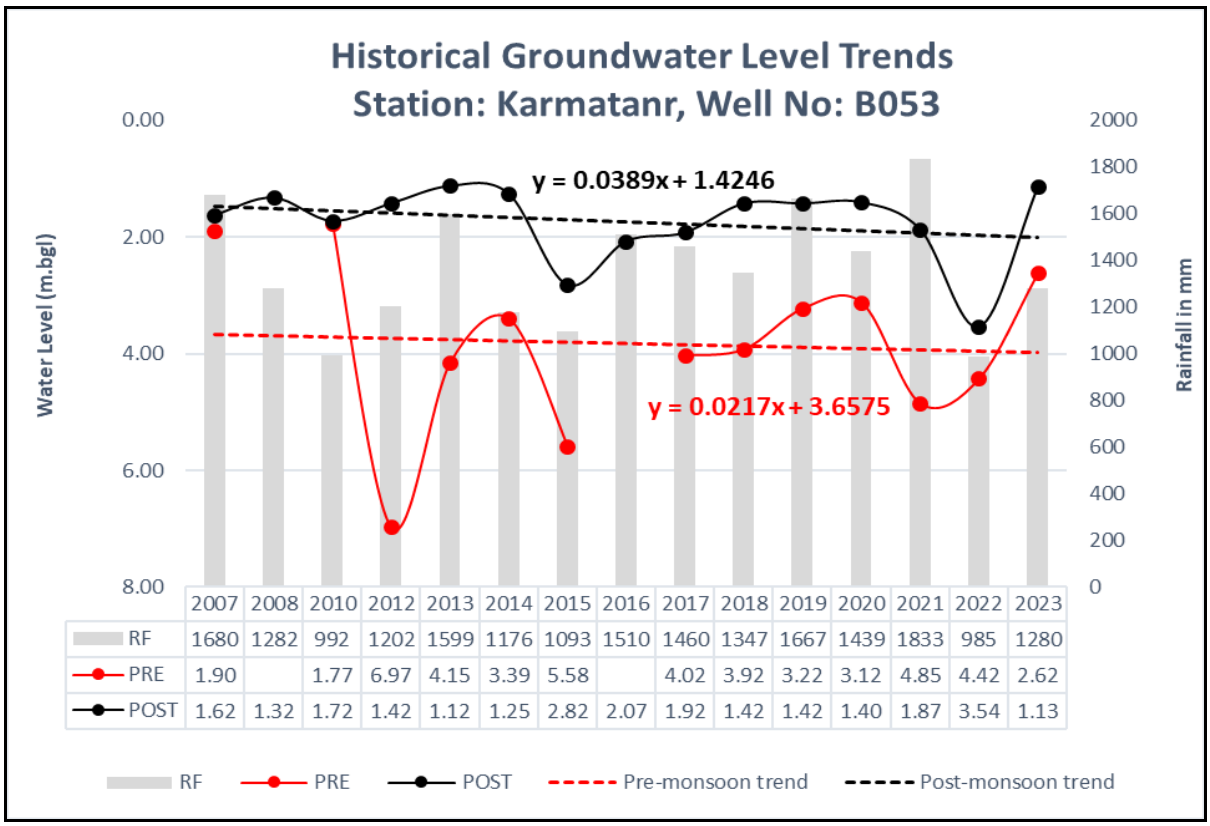
B054	7.62	4.56	9.25	5.55	7.2	4.1	7.55	3.65	9.05	3.55	7.7	3.87	7.4	3.43	7.3	4.75	7.65	5.8
B055	3.46	2.25	4.45	2.2	4.6	5.52	3.6	2.48		2.5	4.15	2.58	3.73	2.52	3.3	2	3.73	2.2
B057	6.18	3.35	6.9	3.45	5.9	3.6	6.2	3.1		2.95	6.4	3.05	5.36	2.92	6.1	3.5	5.36	3.26
B059	4.12	1.6	4.4	0.5	5.4	0.6	3.9	0.9	6.2	0.9	5.25	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

HYDROGRAPHS OF CLUSTER-I



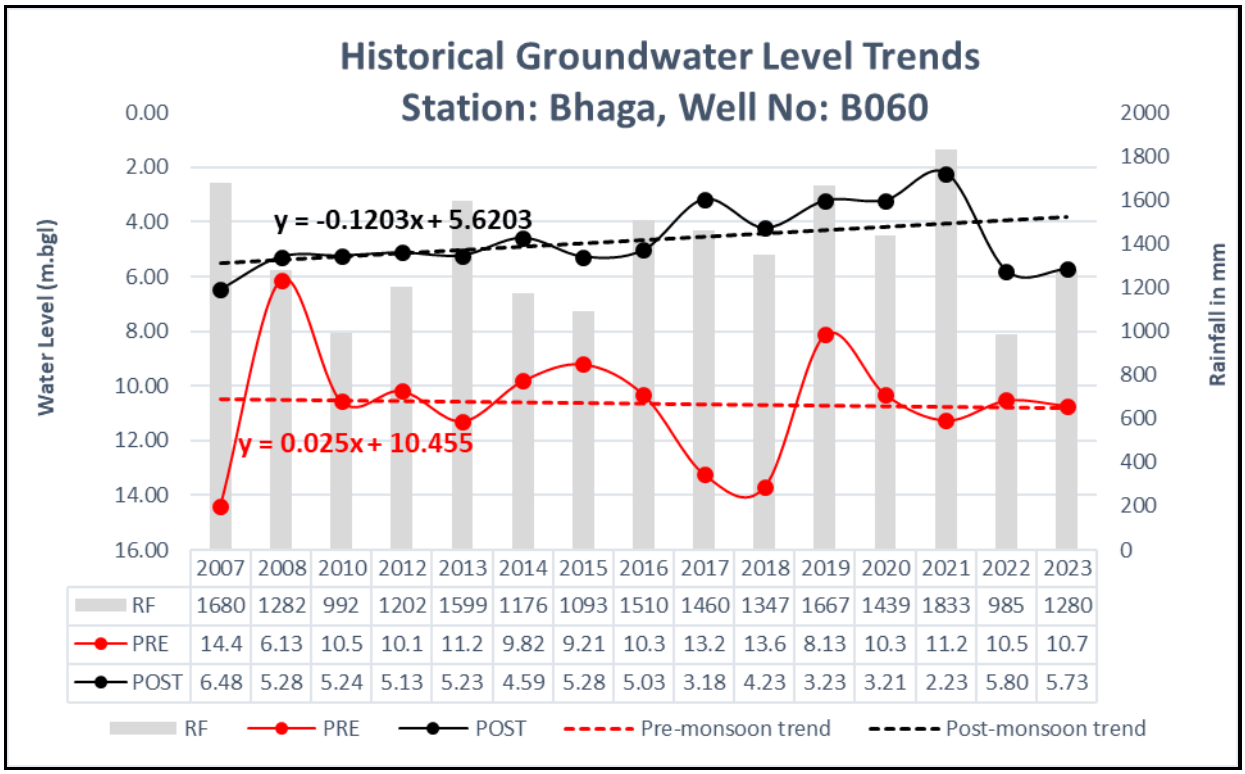
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	3.22	3.90	3.94	3.60	3.35	4.11	4.65	4.90	4.98	5.02	5.10	5.00	5.70	5.06	5.20
POST	2.25	2.38	2.38	2.05	2.49	1.98	3.40	3.18	2.55	2.42	2.70	2.10	1.00	4.57	4.45



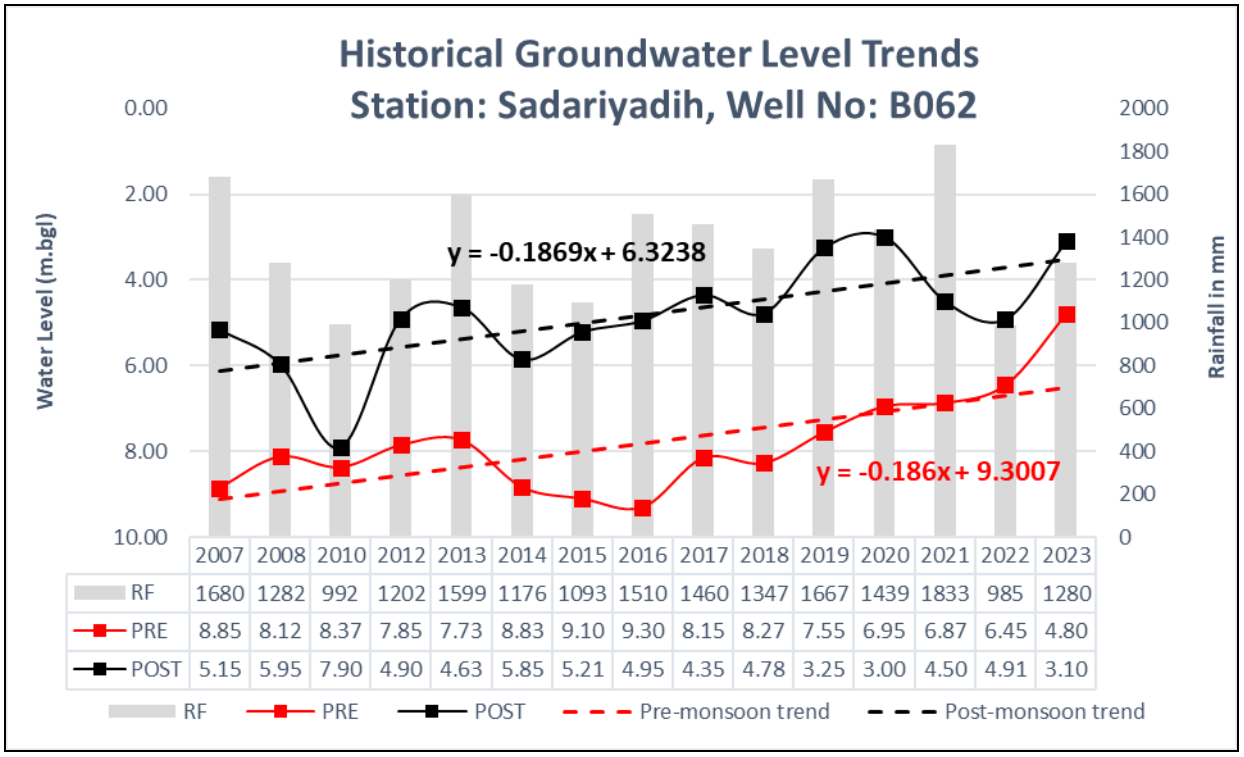
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	1.90		1.77	6.97	4.15	3.39	5.58		4.02	3.92	3.22	3.12	4.85	4.42	2.62
POST	1.62	1.32	1.72	1.42	1.12	1.25	2.82	2.07	1.92	1.42	1.42	1.40	1.87	3.54	1.13

Annexure – VI

HYDROGRAPHS OF CLUSTER-II



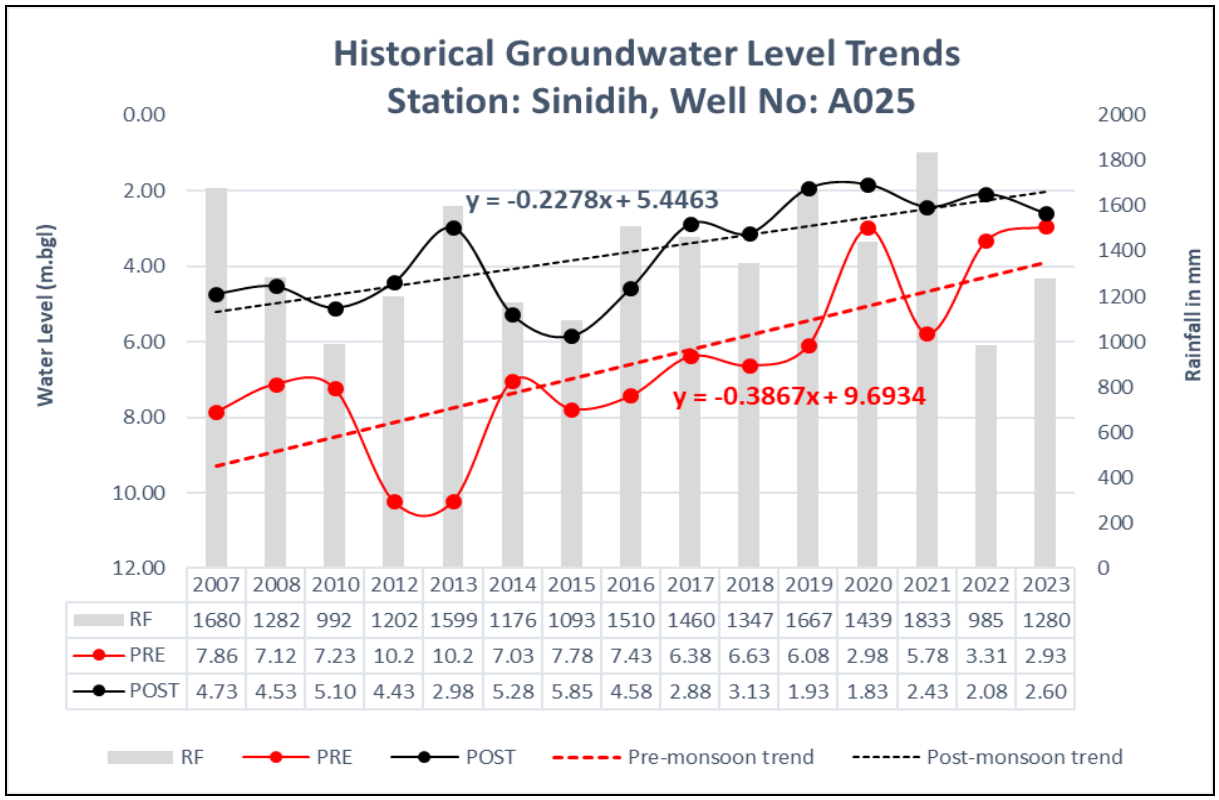
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	14.4	6.13	10.5	10.1	11.2	9.82	9.21	10.3	13.2	13.6	8.13	10.3	11.2	10.5	10.7
POST	6.48	5.28	5.24	5.13	5.23	4.59	5.28	5.03	3.18	4.23	3.23	3.21	2.23	5.80	5.73



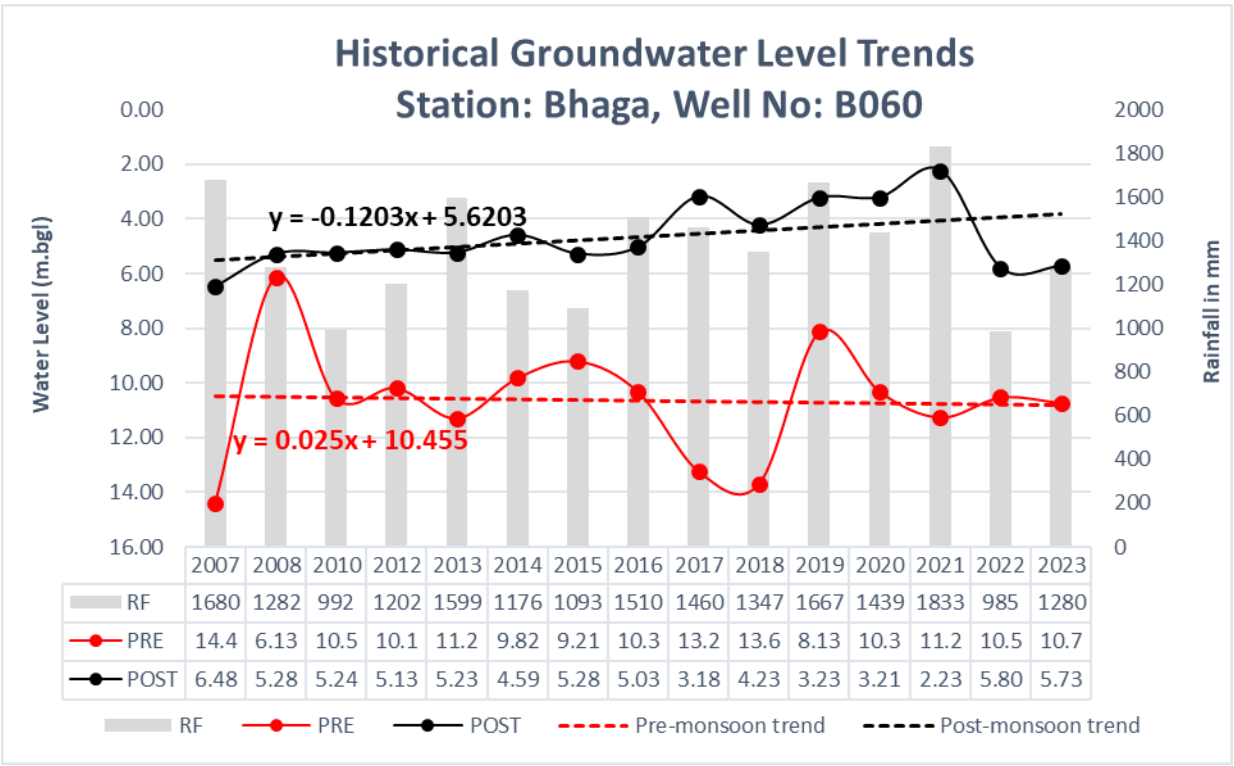
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	8.85	8.12	8.37	7.85	7.73	8.83	9.10	9.30	8.15	8.27	7.55	6.95	6.87	6.45	4.80
POST	5.15	5.95	7.90	4.90	4.63	5.85	5.21	4.95	4.35	4.78	3.25	3.00	4.50	4.91	3.10

Annexure – VI

HYDROGRAPHS OF CLUSTER-III



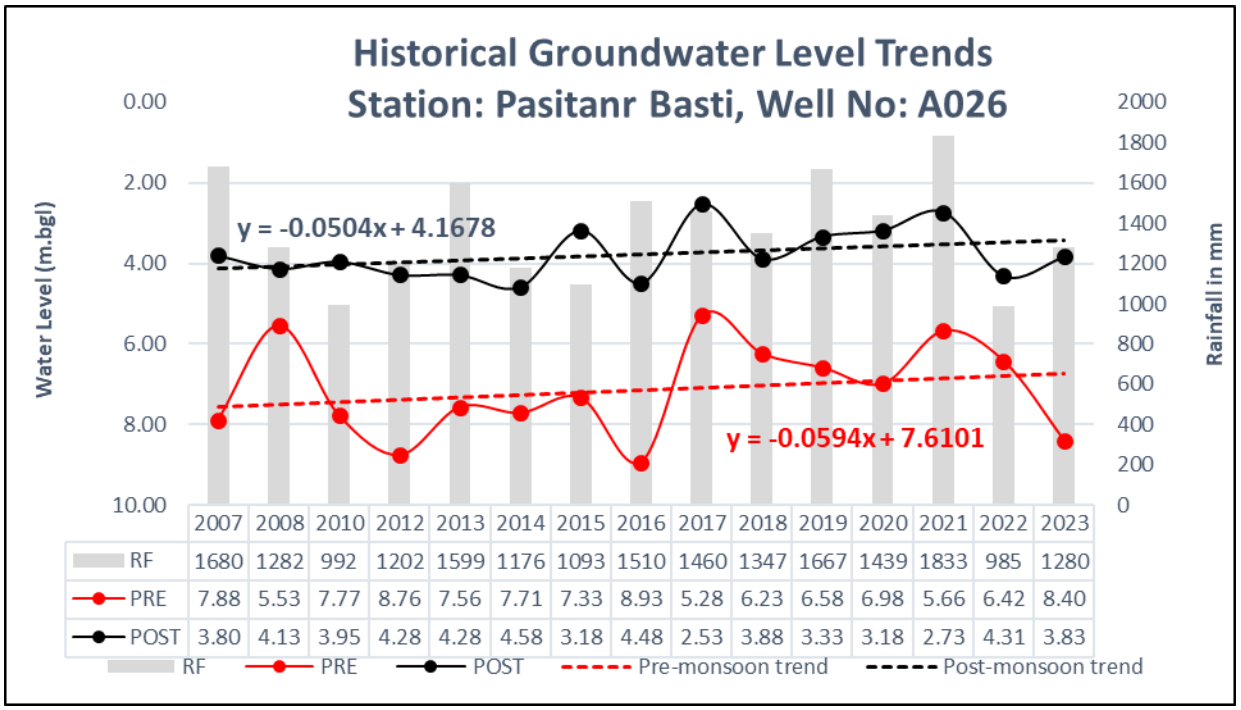
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	7.86	7.12	7.23	10.2	10.2	7.03	7.78	7.43	6.38	6.63	6.08	2.98	5.78	3.31	2.93
POST	4.73	4.53	5.10	4.43	2.98	5.28	5.85	4.58	2.88	3.13	1.93	1.83	2.43	2.08	2.60



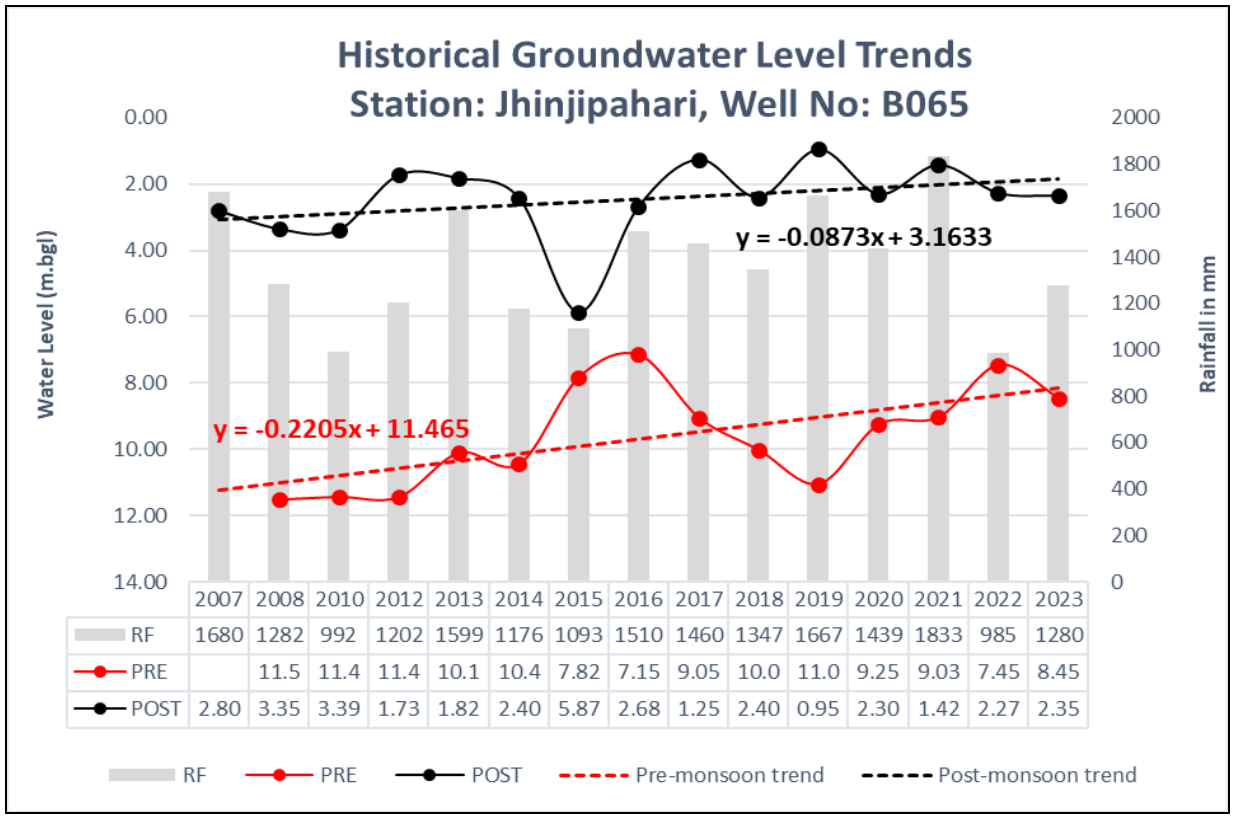
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	14.4	6.13	10.5	10.1	11.2	9.82	9.21	10.3	13.2	13.6	8.13	10.3	11.2	10.5	10.7
POST	6.48	5.28	5.24	5.13	5.23	4.59	5.28	5.03	3.18	4.23	3.23	3.21	2.23	5.80	5.73

Annexure – VI

HYDROGRAPHS OF CLUSTER-IV

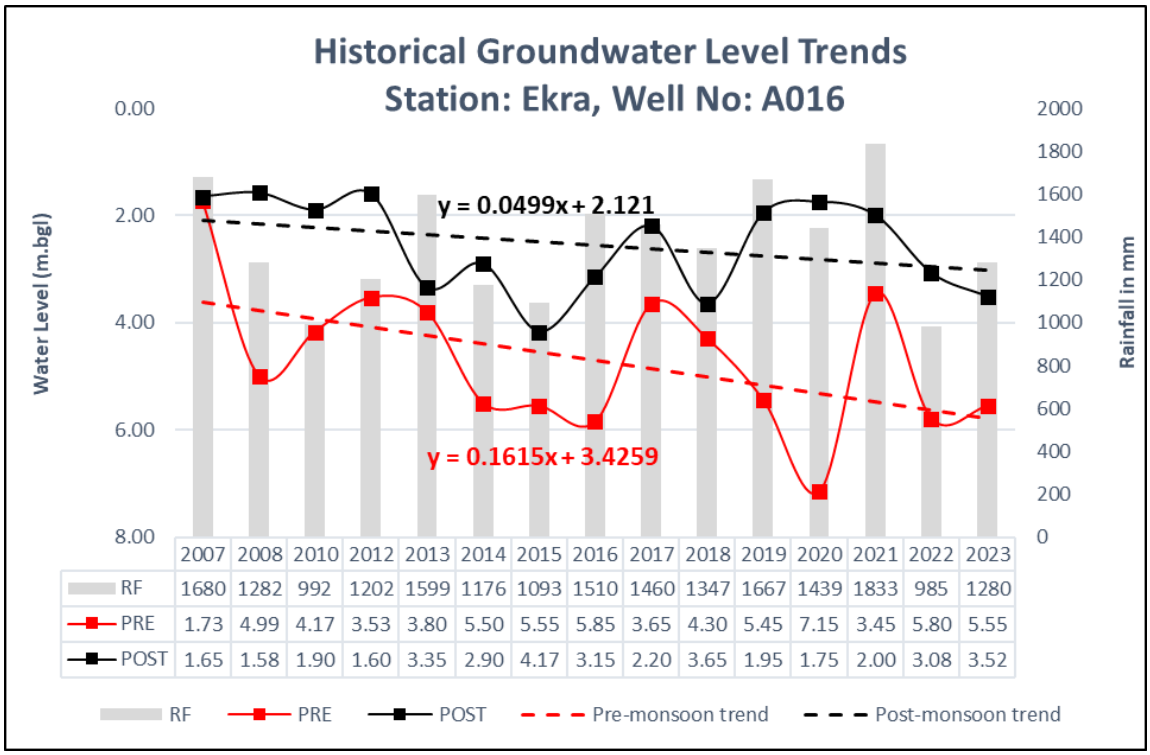


	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	7.88	5.53	7.77	8.76	7.56	7.71	7.33	8.93	5.28	6.23	6.58	6.98	5.66	6.42	8.40
POST	3.80	4.13	3.95	4.28	4.28	4.58	3.18	4.48	2.53	3.88	3.33	3.18	2.73	4.31	3.83

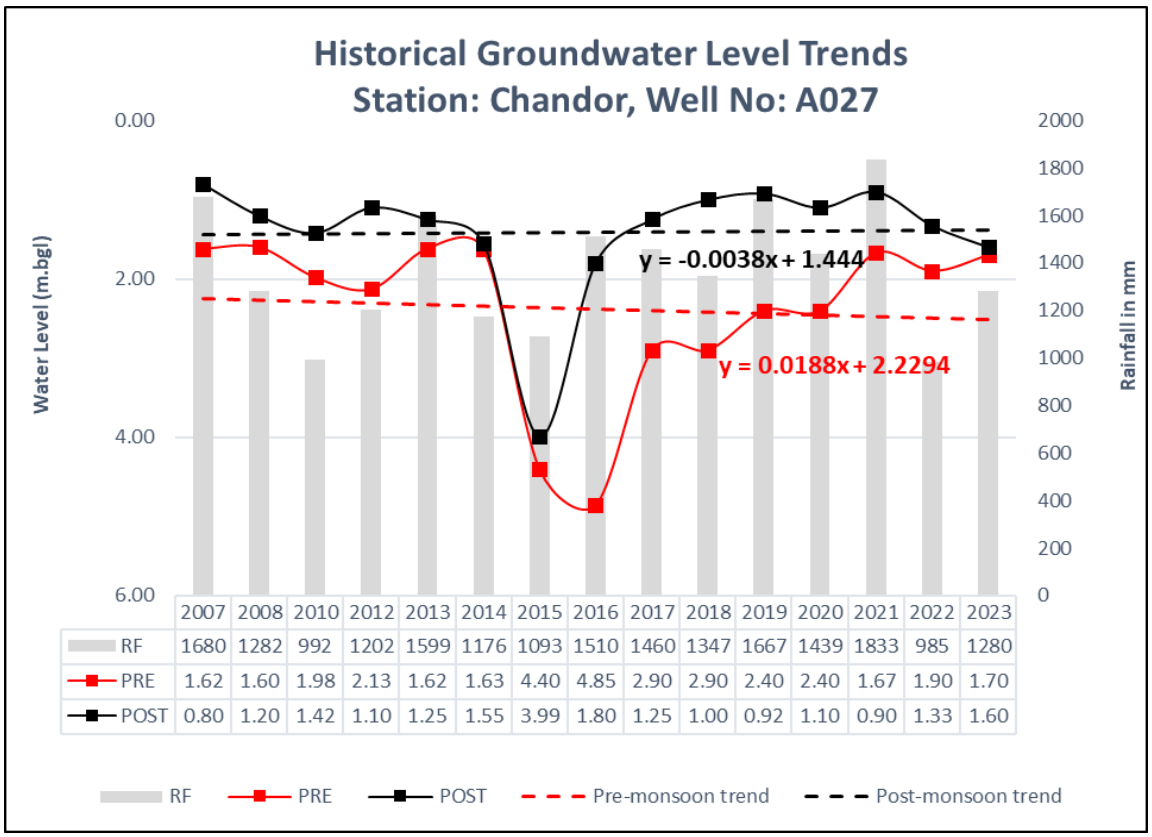


	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE		11.5	11.4	11.4	10.1	10.4	7.82	7.15	9.05	10.0	11.0	9.25	9.03	7.45	8.45
POST	2.80	3.35	3.39	1.73	1.82	2.40	5.87	2.68	1.25	2.40	0.95	2.30	1.42	2.27	2.35

HYDROGRAPHS OF CLUSTER-V



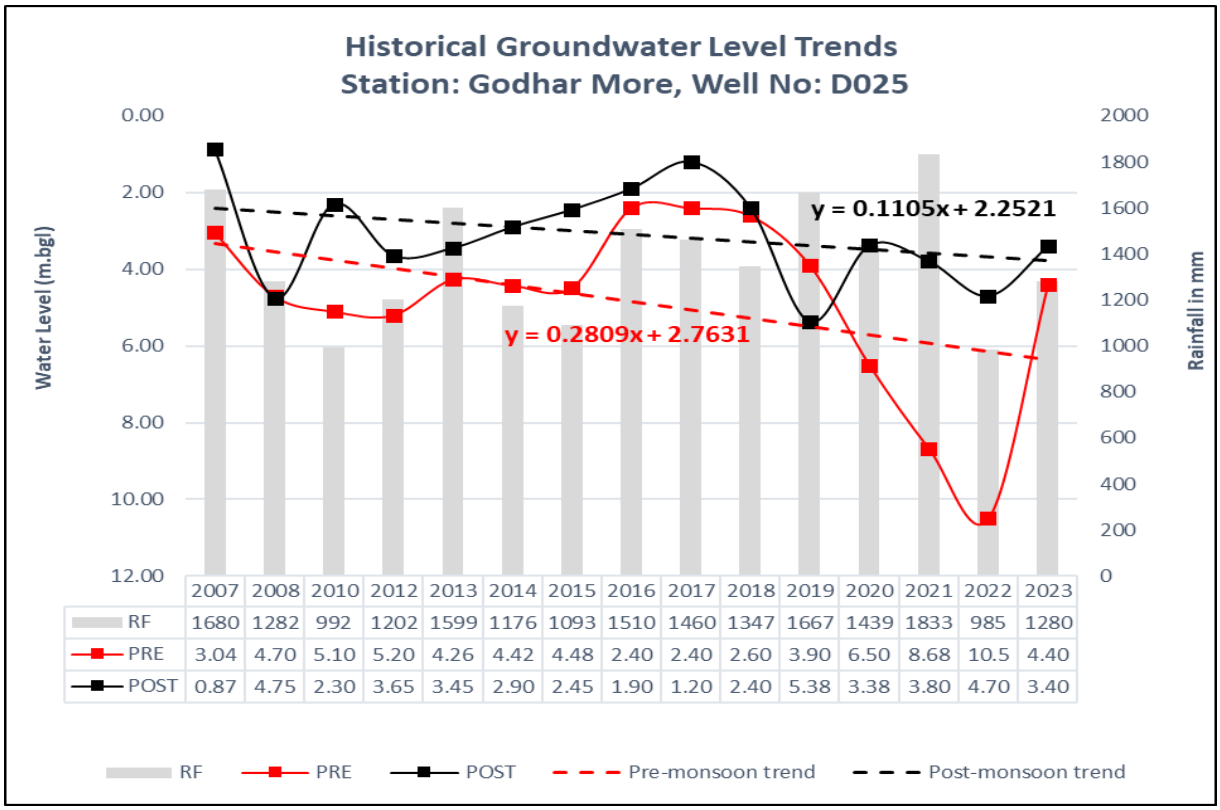
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	1.73	4.99	4.17	3.53	3.80	5.50	5.55	5.85	3.65	4.30	5.45	7.15	3.45	5.80	5.55
POST	1.65	1.58	1.90	1.60	3.35	2.90	4.17	3.15	2.20	3.65	1.95	1.75	2.00	3.08	3.52



