भारत कोकिंग कोल लिमिटेड (कोल इण्डिया लिमिटेड का एक अंग) एक मिनिरत्न 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/GM/Ar. III/Envt./2022-23/17 Dated: 20.05.2022

To
The Director
Ministry of Environment, Forest& CC
Regional Office (ECZ), Bungalow No.-2
Shyamali Colony
Ranchi- 834002

Subject: Six monthly compliance report on implementation of Environmental measures for the period from Oct' 2021 to March'2022 in respect of Cluster –III groups of mines.

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

Dear Sir,

Kindly find herewith the enclosed six-monthly compliance report on implementation of Environmental measures for the period from **Oct' 2021 to March'2022** in respect of Cluster –III groups of mines, BCCL.

This is for your kind information.

Encl: As above

Yours faithfully,

General Manager
Govindpur Area

C.C to (Through e-mail)
1. Regional officer, JSPCB, Housing colony, Dhanbad
2. HoD (Env.) BCCL Koyla Bhawan, Dhanbad
3. Area Manager (Env), Govindpur Area.

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

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

<table>
<tr><th>Sl. No</th><th>EC Conditions (Specific)</th><th>EC compliance status</th></tr>
<tr><td></td><td>A. Specific Conditions by MOEF:</td><td>Compliance</td></tr>
<tr><td>i</td><td>The maximum production from the two opencast sections in the cluster shall not exceed beyond that for which environmental clearance has been granted</td><td>Being Complied. The production from two opencast sections of the cluster is within limit for which the environmental clearance has been granted. Details of production from two opencast sections is given below:
<table>
<tr><td>Mine</td><td colspan="2">EC capacity (MTY)</td><td colspan="2">Actual Production (Te)</td></tr>
<tr><td></td><td>Normative</td><td>Peak</td><td>FY 2020-21</td><td>FY 2021-22</td></tr>
<tr><td>New Akashkinaree Colliery</td><td>1.000</td><td>1.300</td><td>5,45,865</td><td>4,73,011</td></tr>
<tr><td>Block-IV/Kooridih Colliery</td><td>1.100</td><td>1.430</td><td>5,36,065</td><td>2,39,300</td></tr>
</table></td></tr>
<tr><td>ii</td><td>The measure to identify in the Environmental Plan for Cluster- III groups of mine and the conditions given in this environmental clearance letter shall be dovetailed to the implementation of the Jharia Action Plan.</td><td>Being Complied. Master Plan activities are dovetailed with compliance of environmental clearance conditions.</td></tr>
<tr><td>iii</td><td>The proponent shall prepare time-series maps of the Jharia Coalfields through NRSA to monitor and prevent fire problems in the Jharia Coalfields by Isothermal mapping /imaging and monitoring temperatures of the coal seams (whether they are close to spontaneous ignition temperatures) and based on which, areas with potential fire problems shall be identified.
Measures to prevent ingress of air (Ventilation) in such areas, to prevent restart fresh/spread fires in other areas including in mines of cluster III shall be undertaken. Expertise available internationally could also be utilized for control of fire in Jharia Coalfields and for their reclamation and to further minimize time for fire and subsidence control. Isothermal mapping using thermal imaging has been got done by NRSA. Measures would be taken to prevent ingress of air (ventilation) in such areas, which may re-start fresh fires.</td><td>Being Complied. NRSC is conducting thermal Infra-Red Survey periodically. Report for 2014 and 2018 are submitted and action are being taken accordingly (Report for year 2018 is attached herewith as Annexure-I)</td></tr>
</table>

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

		are being kept in escrow accounts. Details of amount kept in escrow account and copy of mine closure plans are attached as **Annexure-II.** Year wise data of OB generated and backfilling is attached as **Annexure-V**. Details of proposed coal production, OB production, and plantation for FY 2022-23 are attached as **Annexure-VI**.
xiii	Mining shall be carried out as per statute from the streams/nalas flowing within the lease and maintaining a safe distance from the Nalas flowing along the lease boundary. A safety barrier of a minimum 60m width shall be maintained along the nalas/water bodies. The small water bodies in OC shall be protected to the extent feasible and the embankment proposed along water body shall be strengthened with stone pitching.	**Being Complied.** Embankments have been constructed as specified in EC and stone pitching has been done. Photographs of the stone pitching are attached as **Annexure-III.**
xiv	Active OB dumps near water bodies and rivers should be rehandled for backfilling abandoned mine voids. However, those which have been biologically reclaimed need not be disturbed.	**Being Complied.** Old OB dump near water bodies is stabilized.
xv	Thick green belt shall be developed along undisturbed areas, mine boundary and in mine reclamation. A total area of 854.72 ha shall be reclaimed and afforested.	Includes post mining requirement and it shall be **complied**. Yearly plantation is being done for development of green belts as per EC. Apart from this avenue/block plantation is being done at spaces available. (Photographs of biological reclaimed site are attached as **Annexure-IV**). Details of year wise plantation up to FY 2021-22 and attached as **Annexure-VII**)
xvi	Details of transportation, CSR, R&R and implementation of environmental action plan for the clusters-III should be brought out in a booklet form within a year and regularly updated.	**Being Complied.** The booklet is maintained at cluster level.
xvi i	Specific Mitigative measures identified for the Jharia Coalfields in the Environmental Action Plan prepared for Dhanbad as a critically polluted area and relevant for Cluster III shall be implemented.	**Being Complied.** Dhanbad Action Plan has been prepared in consultation with Jharkhand Pollution Control Board for entire BCCL and not cluster wise. It is being implemented comprehensively for all the mines of BCCL. Some of the salient actions of this cluster are as under: 1. Construction of pucca road for coal transportation passing through public transportation routes. 2. Construction of water reservoir for mine water utilization 3. OB dumps biological reclamation and avenue plantation. 4. Transportation of coal on public roads is being done in tarpaulin covered vehicles.

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		5. Regular water sprinkling in dust prone areas. (Photographs of ponds, roads constructed within colliery, avenue plantation are attached as **Annexure-VIII**).
xviii	The locations of monitoring stations in the Jharia Coalfields should be finalized in consultation with the Jharkhand State Pollution Control Board. The Committee stated that smoke/dust emission vary from source to source (fuel wood, coal, fly ash from TPPs, silica from natural dust, etc.) and a Poll Mineralogical composition study should be undertaken on the composition of the suspended particulate matter (PM_{10} and $PM_{2.5}$) in Jharia Coalfields and also quantified. These studies would help ascertain source and extent of the air pollution, based on which appropriate Mitigative measures could be taken.	**Being Complied.** The locations of monitoring stations are approved by Jharkhand Pollution Control Board. BCCL has awarded the work order for the Project "Source apportionment of ambient air particulate matter in Jharia coalfields region, Jharkhand" to CSIR-NEERI, Nagpur vide Ref no. BCCL/AGM/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 on 27.04.2022 (report is attached as **Annexure- IX).**
xix	The Plan for conveyor-cum–rail for Cluster-III should be dovetailed with Jharia Action Plan. The Committee desired that road transportation of coal during Phase–I should be by mechanically covered trucks, which should be introduced at the earliest. Coal dispatch shall be diverted from the present rail sidings to Rapid Loading System (RLS) soon after the construction and commissioning of the RLS at Maheshpur is completed. The railway siding order issued and same would come in 3 years. The details of same should be provided to ministry. The mode of transportation of coal by trucktill Railway Siding should be by mechanically covered trucks	**Being Complied.** At present transportation is being done by covered vehicle with a tarpaulin cover. The feasibility of mechanically covered trucks is being studied. Construction of Rapid Loading System at Maheshpur is completed and will be operational after railway connectivity.
xx	3756 nos. of PAF's should be rehabilitated at cost of Rs 27012.66 Lakhs as per the approved Jharia Action Plan.	It is being followed as per the approved Jharia action plan.
xxi	Regular monitoring of groundwater level and quality of the study area shall be carried out by establishing a network of existing wells and construction of new piezometers. The monitoring for quantity shall be done four times a year in pre-monsoon (May), monsoon (August), post-monsoon (November) and winter (January) seasons and for quality including Arsenic and Fluoride during the month of May. Data thus collected shall be submitted to the Ministry of Environment & Forest and to the Central Pollution Control Board/SPCB quarterly within one month of monitoring. Rainwater harvesting measures shall be undertaken in case monitoring of water table indicates a declining trend.	**Being Complied.** The work of monitoring of ambient environment including ground water monitoring is being done by Central Mine Planning and Design institute (CMPDI). (Ground Water report is attached as **Annexure-X**) The Location and design of Piezometers to be installed have been finalized by CMPDI. Piezometer Installation: Construction for Piezometric well has been completed.
xxi	Regular monitoring of subsidence movement on the surface over and around	Shall be complied. At present there is no depillaring activity in Cluster-III.