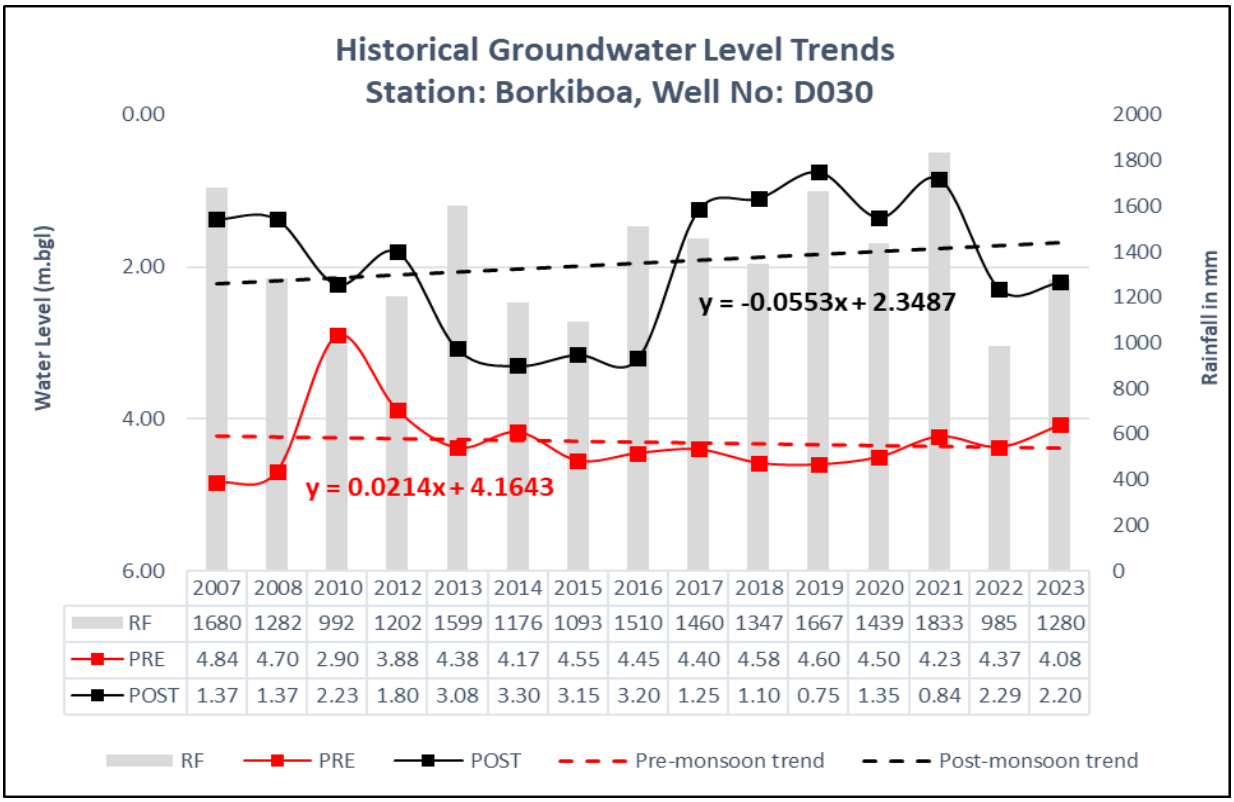
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	1.62	1.60	1.98	2.13	1.62	1.63	4.40	4.85	2.90	2.90	2.40	2.40	1.67	1.90	1.70
POST	0.80	1.20	1.42	1.10	1.25	1.55	3.99	1.80	1.25	1.00	0.92	1.10	0.90	1.33	1.60

Annexure – VI

HYDROGRAPHS OF CLUSTER-VI



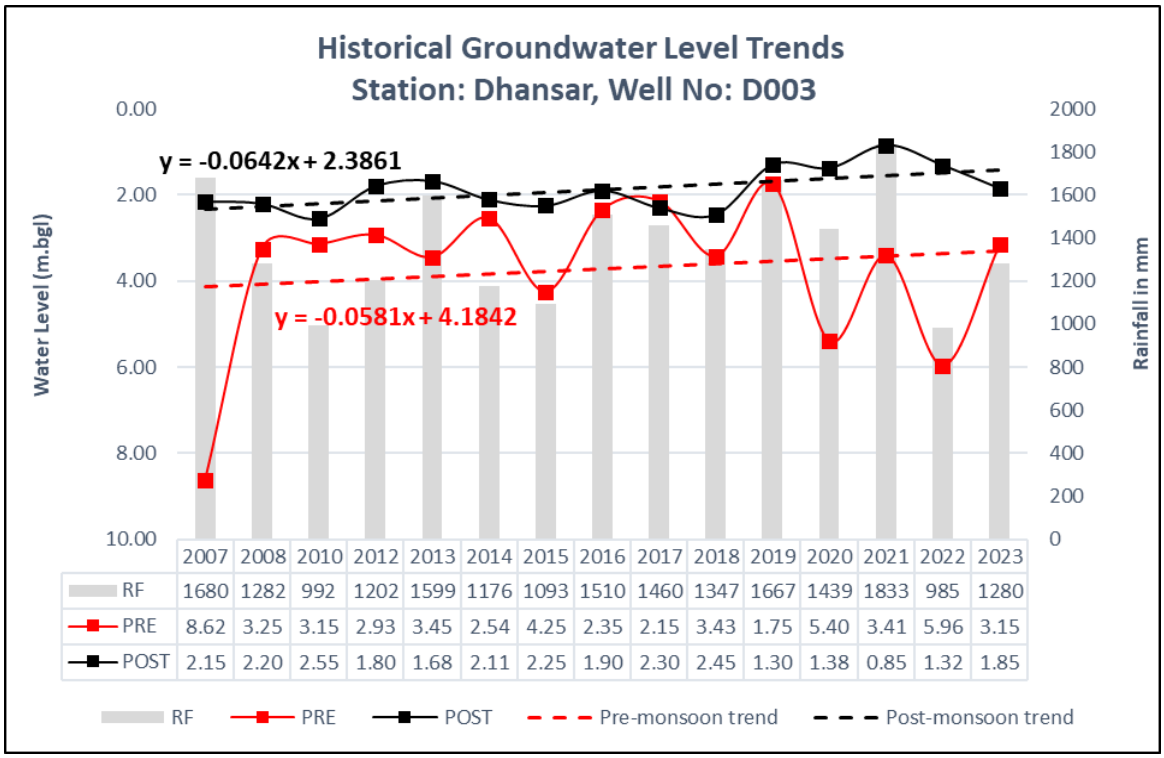
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	3.04	4.70	5.10	5.20	4.26	4.42	4.48	2.40	2.40	2.60	3.90	6.50	8.68	10.5	4.40
POST	0.87	4.75	2.30	3.65	3.45	2.90	2.45	1.90	1.20	2.40	5.38	3.38	3.80	4.70	3.40



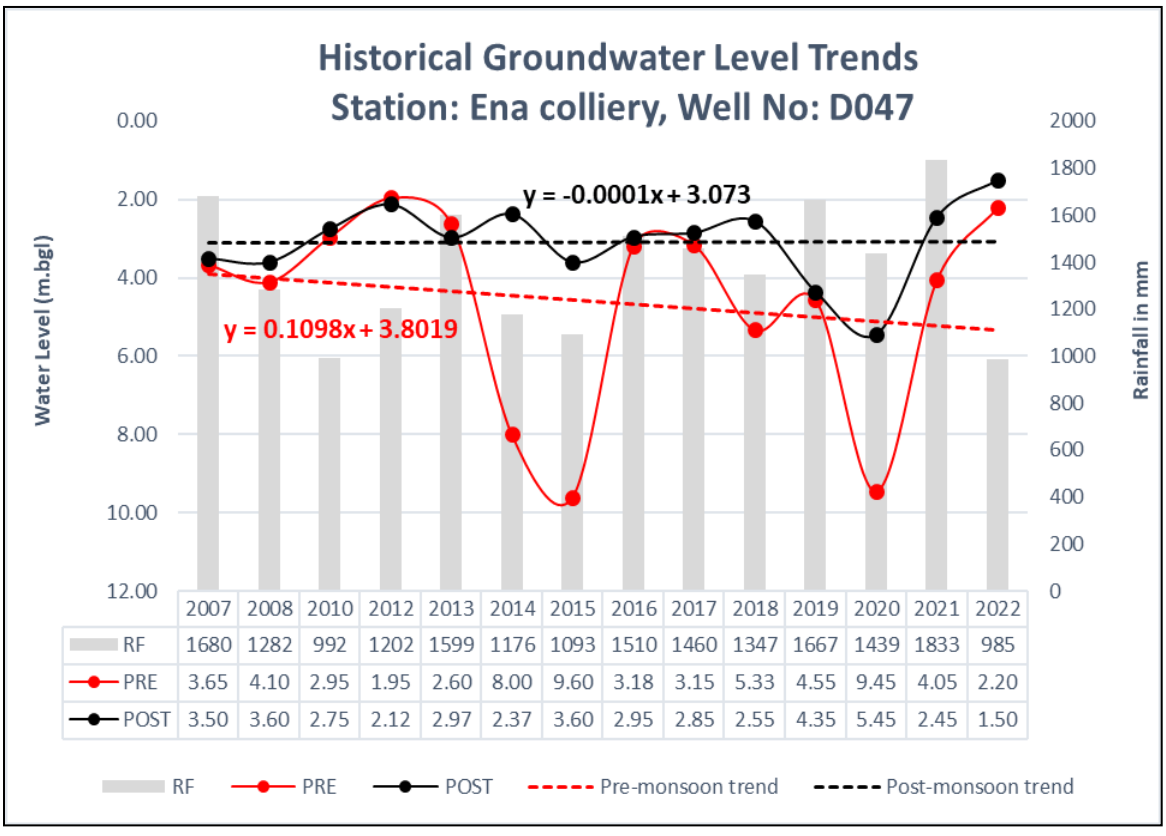
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	4.84	4.70	2.90	3.88	4.38	4.17	4.55	4.45	4.40	4.58	4.60	4.50	4.23	4.37	4.08
POST	1.37	1.37	2.23	1.80	3.08	3.30	3.15	3.20	1.25	1.10	0.75	1.35	0.84	2.29	2.20

Annexure – VI

HYDROGRAPHS OF CLUSTER-VII



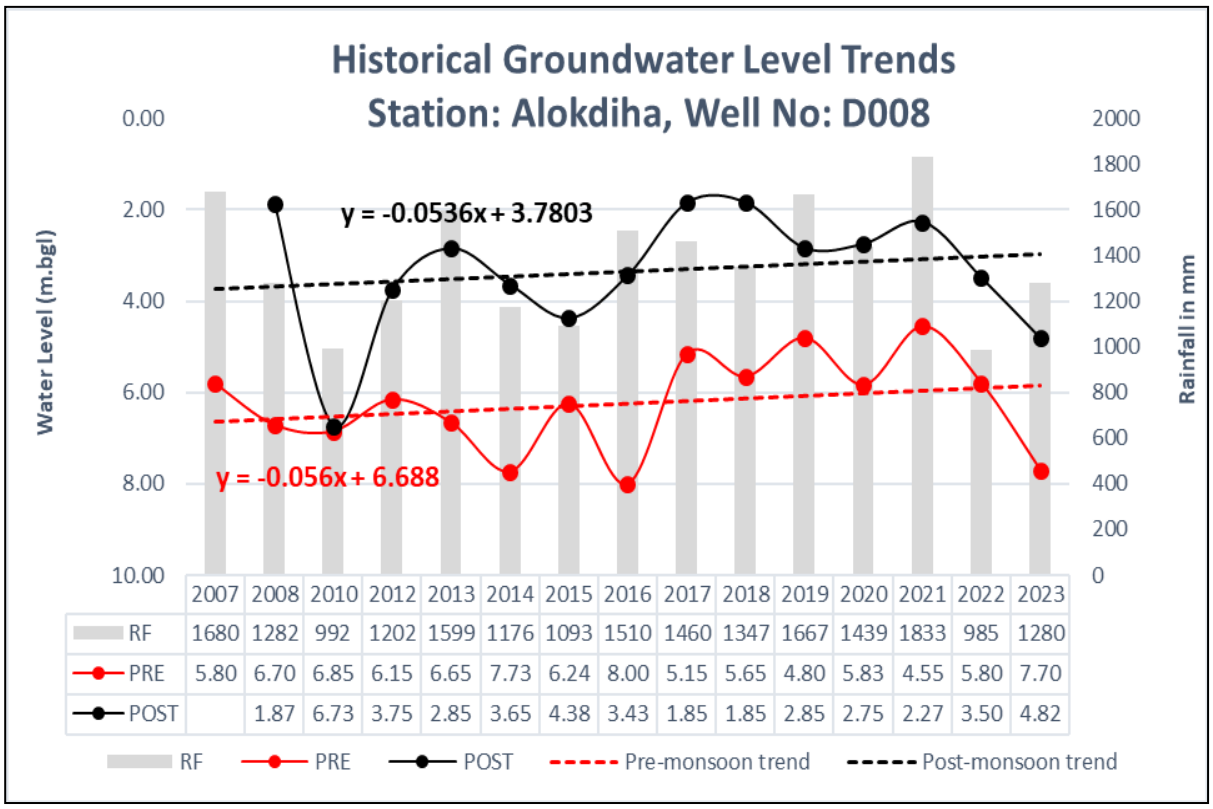
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	8.62	3.25	3.15	2.93	3.45	2.54	4.25	2.35	2.15	3.43	1.75	5.40	3.41	5.96	3.15
POST	2.15	2.20	2.55	1.80	1.68	2.11	2.25	1.90	2.30	2.45	1.30	1.38	0.85	1.32	1.85



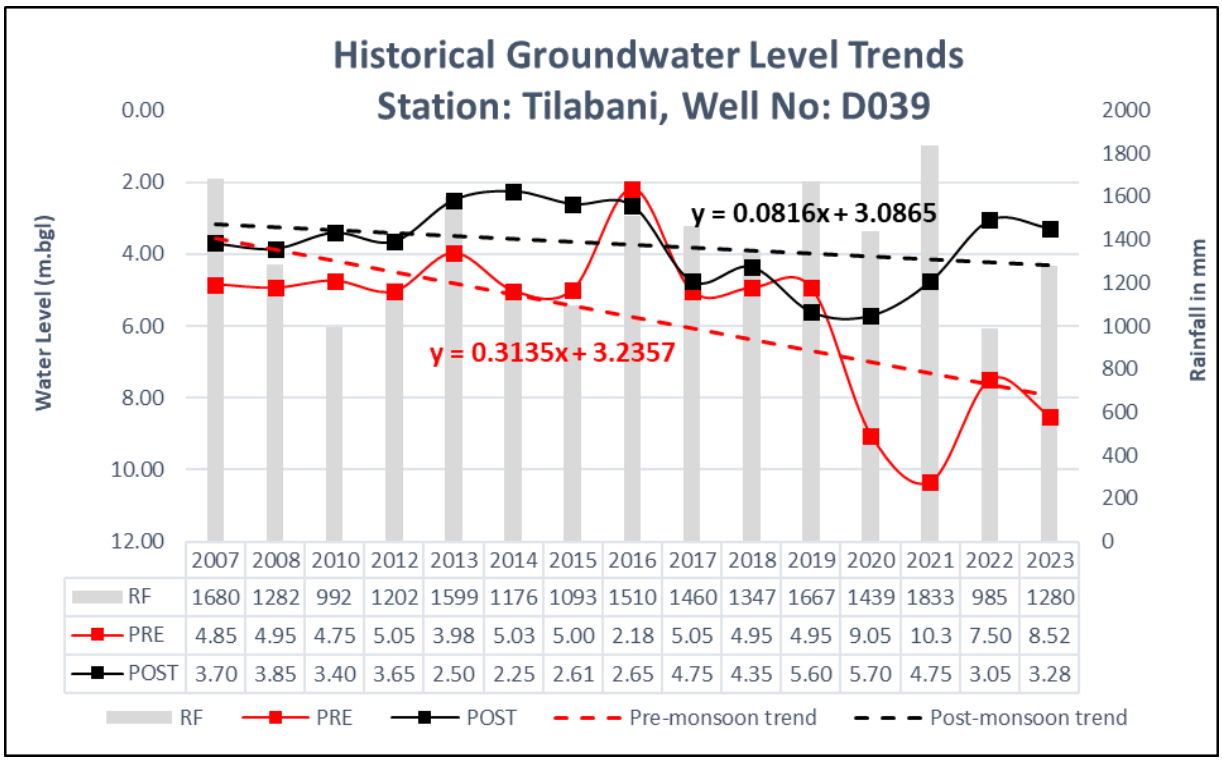
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985
PRE	3.65	4.10	2.95	1.95	2.60	8.00	9.60	3.18	3.15	5.33	4.55	9.45	4.05	2.20
POST	3.50	3.60	2.75	2.12	2.97	2.37	3.60	2.95	2.85	2.55	4.35	5.45	2.45	1.50

Annexure – VI

HYDROGRAPHS OF CLUSTER-VIII

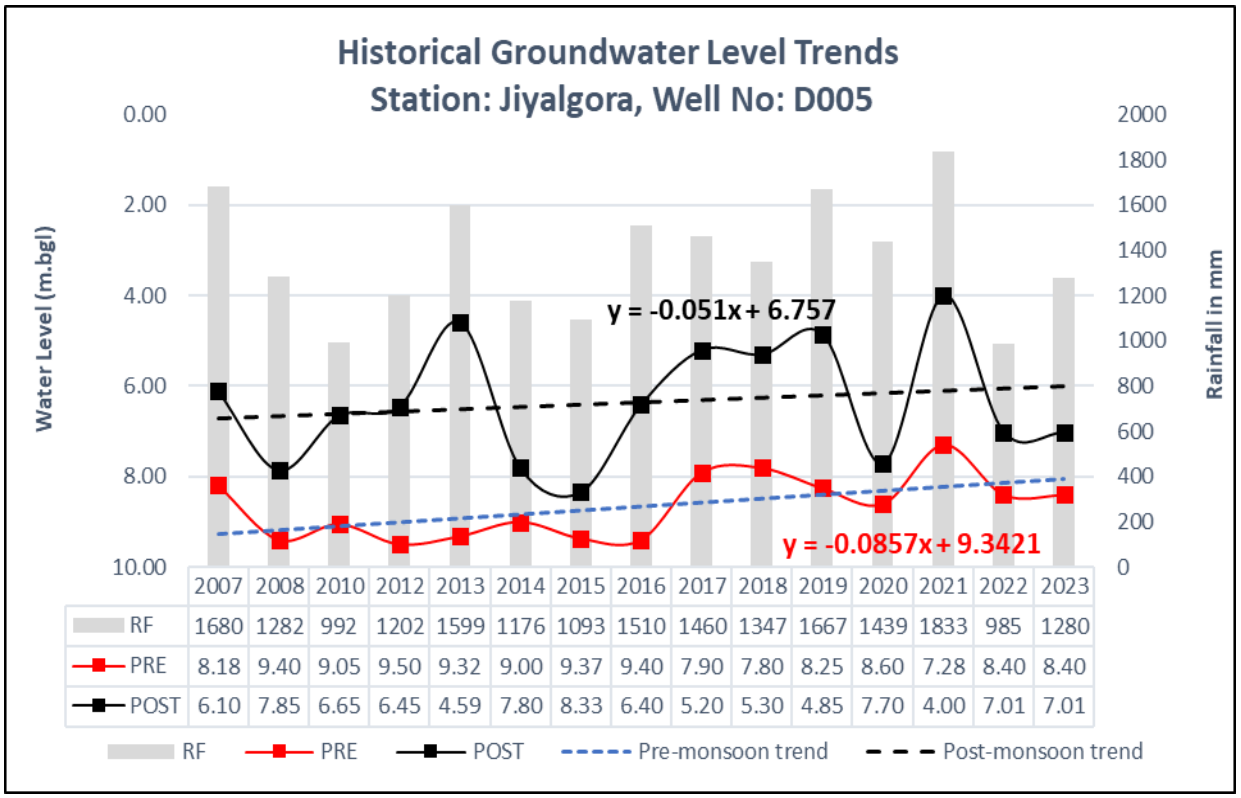


	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	5.80	6.70	6.85	6.15	6.65	7.73	6.24	8.00	5.15	5.65	4.80	5.83	4.55	5.80	7.70
POST		1.87	6.73	3.75	2.85	3.65	4.38	3.43	1.85	1.85	2.85	2.75	2.27	3.50	4.82

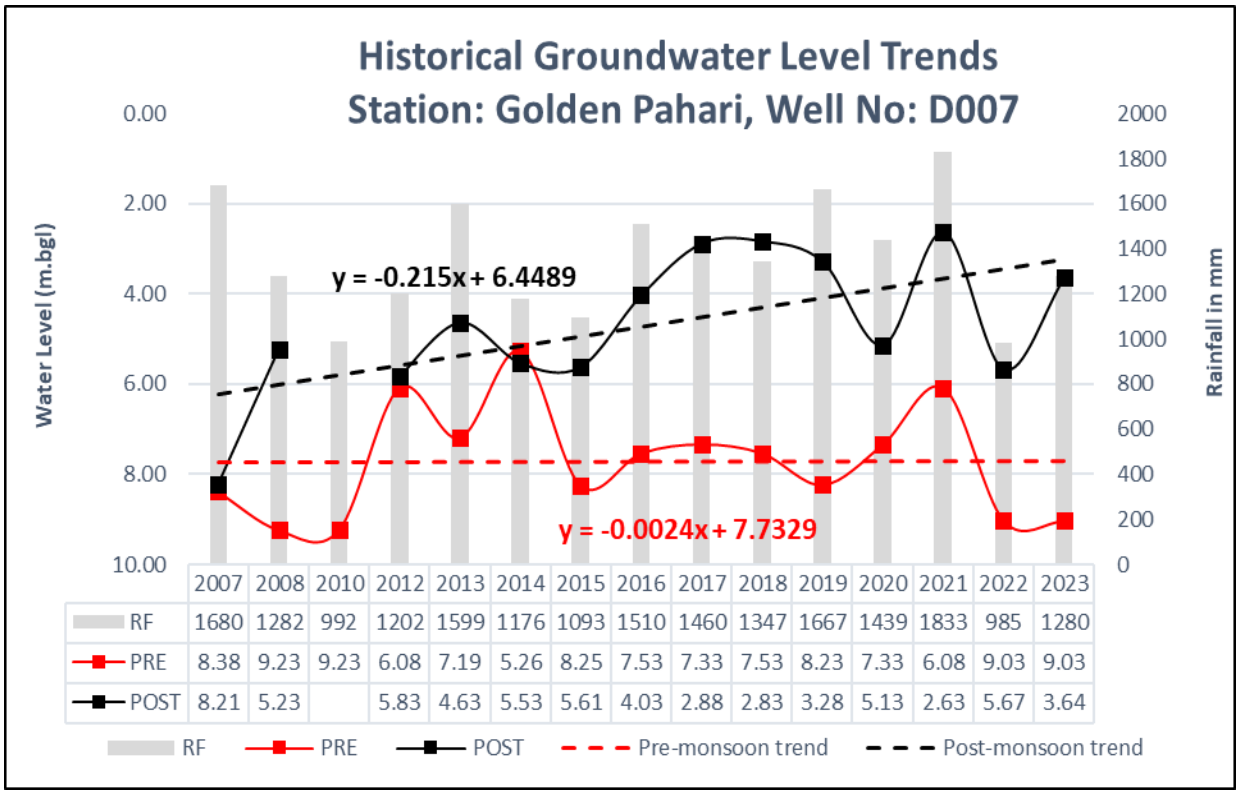


	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	4.85	4.95	4.75	5.05	3.98	5.03	5.00	2.18	5.05	4.95	4.95	9.05	10.3	7.50	8.52
POST	3.70	3.85	3.40	3.65	2.50	2.25	2.61	2.65	4.75	4.35	5.60	5.70	4.75	3.05	3.28

HYDROGRAPHS OF CLUSTER-IX



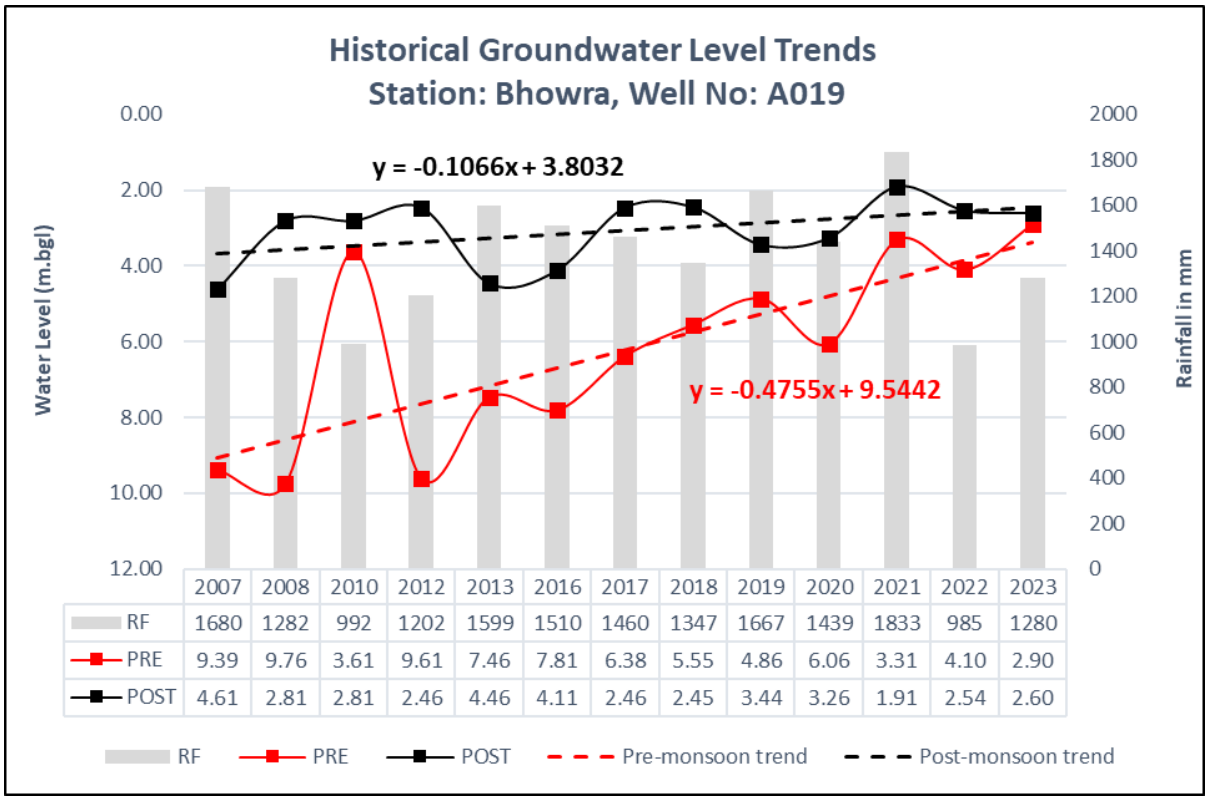
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	8.18	9.40	9.05	9.50	9.32	9.00	9.37	9.40	7.90	7.80	8.25	8.60	7.28	8.40	8.40
POST	6.10	7.85	6.65	6.45	4.59	7.80	8.33	6.40	5.20	5.30	4.85	7.70	4.00	7.01	7.01

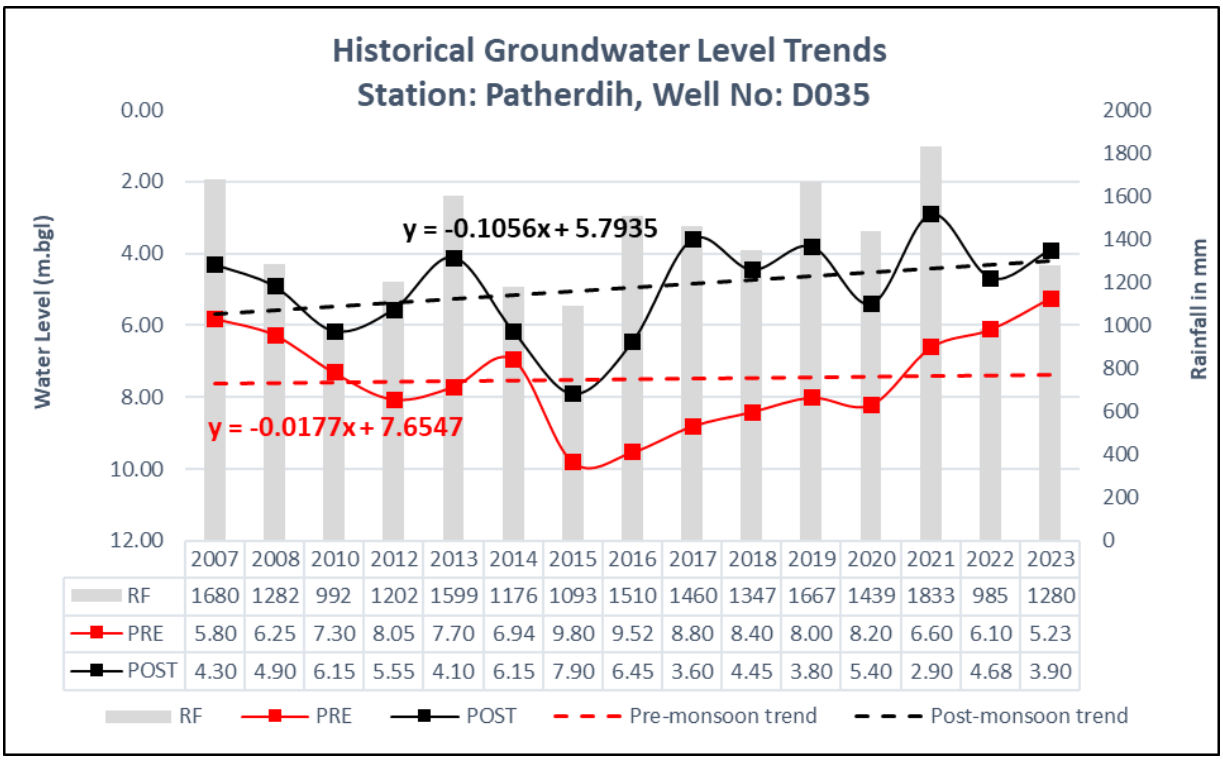


	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	8.38	9.23	9.23	6.08	7.19	5.26	8.25	7.53	7.33	7.53	8.23	7.33	6.08	9.03	9.03
POST	8.21	5.23		5.83	4.63	5.53	5.61	4.03	2.88	2.83	3.28	5.13	2.63	5.67	3.64

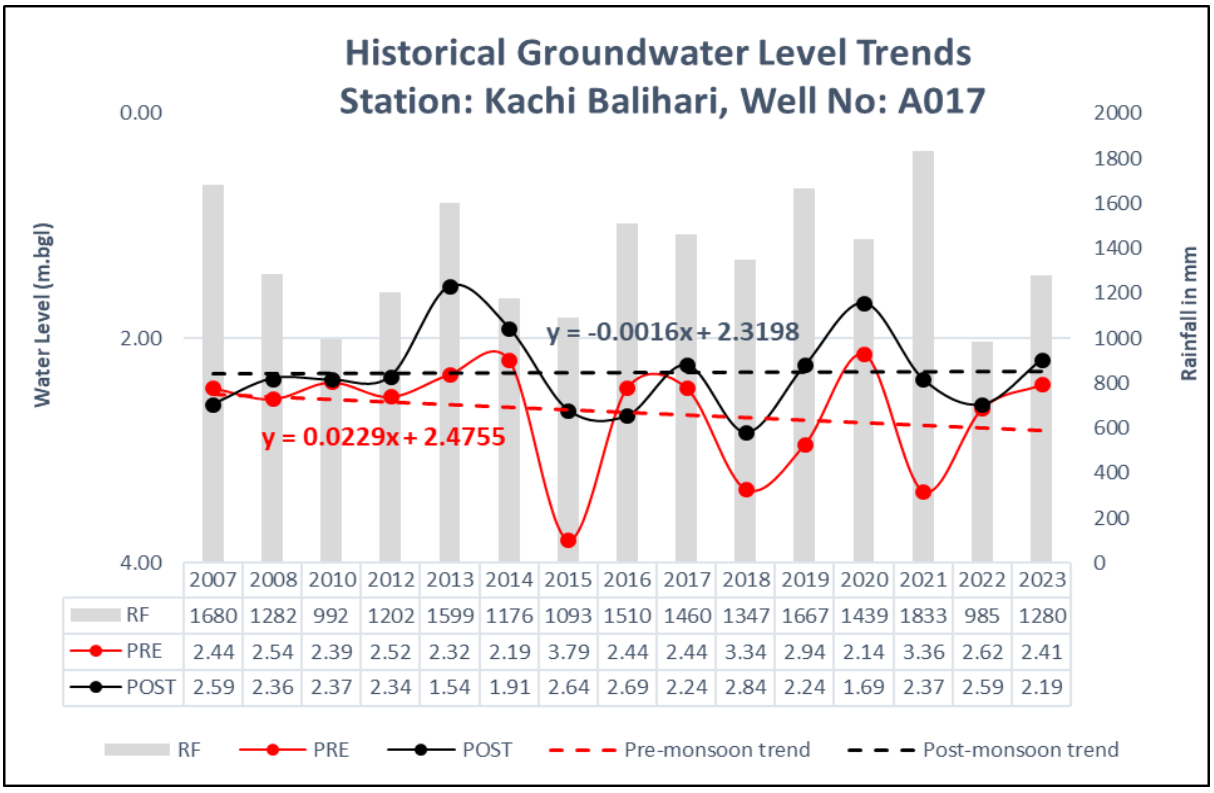
Annexure – VI

HYDROGRAPHS OF CLUSTER-X

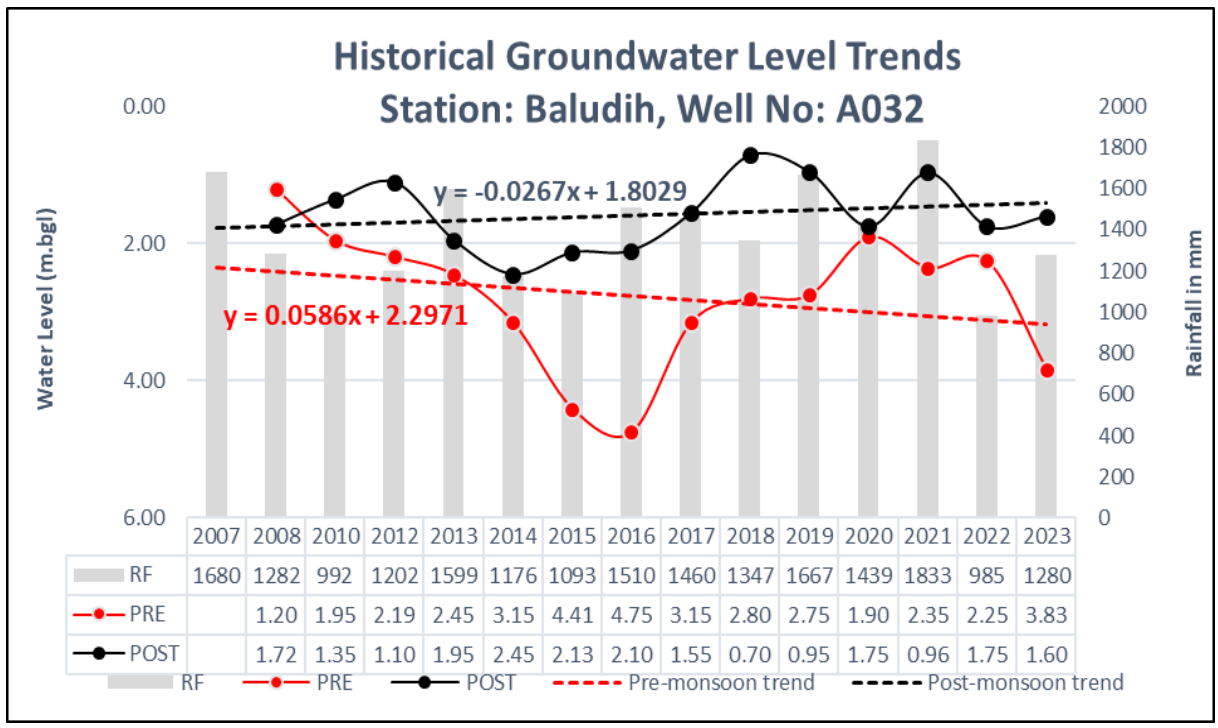




HYDROGRAPHS OF CLUSTER-XI

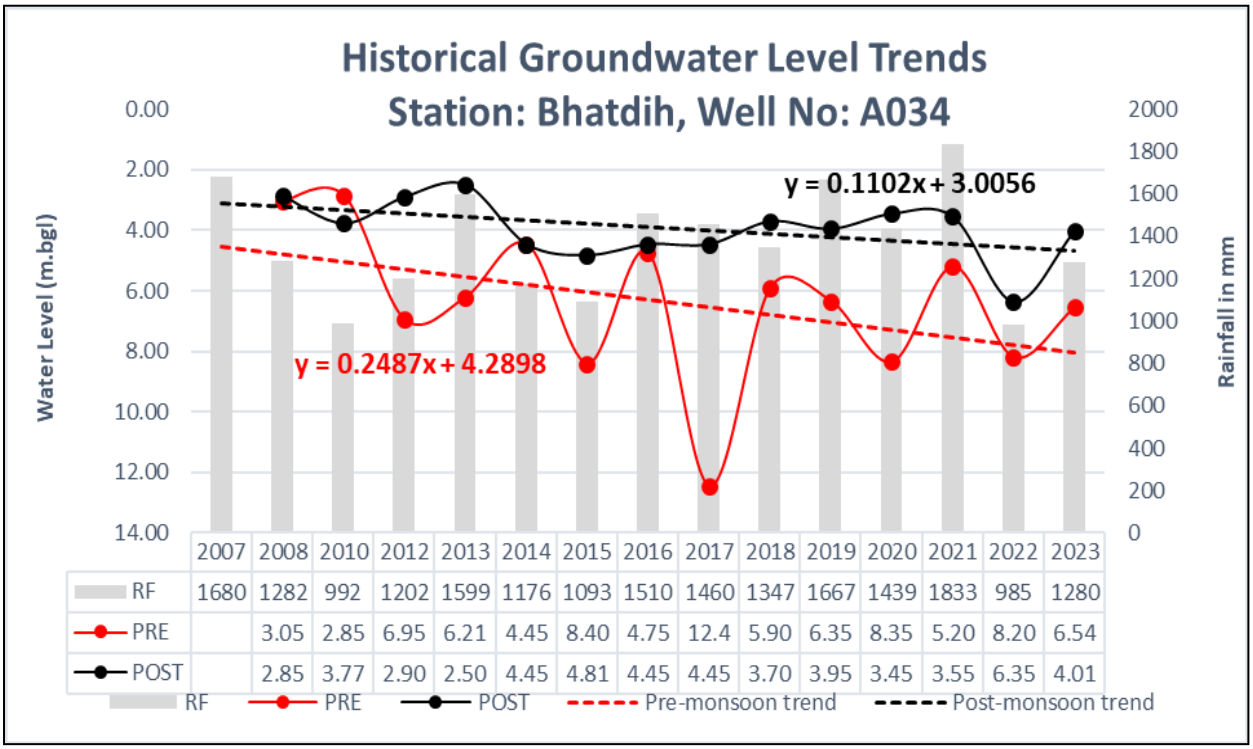


	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	2.44	2.54	2.39	2.52	2.32	2.19	3.79	2.44	2.44	3.34	2.94	2.14	3.36	2.62	2.41
POST	2.59	2.36	2.37	2.34	1.54	1.91	2.64	2.69	2.24	2.84	2.24	1.69	2.37	2.59	2.19

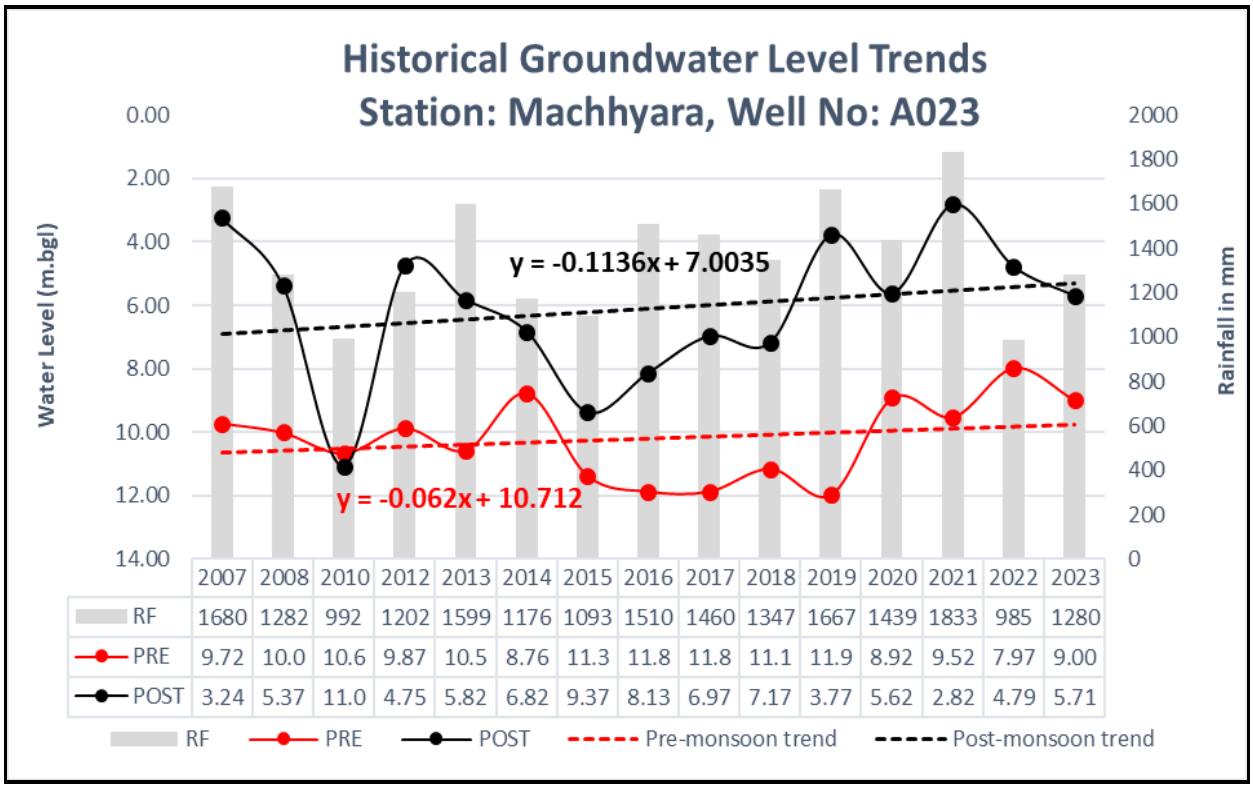


	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE		1.20	1.95	2.19	2.45	3.15	4.41	4.75	3.15	2.80	2.75	1.90	2.35	2.25	3.83
POST		1.72	1.35	1.10	1.95	2.45	2.13	2.10	1.55	0.70	0.95	1.75	0.96	1.75	1.60

HYDROGRAPHS OF CLUSTER-XIII

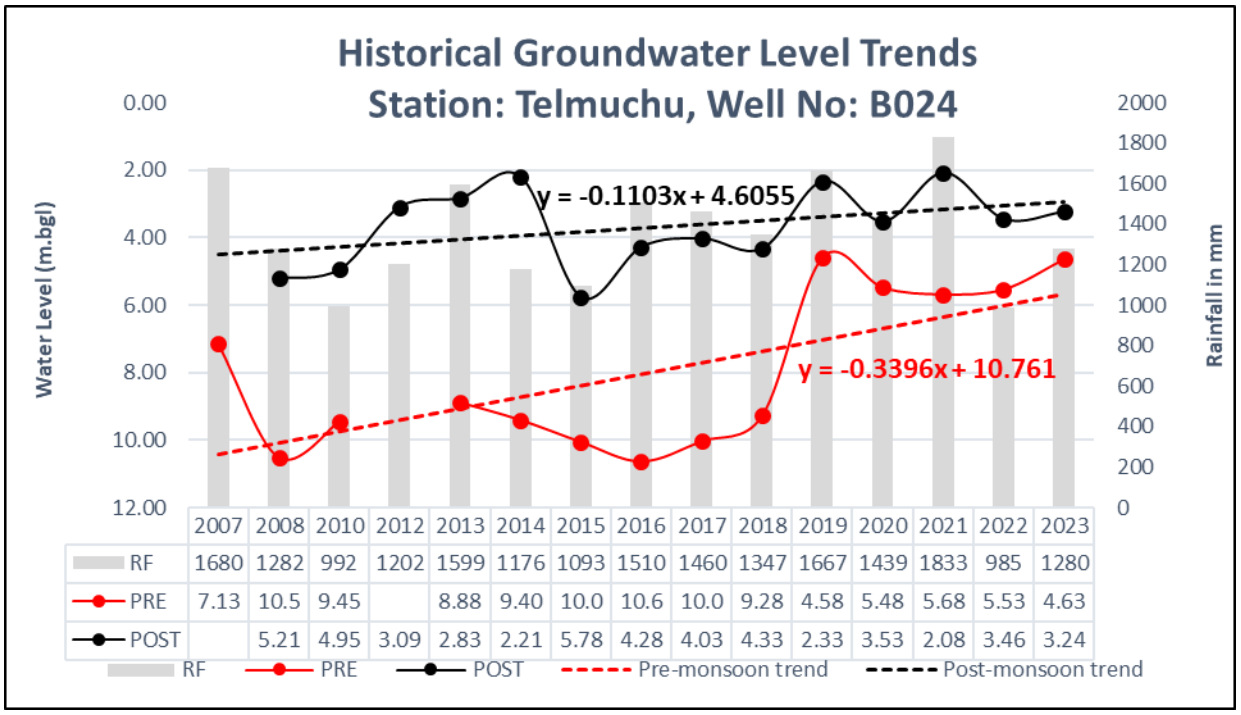


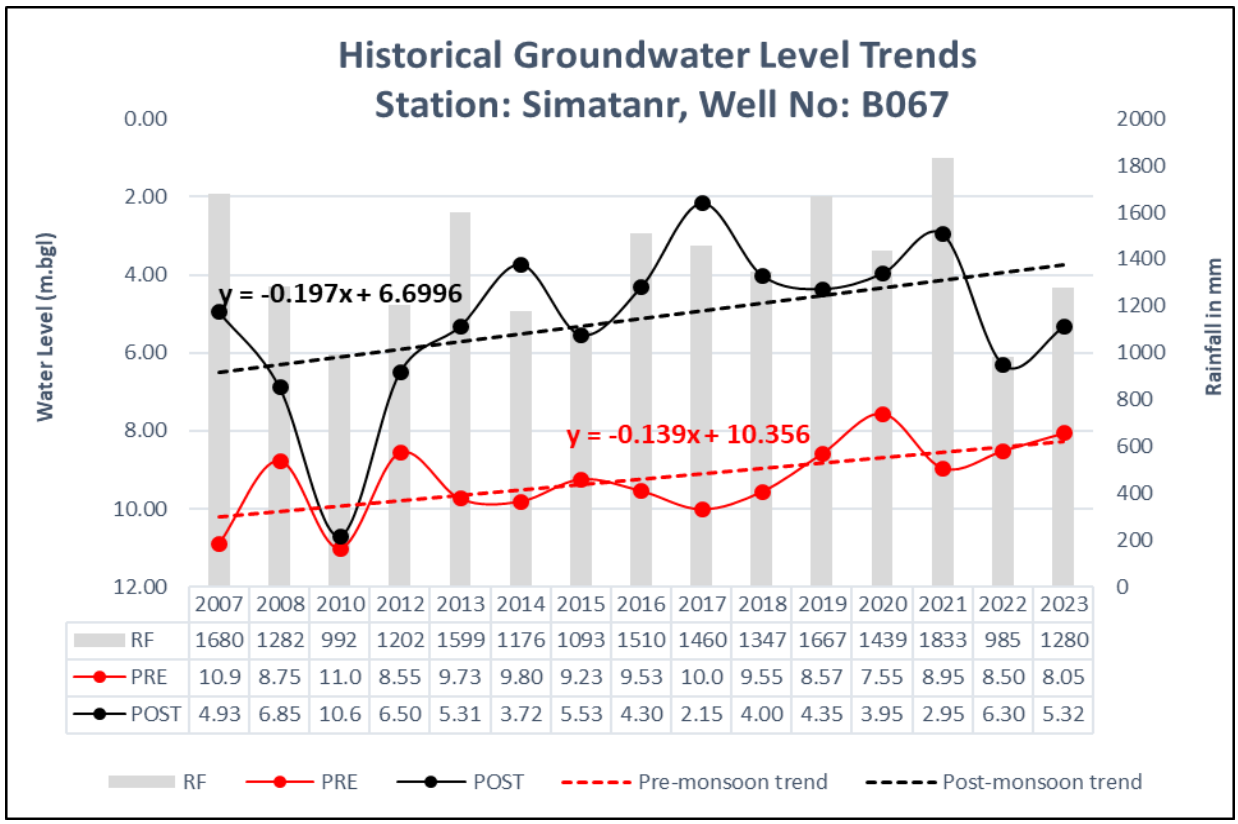
	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE		3.05	2.85	6.95	6.21	4.45	8.40	4.75	12.4	5.90	6.35	8.35	5.20	8.20	6.54
POST		2.85	3.77	2.90	2.50	4.45	4.81	4.45	4.45	3.70	3.95	3.45	3.55	6.35	4.01



	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	9.72	10.0	10.6	9.87	10.5	8.76	11.3	11.8	11.8	11.1	11.9	8.92	9.52	7.97	9.00
POST	3.24	5.37	11.0	4.75	5.82	6.82	9.37	8.13	6.97	7.17	3.77	5.62	2.82	4.79	5.71

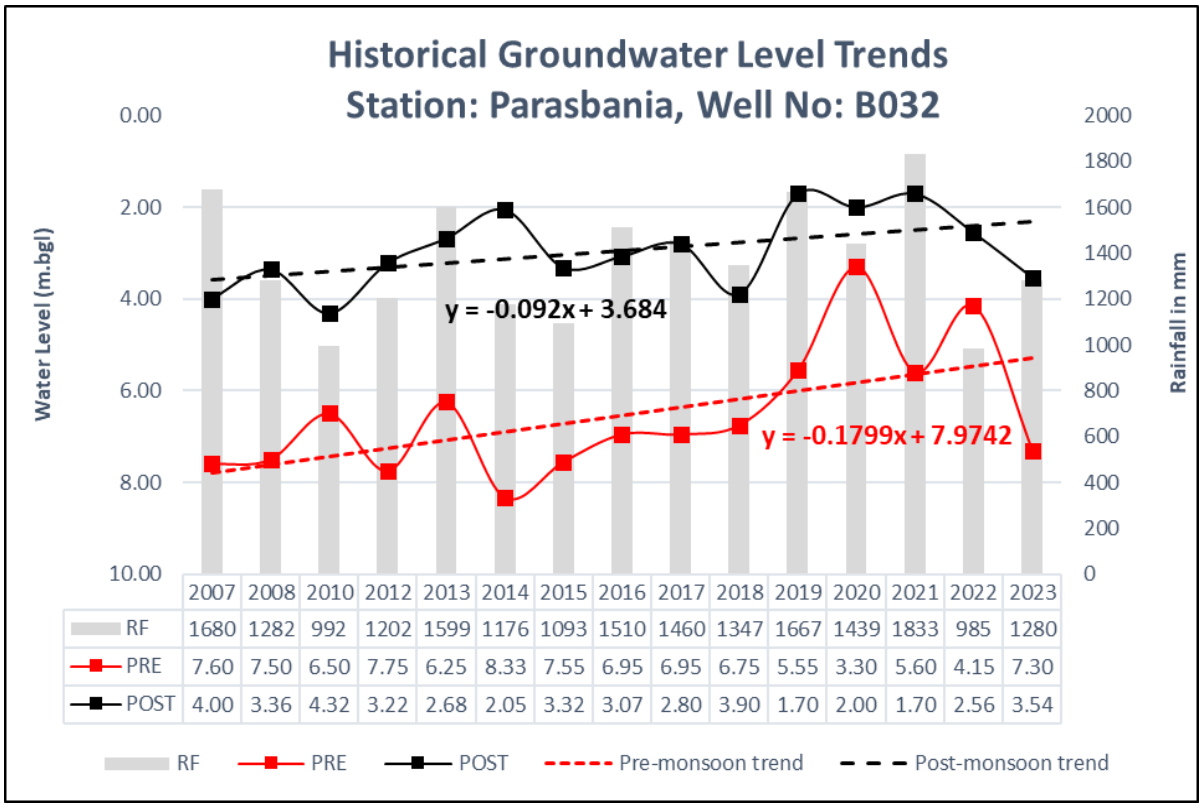
HYDROGRAPHS OF CLUSTER-XIV



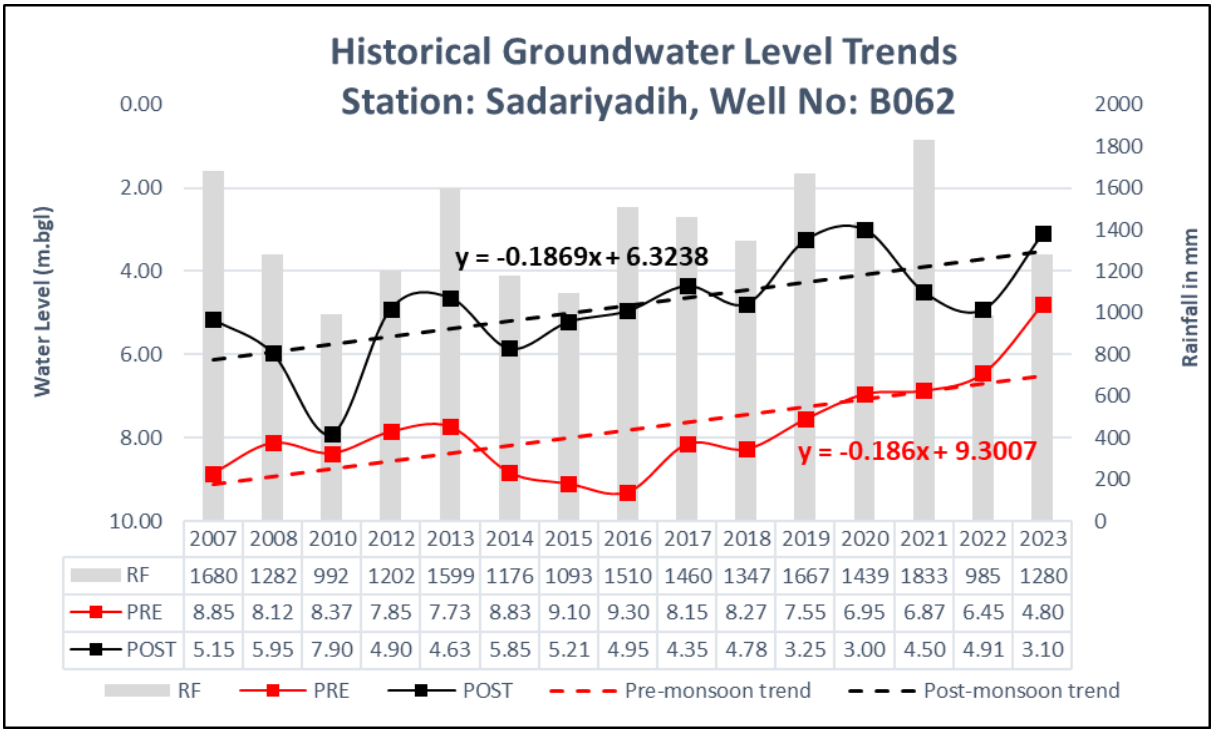


Annexure – VI

HYDROGRAPHS OF CLUSTER-XV

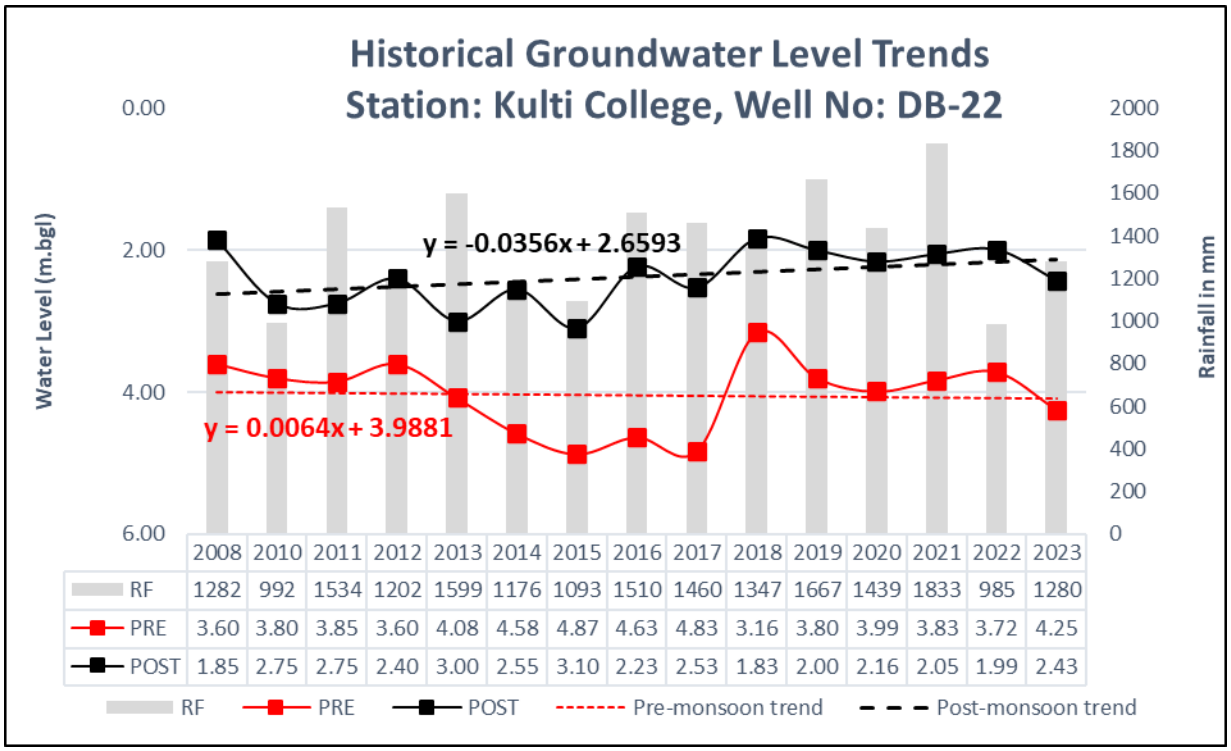


	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	7.60	7.50	6.50	7.75	6.25	8.33	7.55	6.95	6.95	6.75	5.55	3.30	5.60	4.15	7.30
POST	4.00	3.36	4.32	3.22	2.68	2.05	3.32	3.07	2.80	3.90	1.70	2.00	1.70	2.56	3.54

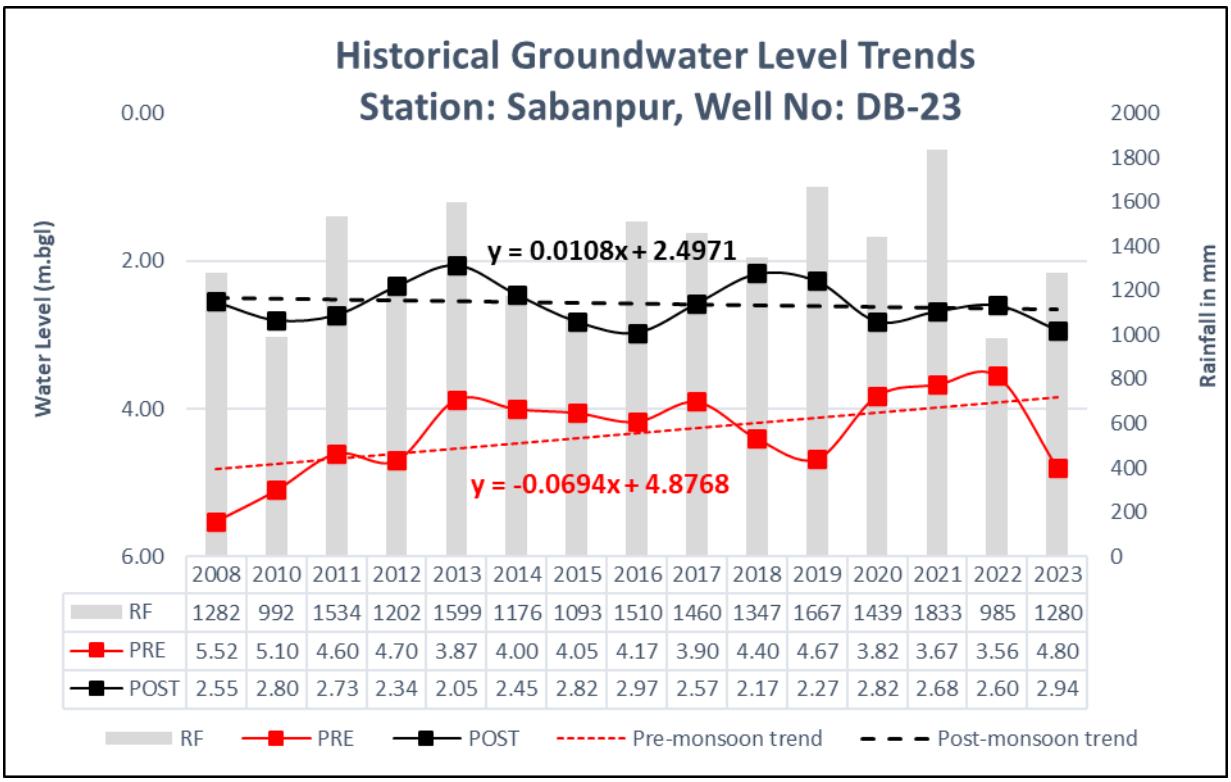


	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1680	1282	992	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	8.85	8.12	8.37	7.85	7.73	8.83	9.10	9.30	8.15	8.27	7.55	6.95	6.87	6.45	4.80
POST	5.15	5.95	7.90	4.90	4.63	5.85	5.21	4.95	4.35	4.78	3.25	3.00	4.50	4.91	3.10

HYDROGRAPHS OF CLUSTER-XVI

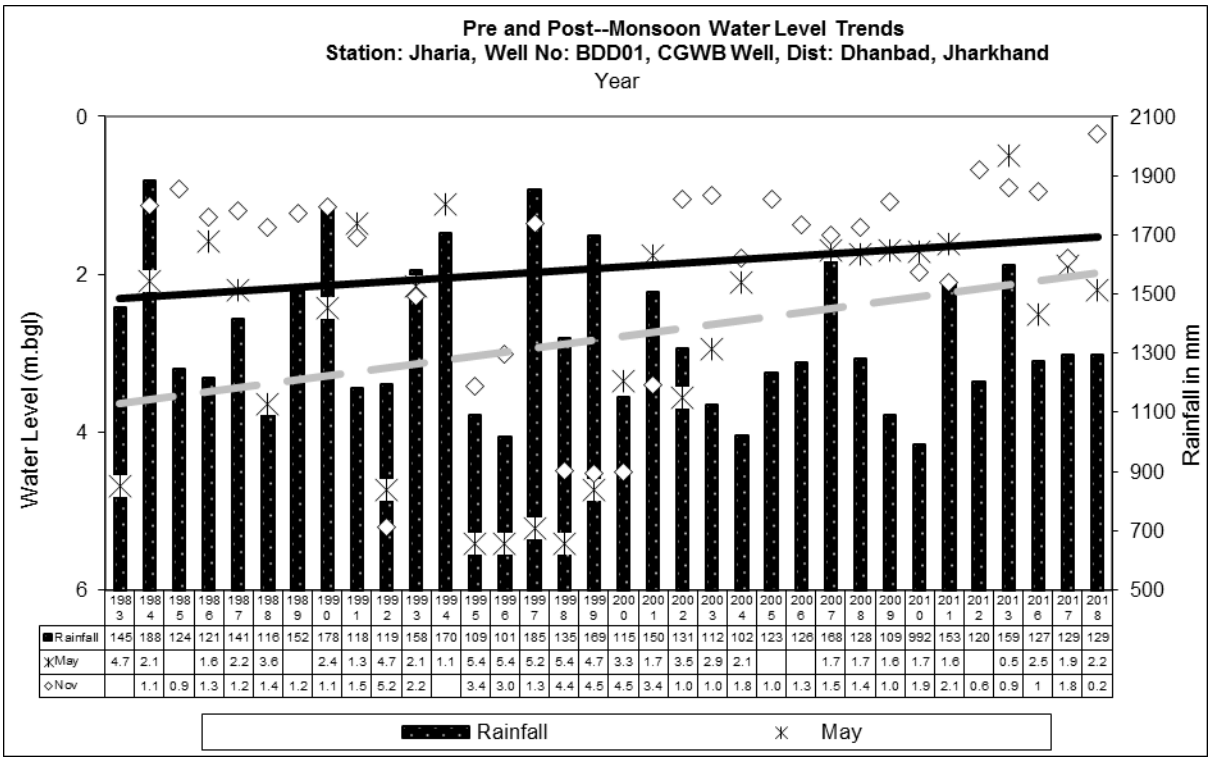


	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1282	992	1534	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	3.60	3.80	3.85	3.60	4.08	4.58	4.87	4.63	4.83	3.16	3.80	3.99	3.83	3.72	4.25
POST	1.85	2.75	2.75	2.40	3.00	2.55	3.10	2.23	2.53	1.83	2.00	2.16	2.05	1.99	2.43

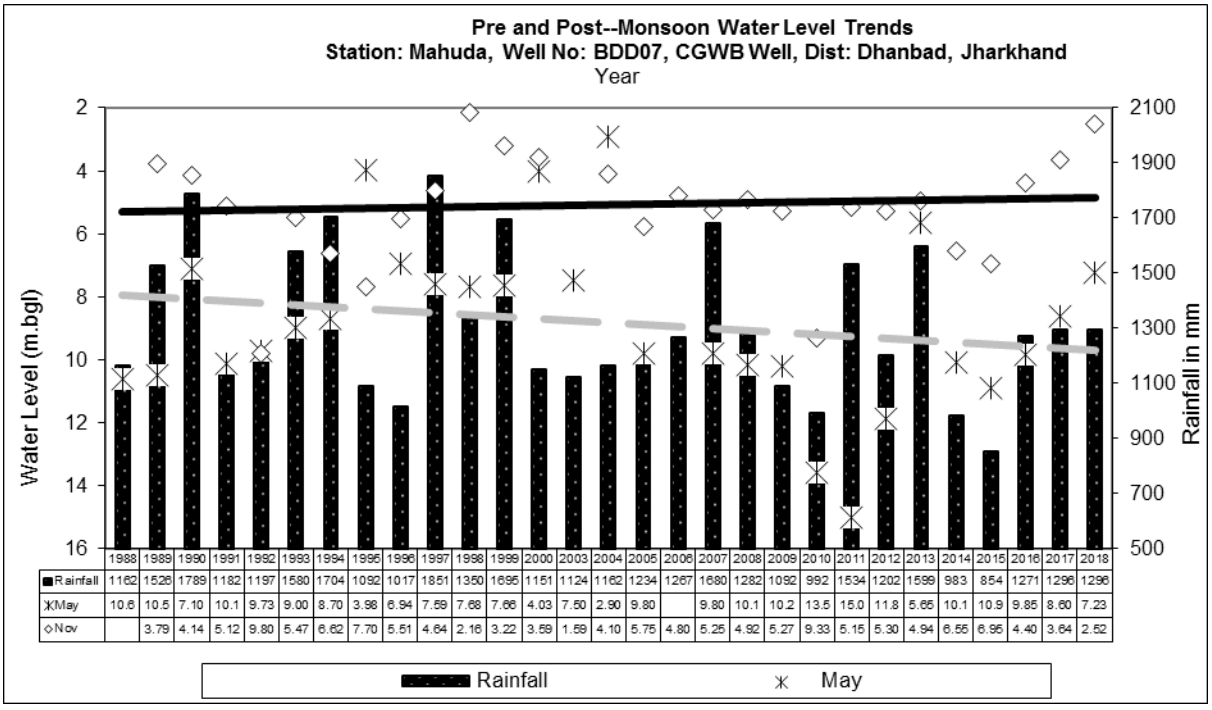


	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RF	1282	992	1534	1202	1599	1176	1093	1510	1460	1347	1667	1439	1833	985	1280
PRE	5.52	5.10	4.60	4.70	3.87	4.00	4.05	4.17	3.90	4.40	4.67	3.82	3.67	3.56	4.80
POST	2.55	2.80	2.73	2.34	2.05	2.45	2.82	2.97	2.57	2.17	2.27	2.82	2.68	2.60	2.94