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i	the working area and impact on natural drainage pattern, water bodies, vegetation, structure, roads, and surroundings shall be continued till movement ceases completely. In case of observation of any high rate of subsidence movement, appropriate effective corrective measures shall be taken to avoid loss of life and material. Cracks shall be effectively plugged with ballast and clayey soil/suitable material.	
xxi ii	Sufficient coal pillars shall be left un-extracted around the air shaft (within the Subsidence influence area) to protect from any damage from subsidence, if any.	**Being Complied.** Sufficient coal pillars have been left around air shafts as per the statutes and DGMS guidelines.
xxi v	High root density tree species shall be selected and planted over areas likely to be affected by subsidence.	It is **being complied.**
xx v	Depression due to subsidence resulting in water accumulating within the low lying areas shall be filled up or drained out by cutting drains.	It shall be **complied.** At present there is no depillaring activity in Cluster-III.
xx vi	Solid barriers shall be left below the roads falling within the blocks to avoid any damage to the roads.	It is being followed. Sufficient barriers are left for saving the surface Installation and infra structures as per the statute and DGMS guidelines.
xx vii	No depillaring operation shall be carried out below the township/colony.	It is being followed.
xx viii	A detailed CSR Action Plan shall be prepared for Cluster III group of mines. Specific activities shall be identified for CSR for the budget of Rs 139 Lakhs per year@ Rs 5/T of coal provided for CSR for 2012-2013 and Rs. 5/T of coal as recurring expenditure. The 491.91ha of area within Cluster III ML existing as waste land and not being acquired shall be put to productive use under CSR and developed with fruit bearing and other useful species for the local communities. Third party evaluation shall be got carried out regularly for the proper implementation of activities undertaken in the project area under CSR. Issue raised in the Public Hearing shall also be integrated with activities being taken up under CSR. The details of CSR undertaken along with budgetary provisions for the village-wise various activities and expenditure thereon shall be uploaded on the company website every year. The company must give priority to capacity building both within the company and to the local youth, who are motivated to carry out the work in future. The gap/space available between the entire mine area should be suitably planted with native species. Plantation should also be made in vacant area and along the road side so as	**Being Complied.** BCCL is implementing CSR activities. A separate CSR/Welfare committee has been formed at area level that will look after the works being executed under CSR. CSR dept. is established at the Headquarter level and area level for Executing the CSR Activities. All welfare/ CSR activities are also uploaded in Company web site (http://www.bcclweb.in/?page_id=265). TISS has conducted survey to frame CSR policy for better implementation and monitoring of the CSR activities. CSR activities have not been dealt at cluster level. However, expenditure was allotted and made at corporate level, i.e. M/s BCCL level and cluster III is

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

	abandoned pits and voids should be backfilled with OB and reclaimed with plantation and or may be used for pisciculture.	
xx xvi ii	Regular monitoring of groundwater level and quality of the study area shall be carried out by establishing a network of existing wells and construction of new piezometers. The monitoring for quantity shall be done four times a year in pre-monsoon (May), monsoon (August), post-monsoon (November) and winter (January) seasons and for quality including Arsenic and Fluoride during the month of May. Data thus collected shall be submitted to the Ministry of Environment & Forest and to the Central Pollution Control Board/SPCB quarterly within one month of monitoring. Rainwater harvesting measures shall be undertaken in case monitoring of water table indicates a declining trend.	**Being Complied.** The work of monitoring of ambient environment including ground water monitoring is being done by Central Mine Planning and Design institute (CMPDI). (Ground Water quality report is attached as **Annexure-X**) Monitoring stations have been set up and Central Mine Planning and Design institute (CMPDI) has been keeping a constant check. The Location and design of Piezometers to be installed have been finalized by CMPDI. Piezometer Installation: Tender for piezometer installation has been completed and LOA will be issued to L-1 bidder shortly after competent approval.
xx xix	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.	It is **being complied.**
xl	The location of monitoring stations in the Jharia coalfield should be finalized in consultation with Jharkhand State Pollution Control Board.	It is **being complied.**
xli	For monitoring land use pattern and for post mining land use, a time series of land use maps, based on satellite imagery (on a scale of 1: 5000) of the core zone and buffer zone, from the start of the project until end of mine life shall be prepared once in 3 years (for any one particular season which is consistent in the time series), and the report submitted to MOEF and its Regional office at Bhubaneswar.	**Being Complied.** CMPDI is conducting "Time series of land use maps based on satellite imagery of the core zone and buffer zone in the scale 1:5000 on cluster basis every 03 year. Land use map report for cluster-III is attached as **Annexure-XIV.**
xlii	A Final Mine Closure Plan along with details of Corpus Fund shall be submitted to the Ministry of Environment & Forests five year before mine closure for approval. Habitat Restoration Plan of the mine area shall be carried out using a mix of native species found in the original ecosystem, which were conserved in-situ and ex-situ in an identified area within the lease for reintroduction in the mine during mine reclamation and at the post mining stage for habitat restoration.	**Being complied.** Mine closure plan as per the guidelines of Ministry of Coal has already been prepared by Central Mine planning and Design Institute, Dhanbad and approved by BCCL Board on 21.09.2013. The financial provisions required for the implementation of mine closure plan are being kept in accounts. Details of amount kept in escrow account and copy of mine closure plans are attached as **Annexure-II.**
xli v	A separate management structure for implementing environment policy and socio-economic issues and the capacity building required in this regard.	**Being Complied.** Environment Engineers are provided at Mine and Area level. Environment Management cell has been constituted at Area level with GM as Chairman.

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<table>
<tr><td></td><td></td><td>A full-fledged Environment Department, headed by a HOD (Environment) along with a suitable qualified multidisciplinary team of executives has been established in Headquarters. Community Development executives support capacity building.</td></tr>
<tr><td>xlv</td><td>Corporate Environment Responsibility:

a) The Company shall have a well laid down Environment Policy approved by the Board of Directors.</td><td>Being Complied.

A well-defined Corporate Environment Policy has already been laid down and approved by the Board of Directors. This is also posted on BCCL website. (http://www.bcclweb.in/environment/CEP_14.11.2019.pdf)</td></tr>
<tr><td></td><td>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.</td><td>Complied.</td></tr>
<tr><td></td><td>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.</td><td>A hierarchical system of the company to deal with environmental issues from corporate level to mine level already exists.</td></tr>
<tr><td></td><td>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.</td><td>Environment Management cell has been constituted at Area level with GM as Chairman.
Internal Monitoring Mechanism is in place.</td></tr>
<tr><td>B</td><td>EC Conditions (General):</td><td></td></tr>
<tr><td>i</td><td>No change in mining technology and scope of working shall be made without prior approval of the Ministry of Environment and Forests.</td><td>Being Complied.</td></tr>
<tr><td>ii</td><td>No change in the calendar plan of production for quantum of mineral coal shall be made.</td><td>Being Complied. Production is being done well within the peak production capacity as per EC. Details of production from cluster-III is given below:
<table>
<tr><th colspan="2">EC capacity (MTY)</th><th colspan="3">Actual Production (MTe)</th></tr>
<tr><td>Normative</td><td>Peak</td><td>FY 2019-20</td><td>FY 2020-21</td><td>FY 2021-22</td></tr>
<tr><td>2.769</td><td>3.600</td><td>1.811</td><td>1.205</td><td>7.861</td></tr>
</table></td></tr>
<tr><td>iii</td><td>Four ambient air quality monitoring stations shall be established</td><td>Being Complied. Location of Four ambient air quality monitoring stations for</td></tr>
</table>