HYDROGRAPHS OF CGWB PERMANENT OBSERVATION STATIONS

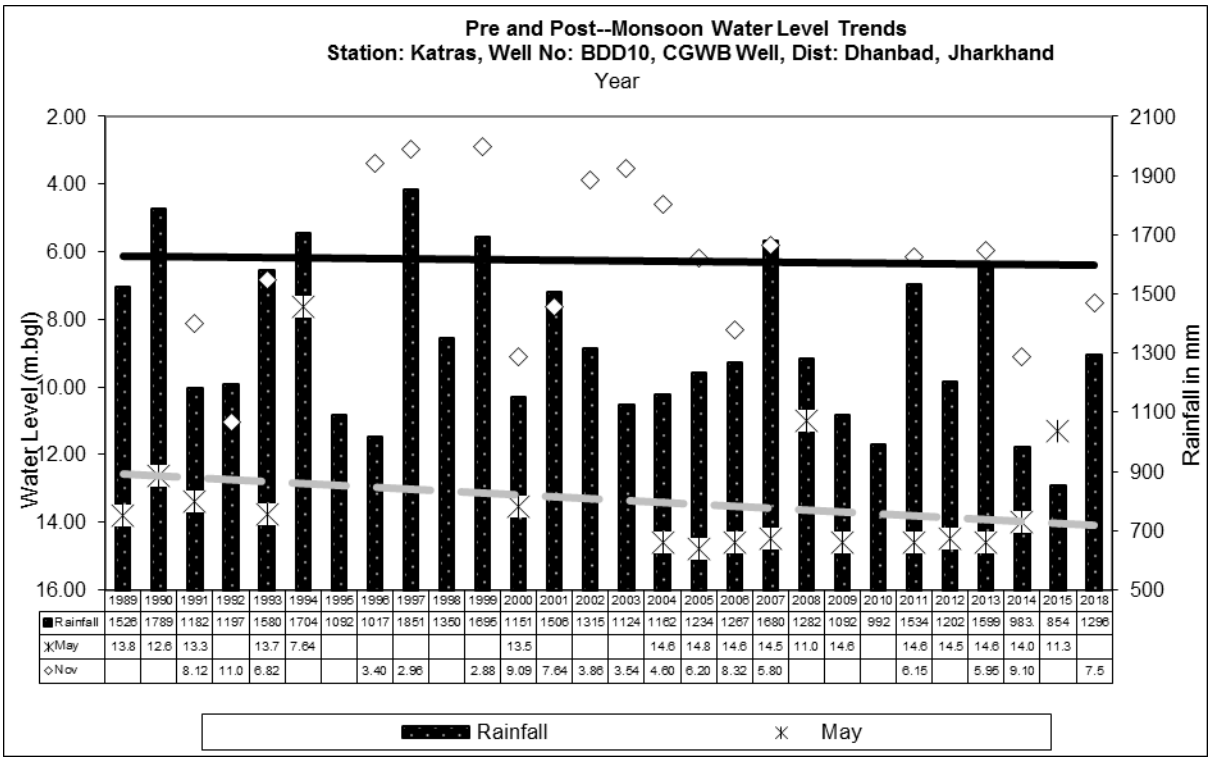


	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	145	188	124	121	141	116	152	178	118	119	158	170	109	101	185	135	169	115	150	131	112	102	123	126	168	128	109	992	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		

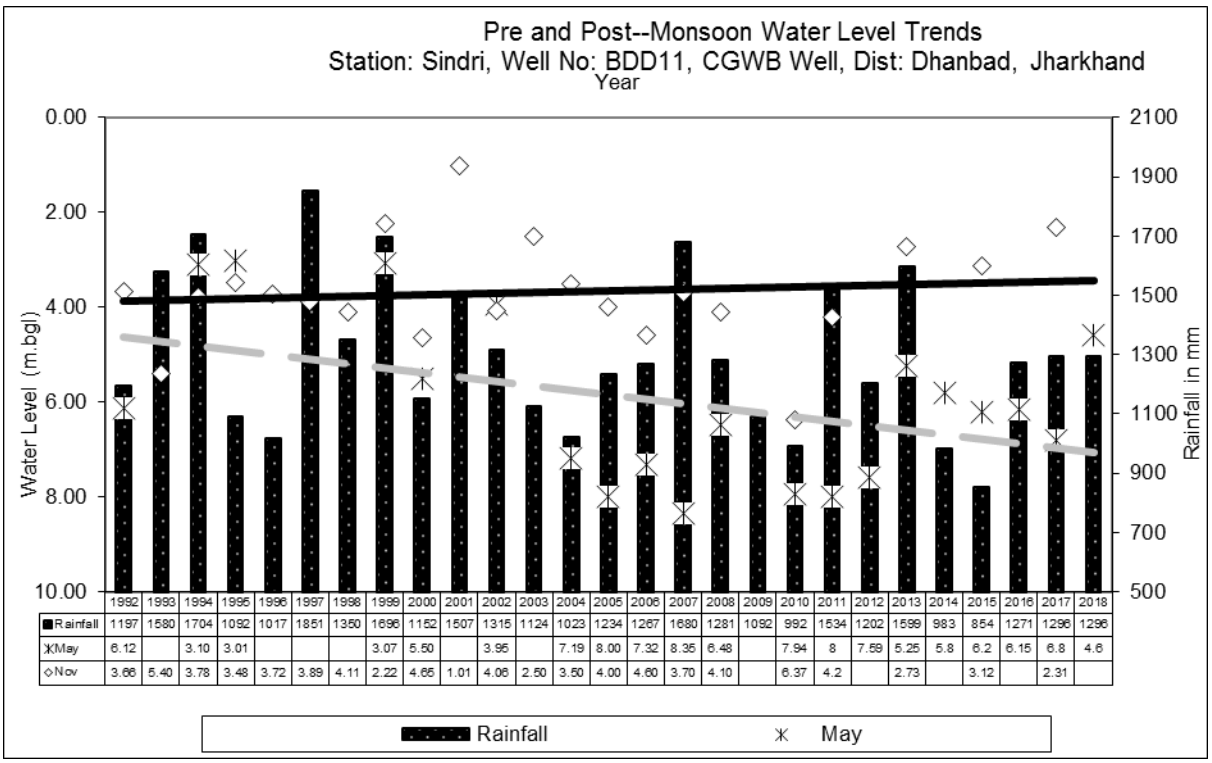


	1988	1989	1990	1991	1992	1993	1994	1996	1996	1997	1998	1999	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1162	1526	1789	1182	1197	1580	1704	1092	1017	1851	1350	1695	1151	1124	1162	1234	1267	1680	1282	1092	992	1534	1202	1599	983	854	1271	1296	1296
May	10.6	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

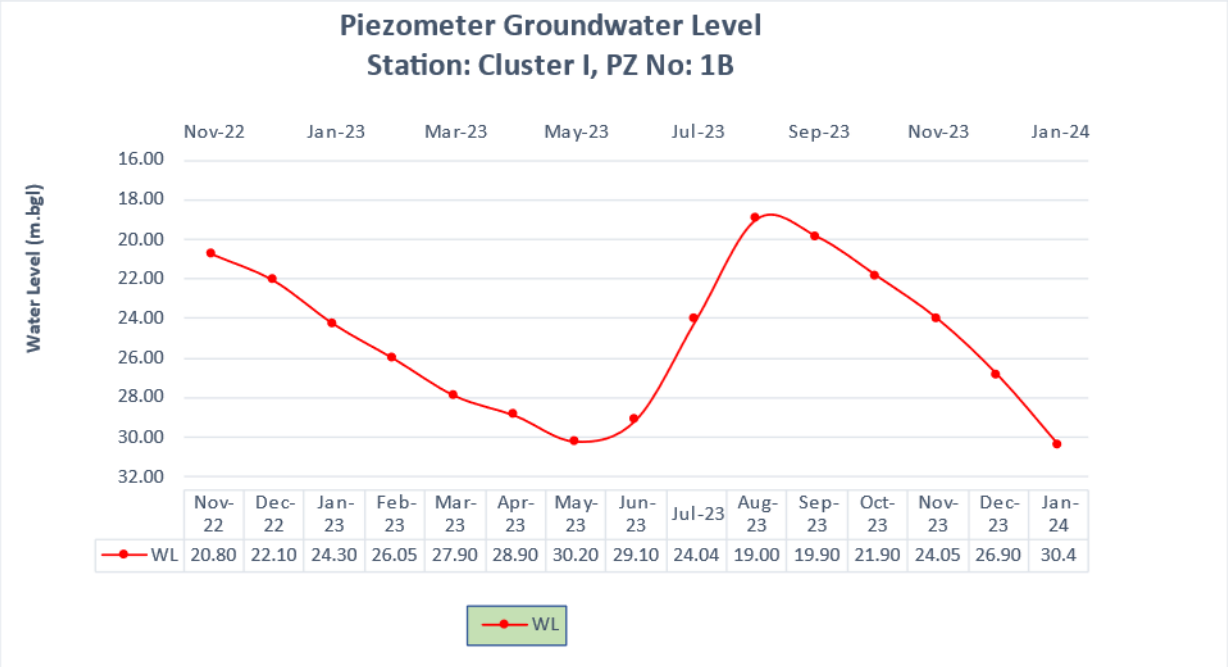


	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2018
Rainfall	1526	1789	1182	1197	1580	1704	1092	1017	1851	1350	1695	1151	1506	1315	1124	1162	1234	1267	1680	1282	1092	992	1534	1202	1599	983.	854	1296
May	13.8	12.6	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

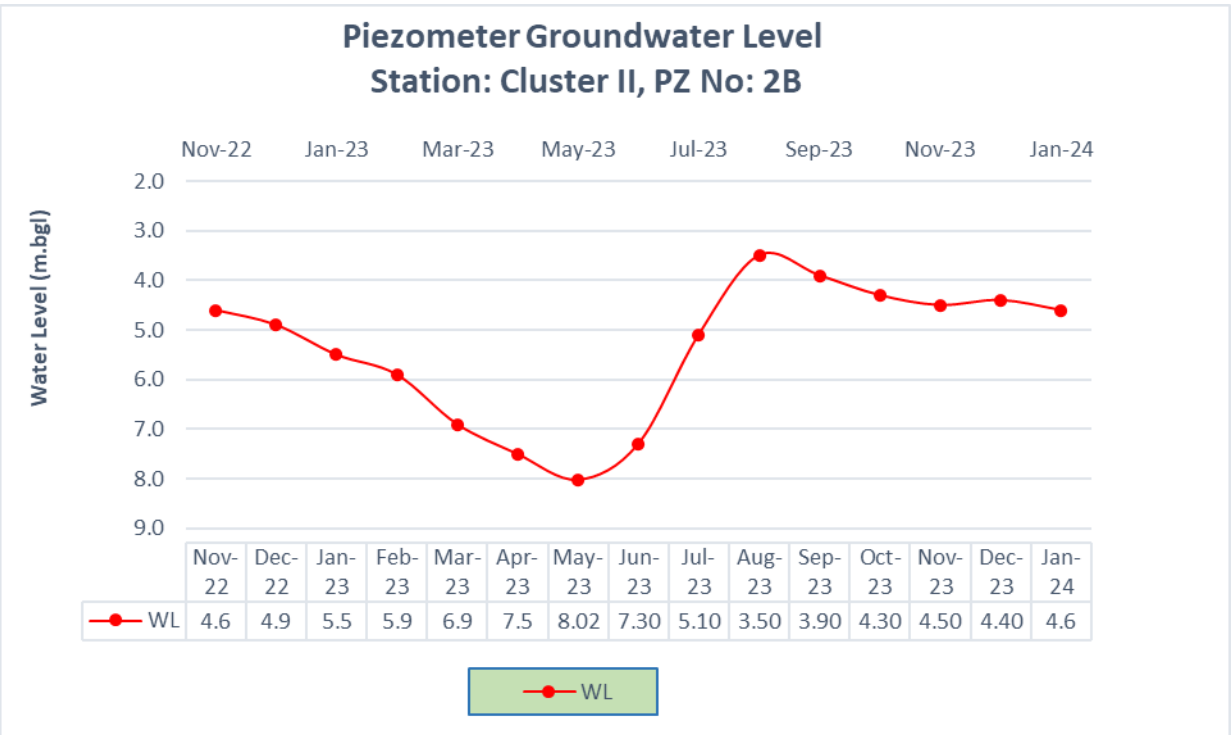


	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1197	1580	1704	1092	1017	1851	1350	1696	1152	1507	1315	1124	1023	1234	1267	1680	1281	1092	992	1534	1202	1599	983	854	1271	1296	1296
May	6.12		3.10	3.01				3.07	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	

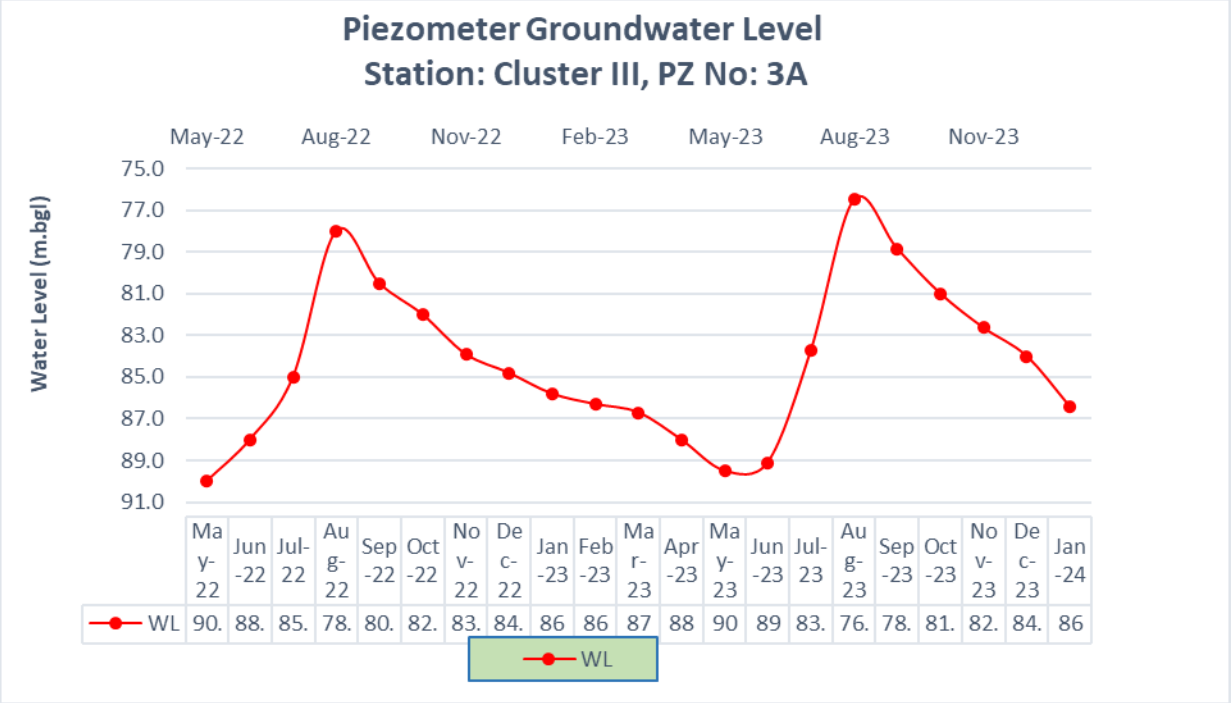
PIEZOMETER HYDROGRAPHS

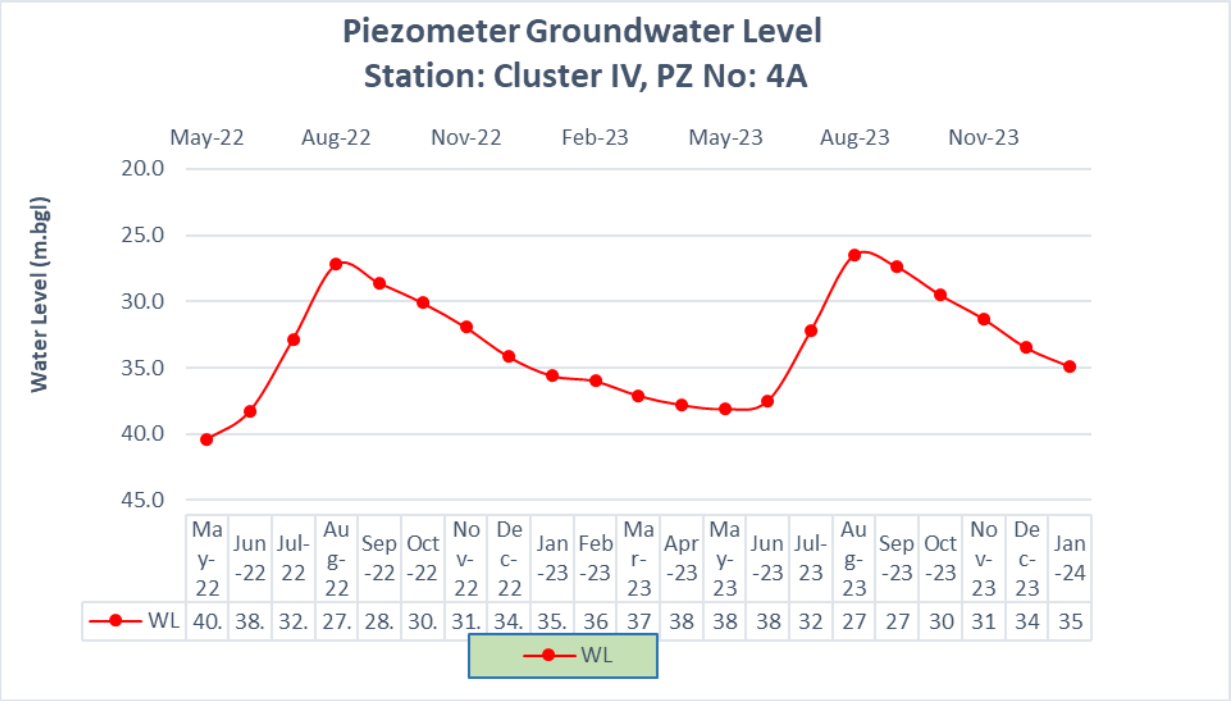


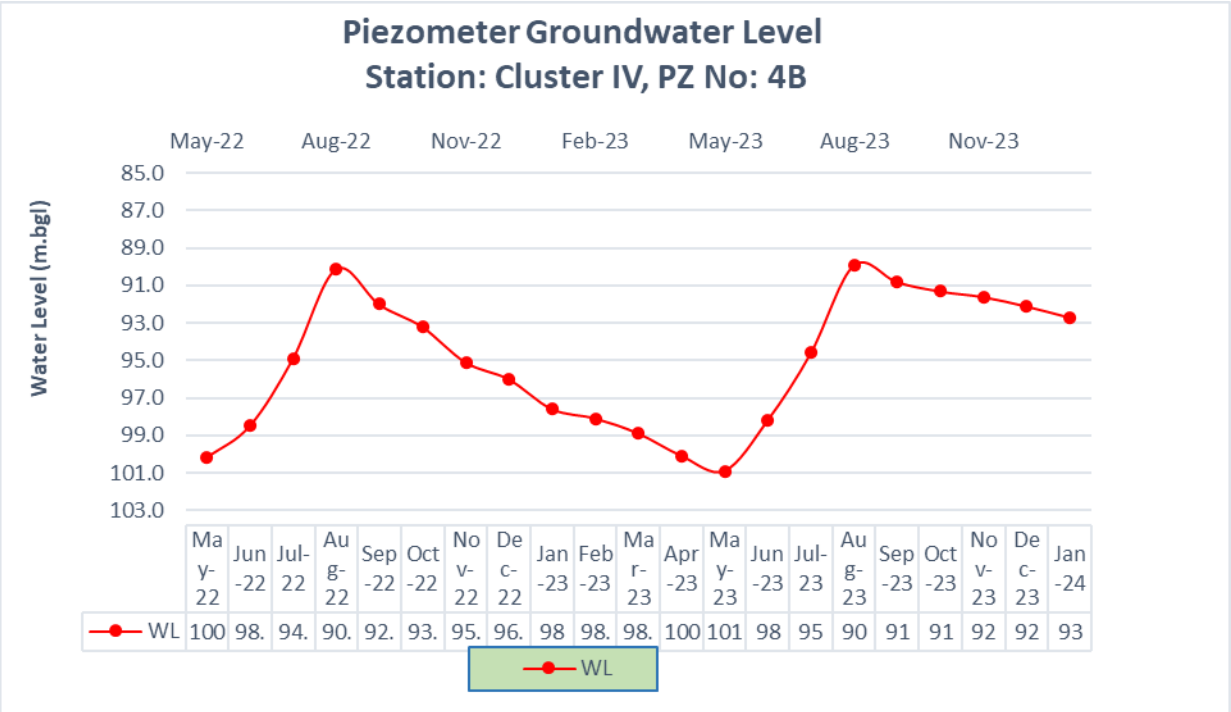
	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24
WL	20.80	22.10	24.30	26.05	27.90	28.90	30.20	29.10	24.04	19.00	19.90	21.90	24.05	26.90	30.4

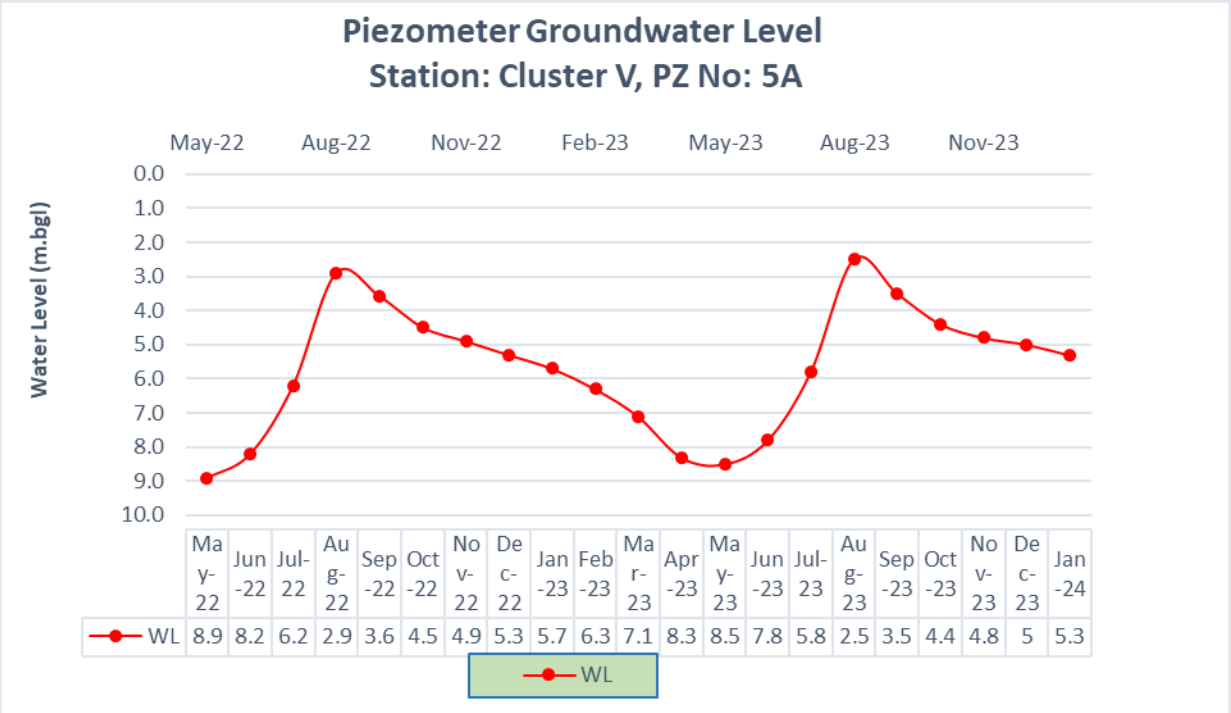


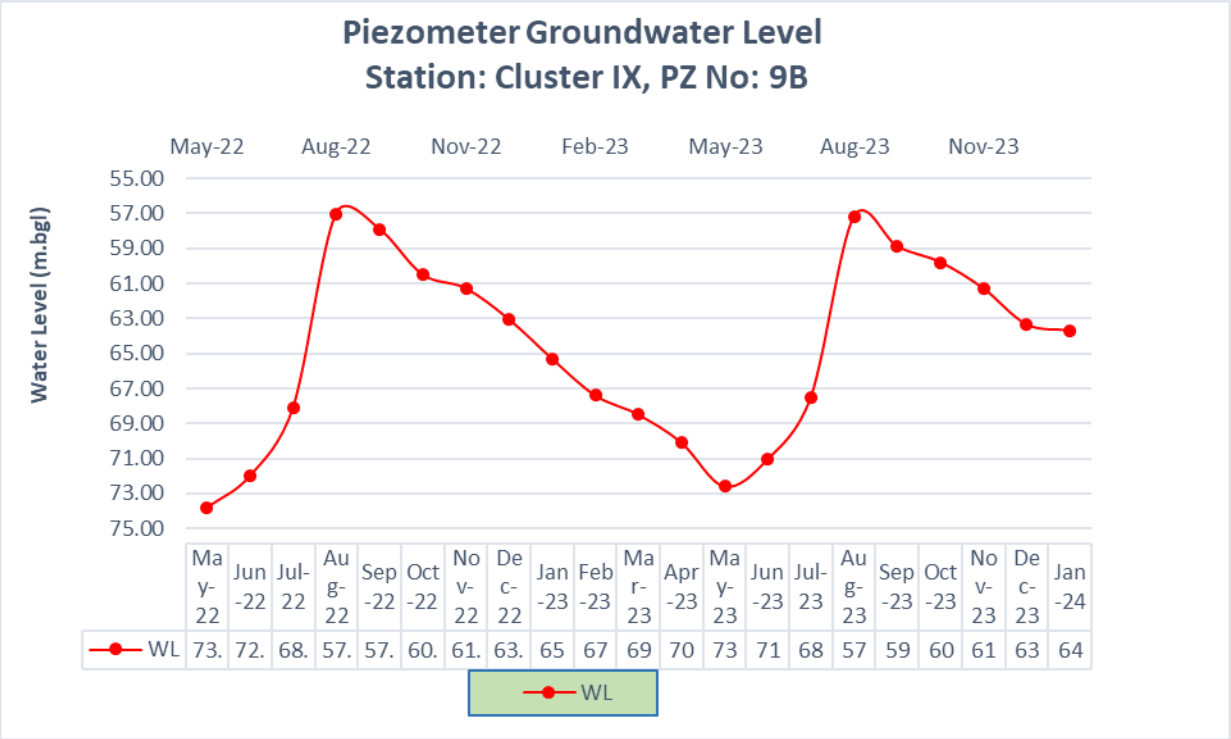
	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24
WL	4.6	4.9	5.5	5.9	6.9	7.5	8.02	7.30	5.10	3.50	3.90	4.30	4.50	4.40	4.6

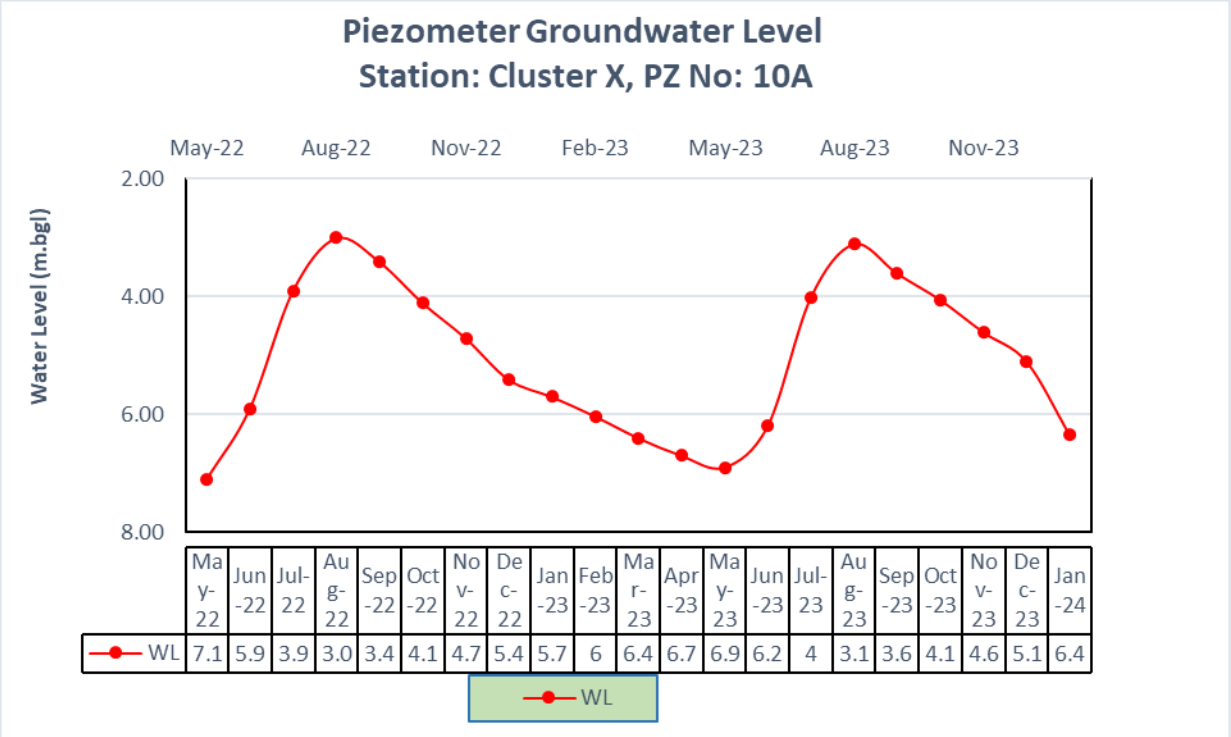

Piezometer Groundwater Level
Station: Cluster III, PZ No: 3A
Water Level (m.bgl)
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
75.0
77.0
79.0
81.0
83.0
85.0
87.0
89.0
91.0
May-22 Jun-22 Jul-22 Aug-22 Sep-22 Oct-22 Nov-22 Dec-22 Jan-23 Feb-23 Mar-23 Apr-23 May-23 Jun-23 Jul-23 Aug-23 Sep-23 Oct-23 Nov-23 Dec-23 Jan-24
WL 90. 88. 85. 78. 80. 82. 83. 84. 86 86 87 88 90 89 83. 76. 78. 81. 82. 84. 86
WL

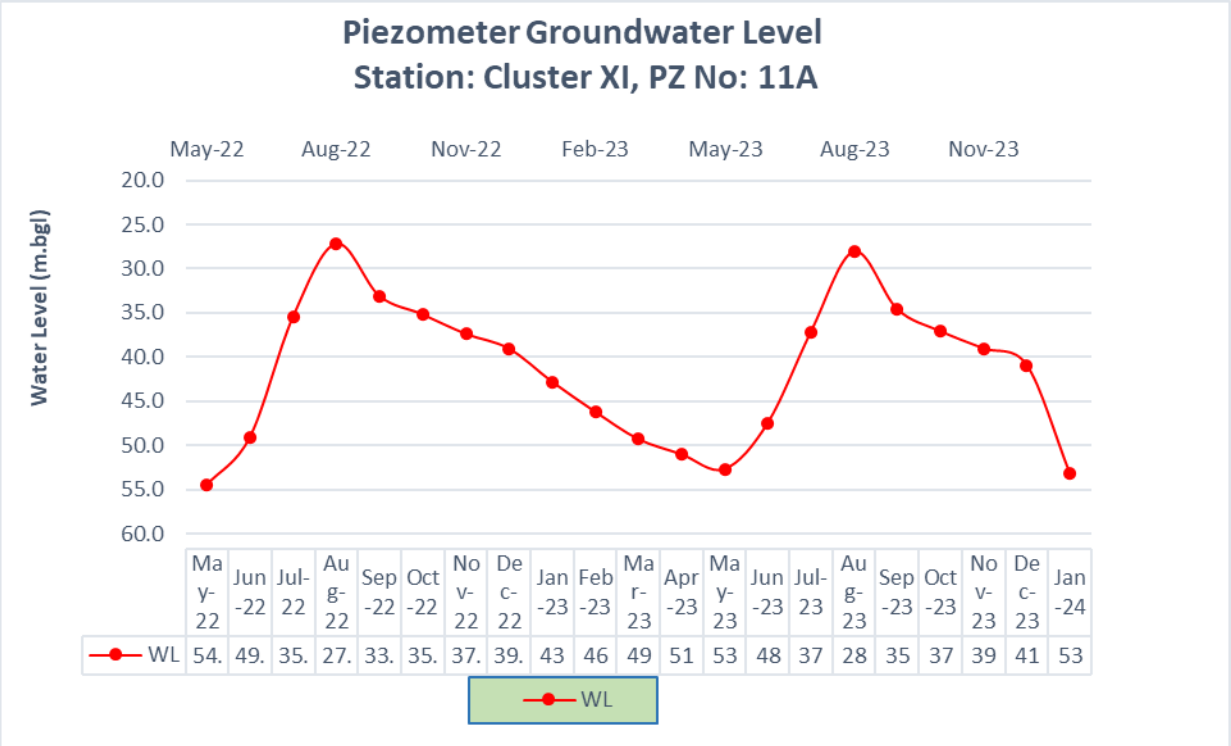

Piezometer Groundwater Level
Station: Cluster IV, PZ No: 4A
Water Level (m.bgl)
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
20.0
25.0
30.0
35.0
40.0
45.0
May-22 Jun-22 Jul-22 Aug-22 Sep-22 Oct-22 Nov-22 Dec-22 Jan-23 Feb-23 Mar-23 Apr-23 May-23 Jun-23 Jul-23 Aug-23 Sep-23 Oct-23 Nov-23 Dec-23 Jan-24
WL 40. 38. 32. 27. 28. 30. 31. 34. 35. 36 37 38 38 38 32 27 27 30 31 34 35
WL

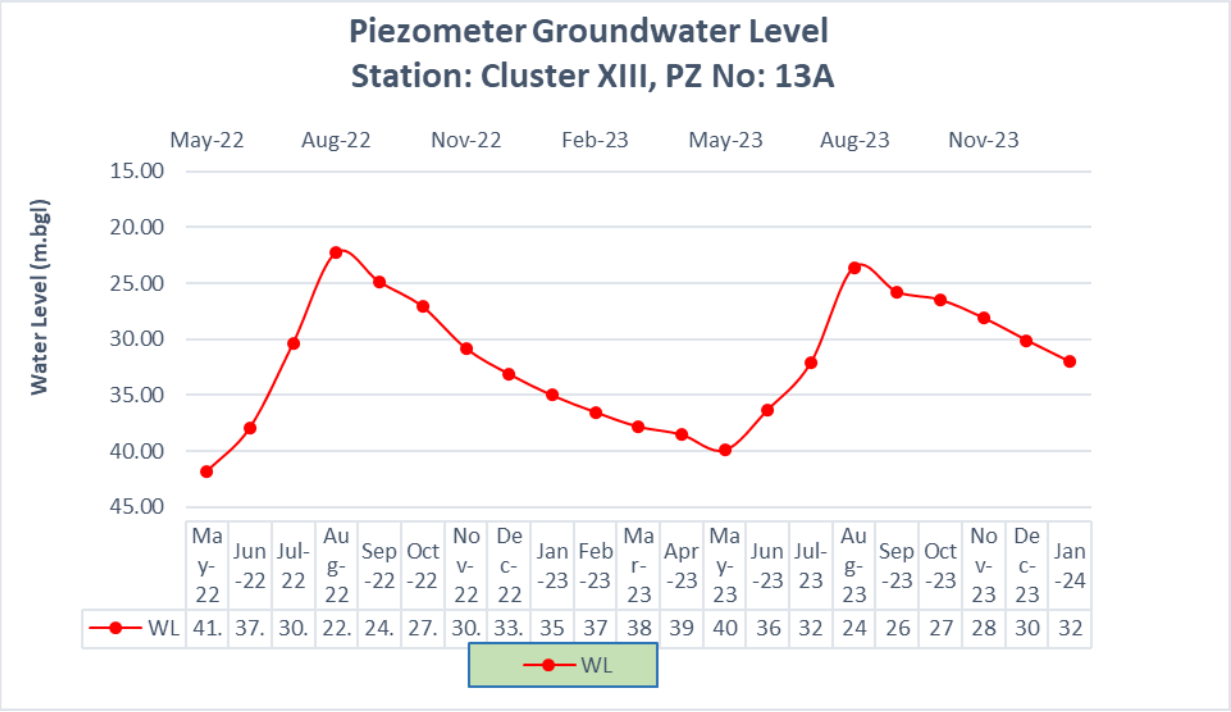

Piezometer Groundwater Level
Station: Cluster IV, PZ No: 4B
Water Level (m.bgl)
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
85.0
87.0
89.0
91.0
93.0
95.0
97.0
99.0
101.0
103.0
May-22 Jun-22 Jul-22 Aug-22 Sep-22 Oct-22 Nov-22 Dec-22 Jan-23 Feb-23 Mar-23 Apr-23 May-23 Jun-23 Jul-23 Aug-23 Sep-23 Oct-23 Nov-23 Dec-23 Jan-24
WL 100 98. 94. 90. 92. 93. 95. 96. 98 98. 98. 100 101 98 95 90 91 91 92 92 93
WL

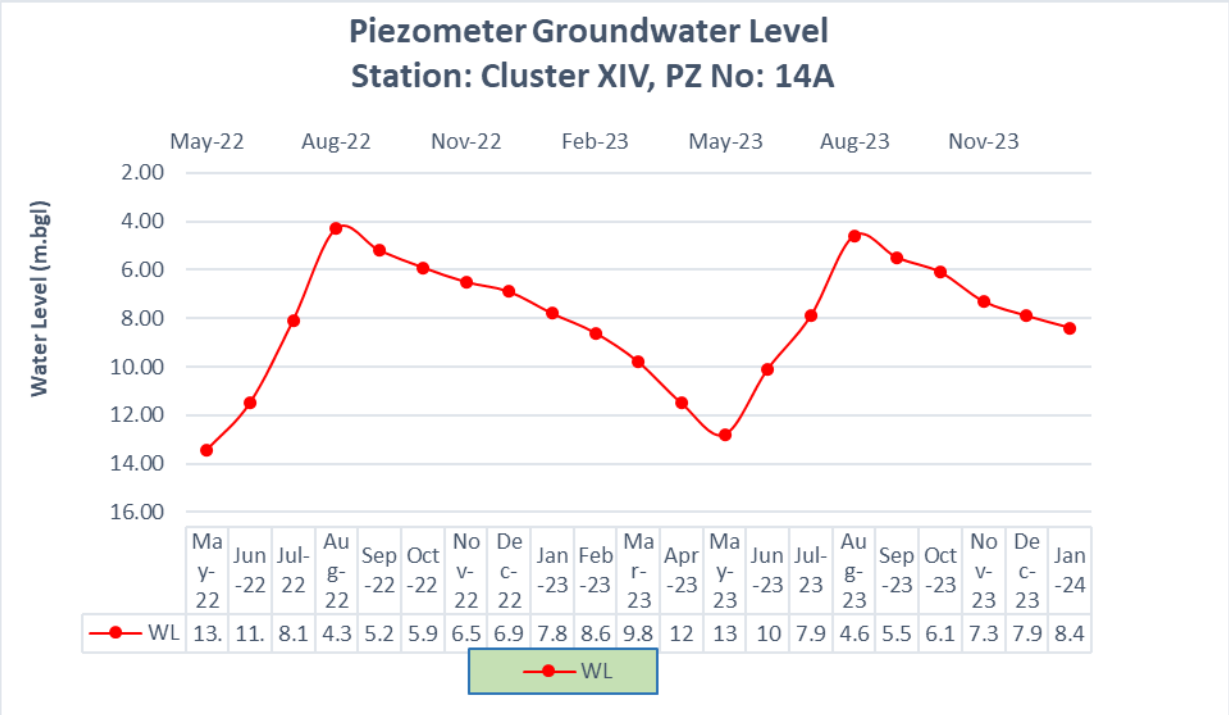

Piezometer Groundwater Level
Station: Cluster V, PZ No: 5A
Water Level (m.bgl)
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
May-22 Jun-22 Jul-22 Aug-22 Sep-22 Oct-22 Nov-22 Dec-22 Jan-23 Feb-23 Mar-23 Apr-23 May-23 Jun-23 Jul-23 Aug-23 Sep-23 Oct-23 Nov-23 Dec-23 Jan-24
WL 8.9 8.2 6.2 2.9 3.6 4.5 4.9 5.3 5.7 6.3 7.1 8.3 8.5 7.8 5.8 2.5 3.5 4.4 4.8 5 5.3
WL

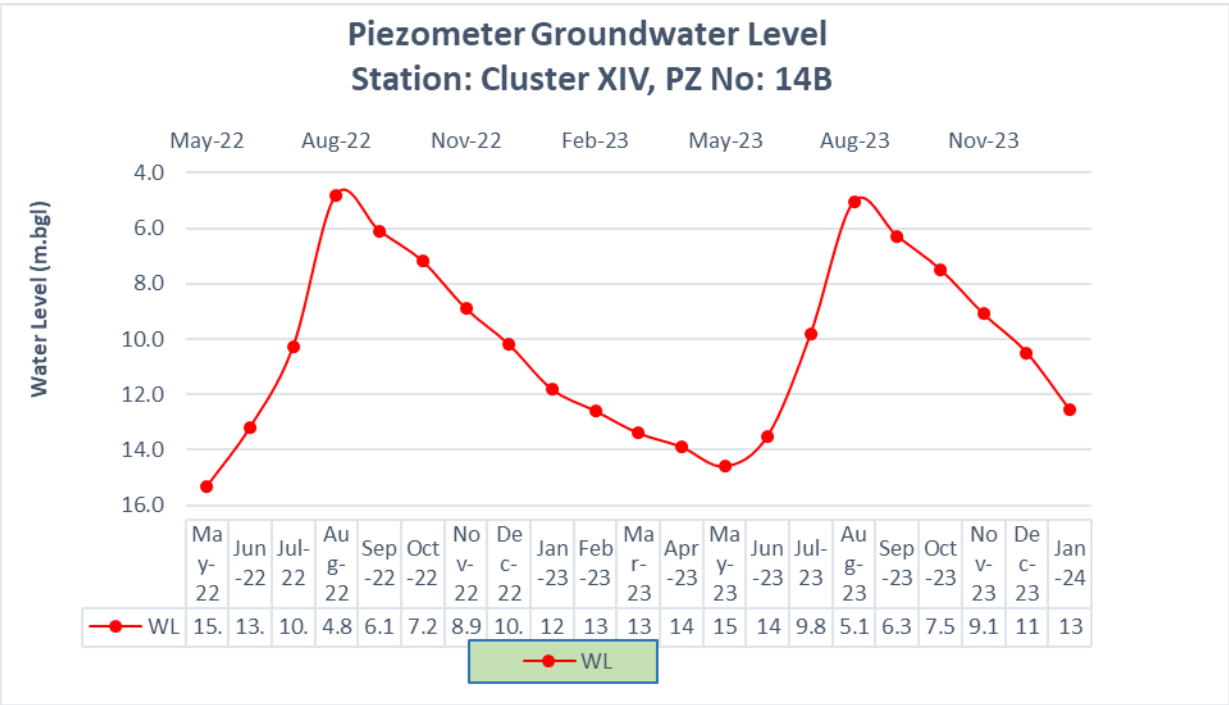

Piezometer Groundwater Level
Station: Cluster IX, PZ No: 9B
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
Water Level (m.bgl)
55.00
57.00
59.00
61.00
63.00
65.00
67.00
69.00
71.00
73.00
75.00
May-22 Jun-22 Jul-22 Aug-22 Sep-22 Oct-22 Nov-22 Dec-22 Jan-23 Feb-23 Mar-23 Apr-23 May-23 Jun-23 Jul-23 Aug-23 Sep-23 Oct-23 Nov-23 Dec-23 Jan-24
WL 73. 72. 68. 57. 57. 60. 61. 63. 65 67 69 70 73 71 68 57 59 60 61 63 64
WL


Piezometer Groundwater Level
Station: Cluster X, PZ No: 10A
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
Water Level (m.bgl)
2.00
4.00
6.00
8.00
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
WL 7.1 5.9 3.9 3.0 3.4 4.1 4.7 5.4 5.7 6 6.4 6.7 6.9 6.2 4 3.1 3.6 4.1 4.6 5.1 6.4
WL


Piezometer Groundwater Level
Station: Cluster XI, PZ No: 11A
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
Water Level (m.bgl)
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
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
WL 54. 49. 35. 27. 33. 35. 37. 39. 43 46 49 51 53 48 37 28 35 37 39 41 53
WL


Piezometer Groundwater Level
Station: Cluster XIII, PZ No: 13A
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
Water Level (m.bgl)
15.00
20.00
25.00
30.00
35.00
40.00
45.00
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
WL 41. 37. 30. 22. 24. 27. 30. 33. 35 37 38 39 40 36 32 24 26 27 28 30 32
WL


Piezometer Groundwater Level
Station: Cluster XIV, PZ No: 14A
Water Level (m.bgl)
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
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
WL 13. 11. 8.1 4.3 5.2 5.9 6.5 6.9 7.8 8.6 9.8 12 13 10 7.9 4.6 5.5 6.1 7.3 7.9 8.4
WL


Piezometer Groundwater Level
Station: Cluster XIV, PZ No: 14B
Water Level (m.bgl)
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
4.0
6.0
8.0
10.0
12.0
14.0
16.0
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
WL 15. 13. 10. 4.8 6.1 7.2 8.9 10. 12 13 13 14 15 14 9.8 5.1 6.3 7.5 9.1 11 13
WL

Annexure – VII

GROUNDWATER SAMPLE LOCATION DETAILS

Sampling month: June month of the assessment year of 2022-23

Sl No	Dug well (CMPDI)	Location	Sampling Date
			April'2023
1	**A4**	DALDOLI	04.04.2023
2	**A9**	SRIRAMPUR	04.04.2023
3	**A10**	PHULWAR	04.04.2023
4	**A13**	BHELATANR	04.04.2023
5	**A23**	MACHHAYARA	04.04.2023
6	**A29**	GOVINDPUR, AMBAGAN VILLAGE	04.04.2023
7	**A32**	MOONIDIH BAZAR	04.04.2023
8	**B10**	AMDIH NARAYANPUR	04.04.2023
9	**B15**	BERA VILLAGE	04.04.2023
10	**B19**	BHANDARIDAH	04.04.2023
11	**B23**	LOHAPATTI VILLAGE	04.04.2023
12	**B32**	MADHUBAND VILLAGE	04.04.2023
13	**B40**	BHUIANCHITRO	04.04.2023
14	**B46**	TELO	04.04.2023
15	**B55**	RANTANR VILLAGE	04.04.2023
16	**B59**	KHODOVALY VILLAGE	04.04.2023
17	**B64**	KESHALPUR, BATIGHAR	04.04.2023
18	**D2**	BIRSA MUNDA CHAWK, BANKMORE	05.04.2023
19	**D4**	JHARIA THANA	05.04.2023
20	**D5**	JIYALGORA (NEAR P.O.)	05.04.2023
21	**D14**	KARMATANR	04.04.2023
22	**D19**	MEMKO MORE	04.04.2023
23	**D25**	GODHUR MORE	04.04.2023
24	**D30**	BORKIBOA VILLAGE	04.04.2023
25	**D35**	PATHERDIH RAILWAY COLONY	05.04.2023
26	**D41**	JOYRAMPUR	05.04.2023
27	**D49**	TISRA THANA	05.04.2023
28	**D59**	SITALPUR	05.04.2023
29	**D70**	JALADIH	05.04.2023
30	**D72**	CHATI GOVINDPUR	04.04.2023
31	**D80**	DHANSAR MINE RESCUE STATION	05.04.2023
32	**D96**	BANSHRA	05.04.2023
33	**D107**	BOGULA	05.04.2023
34	**D112**	DEMUDI (DOMATANR)	04.04.2023
35	**D115**	TELMUCHU	04.04.2023

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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.26	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.79	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	39.5	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	0.6	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	40	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	55	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	*0*	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	216	*0*	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2- E. , Turbidimetric Method	92	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	44	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	39.05	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.4	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	<0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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 : - A13 , BHELATANR* **Date of Sampling at Station: 04.04.2023**

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.16	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.15	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	35	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	4.2	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	78	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	44	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	174	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2- E. , Turbidimetric Method	135	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	133	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	13.53	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.77	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	1.15	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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 : - A23(MACHHAYARA)*

Date of Sampling at Station: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.07	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.9	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	15.2	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	0.7	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	59	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	63	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	222	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2- E. , Turbidimetric Method	112	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	99	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	26	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.69	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	3.94	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.07	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.33	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 : - A29 , GOVINDPUR,AMBAGAN VILLAGE*

Date of Sampling at Station: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.02	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.15	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	45.5	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	3.6	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	71	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	79	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	120	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	120	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	122	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	23.1	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.74	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.03	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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 : - A32 , MOONIDIH BAZAR*

Date of Sampling at Station: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	7.98	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.33	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	62.4	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	1.7	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	82	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	98	2	75	200
7	Carbonate Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	432	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	166	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	132	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	15.48	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.35	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	3.58	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.04	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	2.16	0.1	5	15

X

***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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	7.89	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.98	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	30.5	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	0.8	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	56	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	63	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	126	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	184	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	119	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	4.76	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.46	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	<0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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 : - A9, SRIRAMPUR*

Date of Sampling at Station: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.42	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.56	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	8.9	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	0.8	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	19	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	60	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	138	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	185	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	88	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	5.64	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.45	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.38	0.1	5	15

X

***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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.21	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.48	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	21	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	0.6	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	27	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	48	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	312	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2- E. , Turbidimetric Method	271	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	110	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	11.26	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.53	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	8.73	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.3	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.1	5	15

X

***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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.04	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	47.8	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	1.7	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	26	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	95	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	360	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	152	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	132	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	4.11	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.51	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.04	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	7.95	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.98	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	45.9	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	9.2	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	80	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	76	0	-	-
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	300	25	500	2000
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	206	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	112	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	39.82	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.36	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.05	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.1	5	15

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***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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.27	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.96	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	65.1	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	1.5	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	48	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	60	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	402	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	98	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	59	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	1	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.32	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	<0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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 : 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.19	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.2	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	60.8	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	1.7	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	57	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	103	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	312	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	85	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	73	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	2.44	0.5	45	No relaxation
012	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.24	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.22	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.95	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	47.5	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	0.7	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	22	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	148	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	72	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	198	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	145	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	24.4	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.19	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.04	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.55	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	27.6	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	0.5	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	24	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	60	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	240	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	110	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	84	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	20.67	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.37	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.15	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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	7.93	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.26	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	7.6	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	1	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	15	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	21	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	360	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	40	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	24	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	7.71	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.6	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.27	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	<0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.03	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.05	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	56.9	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	2.3	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	42	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	92	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	300	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2- E. , Turbidimetric Method	140	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	121	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	1.74	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.87	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.14	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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.62	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.1	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	38.4	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	5.2	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	94	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	134	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	120	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	66	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	44	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	1.07	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.78	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.34	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.14	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: 05.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.32	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.7	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	73.6	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	13.7	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	63	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	190	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	288	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	167	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	249	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	14.56	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.5	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	1.7	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	7.63	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.85	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	83.1	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	1.6	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	193	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	73	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	720	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	156	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	132	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	37	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.94	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	7.96	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.9	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	38.5	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	0.8	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	70	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	37	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	240	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2- E. , Turbidimetric Method	203	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	205	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	41.39	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.58	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	<0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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 : - D14 , KARMATANR*

Date of Sampling at Station: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.02	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.35	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	64.6	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	1.4	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	58	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	161	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	180	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2- E. , Turbidimetric Method	190	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	180	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	42.14	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.95	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.04	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.13	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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.15	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.44	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	19.7	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	1.3	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	10	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	40	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	156	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	88	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	33	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	0.05	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	1.02	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.03	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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 : - D2 , BIRSA MUNDA CHAWK,BANKMORE*

Date of Sampling at Station: 05.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.07	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.66	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	36.5	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	0.5	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	58	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	45	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	960	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	192	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	330	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	19.97	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.56	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.2	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 : - D25 , GODHUR MORE*

Date of Sampling at Station: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	7.96	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.55	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	25.7	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	2.1	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	31	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	37	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	324	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	197	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	132	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	8.5	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.71	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	<0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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 : - D30 , BORKIBOA VILLAGE*

Date of Sampling at Station: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	7.99	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.74	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	33.6	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	0.9	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	42	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	61	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	240	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	90	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	79	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	1	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.4	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.34	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.61	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: 05.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	7.86	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.4	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	47.9	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	0.8	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	46	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	147	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	360	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	659	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	132	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	41.8	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.92	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.03	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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: 05.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.02	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.59	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	31	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	6	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	10	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	60	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	108	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	56	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	44	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	7.51	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.54	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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: 05.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.06	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.55	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	64.9	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	18.7	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	206	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	147	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	360	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	156	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	132	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	1.16	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.51	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.03	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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: 05.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.06	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.27	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	42.4	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	7.7	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	57	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	115	2	75	200
7	Carbonate Alkalinity (c_ac_o3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_ac_o3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	720	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	278	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	264	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	41.33	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.39	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.08	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.12	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: 05.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.06	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.27	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	42.4	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	7.7	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	57	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	115	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	720	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	278	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	264	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	41.33	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.39	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.08	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.12	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: 05.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	7.91	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.2	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	75.4	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	2.6	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	48	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	52	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	150	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	120	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	106	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	0.17	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.55	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.06	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.13	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: 05.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	7.93	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.65	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	32.6	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	1.1	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	26	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	89	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	240	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	94	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	35	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	41.94	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.65	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.03	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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: 04.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.11	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.6	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	98.7	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	1.1	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	99	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	66	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	210	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	171	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	99	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	10.37	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.78	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.11	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: 05.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.06	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	0.41	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	36.7	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	2.6	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	26	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	39	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	252	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	165	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	66	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	40.18	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.41	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.16	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

1.

Date of Sampling at Station: 05.04.2023

Sl. No.	Parameter	Method of Analysis	Observed Values	LDL	IS 10500: 2012	
					Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	pH value	IS 3025, Part 11 : 1983 R 2017 Electrometric(pH Meter) Method	8.15	0.1	6.5-8.5	No relaxation
2	Electric Conductivity	IS 3025 (Part 14) -1984 R 2002	1.07	-	-	-
3	Sodium as Na	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	46.4	0.5	-	-
4	Potassium as K	IS : 3025, Part 45: 1993 R: 2003 Flame Photometer	2.3	0.5	-	
5	Magnesium	APHA 24th Edition , 3500-Mg B: Calculation Method	42	6	30	100
6	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	87	2	75	200
7	Carbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	0	0	-	-
8	Bicarbonate Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	156	0	-	-
9	Sulphate, mg/l	APHA –23rd Edition, 4500-S 2-E. , Turbidimetric Method	169	10	200	400
10	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	101	5	250	1000
11	Nitrate , mg/l	APHA 24th Edition , UV-Spectrophotometric Method	1.11	0.5	45	No relaxation
12	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.76	0.2	1	1.5
13	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2	1	No relaxation
14	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	0.02	0.02	0.1	0.3
15	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th Edition AAS-VGA	<0.006	0.006	0.01	0.05
16	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA 24th Edition , AAS-GTA	<0.1	0.01	0.05	No relaxation
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	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,*

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

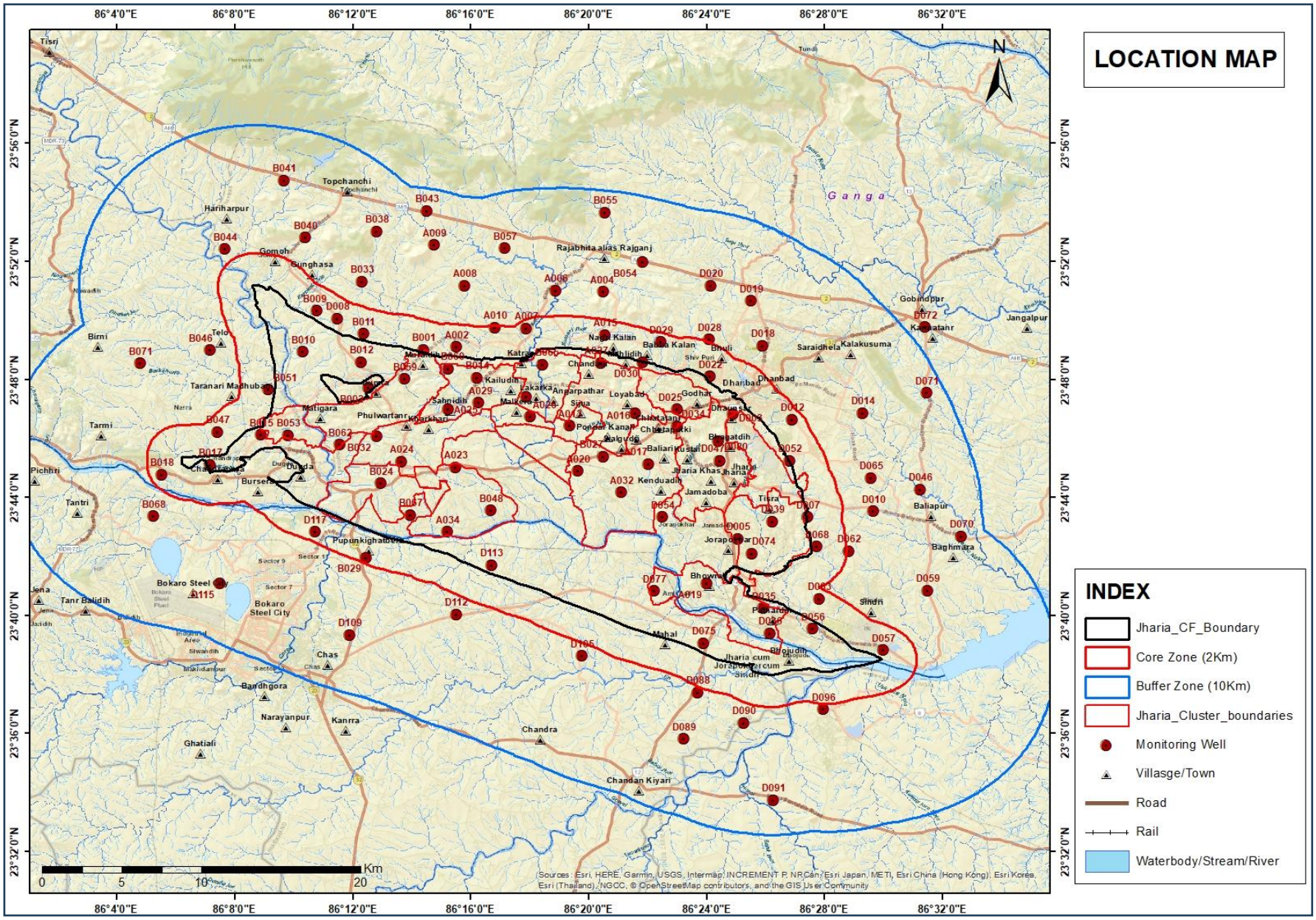


Plate- I: Location Map of Groundwater Level Monitoring stations (Dug wells)

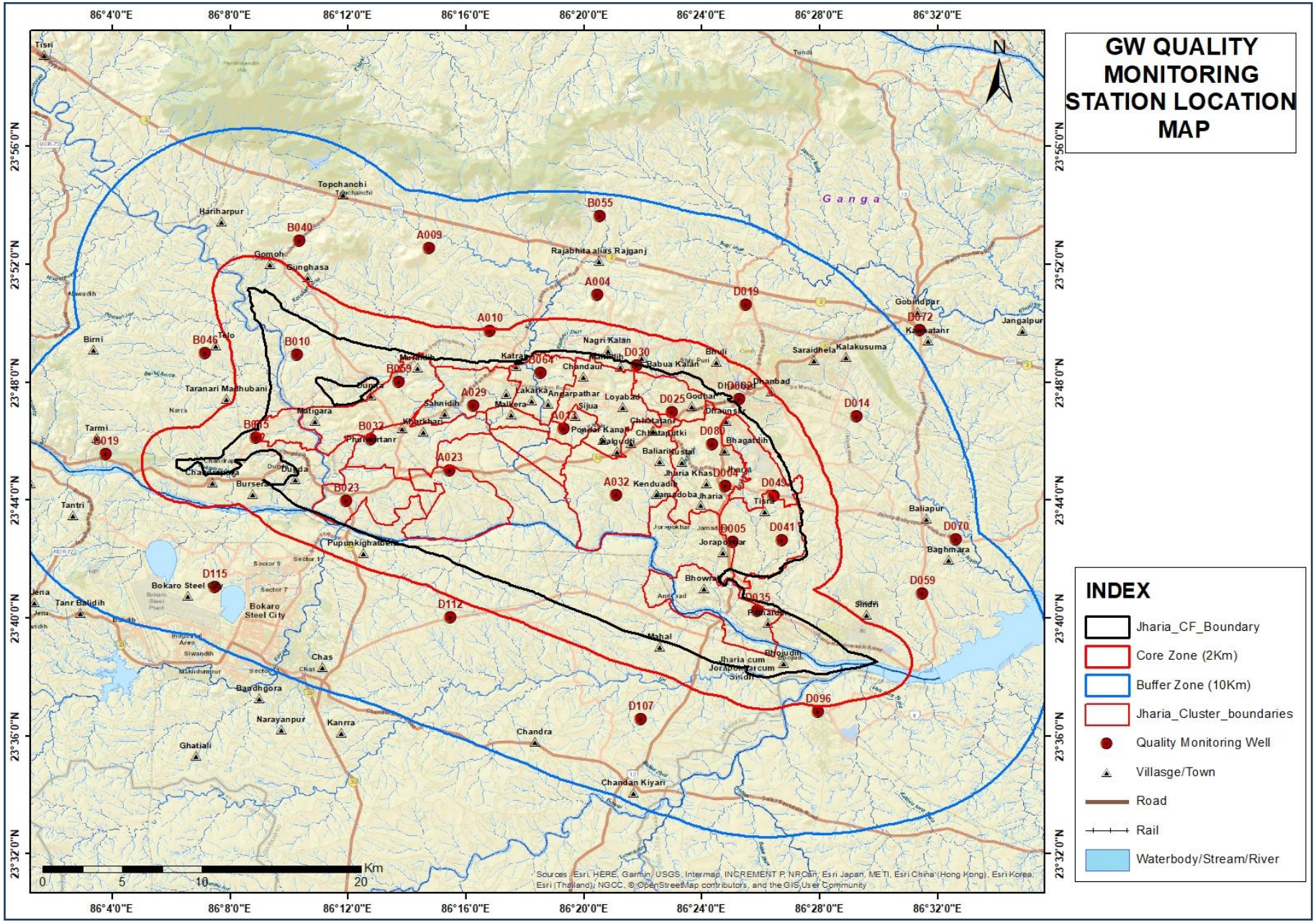


Plate- II: Location Map of Groundwater Quality Monitoring stations

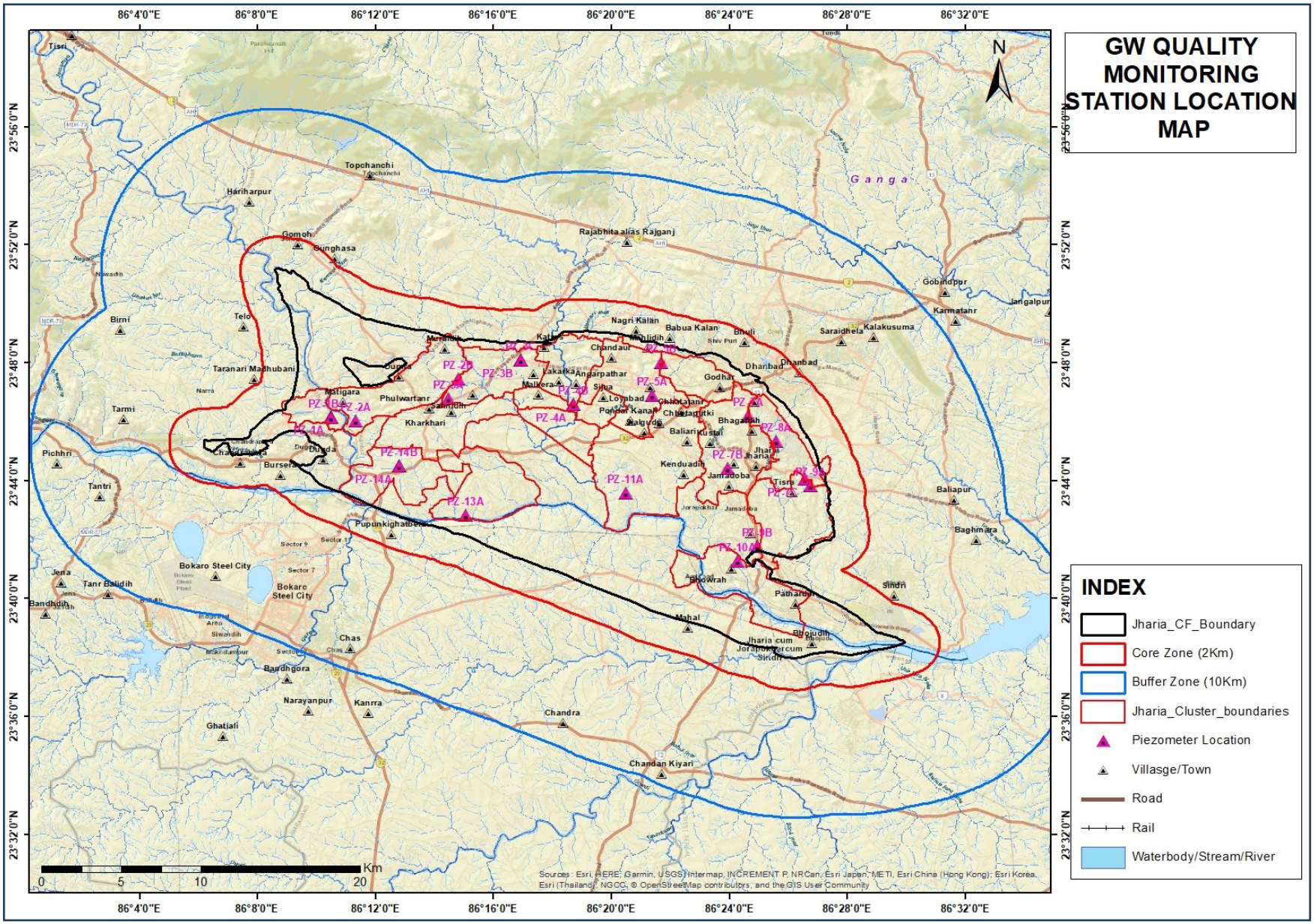


Plate- III: Location Map of Piezometers

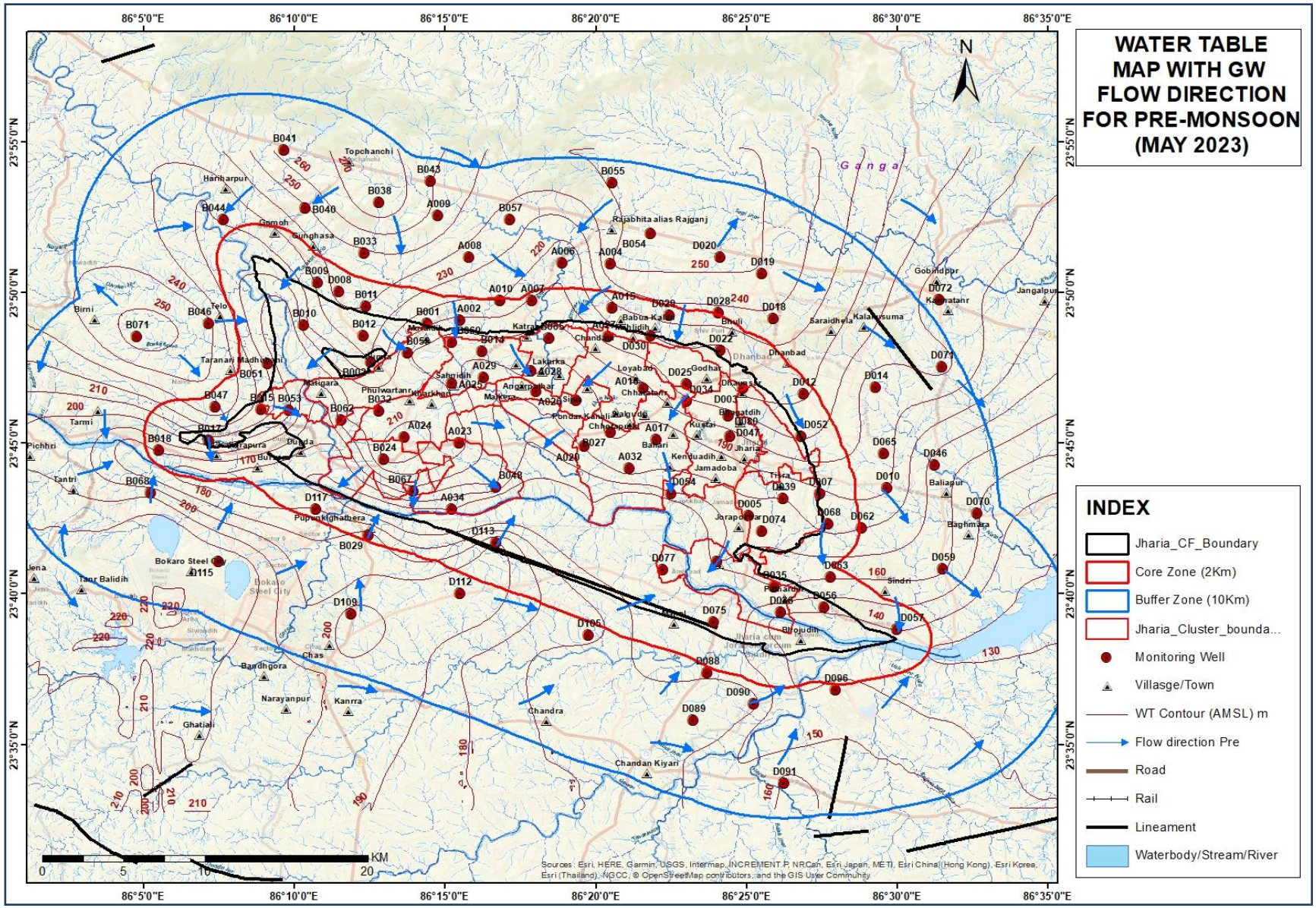


Plate- IVA: Water table Contour Map of JCF, Pre Monsoon (May'23)