	in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2 and NO_x monitoring. Location of the stations shall be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets in consultation with the State Pollution Control Board. Monitoring of heavy metals such as Hg, As, Ni, Cd, Cr, etc. carried out at least once in six months.	the cluster is approved by Jharkhand pollution control Board. The work for monitoring of ambient environment is being done by Central Mine Planning and Design institute (CMPDIL). Monitoring reports of Air (including heavy metal analysis), Water (drinking, surface) and Noise is attached as **Annexure-XIII.**
iv	Data on ambient air quality (PM_{10}, $PM_{2.5}$, SO_2 and NO_x) and heavy metals such as Hg, As, Ni, Cd, Cr and other monitoring data shall be regularly submitted to the Ministry including its Regional Office at Bhubaneswar and to the State Pollution Control Board and the Central Pollution Control Board once in six months. Random verification of samples through analysis from independent laboratories recognized under the EPA rules, 1986 shall be furnished as part of compliance report.	**Being Complied.** The work for monitoring of ambient environment is being done by Central Mine Planning and Design institute (CMPDIL). Monitoring reports of Air (including heavy metal analysis), Water (drinking, surface) and Noise is attached as **Annexure-XIII.** Random verification has been completed by IIT(ISM) Dhanbad.
v	Adequate measures shall be taken for control of noise levels below 85 dBA in the work environment. Workers engaged in blasting and drilling operations, operation of HEMM, etc shall be provided with ear plugs/muffs.	**Being Complied.** Details of ear plugs/muffs and dust masks distributed is as below: **Year** / **Dust masks (nos.)** / **Ear plugs (nos.)** 2021-22 (Up to 31.03.2022) / 500 / 10
vi	Industrial wastewater (workshop and wastewater from the mine) shall be properly collected, treated so as to conform to the standards prescribed under GSR 422 (E) dated 19th May 1993 and 31st December 1993 or as amended from time to time before discharge. Oil and grease trap shall be installed before discharge of workshop effluents.	**Being Complied.** Discharge of water confirms to applicable standards. Oil & grease trap exists at Sinidih workshop and (Water quality report is attached as **Annexure-XIII**).
vii	Vehicular emissions shall be kept under control and regularly monitored. Vehicles used for transporting the mineral shall be covered with tarpaulins and optimally loaded.	**Being Complied.** Regular maintenance of vehicles is being done. Vehicles with valid Pollution under control certificates are being used for coal transportation. Covered transportation is in practice.
viii	Monitoring of environmental quality parameters shall be carried out through establishment of adequate number and type of pollution monitoring and analysis equipment in consultation with the State Pollution Control Board and data got analyzed through a laboratory recognized under EPA Rules, 1986.	**Being Complied.** The locations of monitoring stations are approved by Jharkhand Pollution Control Board. Monitoring is being done by CMPDI. Monitoring reports of Air (including heavy metal analysis), Water (drinking, surface) and Noise is attached as **Annexure-XIII.**
ix	Personnel working in dusty areas shall wear protective respiratory devices and they shall also be provided with adequate training and information on safety	Being **Complied**. A separate full-fledged Human Resource Development Department Is conducting regular training programme on these issues. Apart

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and health aspects.

from this Vocational Training Centers are existing in Cluster-III which provides periodical training on the safety and occupational health issue to each of the workers working in the mines. Details of training conducted at VTC for **FY 2021-22** (up to 31.03.2022) are given below:

Type of Training	**Number of Persons**
Basic	18
Refresher	626
Safety Committee Recommendation	194
MVT training	86
Total	**924**

Details of protective devices distributed (Up to 31.03.2022) to workers engaged in mining activities are as below:

Year	**Dust masks**	**Ear plugs**
FY 2021-22	100	40

x Occupational health surveillance programme of the workers shall be undertaken periodically to observe any contractions due to exposure to dust and to take corrective measures, if needed and records maintained thereof. The quality of environment due to outsourcing and the health and safety issues of the outsourced manpower should be addressed by the company while outsourcing.

Being Complied. Initial Medical Examination (IME) and Periodical Medical Examination (PME) of all the personnel are carried out as per the Statutes and Director General of Mines Safety (DGMS) guideline. Details of PME conducted for FY 2021-22 are given below:

Name of Colliery	**PME's conducted**
New Akashkinaree Colliery	365
Block-IV/Kooridih Colliery	326
Maheshpur Colliery	130
Jogidih Colliery	101

xi A separate environmental management cell with suitable qualified personnel shall be set up under the control of a Senior Executive, who will report directly to the Head of the company.

Being Complied. Environment Engineer provided at Mine and Area level. Environment Management cell has been constituted at Area level with GM as Chairman.

A full-fledged Environment Department, headed by a HOD (Environment) along with a suitable qualified multidisciplinary team of executives has been

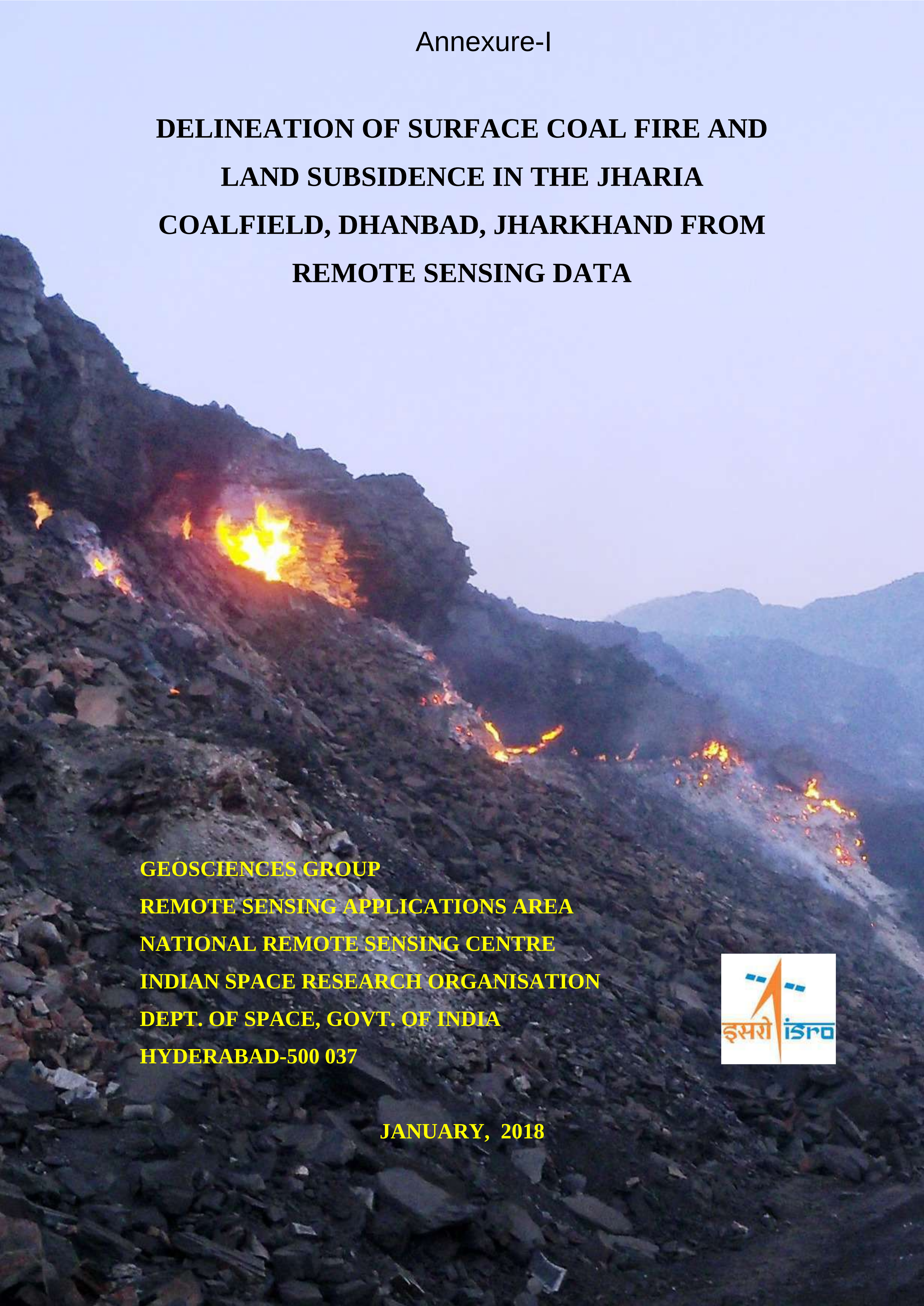
		established in Headquarters.
xii	The funds earmarked for environmental protection measures shall be kept in separate account and shall not be diverted for other purpose. Year-wise expenditure shall be reported to this Ministry and its Regional Office at Bhubaneswar.	**Being Complied.** A separate fund under the environmental protection measures has already been allocated. Expenditure details as per EIA/EMP for FY 2021-22 are enclosed as **Annexure-XV**
xiii	The Project authorities shall advertise at least in two local newspapers widely circulated around the project, one of which shall be in the vernacular language of the locality concerned within seven days of the clearance letter informing that the project has been accorded environmental clearance and a copy of the clearance letter is available with the State Pollution control Board and may also be seen at the website of the ministry of Environment & Forests at http://envfor.nic.in.	Advertised timely, **Complied**. Advertisements published and EC letter circulated to concerned panchayats have been attached as **Annexure-XVI.**
xiv	A copy of the environmental clearance letter shall be marked to concern Panchayat/Zila Parishad, Municipal Corporation or Urban local body and local NGO, if any, from whom any suggestion/representation has been received while processing the proposal. A copy of the clearance letter shall also be displayed on company's website.	**Complied**. EC on receipt circulated to all concerned authorities (EC letter circulated to concerned panchayats have been attached as **Annexure-XVI).**
xv	A copy of the environmental clearance letter shall be shall also be displayed on the website of the concerned State Pollution Control Board. The EC letter shall also be displayed at the Regional Office, District Industry Sector and Collector's Office/Tehsildar's Office for 30 days.	**Complied**.
xvi	The clearance letter shall be uploaded on the company's website. The compliance status of the stipulated environmental clearance conditions shall also be uploaded by the project authorities on their website and updated at least once every six months so as to bring the same in public domain. The monitoring data of environmental quality parameter (air, water, noise and soil) and critical pollutant such as PM_{10}, $PM_{2.5}$, SO_2 and NO_x (ambient) and critical sectoral parameters shall also be displayed at the entrance of the project premises and mine office and in corporate office and on company's website.	**Complied**. Environmental Clearance and Six monthly compliance of Environmental Clearance along with monitoring reports are uploaded on BCCL website.
xvi i	The project proponent shall submit six monthly compliance reports on status of compliance of the stipulated environmental clearance conditions (both in hard copy and in e-mail) to the respective Regional Office of the Ministry,	**Being complied.**

Ukarma

	respective Zonal Office s of CPCB and the SPCB.	
xviii	The Regional Office of this Ministry located at Bhubaneswar shall monitor compliance of the stipulated conditions. The Project authorities shall extend full cooperation to the office(s) of the Regional Office by furnishing the requisite data/ information/monitoring reports.	Shall be **complied**.
xix	The Environmental statement for each financial year ending 31 March in Form –V is mandated to be submitted by the project proponent for the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules,1986,as amended subsequently, shall also be uploaded on the company's website along with the status of compliance of EC conditions and shall be sent to the respective Regional Offices of the MoEFCC by E-mail	**Being Complied.** Environmental Statement is regularly submitted.
C	**EC Conditions (Other):**	
i	The Ministry or any other competent authority may stipulate any further condition for environmental protection.	Conditions of CTO are **being complied.**
ii	Failure to comply with any of the conditions mentioned above may result in withdrawal of this clearance and attract the provisions of the Environment (Protection) Act, 1986.	All condition **complied** to avoid this condition.
iii	The above conditions will be enforced *inter-alia*, under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986 and the Public Liability Insurance Act, 1991 along with their amendments and Rules. The proponent shall ensure to undertake and provide for the costs incurred for taking up remedial measures in case of soil contamination, contamination of groundwater and surface water, and occupational and other diseases due to the mining operations.	It is **being complied.** Conditions of CTO are **being complied.** The storage of material is below threshold attracting Public Liability Insurance Act, 1991.
iv	The Environmental Clearance is subject to the outcome of the Writ Petition filed by M/S Bharat Coking Coal Limited (BCCL) in response to the closure orders issued by the Jharkhand State Pollution Control Board which is pending in the Jharkhand High Court.	Agree.

Annexure-I

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



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

JANUARY, 2018

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

Report for

BHARAT COKING COAL LIMITED (BCCL)

(A SUBSIDIARY OF COAL INDIA LTD.)

ENVIRONMENT DEPARTMENT, KOYLA BHAWAN

KOYLA NAGAR, DHANBAD – 826 005, JHARKHAND

GEOSCIENCES GROUP

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DEPT. OF SPACE, GOVT. OF INDIA

HYDERABAD-500 037

JANUARY, 2018

PROJECT TEAM

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

CONTENTS

ACKNOWLEDGEMENTS

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

EXECUTIVE SUMMARY

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

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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. In view of the past experiences, based on the letter (Ref. no. NRSC/16/76) from Director (Tech.), Operations, BCCL addressed to Director, NRSC on 01 February 2016. a project was formulated to take up Coal fire and Land Subsidence study of the Jharia Coal Field using space-borne remote sensing technique. The formal Memorandum of Understanding between BCCL and NRSC was signed on 23rd of Dec, 2016.

1.2 Objectives

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

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

1.3 Study Area

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

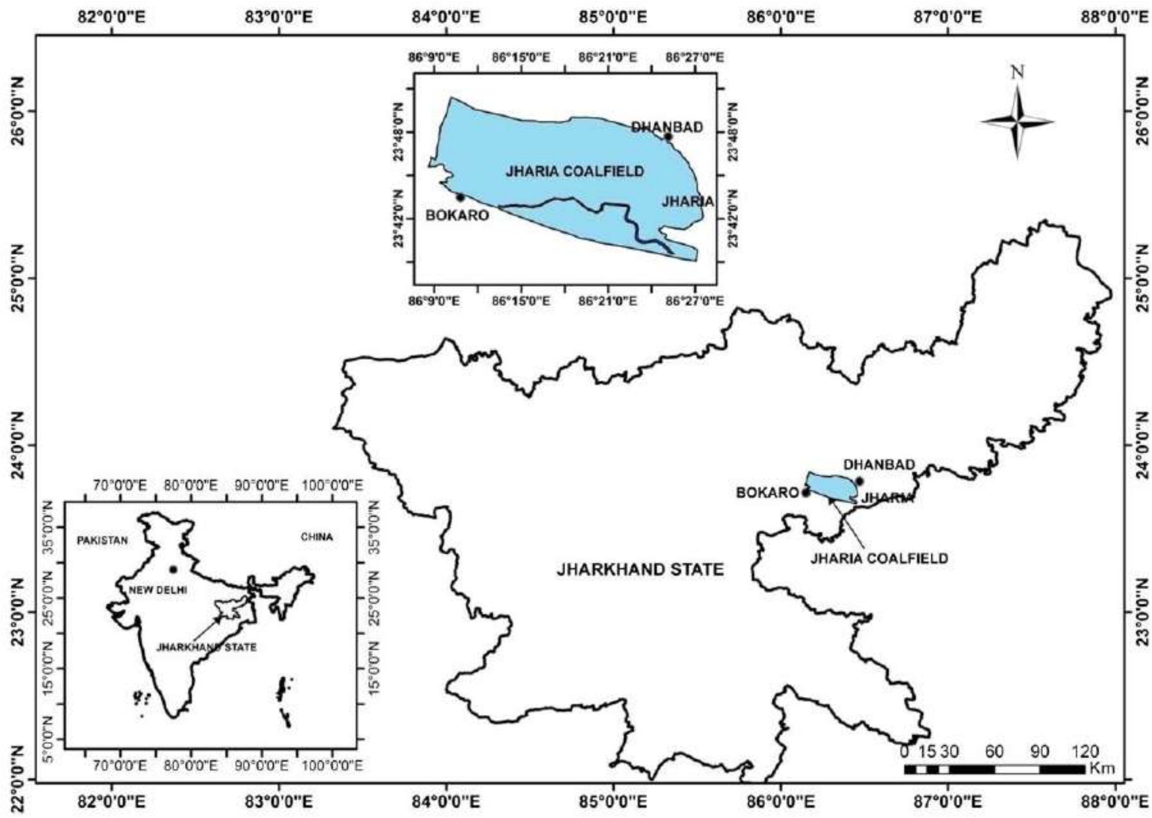

Figure 1: Study area map of Jharia Coalfied, Jharkhand

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.