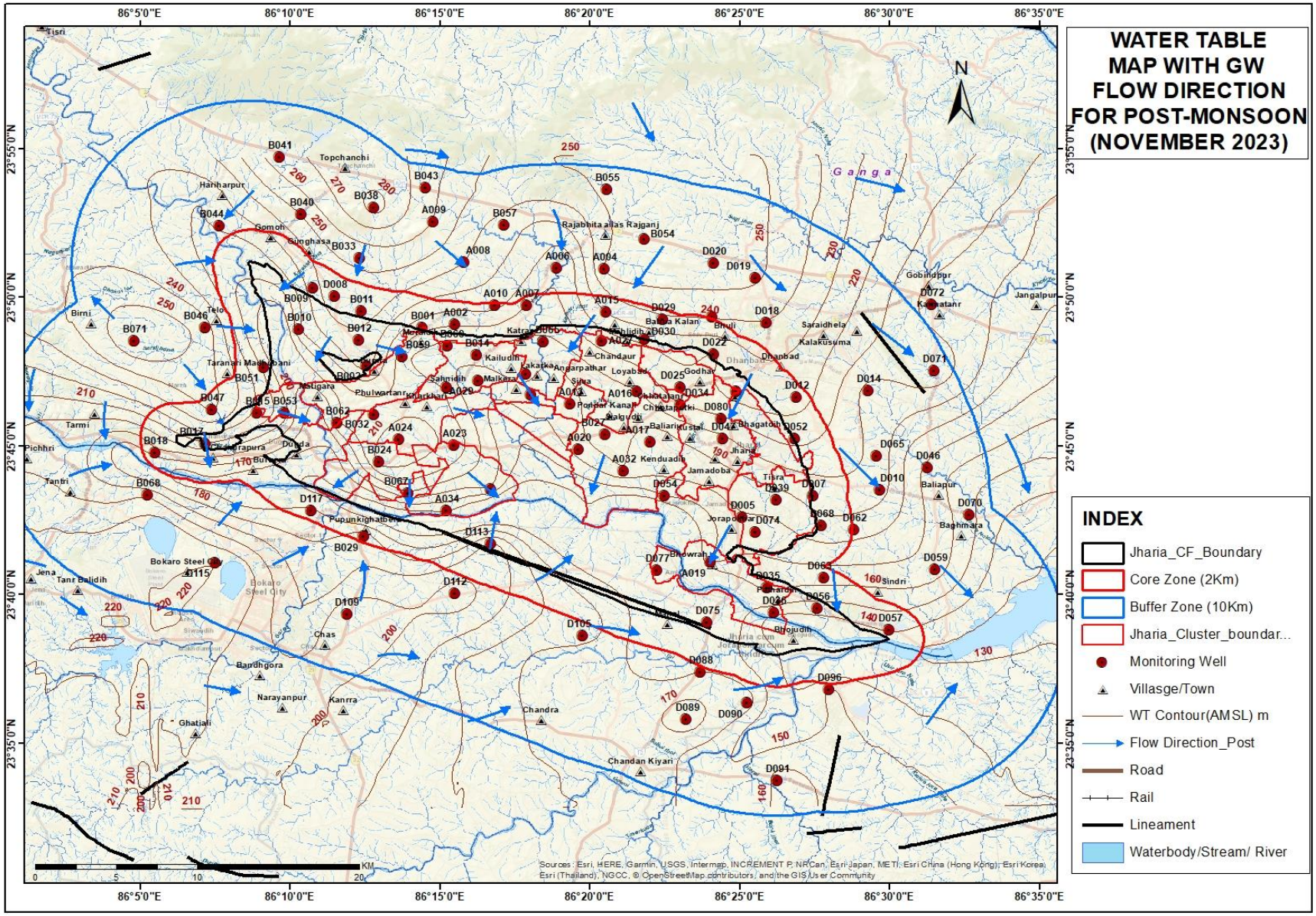


Plate- IVB: Water table Contour Map of JCF, Post Monsoon (Nov'23)

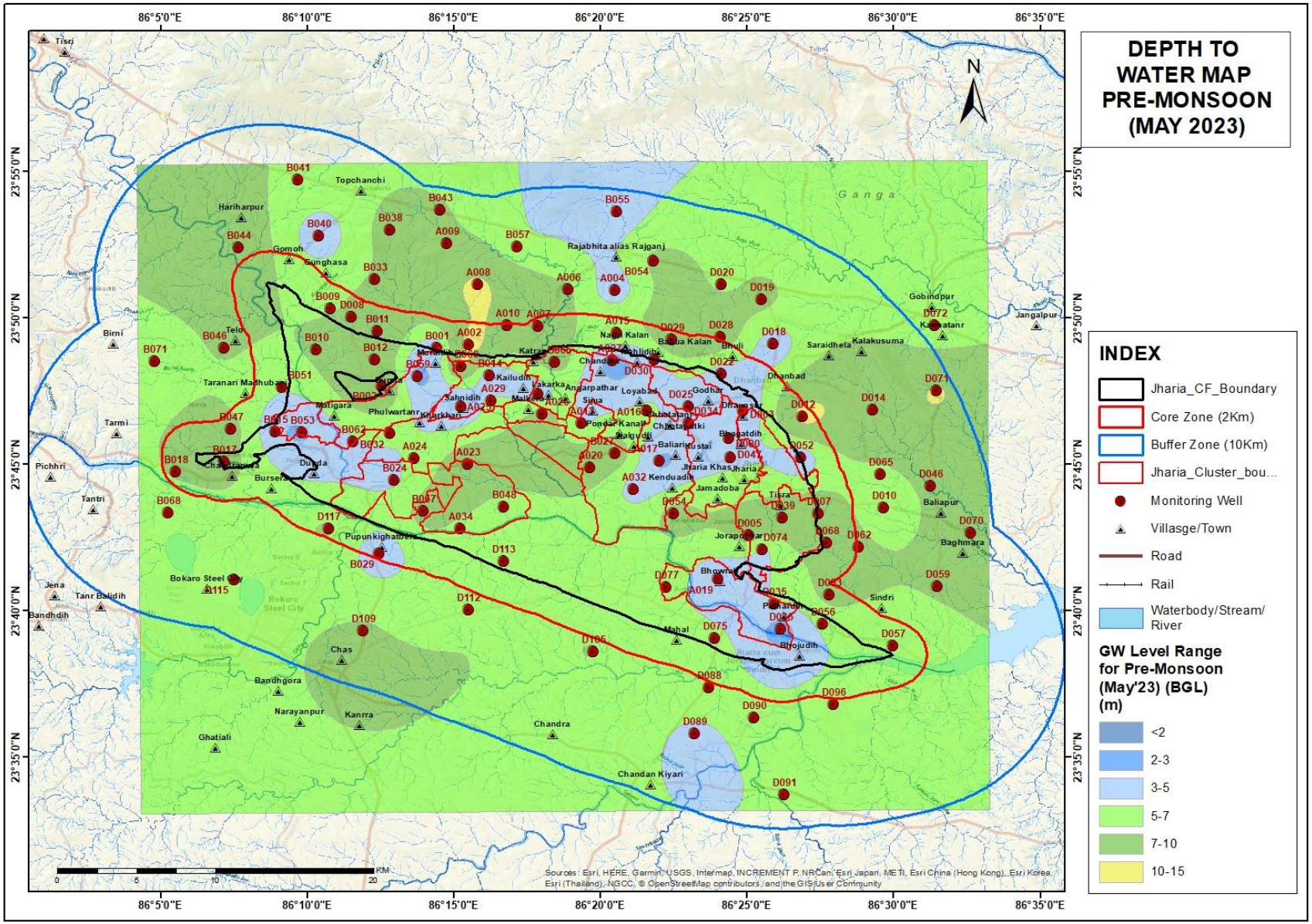


Plate- VA: Depth to Groundwater Level map of JCF, Pre Monsoon (May'23)

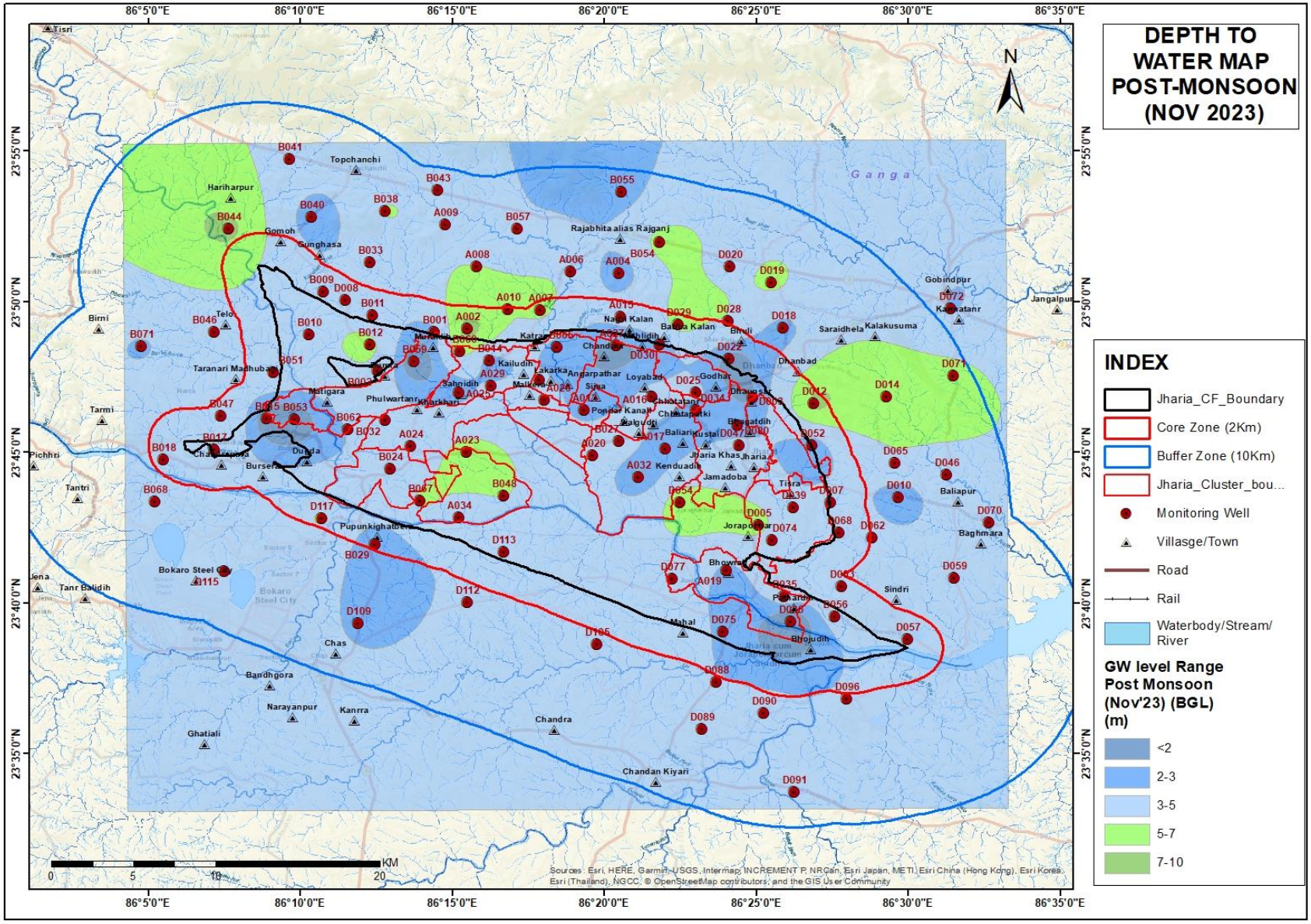
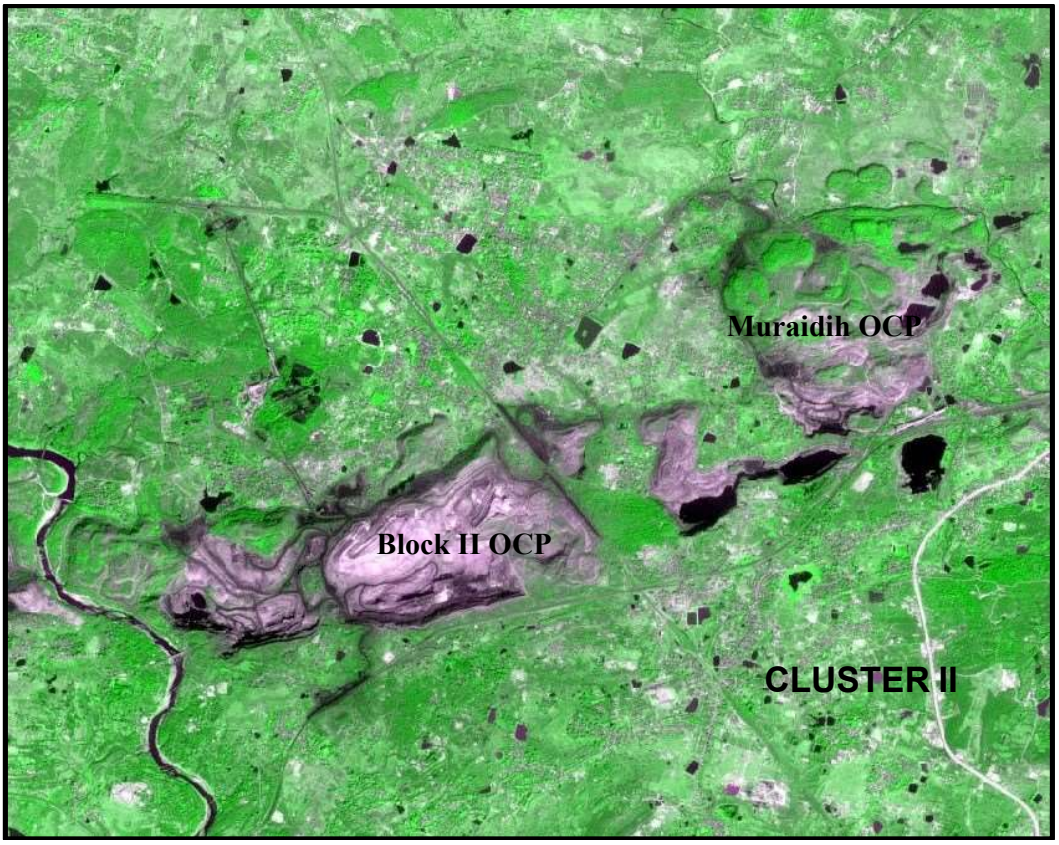


Plate- VB: Depth to Groundwater Level map of JCF, Post Monsoon (Nov'23)

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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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".

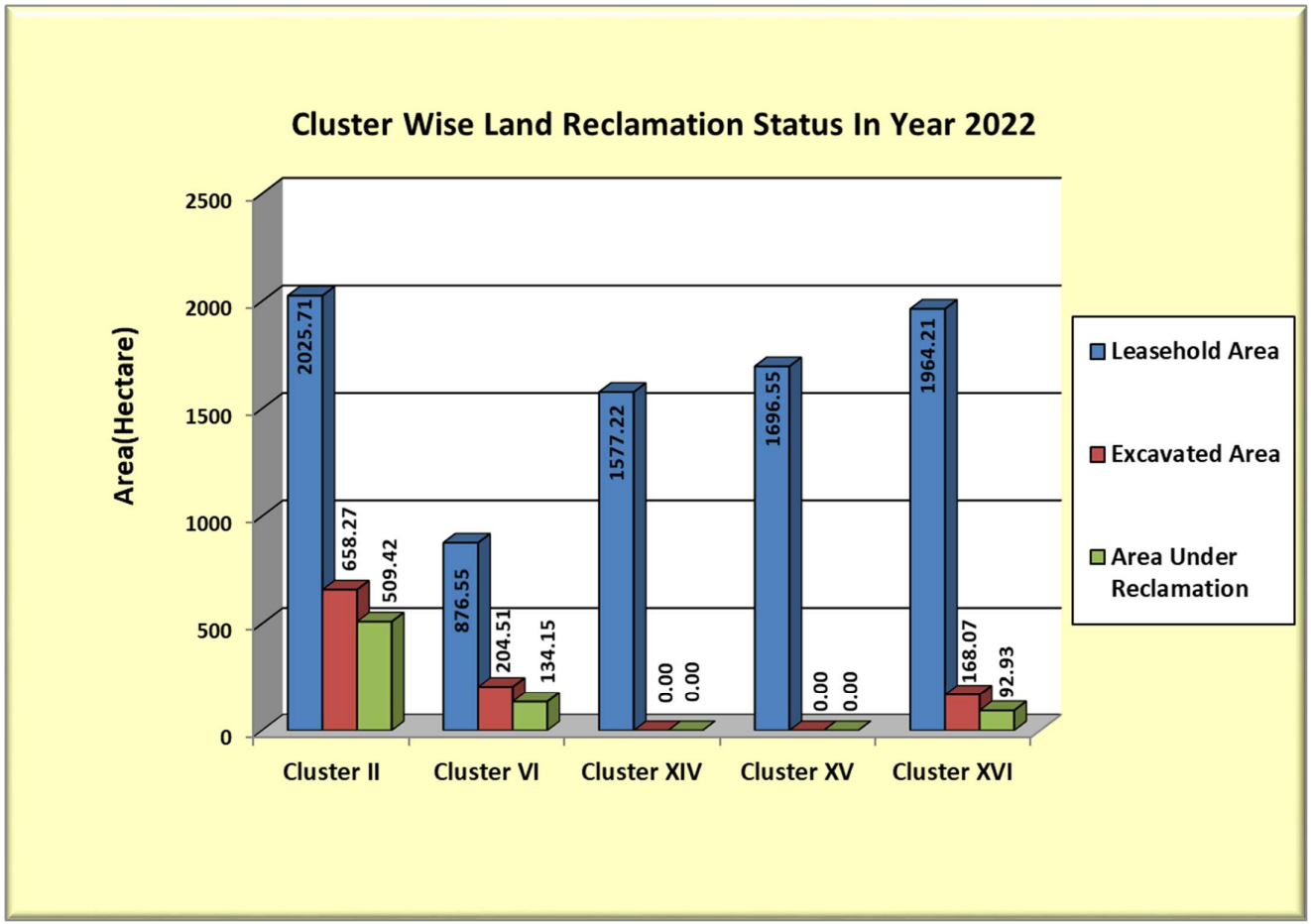


Fig. 1: Cluster wise Land Reclamation Status in five Clusters - 2022 (BCCL)

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:

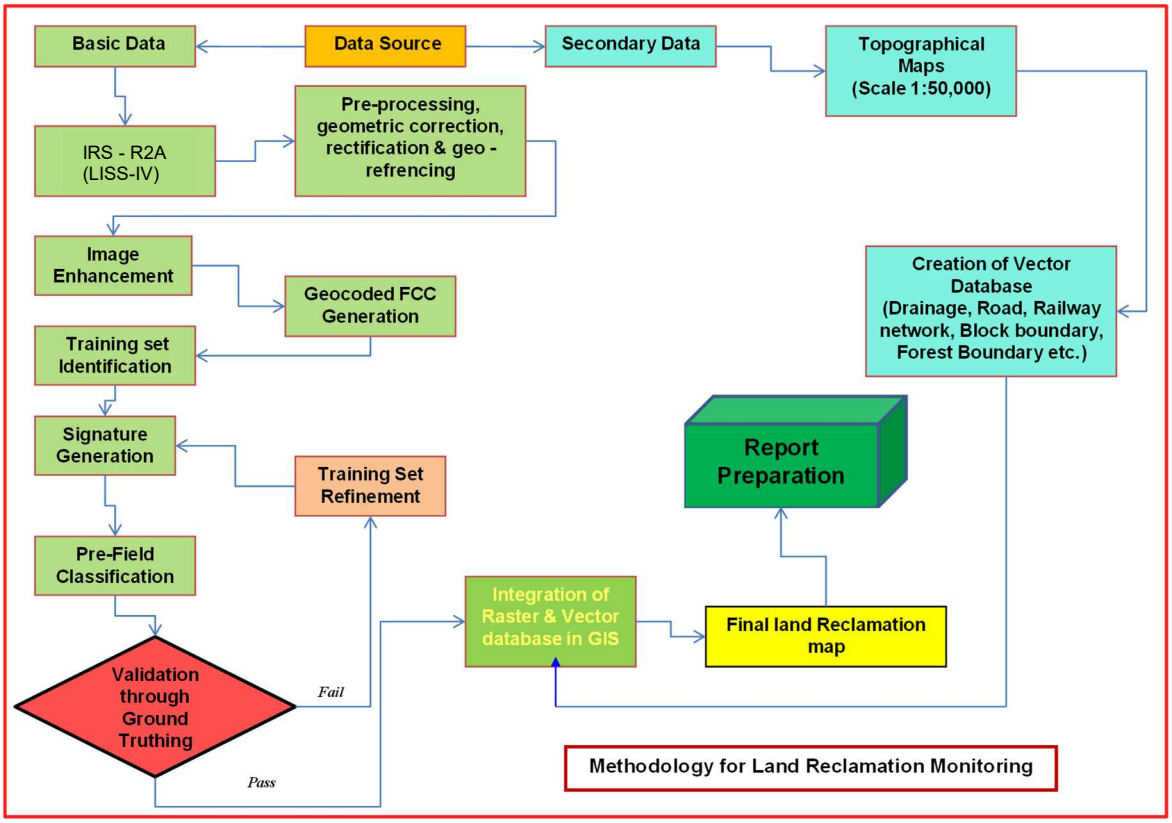


Fig. 2: Methodology of Land Reclamation Monitoring

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.

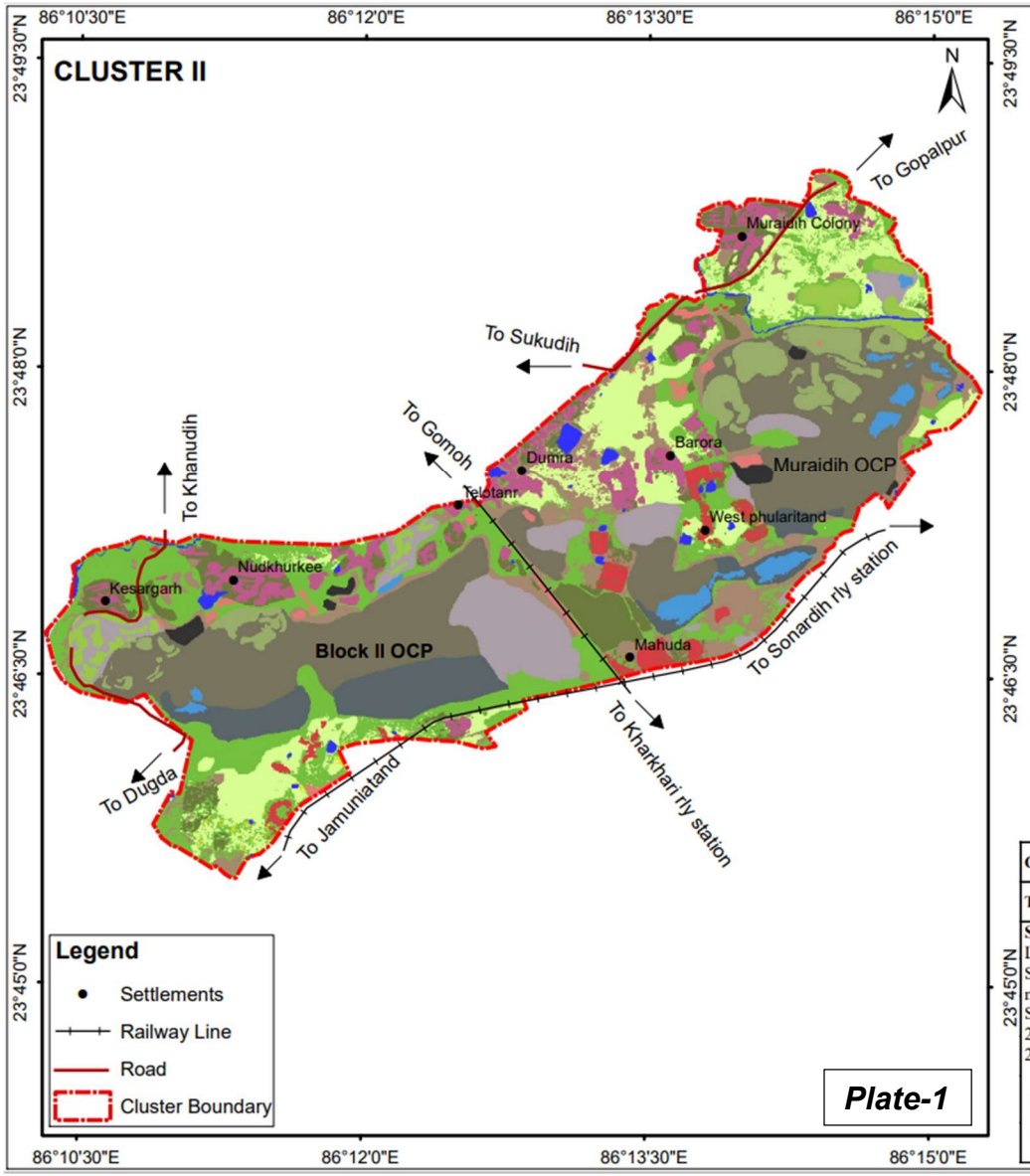
4.13 The area under total plantation (Green Cover) is maximum in Cluster II (12.97%) followed by Cluster XV with (4.76%), Cluster XVI with (4.70%), Cluster XIV with (4.59%) and Cluster VI with (4.35%).

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)

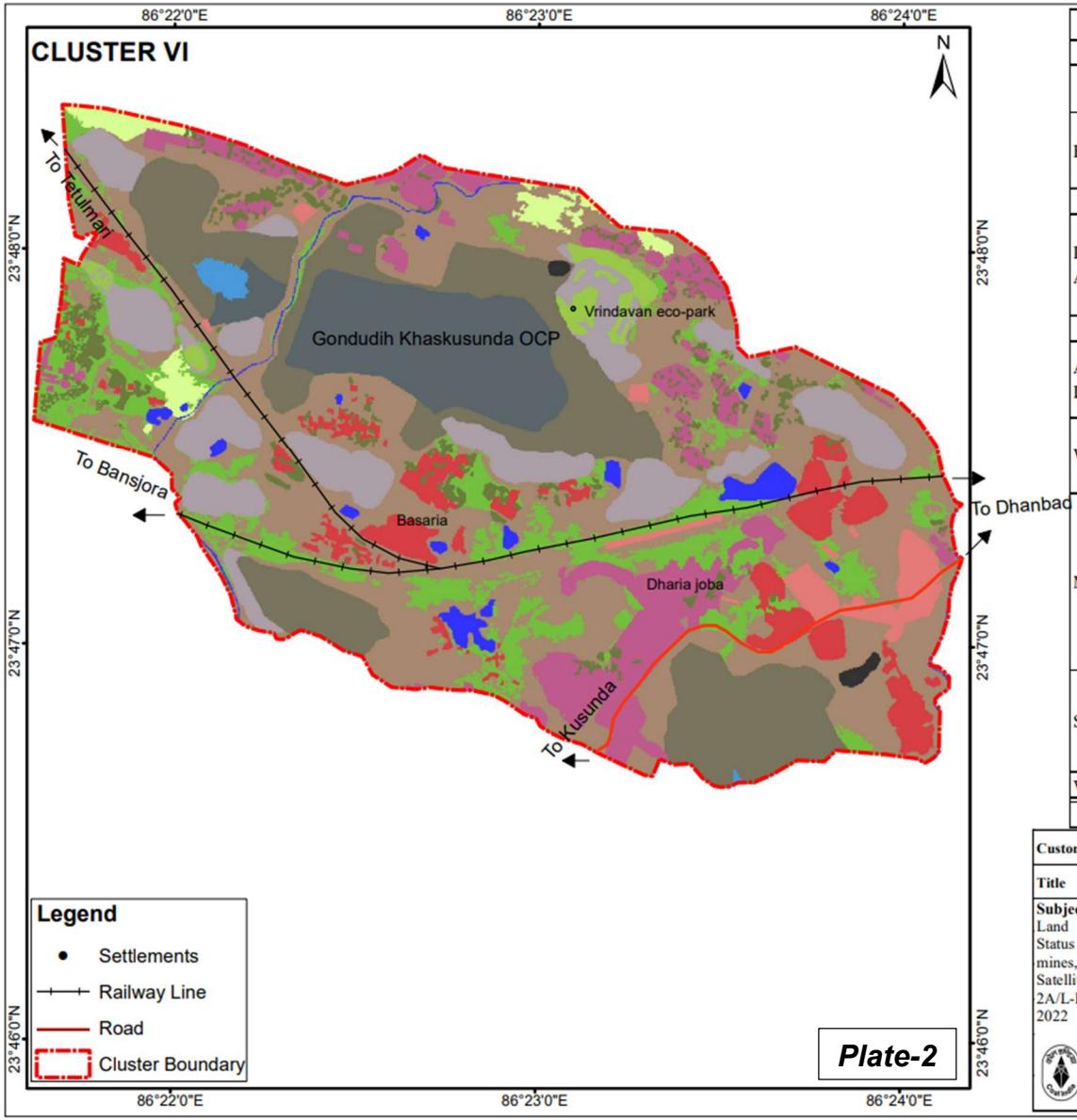
		CLUSTER II		CLUSTER VI		CLUSTER XIV		CLUSTER XV		CLUSTER XVI		TOTAL	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FORESTS	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.30	1.34	26.30	0.32
	Total Forest	0.00	0.00	0.00	0.00	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**