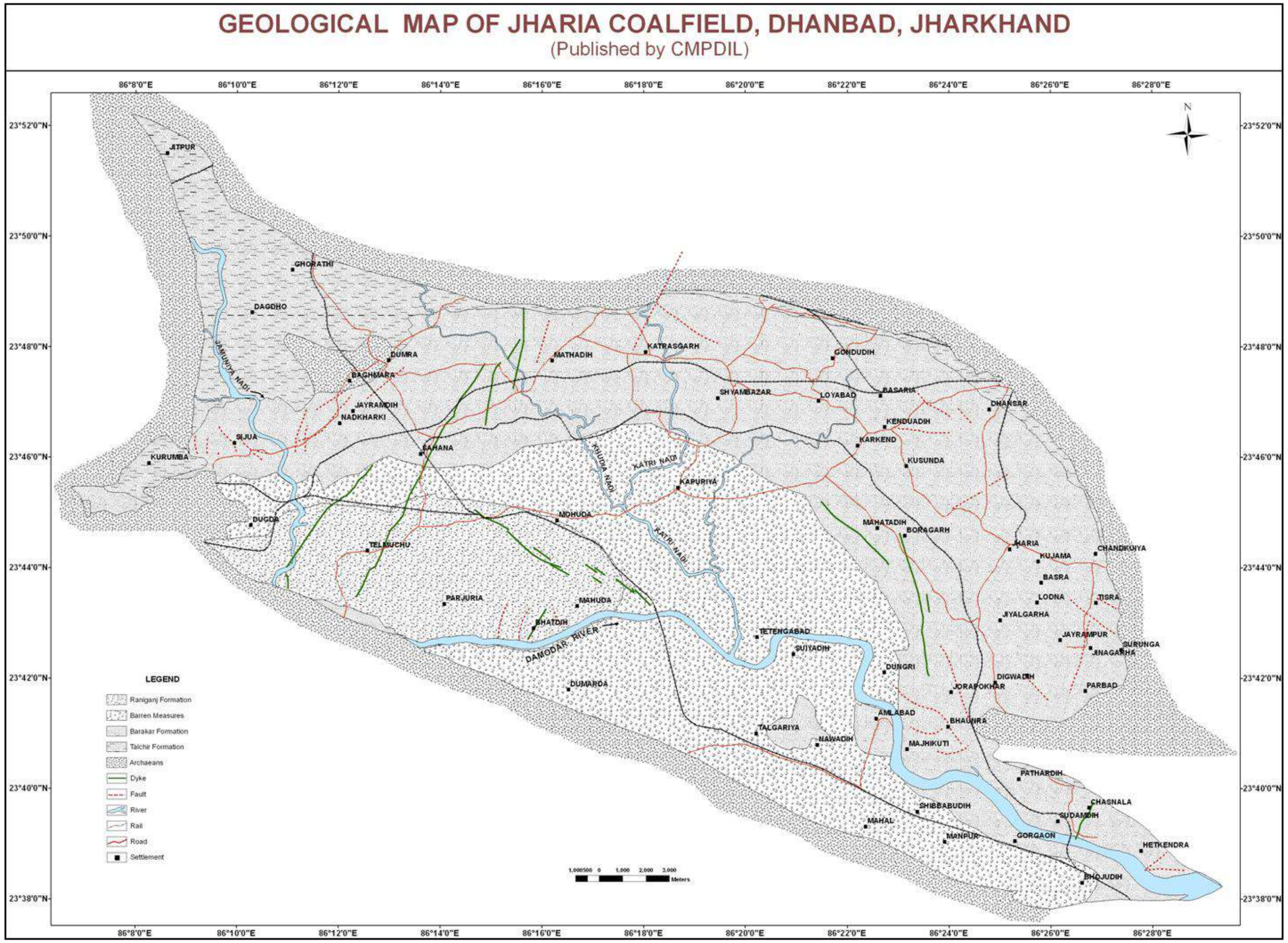

Figure 2 : Geological map of Jharia coal field, Dhanbad, Jharkhand (published by CMPIDL)

CHAPTER III

DATA REQUIREMENTS

3.1 Remote Sensing Data

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

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

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

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

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

3.2 Ancillary data

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

CHAPTER IV

REMOTE SENSING DATA ANALYSIS

4.1 Methodology

4.1.1 Processing of Landsat 8 Data

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

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

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

Where:

L_λ = Spectral radiance (Watts/ (m2 * 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 (Lλ) for ASTER Band 13 and Landsat-8 band 10 data is generated, it is possible to calculate radiant (brightness) temperature directly using equation 2. Planck's radiation function (Planck, 1914) forms the basis of radiant temperature derivation from spectral radiances and the theory is discussed in detail in existing literatures (Gupta, 2003).

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

T_R = Radiant (brightness) temperature,

K_1 = Calibration constant (1260.56 K),

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

L_λ = Spectral radiance

4.1.2 Thresholding of radiant temperature image

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

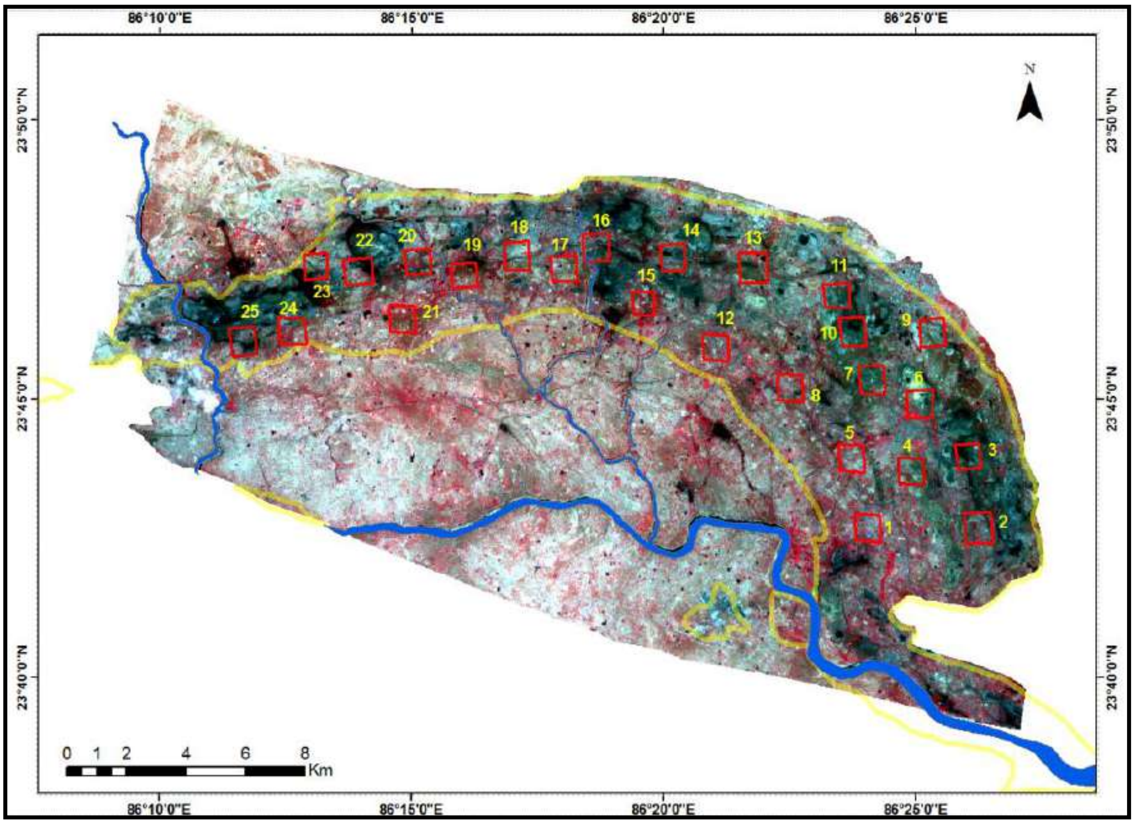

Figure 3. False colour composite image of Jharia Coalfield, with subset blocks (in red boxes) to obtain temperature values (from radiant temperature image) within the Barakar formation across the Jharia coalfield.

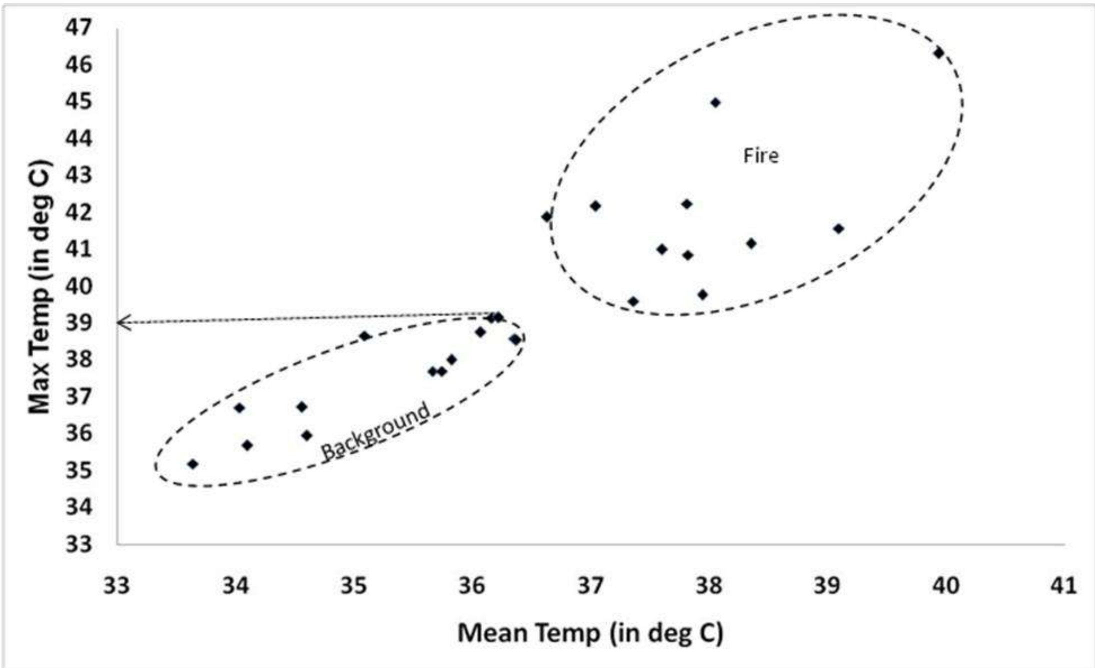

Figure 4. Maximum temperature plotted against mean temperature for various locations; cluster separation observed around 39 °C (marked with arrow)

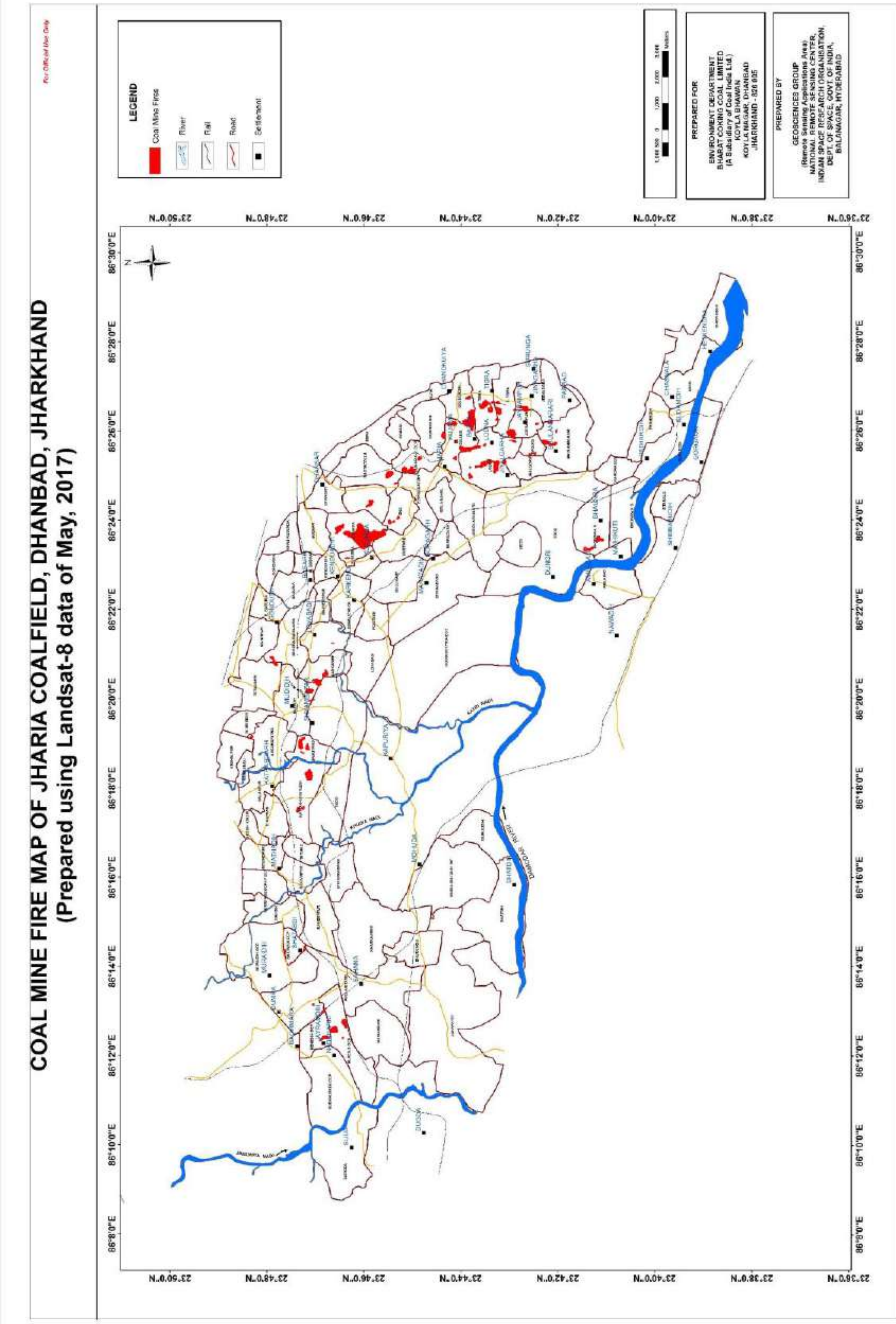

Figure 5: Coal mine fire map (May, 2017) of Jharia coal field, Dhanbad. The fire areas shown in this map have been verified in the field as per field points in figure 13.

4.2 Methodology For Subsidence Detection

4.2.1 Processing of ALOS-PALSAR 2 Data

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

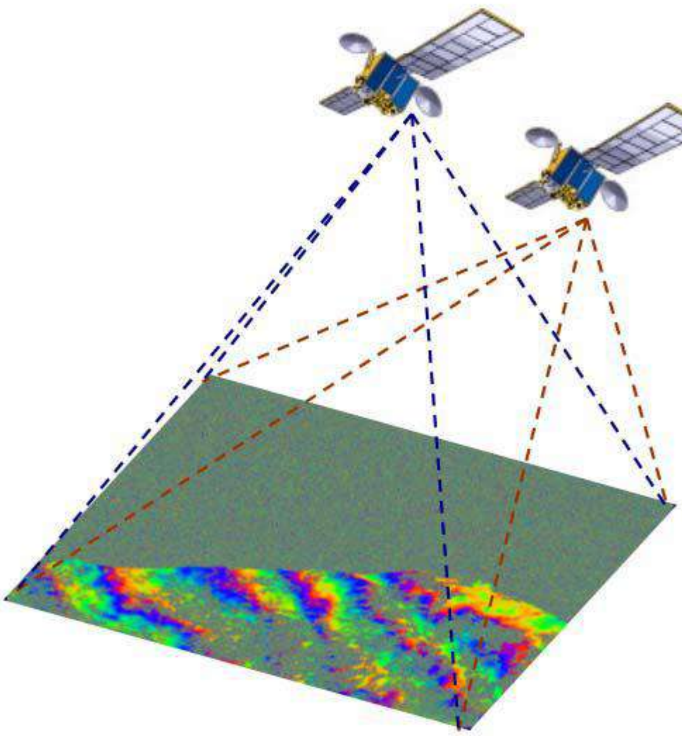

Figure 6. DInSAR acquisition scheme.

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

$$\Delta\Phi Int = \Phi Topo + \Phi Mov + \Phi Atm + \Phi Noise \qquad (3)$$

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.

$$\Delta\Phi dif = \Phi ErrorTopo + \Phi Mov + \Phi Atm + \Phi Noise \qquad \text{(ii)}$$

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

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

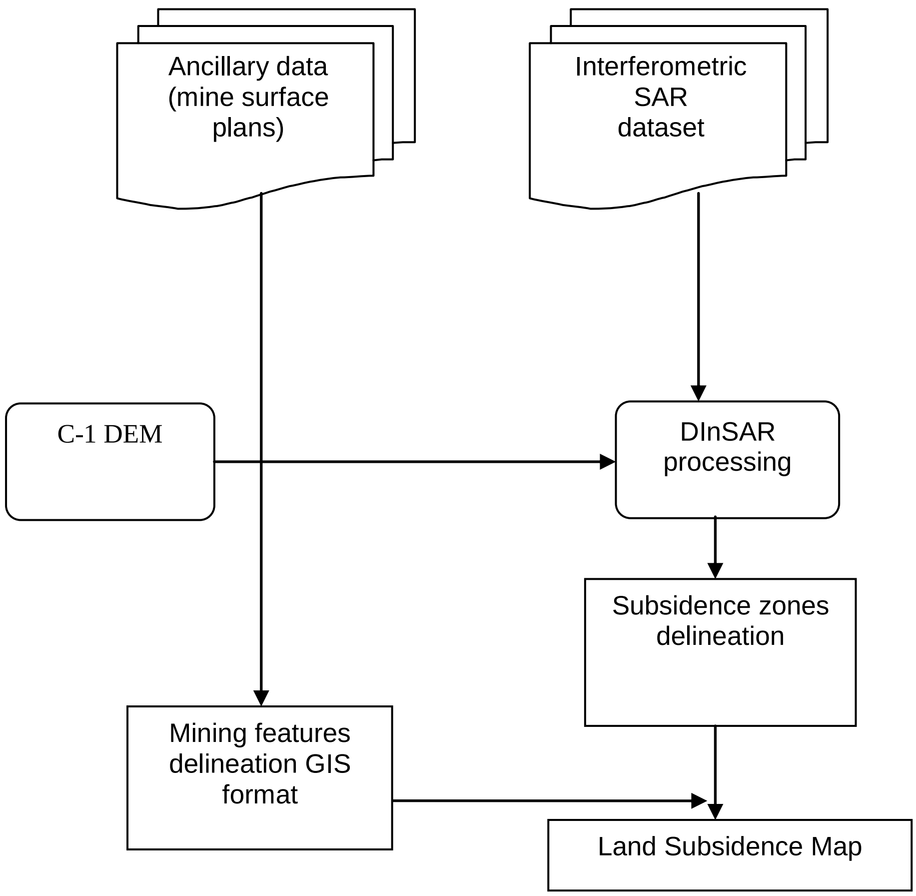

Figure 7. Work flow diagram for generating land subsidence map using DInSAR technique.

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

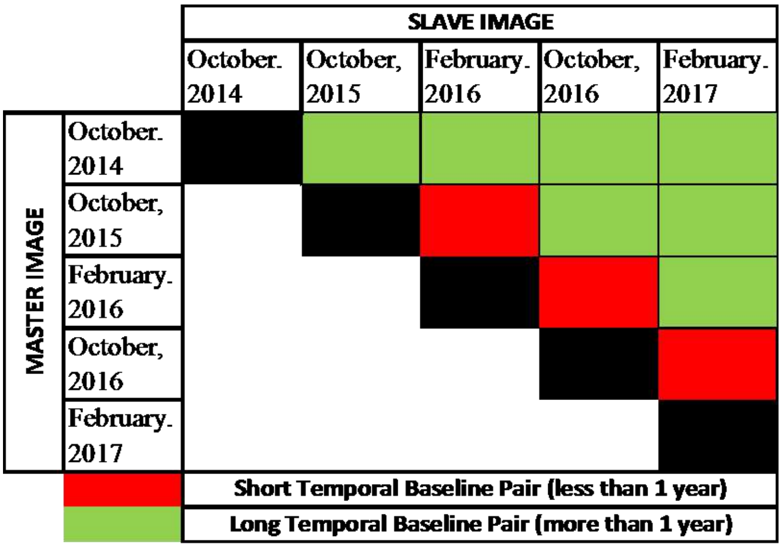

Figure 8. ALOS-PALSAR - 2 Master-Slave pairs for short and long temporal base line processing

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).