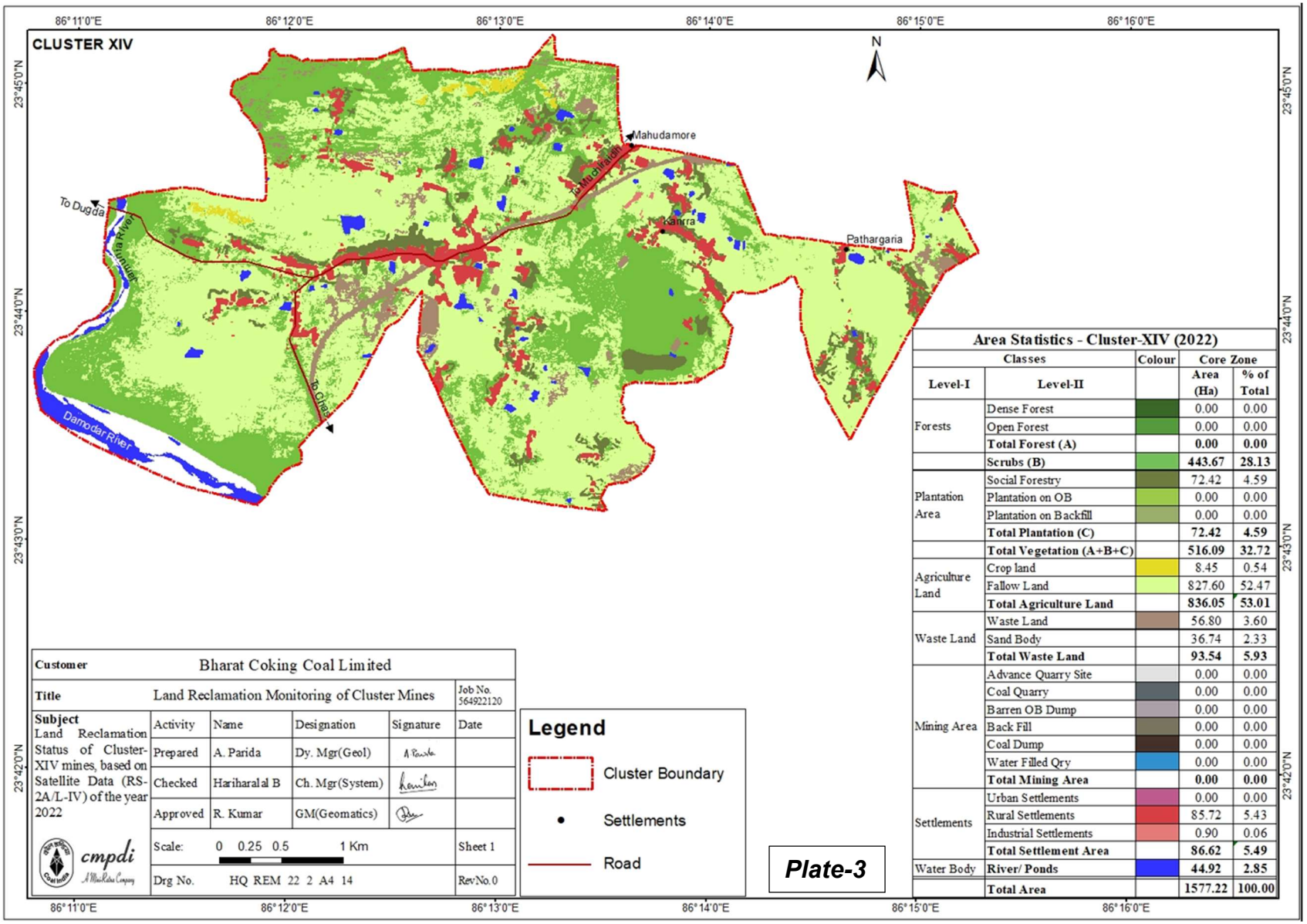
Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 564922120
Subject Land Reclamation Status of Cluster-II mines, based on Satellite Data (RS-2A/L-IV) of the year 2022	Activity	Name	Designation	Signature	Date
	Prepared	A. Parida	Dy. Mgr(Geol)		
	Checked	Hariharalal B	Ch. Mgr(System)		
	Approved	R. Kumar	GM(Geomatics)		
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	Drg No. HQ REM 22 2 A4 02				Rev No.0



Area Statistics - Cluster-VI (2022)

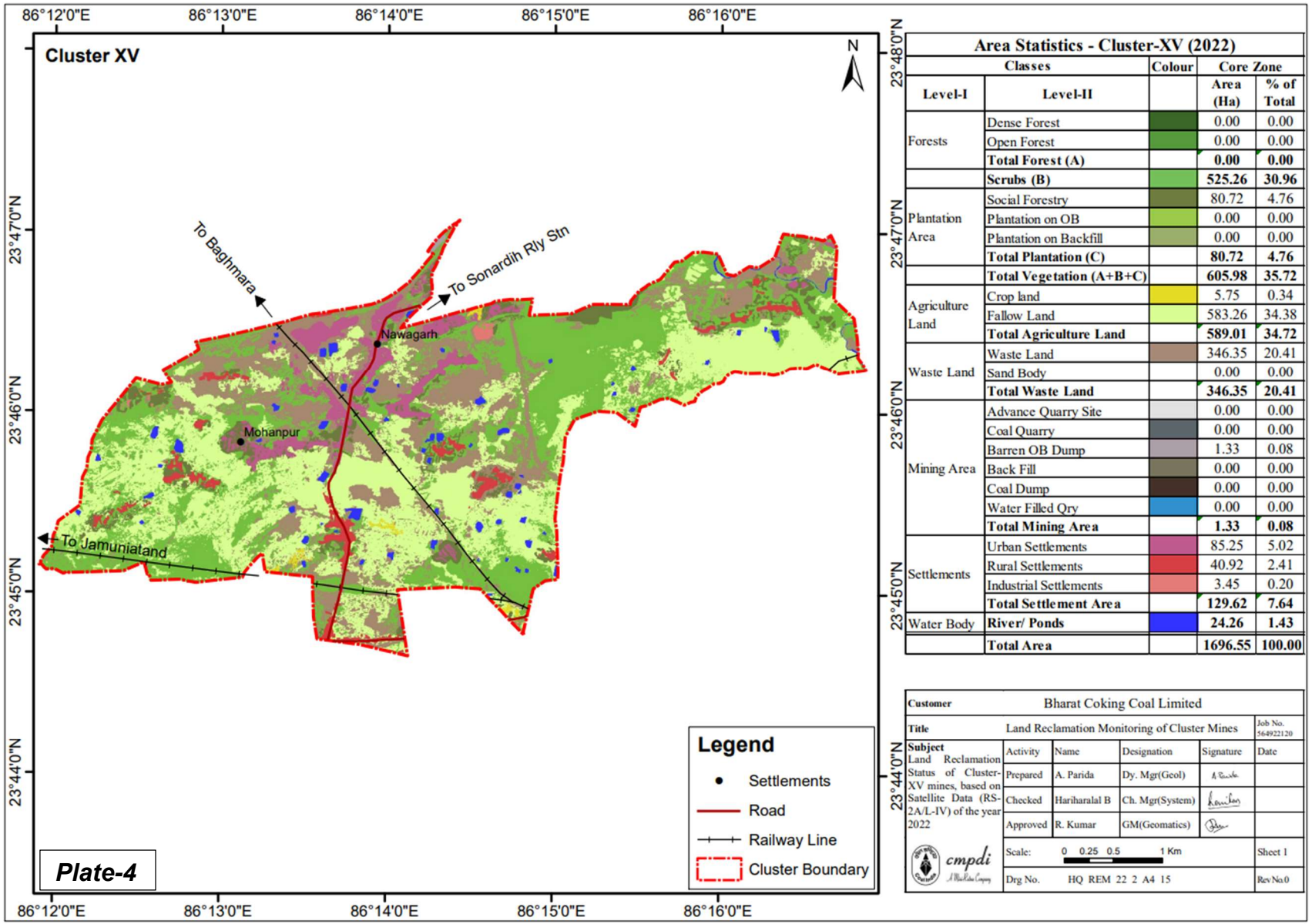
Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**87.34**	**9.96**
Plantation Area	Social Forestry		28.41	3.24
	Plantation on OB		9.70	1.11
	Plantation on Backfill		0.00	0.00
	Total 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)		
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	Drg No. HQ REM 22 2 A4 06				RevNo.0



Area Statistics - Cluster-XIV (2022)

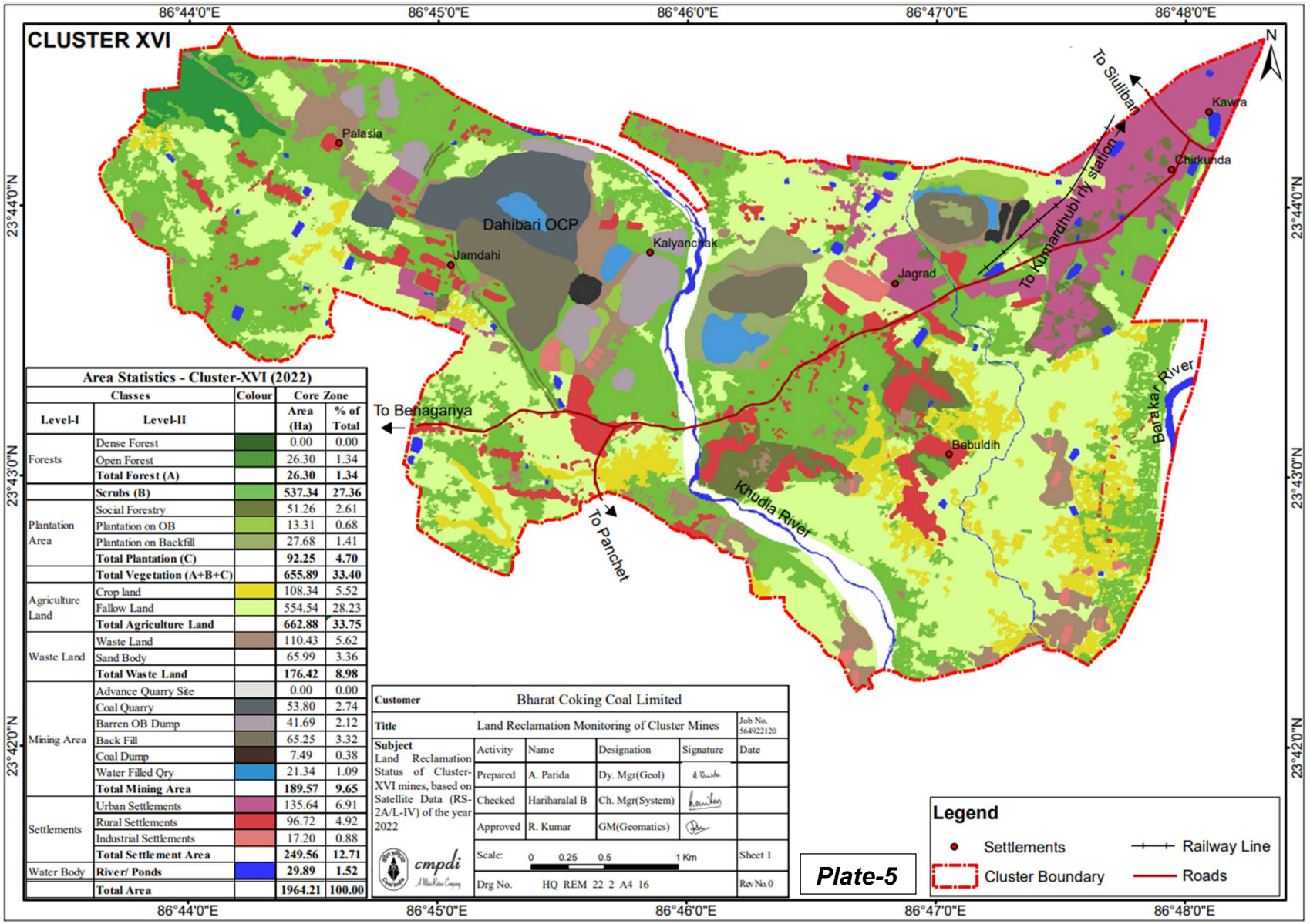
Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**443.67**	**28.13**
Plantation Area	Social Forestry		72.42	4.59
	Plantation on OB		0.00	0.00
	Plantation on Backfill		0.00	0.00
	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

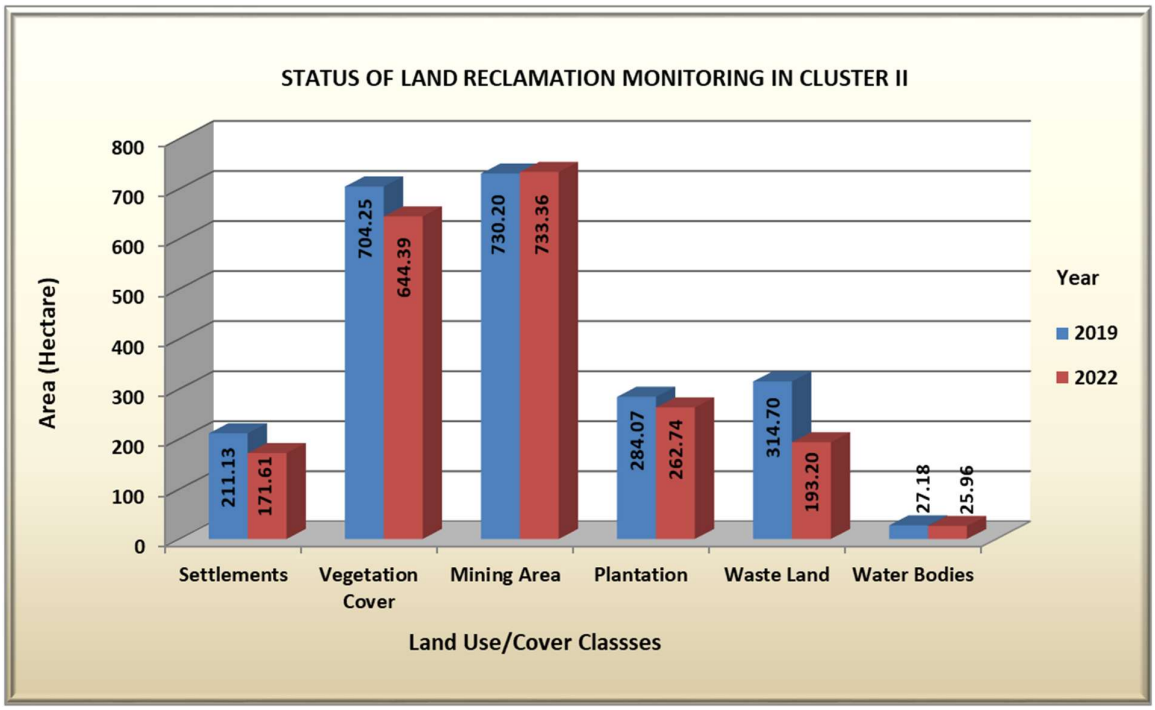


Fig. 3: Land Reclamation Status of Cluster II

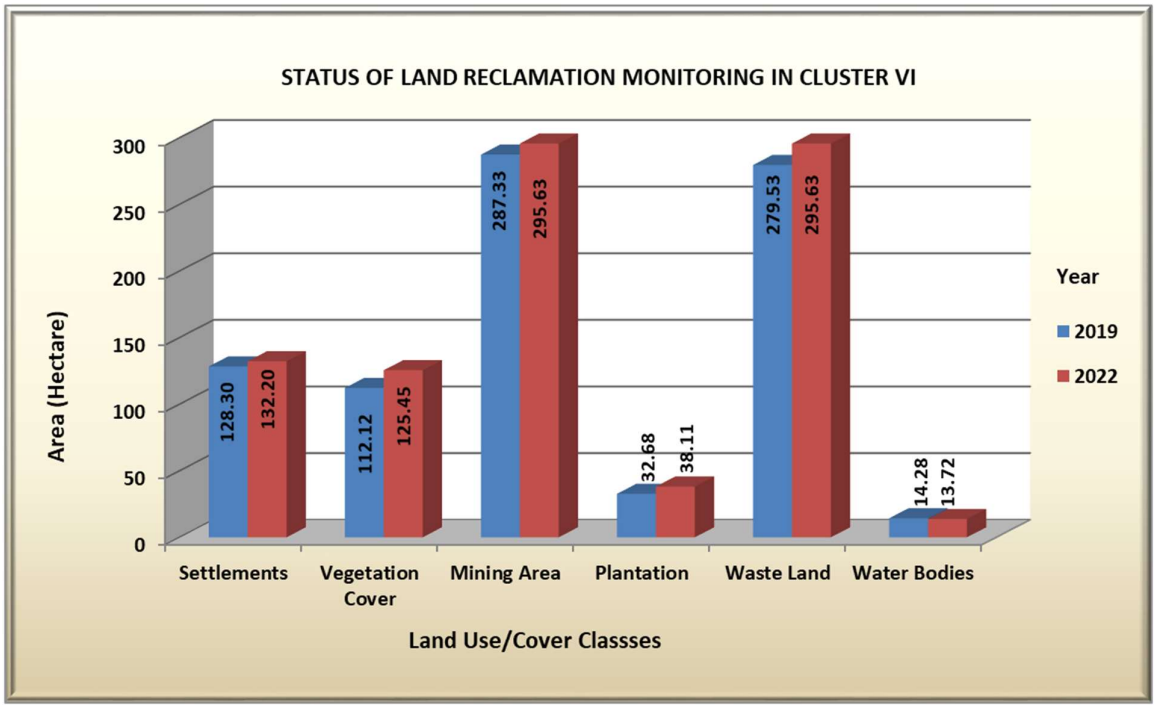


Fig. 4: Land Reclamation Status of Cluster VI

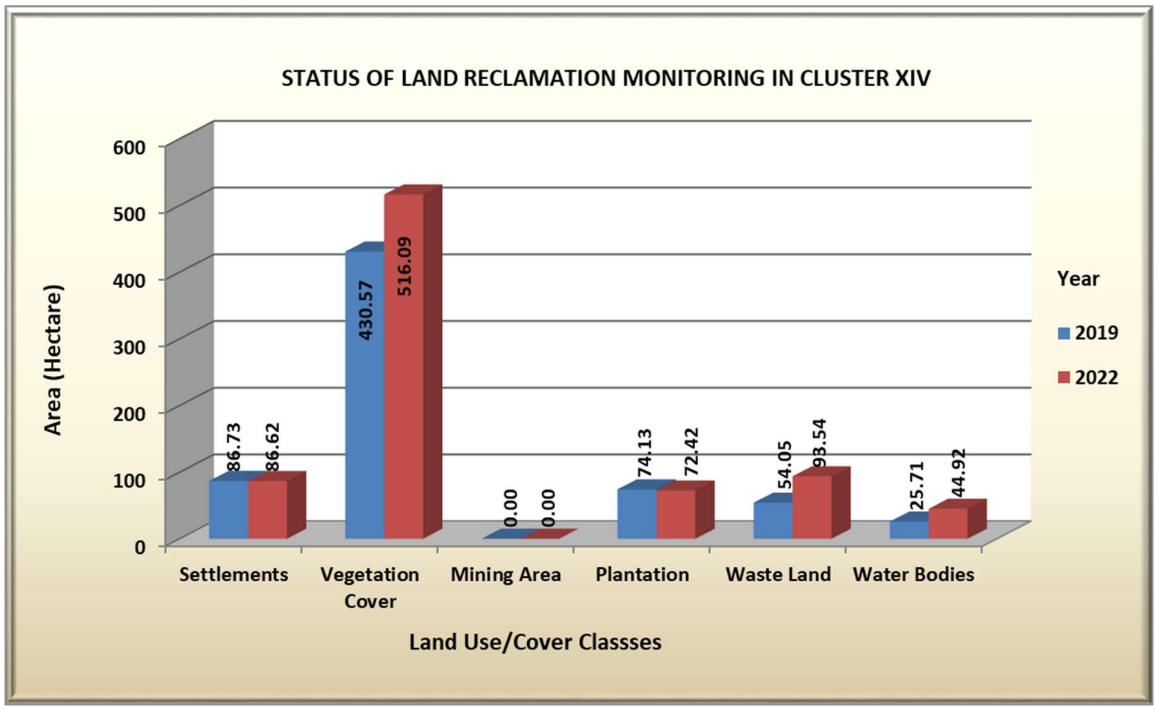


Fig. 5: Land Reclamation Status of Cluster XIV

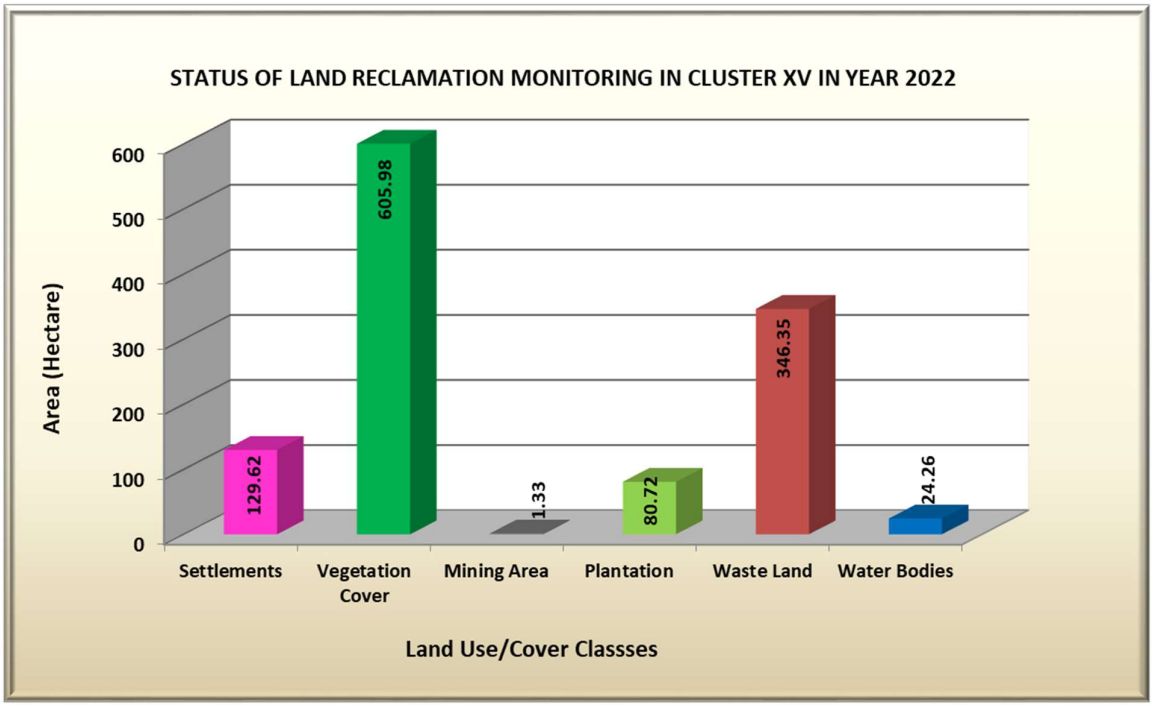


Fig. 6: Land Reclamation Status of Cluster XV

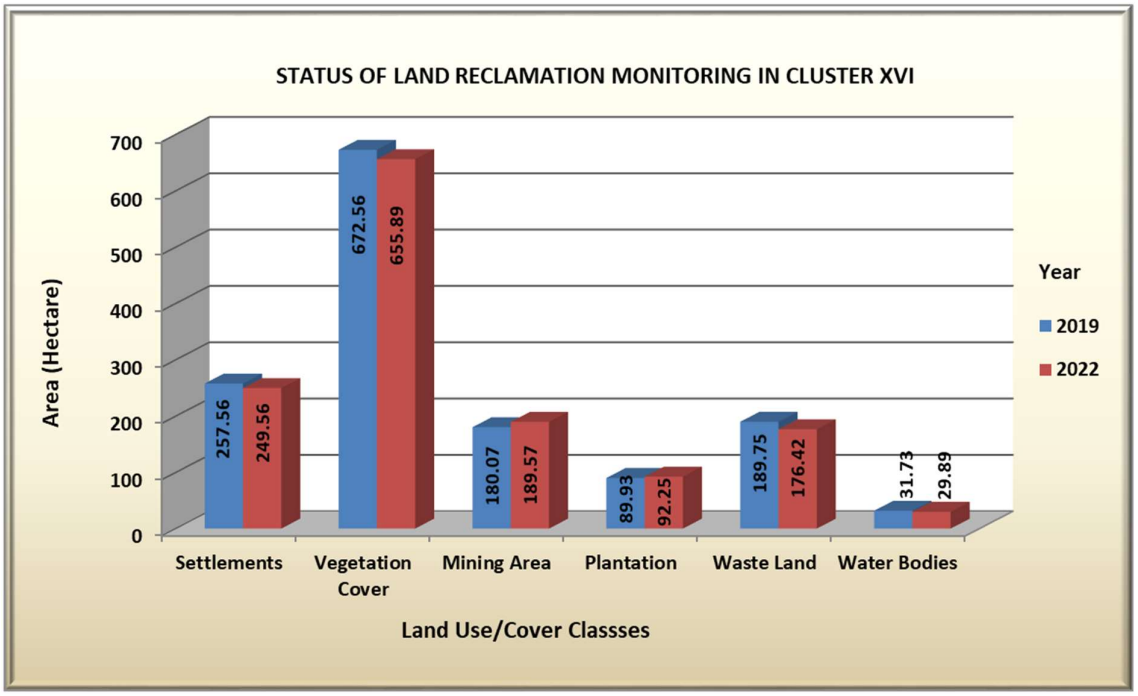


Fig. 7: Land Reclamation Status of Cluster XVI



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



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Deposit in Escrow Accounts with Bank of Baroda/Union Bank of India

Rs. In lakhs

Sr No	ESCROW ACCOUNT AT BOB	A/C No	Deposit											Interest										G Total
			2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	Total	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	Total	
1	MURAIDIH,SHATBDI GRP.OF MINES	00150100008816	270.79	284.33	298.55	313.48	329.15	345.61	-	-	-	-	**1,841.91**	10.30	26.70	50.67	63.11	81.78	109.71	141.91	138.81	67.79	96.83	**787.60**	**2,629.51**
2	PHULARITAND MIXED MINES	00150100009052	184.48	193.70	203.39	213.56	224.24	235.45	-	-	-	-	**1,254.82**	-	17.44	34.05	53.37	53.81	70.57	96.43	94.28	44.76	56.24	**520.95**	**1,775.77**
3	DAMODA GRP OF MINES	00150100008869	109.74	115.22	120.99	127.03	133.39	140.06	147.06	233.90	44.75	46.99	**1,219.13**	3.33	10.59	20.44	28.14	33.23	44.40	57.63	72.89	46.39	65.81	**382.84**	**1,601.97**
4	AMAL MURAIDIH PHULARITAND PART	00150100012014							-	608.79	406.75	372.91	**1,388.45**							-	4.53	19.91	33.68	**58.12**	**1,446.57**
5	MADHUBAND UG MINE	469403800000280							227.89	12.65	17.77	-	**258.31**							0.07	12.21	13.55	14.77	**40.59**	**298.90**
	TOTAL		**565.01**	**593.26**	**622.92**	**654.07**	**686.77**	**721.12**	**374.95**	**855.35**	**469.27**	**419.91**	**5,962.62**	**13.63**	**54.72**	**105.16**	**144.62**	**168.81**	**224.68**	**296.03**	**322.72**	**192.40**	**267.32**	**1,790.09**	**7,752.72**
6	AMAL BLOCK II MINE	00150100009044	207.40	217.77	228.65	240.09	252.09	264.70	199.23	227.86	319.32	274.09	**2,431.19**	-	19.60	38.28	60.00	60.50	79.34	108.44	120.70	68.87	99.16	**654.89**	**3,086.08**
	TOTAL		**207.40**	**217.77**	**228.65**	**240.09**	**252.09**	**264.70**	**199.23**	**227.86**	**319.32**	**274.09**	**2,431.19**	**-**	**19.60**	**38.28**	**60.00**	**60.50**	**79.34**	**108.44**	**120.70**	**68.87**	**99.16**	**654.89**	**3,086.08**
8	MAHESHPUR COLLIERY	00150100008836	38.40	15.84	16.63	17.46	18.34	19.25	20.22	21.23	22.29	23.40	**213.06**	1.46	3.73	5.09	5.47	6.46	8.18	10.16	12.47	7.36	9.14	**69.51**	**282.57**
9	KHARKHAREE COLLIERY	00150100008824	16.02	16.82	17.66	18.54	19.47	20.44	21.46	22.53	23.66	24.84	**201.44**	0.61	1.56	3.00	3.75	4.84	6.49	8.40	10.62	8.61	9.43	**57.31**	**258.75**
10	JOGIDIH COLLIERY	00150100008823	39.85	8.58	9.01	9.46	9.94	10.43	10.96	11.50	12.08	12.68	**134.49**	1.52	3.87	4.61	4.55	5.05	6.12	7.34	8.77	6.79	8.44	**57.06**	**191.55**
11	GOVINDPUR UG	00150100008835	20.58	21.61	22.68	23.82	25.01	26.26	27.58	28.96	30.40	31.93	**258.83**	0.78	2.00	3.85	4.82	6.21	8.34	10.79	13.65	8.24	10.44	**69.12**	**327.95**
12	BLOCK IV /KOORIDIH MINE	00150100008834	100.83	105.87	111.16	116.72	122.56	128.68	135.12	141.88	148.97	156.42	**1,268.21**	3.84	9.80	18.85	23.62	30.45	40.85	52.86	60.69	34.82	56.62	**332.40**	**1,600.61**
13	NAKC	00150100008831	60.59	63.62	66.80	70.14	73.65	77.34	81.19	85.26	89.52	94.00	**762.11**	2.31	5.89	11.33	14.19	18.30	24.55	31.77	36.47	20.93	26.94	**192.66**	**954.77**
	TOTAL		**276.27**	**232.34**	**243.94**	**256.14**	**268.97**	**282.40**	**296.53**	**311.36**	**326.92**	**343.27**	**2,838.14**	**10.51**	**26.85**	**46.72**	**56.41**	**71.30**	**94.51**	**121.31**	**142.67**	**86.75**	**121.00**	**778.05**	**3,616.19**
14	AKWMC	00150100009051	189.04	198.50	208.42	218.84	133.38	140.05	147.05	154.40	162.12	170.23	**1,722.03**	-	17.87	34.89	54.69	55.14	66.54	85.62	93.34	52.38	72.24	**532.72**	**2,254.74**
15	AARC	00150100009053	51.05	19.48	20.45	21.48	97.27	102.13	107.24	112.60	118.23	124.14	**774.05**	-	4.82	6.48	8.62	7.47	14.42	23.00	32.32	20.43	30.35	**147.91**	**921.95**
16	SALANPUR UG MINE	00150100009050	84.13	20.08	21.09	22.14	44.47	46.69	49.02	51.47	54.05	15.46	**408.60**	-	7.95	9.65	12.05	10.61	13.91	19.03	24.10	14.17	19.92	**131.40**	**540.00**
17	KATRAS CHAITUDIH	00150100010086	-	82.12	86.23	90.54	114.64	120.37	126.39	132.71	-	207.08	**960.07**	-	-	6.09	14.12	22.62	33.77	37.45	49.05	30.03	38.27	**231.38**	**1,191.45**
18	GASLITAND COLLIERY	00150100011048	-	-	-	-	99.98	104.98	110.22	115.74	121.52	127.60	**680.03**	-	-	-	-	0.02	5.77	13.71	22.62	15.48	24.79	**82.39**	**762.43**
	TOTAL		**324.22**	**320.18**	**336.19**	**352.99**	**489.73**	**514.21**	**539.92**	**566.92**	**455.92**	**644.51**	**4,544.77**	**-**	**30.64**	**57.12**	**89.48**	**95.85**	**134.40**	**178.81**	**221.43**	**132.48**	**185.58**	**1,125.80**	**5,670.57**
19	NICHITPUR COLLIERY	00150100008825	99.66	104.64	109.88	115.37	121.14	127.20	133.56	67.81	71.20	74.76	**1,025.22**	3.79	9.68	18.64	23.35	30.09	40.37	52.25	63.18	35.46	51.74	**328.55**	**1,353.77**
20	TETULMARI COLLIERY	00150100008833	129.16	135.62	142.40	149.52	156.99	164.84	173.09	181.74	190.83	200.37	**1,624.56**	4.91	12.55	24.15	30.26	39.00	52.32	67.71	80.28	48.32	77.84	**437.36**	**2,061.92**
21	SENDRA BANSJORA COLLIERY	00150100008832	52.96	55.61	58.39	61.31	63.51	66.69	70.02	73.52	77.20	81.06	**660.27**	2.02	5.15	9.90	12.41	15.99	21.40	27.65	30.81	18.46	23.70	**167.49**	**827.76**
22	MUDIDIH COLLIERY	00150100008829	118.24	124.15	130.36	136.87	143.72	150.90	158.45	166.37	174.69	4.29	**1,308.04**	4.50	11.49	22.11	27.70	35.70	47.90	61.99	78.43	47.37	75.65	**412.84**	**1,720.88**
23	LOYABAD COLLIERY	00150100008826	83.75	19.73	20.72	21.75	22.84	23.98	25.18	26.44	27.76	29.15	**301.30**	3.19	8.14	9.82	9.80	10.98	13.37	16.12	19.33	11.19	13.67	**115.60**	**416.90**
24	KANKANEE COLLIERY	00150100010973	-	-	-	-	161.44	169.51	177.99	186.88	196.23	206.04	**1,098.09**	-	-	-	-	0.02	9.59	22.16	36.10	25.21	41.11	**134.20**	**1,232.29**
25	BANSDEOPUR COLLIERY	00150100011831							125.28	91.36	95.93	100.73	**413.29**							0.02	7.20	12.57	18.96	**38.75**	**452.04**
	TOTAL		**483.77**	**439.75**	**461.75**	**484.82**	**669.64**	**703.12**	**863.56**	**794.12**	**833.84**	**696.40**	**6,430.77**	**18.41**	**47.01**	**84.63**	**103.51**	**131.79**	**184.96**	**247.90**	**315.33**	**198.58**	**302.66**	**1,634.79**	**8,065.56**
26	KUSUNDA OCP	00150100008870	103.82	109.01	114.46	120.18	126.19	132.50	139.13	146.08	153.39	161.06	**1,305.83**	3.15	10.01	19.34	26.62	31.43	42.01	54.52	68.96	41.43	63.79	**361.26**	**1,667.09**
27	EAST BASSURIYA OC	00150100008876	48.31	50.72	53.26	55.92	58.72	61.65	64.73	67.97	71.37	74.94	**607.58**	1.47	4.66	9.00	12.39	14.63	19.54	25.37	32.09	19.27	24.31	**162.72**	**770.30**
28	DHANSAR(ADIC)	00150100008939	92.02	96.62	101.45	106.52	111.85	49.21	46.36	48.68	51.11	53.67	**757.50**	1.40	8.80	17.11	24.60	27.68	35.75	43.74	50.99	28.25	37.47	**275.77**	**1,033.26**
29	GODHUR GRP OF MINES	00150100009048	55.23	57.99	60.89	63.94	67.13	70.49	74.01	77.72	81.60	85.68	**694.69**	-	5.22	10.19	15.98	15.98	21.12	28.87	37.01	21.49	30.23	**186.10**	**880.79**
30	BASSURIYA UG MINE	00150100008944	151.88	5.91	6.21	6.52	6.85	7.19	7.55	7.92	8.32	8.74	**217.08**	2.30	14.52	15.03	15.18	13.60	14.47	16.87	18.98	10.18	13.10	**134.23**	**351.31**
31	GONDUDIH/KHAS KUSUNDA OC	00150100008875	134.40	141.12	148.18	155.59	163.37	171.53	180.11	189.12	198.57	208.50	**1,690.48**	4.08	12.96	25.04	34.46	40.69	54.38	70.58	89.28	53.63	82.58	**467.68**	**2,158.16**
32	ENA OCP	00150100008938	47.67	50.05	52.55	55.18	57.94	62.08	65.19	68.45	71.87	75.46	**606.43**	0.72	4.56	8.86	12.74	14.34	18.52	25.04	31.76	18.86	26.52	**161.92**	**768.35**
	TOTAL		**633.33**	**511.43**	**537.00**	**563.85**	**592.04**	**554.66**	**577.08**	**605.94**	**636.23**	**668.04**	**5,879.60**	**13.11**	**60.73**	**104.57**	**141.97**	**158.35**	**205.79**	**264.99**	**329.07**	**193.10**	**277.99**	**1,749.67**	**7,629.26**
33	PB GRP OF MINES	00150100009045	84.91	34.30	36.02	37.82	39.71	41.70	43.78	45.97	48.27	50.68	**463.15**	-	8.03	10.95	14.69	13.58	16.77	22.00	27.01	15.49	21.38	**149.89**	**613.03**
34	BURRAGARH UG	00150100008821	6.67	7.00	7.35	7.72	8.11	8.51	8.94	9.38	9.85	10.35	**83.88**	0.25	0.65	1.25	1.56	2.01	2.64	3.31	4.18	3.56	4.60	**24.03**	**107.91**
35	HURRLADIH UG	00150100008820	8.49	7.22	7.58	7.96	8.35	8.77	9.21	9.67	10.16	10.66	**88.07**	0.32	0.83	1.44	1.56	2.20	2.85	3.55	4.46	3.79	4.87	**25.87**	**113.94**
36	BHUTGORIA UG	00150100008818	7.43	7.80	8.19	8.60	9.03	9.48	9.95	10.45	10.97	11.52	**93.42**	0.28	0.72	1.39	1.74	2.24	2.94	3.69	4.66	3.97	5.13	**26.77**	**120.19**
37	GOPALICHOK UG	00150100008819	75.49	11.06	11.61	12.19	-	-	-	-	-	-	**110.35**	2.87	7.34	8.28	7.86	8.48	9.21	10.03	10.99	7.85	9.07	**81.99**	**192.34**
38	GOPALICHOK MINE	00150100010972	-	-	-	-	61.76	64.85	68.09	71.49	75.07	78.82	**420.08**	-	-	-	-	0.01	3.67	8.48	13.81	9.64	13.50	**49.12**	**469.20**
39	KENDWADIH OC MINE	00150100011209						56.76	59.59	62.57	65.70	68.99	**313.61**						0.02	3.49	7.59	9.59	15.00	**35.70**	**349.31**
	TOTAL		**182.99**	**67.38**	**70.75**	**74.29**	**126.96**	**190.06**	**199.56**	**209.54**	**220.02**	**231.02**	**1,572.56**	**3.73**	**17.56**	**23.31**	**27.42**	**28.52**	**38.10**	**54.56**	**72.70**	**53.90**	**73.56**	**393.35**	**1,965.91**
40	BASTACOLLA COLLIERY	00150100008877	20.63	21.67	22.75	23.89	25.08	26.33	27.65	144.06	176.27	212.19	**700.50**	0.63	1.99	3.84	5.29	6.25	8.35	10.84	13.71	12.09	20.02	**82.99**	**783.49**
41	BERA COLLIERY	00150100008873	48.69	51.13	53.69	56.37	20.92	21.97	23.06	-	-	-	**275.83**	1.48	4.83	9.08	12.50	14.75	17.29	20.32	22.56	11.66	12.33	**126.81**	**402.63**