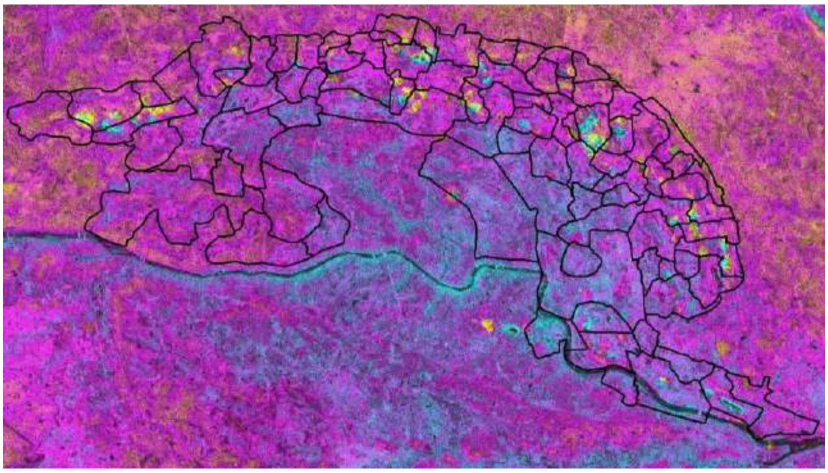

Figure 9. Fringe patterns generated from short baseline processing (e.g. Master: Oct, 16, Slave: Feb, 17).

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

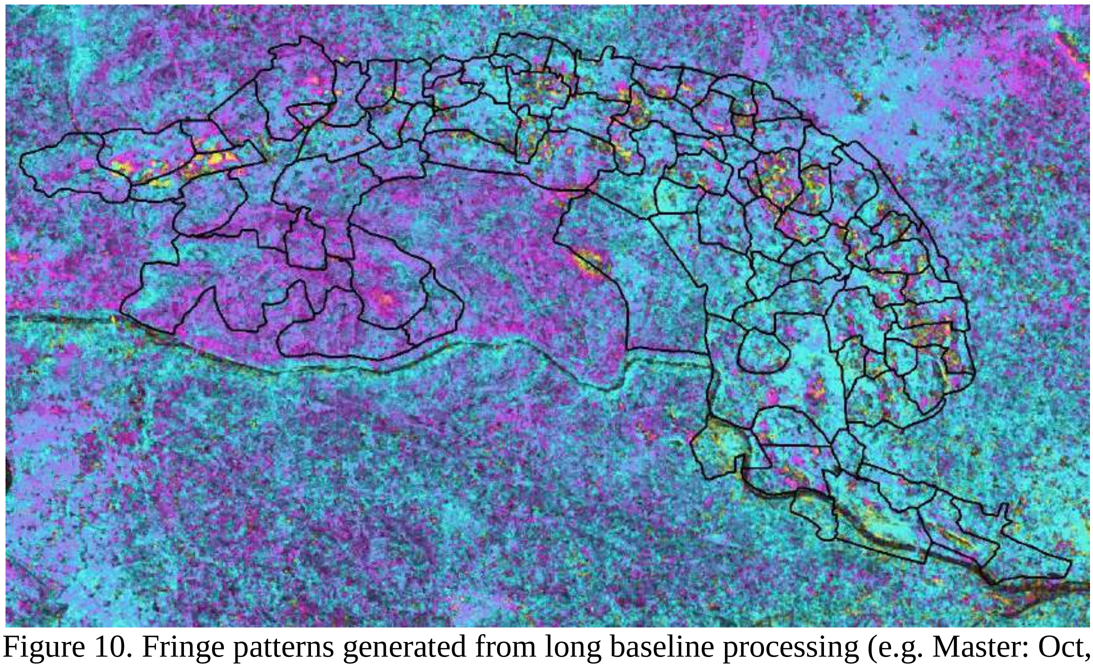

Figure 10. Fringe patterns generated from long baseline processing (e.g. Master: Oct, 15, Slave: Feb, 17).

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

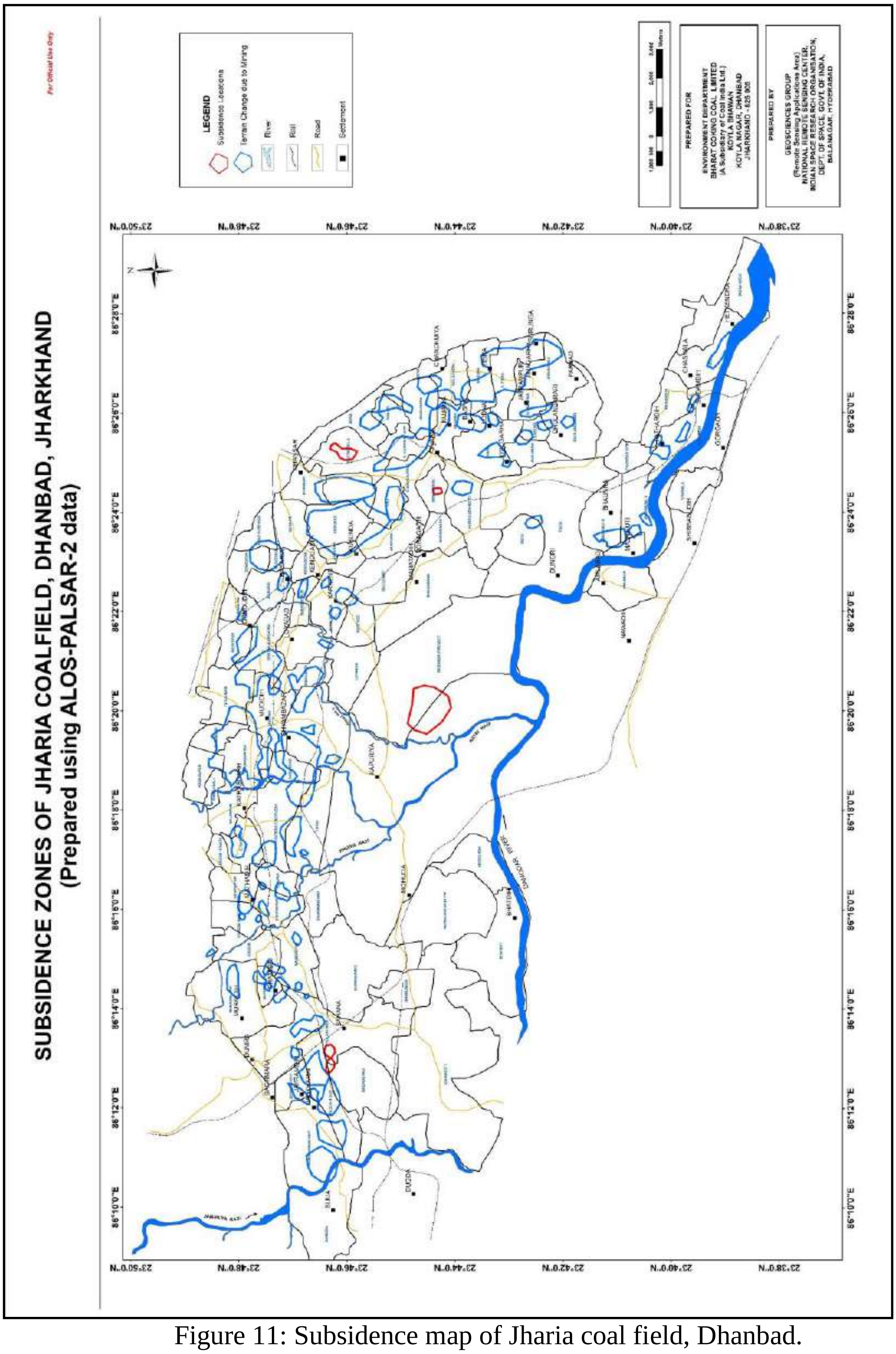

Figure 11: Subsidence map of Jharia coal field, Dhanbad.

CHAPTER V

FIELD WORK

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

The salient overview of the field observations are as follows:

Coal-fire observations:

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

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

Subsidence location observations:

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

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

CHAPTER VI

POST FIELDWORK ANALYSIS

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

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

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

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

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

DISCUSSIONS AND CONCLUSIONS

CHAPTER VII

7.1 Discussions

7.1.1 Coal fire analysis

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

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

In the western flank, three distinguishable fire affected zones are seen. Toward the western end of the mining area, the Benedih and Block II OCP are affected by smaller fires from isolated coal seams. These again are surfacialy manifested in the form of fume cracks with smoke emanating from them. The Shatabdi OCP are also affected but fire is manifested in the along vertical mining wall sections.