Deposit in Escrow Accounts with Bank of Baroda/Union Bank of India

Rs. In lakhs

Sr No	ESCROW ACCOUNT AT BOB	A/C No	Deposit											Interest										G Total
			2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	Total	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	Total	
42	DOBARI COLLIERY	00150100008935	5.50	5.78	172.22	180.83	189.87	99.88	155.83	163.62	180.26	-	**1,153.77**	0.08	0.53	1.02	14.83	22.69	36.07	47.41	54.07	32.84	50.19	**259.75**	**1,413.52**
43	GANHOODIH OCP	00150100008936	78.35	82.27	86.38	90.70	95.23	99.99	104.99	-	-	-	**637.91**	1.19	7.49	14.57	20.94	23.57	30.44	41.03	46.01	23.05	28.91	**237.18**	**875.09**
44	SIMLABAHAL COLLIERY	00150100008822	11.27	8.42	8.84	9.28	9.75	364.76	127.50	133.87	140.57	147.59	**961.85**	0.43	1.10	1.82	2.15	2.69	3.54	27.57	38.67	25.11	33.53	**136.60**	**1,098.45**
45	KUYA GRP OF MINES	00150100008874	165.03	173.29	181.95	191.05	200.60	138.22	145.13	152.38	160.00	472.29	**1,979.94**	5.01	15.92	30.74	42.32	49.97	66.77	81.95	94.48	54.65	82.42	**524.22**	**2,504.16**
46	RAJAPUR S/JHARIA OCP	00150100008937	73.81	77.50	81.37	85.44	89.72	94.20	150.17	175.24	231.15	204.37	**1,262.97**	1.12	7.05	13.73	19.73	22.20	28.68	38.66	46.46	29.10	47.52	**254.24**	**1,517.21**
	TOTAL		**403.29**	**420.04**	**607.19**	**637.55**	**631.16**	**845.35**	**734.33**	**769.17**	**888.24**	**1,036.44**	**6,972.77**	**9.93**	**38.92**	**74.80**	**117.76**	**142.11**	**191.14**	**267.77**	**315.95**	**188.49**	**274.92**	**1,621.79**	**8,594.55**
47	NT-ST-JEENAGORA GRP OF MINES	00150100009046	387.56	406.94	427.29	448.65	471.09	494.64	519.37	545.34	572.61	601.24	**4,874.72**	-	36.63	71.53	112.12	113.05	148.26	202.67	222.21	129.54	185.47	**1,221.48**	**6,096.20**
48	JOYRAMPUR UG MINE	00150100009049	18.86	6.75	7.09	7.45	-	-	-	-	-	-	**40.15**	-	1.78	2.36	3.11	2.84	3.01	3.28	3.59	2.69	2.89	**25.55**	**65.70**
49	BARAREE COLLIERY	00150100008940	163.59	25.04	26.29	27.60	-	-	-	-	-	-	**242.52**	2.48	15.64	17.79	19.44	18.55	19.24	21.81	23.89	12.48	15.65	**166.97**	**409.49**
50	LODNA COLLIERY	00150100008942	61.64	17.80	18.69	19.62	-	-	-	-	-	-	**117.75**	0.93	5.89	7.42	8.71	8.74	9.09	10.30	11.28	8.06	9.04	**79.47**	**197.22**
51	KUJAMA COLLIERY	00150100008941	45.50	47.77	50.16	52.67	55.30	58.06	60.97	64.02	67.22	70.58	**572.23**	0.69	4.35	8.46	12.16	13.68	17.68	23.82	30.14	17.87	25.09	**153.95**	**726.17**
52	AMALGAMATED JOYRAMPUR OC	00150100011026	-	-	-	-	560.98	585.04	614.29	645.01	677.26	711.12	**3,793.70**	-	-	-	-	0.09	36.92	76.97	125.13	86.33	133.74	**459.19**	**4,252.88**
	TOTAL		**677.15**	**504.30**	**529.52**	**555.99**	**1,087.36**	**1,137.74**	**1,194.63**	**1,254.36**	**1,317.08**	**1,382.94**	**9,641.07**	**4.11**	**64.29**	**107.56**	**155.54**	**156.95**	**234.18**	**338.86**	**416.24**	**256.97**	**371.89**	**2,106.59**	**11,747.66**
53	SUDAMDIH INC MINES	00150100008872	64.31	5.33	5.59	5.87	6.17	6.48	-	-	-	-	**93.74**	1.95	6.20	6.66	6.66	6.36	7.28	8.37	9.17	6.55	7.45	**66.66**	**160.40**
54	BHOWRA(N) GRP OF MINES	00150100008868	136.22	143.03	150.18	6.88	7.23	7.59	7.97	73.21	-	4.80	**537.08**	4.13	13.14	25.37	34.93	31.88	34.97	38.70	35.25	19.93	18.62	**256.93**	**794.01**
55	BHOWRA(S) GRP OF MINES	00150100008830	563.49	211.98	87.57	91.95	96.55	40.85	190.13	124.22	130.43	136.95	**1,674.12**	21.44	54.76	72.88	68.24	72.74	85.13	95.39	107.17	59.00	83.32	**720.06**	**2,394.18**
56	PATHERDIH GRP OF MINES	00150100008871	57.22	60.08	63.09	66.24	69.55	73.03	-	-	-	-	**389.22**	1.74	5.52	10.66	14.67	17.33	23.15	30.04	32.90	17.42	19.64	**173.06**	**562.28**
57	AMALGAMATED SUDAMDIH PATHERDIH	00150100011524						-	13.60	50.08	52.58	55.21	**171.47**						-	0.00	0.86	3.94	5.67	**10.47**	**181.94**
58	SUDAMDIH SHAFT MINES	00150100011673							174.22	-	-	-	**174.22**							0.03	10.60	10.95	10.29	**31.87**	**206.09**
	TOTAL		**821.23**	**420.42**	**306.43**	**170.95**	**179.50**	**127.94**	**385.92**	**247.51**	**183.01**	**196.96**	**3,039.86**	**29.26**	**79.62**	**115.57**	**124.50**	**128.31**	**150.53**	**172.52**	**195.95**	**117.80**	**144.99**	**1,259.05**	**4,298.90**
59	MOONIDIH UG PROJECT	00150100008943	82.18	86.29	90.60	95.13	99.89	104.88	54.44	85.69	89.97	94.47	**883.55**	1.25	7.85	15.28	22.33	24.35	31.93	43.02	48.32	27.51	36.35	**258.19**	**1,141.74**
60	MURLIDIH 20/21 PIT COLLIERY	00150100009047	31.41	32.98	34.63	36.36	38.18	40.09	42.09	44.20	46.41	48.73	**395.07**	-	2.97	5.80	9.09	9.16	12.02	16.43	20.79	12.21	17.18	**105.64**	**500.72**
61	LOHAPATTY COLLIERY	00150100009043	267.70	281.08	140.03	147.03	154.38	162.10	170.21	178.72	187.65	197.04	**1,885.93**	-	25.30	49.41	64.37	59.75	76.88	90.27	109.53	64.17	88.06	**627.73**	**2,513.66**
	TOTAL		**381.28**	**400.35**	**265.26**	**278.53**	**292.45**	**307.07**	**266.74**	**308.60**	**324.03**	**340.23**	**3,164.55**	**1.25**	**36.13**	**70.48**	**95.78**	**93.27**	**120.82**	**149.72**	**178.63**	**103.89**	**141.60**	**991.57**	**4,156.12**
62	BASANTIMATA COLLIERY	00150100008827	121.88	28.90	30.34	31.86	33.45	35.12	36.88	38.72	40.66	42.69	**440.50**	4.64	12.02	14.33	14.30	16.02	19.53	23.55	28.25	16.35	19.97	**168.95**	**609.45**
63	DAHIBARI BASANTIMATA OCP	00150100008828	128.57	135.00	141.75	148.84	156.28	164.09	172.30	180.91	189.96	199.46	**1,617.16**	4.89	12.49	24.04	30.12	38.82	52.09	67.41	73.91	44.29	72.04	**420.10**	**2,037.26**
64	KALYANESHWARI GRP OF MINES	00150100009042	209.61	220.09	231.09	242.65	254.78	234.28	246.00	458.54	481.46	505.54	**3,084.03**	-	19.79	38.68	60.64	60.69	80.16	107.41	117.37	71.96	97.62	**654.31**	**3,738.35**
65	BEGUNIA COLLIERY	00150100011365					-	110.92	-	-	-	-	**110.92**						0.04	6.80	7.47	6.91	6.47	**27.70**	**138.62**
	TOTAL		**460.06**	**383.99**	**403.18**	**423.35**	**444.51**	**544.42**	**455.18**	**678.17**	**712.08**	**747.69**	**5,252.62**	**9.53**	**44.30**	**77.05**	**105.06**	**115.54**	**151.81**	**205.17**	**227.00**	**139.51**	**196.10**	**1,271.06**	**6,523.68**
	GRAND TOTAL		**5,416.00**	**4,511.20**	**4,612.78**	**4,692.61**	**5,721.18**	**6,192.78**	**6,087.63**	**6,828.89**	**6,685.96**	**6,981.49**	**57,730.50**	**113.47**	**520.36**	**905.26**	**1,222.04**	**1,351.30**	**1,810.27**	**2,406.08**	**2,858.39**	**1,732.75**	**2,456.77**	**15,376.70**	**73,107.20**

Note: In 2018-19, the amount deposited in Dobari Colliery is difference of amount provided in MCP approved in Board in Feb 2018 and amount deposited upto March 2018 as per MCP approved in July 2015.

Item No. 351.3D

Quarterly Review for the Quarter October to December, 2018 & January to March, 2019 on Safety, Environment & Quality as per the directive of MoC letter no. 23/3/2015-ASO/BA dated 26.04.2017.

Board reviewed the quarterly report of **October to December 2018** and **January to March 2019** on Safety, Environment & Quality as per the directive of MoC letter no. 23/3/2015-ASO/BA dated 26.04.2017.

Item No. 351.4G
Corporate Environment Policy (CEP) of Bharat Coking Coal Limited.

Background

Coal India Ltd. had brought out its Corporate Environment Policy (CEP) in 2012 Based on CIL Environment Policy 2012, incorporating the Jharia Master Plan, CEP of BCCL was approved by 285th BCCL board on 21.04.2012 (ANNEXURE C of the agenda note). As per the provisions of the policy, it is to be revised every 05 years as per which the policy would have been revised in 2017. However, there was delay in revising the policy at CIL's end due to which there is a delay in revising BCCL's CEP. CIL has revised its Corporate Environment Policy and approved in its 377th CIL Board Meeting dated 20th Dec., 2018(ANNEXURE D of the agenda note).

The CAG during its exit meeting held on 16.11.2018 also pointed out for the need of revising BCCL's Corporate Environment Policy adopted in 2012(ANNEXURE E of the agenda note). Modifying CIL's CEP to suit BCCL's prevailing conditions, the Corporate Environment Policy of BCCL has been revised.

Two versions of Policy was attached herewith out of which any one may be approved as deemed suitable by the Board.

a. An abridged version of the policy as adopted earlier by BCCL in 2012. (ANNEXURE A of the agenda note)
b. A detailed version of the policy similar to the CEP, 2018 of CIL with modifications suited to BCCL's condition. (ANNEXURE B of the agenda note)

Decision:
After detailed deliberation the Corporate Environment Policy, 2018 of CIL was approved by the Board.

Board further directed that the Policy as adopted above to suit the conditions in BCCL should be modified with information to Coal India.

Certified to be True Copy

B. K. Parul
Company Secretary
Bharat Coking Coal Limited
Koyla Bhawan
005

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ENVIRONMENTAL POLICY STATEMENT:

Bharat Coking Coal Limited (BCCL) is committed to promote sustainable development 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 best practices.

OBJECTIVES:

Bharat Coking Coal Limited shall endeavour to:
1. Plan & design projects with due consideration to environmental concerns for Sustainable Development.
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 of surrounding habitation by continuous monitoring and adopting suitable measures for environment protection.
4. Implement Environment Management Plans in all our mines /projects/Clusters effectively to mitigate pollution, conservation of natural resources and restoration of ecology & biodiversity.
5. Ensure compliance of all applicable Environmental Clearance& Forestry Clearance conditions and other statutory conditions issued by regulatory agencies.
6. Recycling of wastes on the principle of REDUCE, REUSE and RECYCLE.
7. Put special thrusts on efficient energy utilization / renewable energy as a measure to reduce carbon foot-print.
8. Strive for continual improvement in our environmental performances by setting targets, measuring progress and taking corrective action.
9. Taking measures to render productive post mining land use.
10. Implementation of activities applicable to BCCL arising out of International Conventions.
11. Create environmental awareness among the employees and the local communities through pro-active communication and training

STRATEGIES FOR IMPLEMENTATION OF ENVIRONMENTAL POLICY:

BackGround:

Bharat Coking Coal Limited subscribes to the view of Sustainable Development. Unless theenvironment can sustain all the developmental activities, any pursuit of developmentin isolation can cause irreparable damage to the ecosystem and associatedenvironmental attributes. Keeping this view in mind, Bharat Coking Coal Limited attaches toppriority towards sustainable development and approved its ‘Corporate EnvironmentalPolicy’. Based on CIL Environment Policy2012,incorporating theJharia Master Plan ,CEP of BCCL was approved by 285th BCCL board on 21.04.2012and is complimentary to theNational Environmental Policy, 2006.The Revised BCCL Policy, 2019 is the outcome of the experience gained since2012, keeping in view the modifications / amendments made time to time inenvironmental policies and additional stipulation notified by MoEF&CC (Ministry of Environment, Forest& Climate Change), and other organisations concerning mineclosure, reclamation of degraded land, environmental clearance etc. and also with theobjective of revisiting the corporate policy.The Policy has a vision of Green Mining and mission of 100% compliance of environmental statutes applicable to coal mining industry.This policy is prepared in line with that of CIL’s

policy with incorporation of prevailing local conditions.

STRATEGIES: Bharat Coking Coal Limited adopts the strategies appended below for effective implementation:

1. MINE/ PROJECT PLANNING & DESIGN FOR SUSTAINABLE DEVELOPMENT:

a) Coal being a non-renewal energy source, extraction shall be planned prudently tomeet national requirement in a planned way. The projects shall be designed on theprinciple of Sustainable Development with due consideration to environment, mine closure,safety and aspirations of the stakeholders at the planning& designstage itself with due regard to mine closure plan.

b) While preparing the Mining plan/project reports, the effort shall be to incorporatelatest mining technologies and equipment's with optimal capacity, which are moreenvironment friendly

c) All Mining Plan/ project reports will be provided with detailed provisions for ensuring environmental compliances

2. ENVIRONMENTAL IMPACT ASSESSMENT (EIA) & ENVIRONMENT MANAGEMENT PLAN (EMP)

a. All mine planning and design shall be environmentally acceptable and operationshall be carried out in such a way as to facilitate the compliance of stipulated environmentalstandards.
b. EIA& EMP for all projects/Clusters shall be formulated as per the approved ToR (Termsof Reference) and pubic consultations for obtaining Environmental Clearance (EC) from MoEF&CC. Similarly, in the existing projects needing enhancementof production capacities with or without increase in land, change of technology,renewal of lease and change in land use etc. fresh EC is required to be sought asper norms. The projects shall be operated after obtaining Consent to Establish(CTE)/Consent to Operate (CTO) from State Pollution Control Boards (SPCB).
c. Detailed Mine Closure Plans shall be prepared for all existing and new mines as per the MoC (Ministry of Coal) guidelines.

3. COMPLIANCE OF THE STATUTORY REQUIREMENTS:

The implementation of EMP and fulfilment of all other statutory requirements like conditions of EC, FC and consents to establish & operate, including timely submission of returns to statutory bodies and various agencies, are to be ensured at all levels.

4. MEASURES TO MITIGATE POLLUTION:

a) Air Pollution:

i) Generation of dust is to be controlled at the source to the possible extent with necessary control measures during drilling, blasting, loading, unloading, CHPtransfer points etc
ii)Deployment of eco-friendly mining technologies.
iii) Dust generation is to be minimized along coal / waste transportation routes.
iv)Mechanized transportation of coal to be encouraged.
v) Green belt is to be created around the source of dust

b) Water pollution:

i) The mine water and other effluent shall be treated to ensure the discharge normsas per statute. The treated effluent shall be utilized to the extent possible with aview to achieve

maximum water conservation.
ii) Oil & grease from the effluent shall be removed by Oil & Grease Traps forproper disposal.

c) Noise / ground vibration:

i) All measures to minimize noise pollution will be taken including maintenance of HEMM, equipment and provision of PPE where required.
ii) Suitable blasting techniques shall be followed to reduce ground vibration as well as noise pollution.

d)Land reclamation:

i) Progressive and concurrent reclamation of mined out areas will be carried out as per approved EIA/EMP and Mine Closure Plan (MCP).
ii) Slopes of external dumps are the important area to be suitably graded / terraced for effective reclamation and plantation.
iii) Preservation of top soil is required for future use. Old as well as existing nonactive dumps are to be technically and biologically reclaimed.
iv) Monitoring of reclamation work of all opencast mines will be done through Satellite Surveillance. The outcome shall be put in the websites.

e) Mine closure plans:

Mine Closure Plan (MCP) shall be prepared for each mineon which Mine closure guidelines are applicable. MCP are being delineated in two phases viz. progressive and final mine closure. Appropriate funds are set aside and deposited under a special Escrow fund every year as per MoC guidelines, to be utilized for proper and final mine closure.
For mines closed prior to issuance of MoC guidelines (i.e. 27th August, 2009) suitable action to be taken as per provisions of Mines Act 1952.

f) Mine fire& subsidence

BCCL shall endeavour to reduce occurrence of mine fire and subsidence due to mining activityfor safety and conservation purpose and, shall take steps for prevention and control of coal mine fire. Monthly report shall be submitted to top management of thesubsidiary and CIL and Quarterly to company board. Action Plan for mine fire control shall be implemented. Monitoring will be done through Satellite Surveillance/other suitable technology. Rehabilitation under Master Plan will be expedited to facilitate faster liquidation of fire. During the execution of the Master Plan since 2009, changes have occurred in the fire dealing methodology, the number of affected families and the infrastructure facilities to be provided to them. However, these modifications were executed in cognizance of HPCC committee for JMP.
BCCL is committed for implementation of the GOI approved Master Plan for Dealing with Fire, Subsidence and Rehabilitation in leasehold of BCCL (Jharia Master Plan) which is also required to be dovetailed with the implementation of EC conditions of various clusters of BCCL . Necessary steps shall be taken for implementation of Jharia master plan to deal with the problem of fire and subsidence in JCF along with R&R of affected people.

g) Monitoring:

I. All receptors in and around the mining projects/clusters all be monitored regularly to assess the efficacy of the pollution control / mitigation measures within stipulated standards.
II. Effect of mining on the hydrology of the area will be monitored through measurement of water level and quality of nearby wells and bore holes provided for this purpose. Conservation of water through rainwater harvesting shall be taken up.
III. Area and Unit environmental cells shall have regular interaction with the people in and around the coal mines and other allied units on matters related to environment to take necessary and timely corrective actions.
V. Environmental initiatives and monitoring through self and third party environment audit shall be conducted for generating useful data for taking corrective actions and mitigation measures as per guidelines.

h) Other measures:

I. Special emphasis shall be given to undertake R&D related to various facets of coal mine environmental management in collaboration with Central Mine Planning and Design Institute (CMPDI) and other competent institutions.

II. Besides ensuring statutory compliance, the BCCL desires to set high standards and continual improvement.

III. Mines & establishments shall be ISO 14001certified in phased manner.

IV. CSR and R&R policies of CIL are to be incorporated by BCCL for better planning and implementation of the socio-economic issues of coal mining areas.

V. The coal mining environmental issues are complex and require multidisciplinary approach to address the same. BCCL will endeavour to enter into MoUs with expert agencies of repute to assist in environment issues and also help in capacity building of BCCL executives.

VI. BCCL conduct periodical medical examination (PME) of its work force on routine basis in compliance of the requirement mining rules and regulation,
additional test will be done as and when require.

5. PRESERVATION OF BIO-DIVERSITY:

BCCL has made the ecological restoration a flagship programme for restoration of degraded mined areas and adopting 3- tier plantation consisting of native species grasses, bushes and trees under the technical expertise of Forest research institute, Dehradun, a renowned institute in the field of forests and ecology. Ecological restoration has been widely accepted as one of the most effective means to restore the ecology and biodiversity.

BCCL is committed towards the conservation and restoration of the natural biodiversity of the region on the degraded mined out areas and restore back to forest like areas. BCCL will strive to restore the habitats for the native fauna of the region by restoring the areas through ecological restoration.

BCCL is committed towards the wellbeing and betterment of the living standards for the local community through establishment of the eco-parks in the reclaimed mined areas in the coalfield and promoting the eco-mining tourism in the coalfield areas and exploring the new opportunities to the local communities. This will start from mine planning including technically and biologically reclamation of mined out areas in collaboration with State Forest Departments, Wild Life Divisions, NGOs, FRI Dehradun etc. working in the fields of biodiversity conservation.

6. COAL BENEFICIATION / COALWASHERIES:

a) For beneficiation of Runoff Mines (ROM) coal, washeries are being set up in a phased manner as per requirement and statutes.

b) Slurry Management System (SMS) in all washeries shall be organized to ensure collection of fines, gainful utilization of rejects viz. power generation in Fluidized Bed Combustion (FBC) plants, selling to brick manufacturers or adopting other environmental friendly disposal options as feasible.

c) The reject dumps and tailings shall be suitably handled to avoid any contamination.

d) The effluent from washeries including tailings pond shall be suitably treated and reused to minimize water consumption with zero discharge concept.

7. CONSERVATION AND CLEAN TECHNOLOGY:

a) R&D projects shall be taken up to promote clean coal technology and improve the existing technologies.

b) Energy saved is energy produced. Voluntary energy audit to be done for corrective action to reduce carbon footprint.

c) Clean Development Mechanisms will be explored for reducing emission of Green House Gases by exploration, identification, preparation of projects reports for extraction of methane from Coal Bed, Coal Mine, Abandoned Mine, Ventilation Air, UG Coal Gasification, generation and utilization of renewable energy etc.

8. AWARENESS PROGRAMME:

a) Publicity to generate awareness through exchange & communication of information, newsletters and periodicals on environment, seminars, workshops, celebration of

World Environment Day etc, at BCCL HQ, Areas & units to be undertaken. Regular training programs to be organized at various levels to inculcate awareness among employees.
b) Courses on environmental and forestry laws and Environmental Protection Measures and the Corporate Policy to be organized for project executives for improving knowledge.
c) BCCL will felicitate its workers for best practices in eco-restoration, land reclamation, conservation, compliance of statutes and innovative ways of sustaining environment.

9. WASTE MANAGEMENT:

BCCL will undertake appropriate action for safe handling, storage and disposal of solid waste and hazardous waste generated from its industrial set up and colonies as per relevant rules. The biomedical waste generated from hospitals and dispensaries will be collected and disposed in appropriate facilities created as per statutes. E-waste management and handling of various types of e-waste generatedin its operations will be done as per rule.

10. CORPORATE ENVIRONMENT RESPONSIBILITY:

Corporate Environment Responsibility (CER) is mandatory for issuing environmental clearance for all the Greenfield and Brownfield projects as per directives of MoEFCC with effect from 1st May, 2018 (O.M.No.22-65/2017- IAIII dt. 19.06.2018). Budgetary provisions should be kept for implementation of provisions of CER for all the projects which will be submitted to MoEFCC for grant of environmental clearance.

11. INCORPORATION OF VIEWS OF STAKEHOLDERS:

BCCL will critically examine and incorporate the viewpoints of various stakeholders like PAPs/PAFs, Parliamentary Committees, Standing Sub-Committees, NGOs etc.

12.IMPLEMENTATION OF POLICY:

i) Manpower: BCCL shall have environmental divisions at decision making & operational levels in its structure. The environment department shall be set up and strengthened at:
i)BCCL HQ
ii)Areas / Units / Collieries / Workshops /Washeries

ii) Roles and Responsibilities: The environmental department, set up at company HQs, Areas and Unit levels with appropriate manpower and resources, shall be responsible for implementation of policy, obtaining EC, FC, consent to establish & operate, statutes requirements and undertaking mitigation measures besides preparation of action plan every year and also to intimate the status of implementation to the management regularly.

iii) Annual Environment Budget (Revenue &Capital): The Annual Environment Budget (revenue & capital) shall be prepared based on the action plan including monitoring of various bench marks and the budget utilization. The year wise funds earmarked for environmental protection measures shall be kept in separate accounts with Environmental cost code.

REVIEW OF ENVIRONMENTAL POLICY:

In view of the present fast changing social, economic and environmental scenario, the CIL 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, the CILCorporate Environmental Policy would be reviewed and suitably revised. It will be followed by revision of this policy accordingly.

Place: Dhanbad **Chairman-cum-Managing Director**
Date:







भारत कोकिंग कोल लिमिटेड
(कोल इण्डिया लिमिटेड का एक अंग)
ऐक मिनीरतन कम्पनी
क्षेत्र संख्या– 3

Bharat Coking Coal Limited
(A Subsidiary of Coal India Limited)
A Miniratna Company
Govindpur Area No. III
OFFICE OF THE GENERAL MANAGER
PO- Sonardih, DHANBAD – 828125
Contact No: 0326-2392162
Email-gmgovindpur.bccl@coalindia.in
CIN : U10101JH1972GOI000918

Ref. No.: BCCL/Ar.III/Envt/2023-24/103 **Date: 28.09.2023**

To
The Regional Engineer/Officer,
Jharkhand State Pollution Control Board,
Sardar Patel Nagar, Dhanbad.

Subject: Submission of Environment Statement along with Ambient Air & Water Analysis Report (in photocopies) in Form –V of Cluster-XV group of mines under Govindpur Area for the financial year 2022-23.

Dear Sir,

Enclosed please find herewith the environment statement for the financial year 2022-23 of Cluster-XV group of mines under Govindpur Area of M/s BCCL.

Enclosure: -

1. Copy of Water Analysis Report& Ambient Air Report.
2. Form-V.

Yours faithfully

28/09/23
Area Manager (Env.)
Govindpur Area

Copy to:

1) Member Secretary, JSPCB, Ranchi
2) GM (Min/Env.), Koyla Bhawan, BCCL

FORM – V
(See rule-14)
Environmental statement for the financial year ending the 31st March 2023

PART – A

1. Name of the address of the owner of the industry operation or process : BCCL, Nominated owner
   Shri Uday Kant Kaole, DT (P&P/OP), Koyla Bhawan, Koyla Nagar, Dhanbad (Jharkhand).
2. Industry category : Large Scale
   Primary (STC code)
   Secondary (SIC code)
3. Production capacity (units) : 0.423 MTPA
4. Year of establishment : 1972
5. Date of the last environmental statement submitted : 11/08/2022

PART – B

1. Water & river material consumption
   Water consumption m^3 /d : 3900 KL/day
   Process : 400 KL/day
   Domestic : 3500 KL/day

Name of the products	Process water consumption per unit of product output	
	During the previous financial year	During the current financial year
1	0.12 KL/Te	0.06 KL/Te

2. Raw material consumption

Name of the raw material	Name of the product	Consumption of raw material per unit of out put	
		During the financial year	During the current financial year
		X	X
		X	X

Industry may use cades if disclosing details of raw material would violate contractual obligations, otherwise all industries have to name the raw materials uses.

PART-C

Pollution discharged to environment/unit of output (parameter as specified in the consent issued)

Pollutants	Quantity of pollutions discharged (mass/day)	Concentration of pollutions discharged (mass/day)	Percentage of variation from prescribed standards with reasons
a) Water (As on 06.03..2023)	Total suspended solids -37 PH – 8.02 Oil &grease < 2.0 COD - 24		
b) Air (As on 02.03.2023)	SPM PM 10 – 83 PM 2.5 - 36		
	SO_2 <10		
	NOx 17		

Monitoring Reports Attached

PART-D

Hazardous Wastes
(as specified under hazardous management and Handling Rules 1989)

Hazardous Wastes	Total quantity (Kg/KL)	
	During the previous financial year	During the current financial year
a) From process	Nil	Nil
b) From pollution control facilities	NA	NA

PART-E

Solid Wastes

	Total quantity (Kg)	
	During the previous financial year	During the current financial year
a) From process	Nil	Nil
b) From pollution control facilities	Nil	Nil
c) 1. Quantity recycled or reutilized within the unit. 2.Sold 3.Disposed	Nil	Nil

PART-F

Please specify the characterizations (in terms of composition of quantum) of hazards as well as solid wastes and indicate disposal practice adopted for both these categories of wastes.

For underground mines : NA

For OCP : Nil

PART-G

Impact of the pollution abatement measures taken on conservation of natural resources and on the cost of production.

The abatement measures are undertaken and practiced by which the impact on the atmosphere has been become positive. Due care is taken to conserve the natural resources and protect the environment and all its components.

PART-H

Additional measures/investment proposal for environmental protection including abatement of pollution, prevention of pollution.

1. Water sprinkling: - Regular Water sprinkling is carried out on coal transportation route. - Regular maintenance of roads is carried out.
2. Exhaust of vehicle control: - Coal transport vehicle with valid PUC.

PART-I

Any other particulars for improving the quality of the environment.

1. 450 nos. bamboo gabion plantations have been done along public coal transportation roads.
2. Ambient air & water monitoring is carried out through CMPDIL.
3. Online PM10 analyzer has been installed for regular monitoring of air quality.
4. 01 nos. of Digital Water Level Recorder have been installed for monitoring the ground water level.

Area Manager (Env.)
Govindpur Area

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

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

Test Report for Ambient Air Samples

Month & Year	03/2023	Cluster	Cluster XV			Report No.	RI-II/AIR/2022-23/12
Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)					Date of Issue	29.04.2023
Project	Sadariadih	Sample Ref. No.	REM/BCCL/2023/12	Sampling Method		CMPDI/RI-II/LPM 13 , (IS 5182)	
Date of Sampling	02.03.23	24.03.23	Period of Analysis	01.03.2023	10.04.2023	Zone of Station:	Buffer Zone

Sl. No.	Parameter	Method of Analysis	Observed Values (in µg/m³)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September,2000 (GSR 742 E)	NAAQS, 2009
			1st FN	2nd FN				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	83	90	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	36	44	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	17	18	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

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

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
HOD's Signature

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

---- End of Report ----

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

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

Test Report for Mine Effluent samples

Month & Year	03/2023	Cluster	Cluster XV	Report No.	RI-II/WATER/2022-23/12
Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)			Date of Issue	29.04.2023
Project		Sampling Ref. No.	REM/BCCL/2023/12	Sampling Method	IS 3025 (Part-1) CMPDI/RI-II/LPM 13
Sampling Stations	(i)	Kharkharee UGP	Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent		Period of Analysis 06.04.203 to 17.04.2023

Sl. No.	Parameter	Method of Analysis	Date of Sampling		STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
			Observed Values			
			First Fortnight (06.03.23)	Second Fortnight (20.03.23)		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	37	29	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	8.02	7.99	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<2.0	<2.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	24	20	*250 (Max)*	4

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

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
HOD's Signature

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

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