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

i. In reference to the map generated in 2012, the 2017 map shows that the emergence/re-emergence of fires in the eastern flank, namely Kujama, Tisra, Lodna and Jharia etc. The entire zone has been affected by multiple fire occurrences. The spatial disposition of fires in Bastacolla, Jharia and Bhulanbarari appear to have a minor increase.

ii. The areal extent of major fire zone around Kusunda/Kenduadih and Ena appears to remain the same, though here again the spatial location of the anomalies has changed. This is probably due to the mitigation and active mining in this region.

iii. The fire zones in Benedih/Block II OCP and Shatabdi OCP have also changed/diminished in areal extent with presence of isolated smaller anomalies. There has been a considerable reduction in fire areas in and around the Shatabdi OCP.

iv. The spatial disposition of fire areas around Katras, Gaslitand and Mudidih show minor change. In 2012, a number of small fire pockets were seen, however presently those fire pockets have given away to a few fire zones of moderate disposition.

v. It needs to be noted that the 2012 study was carried out using ASTER data whereas the present study is carried out using Landsat-8 data. Therefore, the difference of sensor sensitivities will have a influence on the way the fires are sensed on the ground. Difference of sensor sensitivities will influence the number of fires identified as well as the areal extent of the fires in the data.

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

2012, when the total fire affected extent of about 2.18 km^2; in 2017 total fire affected extent is about 3.28 km^2. The colliery wise break-up of change in fire area from 2012 to 2017 is given in Annexure III.

7.1.2 Subsidence analysis

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

7.2 Conclusions

The following conclusions can be made:

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

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

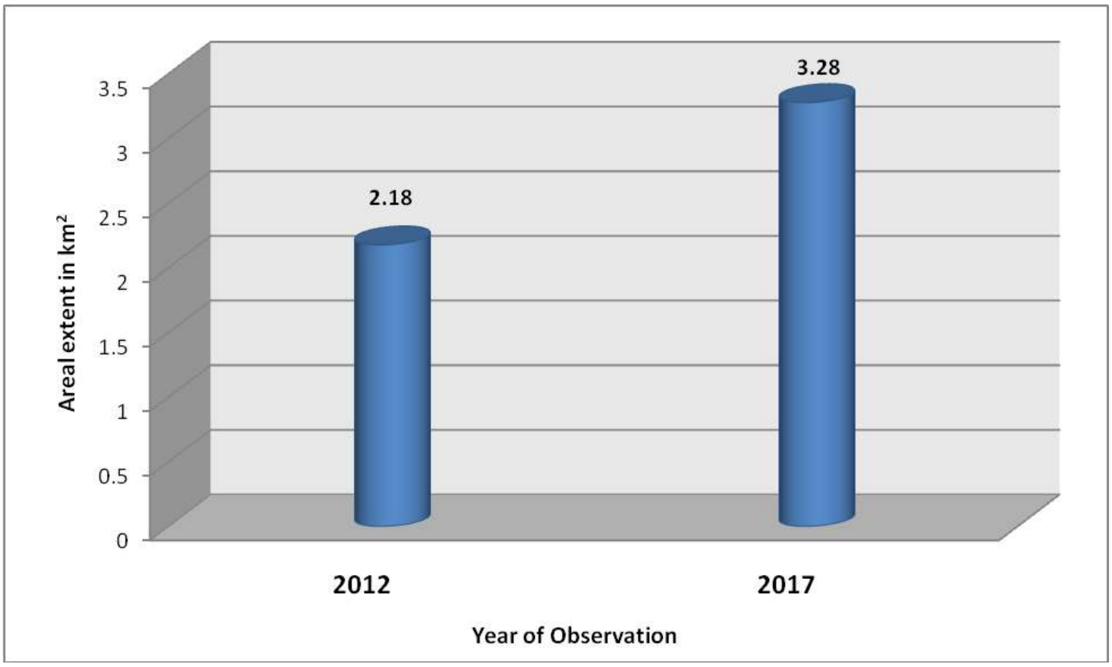

Figure 12: Total fire area statistics

CHAPTER VIII

LIMITATIONS

Delineation and mapping of coal fire from thermal data of remote sensing platforms carries with it some inherent limitations which needs to be understood in order to decipher the results obtained from it. This will assist 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 4.2.1, thresholding the data to separate the fires from the non fire areas, is a statistical technique. However, this method is dependent on how the temperature of non-fire background area is distinctive from the fire temperature.

4) The background temperatures vary with the time of the day when the data is collected, topography, and season of the year when the data is acquired. Night-time data has lower background temperature as compared to day-time. Similarly a data collected in October-November will have a considerably lower background temperature than that collected in May-June due to seasonal temperature variations. Hence, identification of the background temperature range becomes essential in

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

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

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

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

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

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Annexure –I

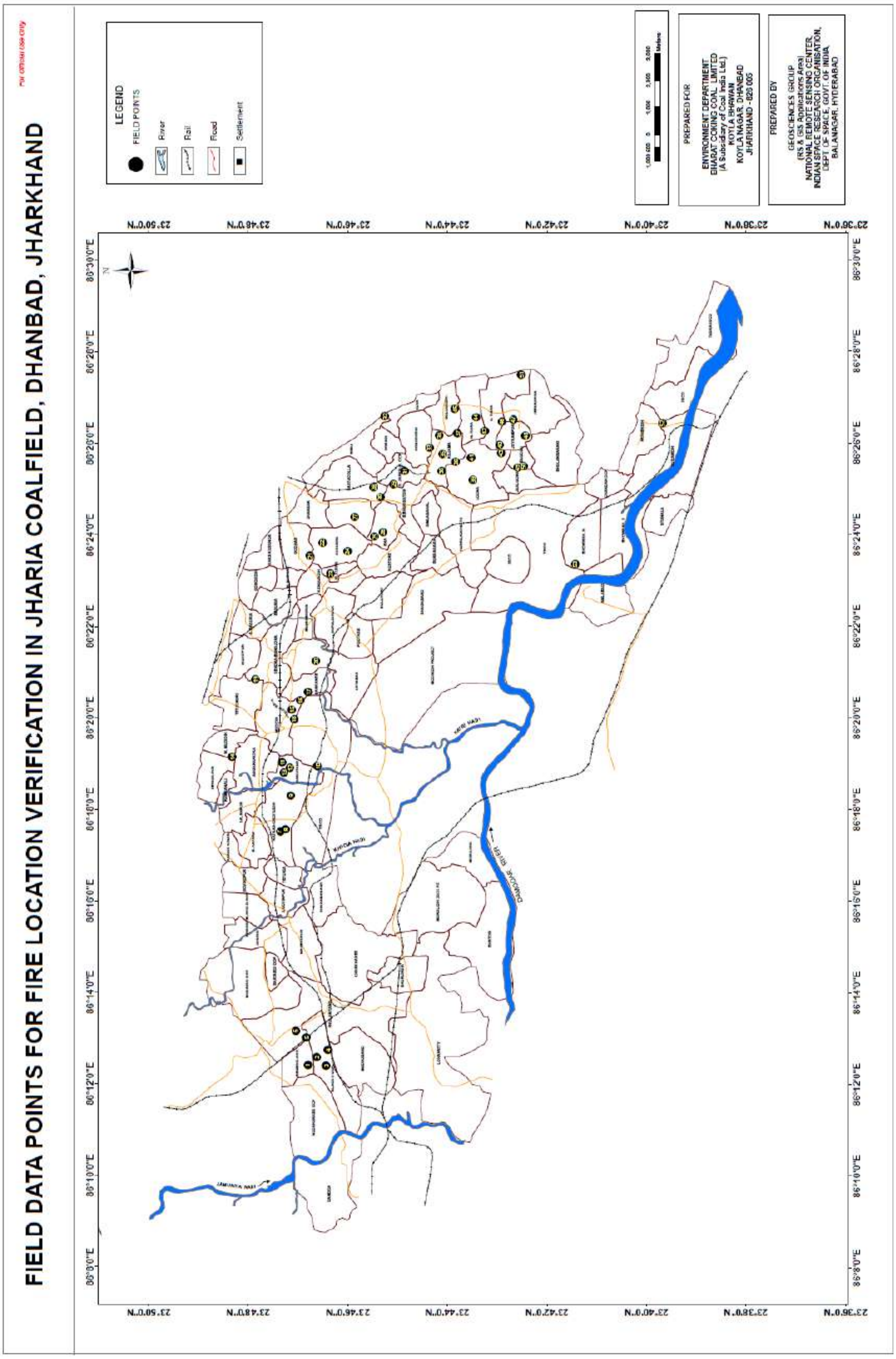


Figure 13. Field data points for coal fire verification

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

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

Annexure –II

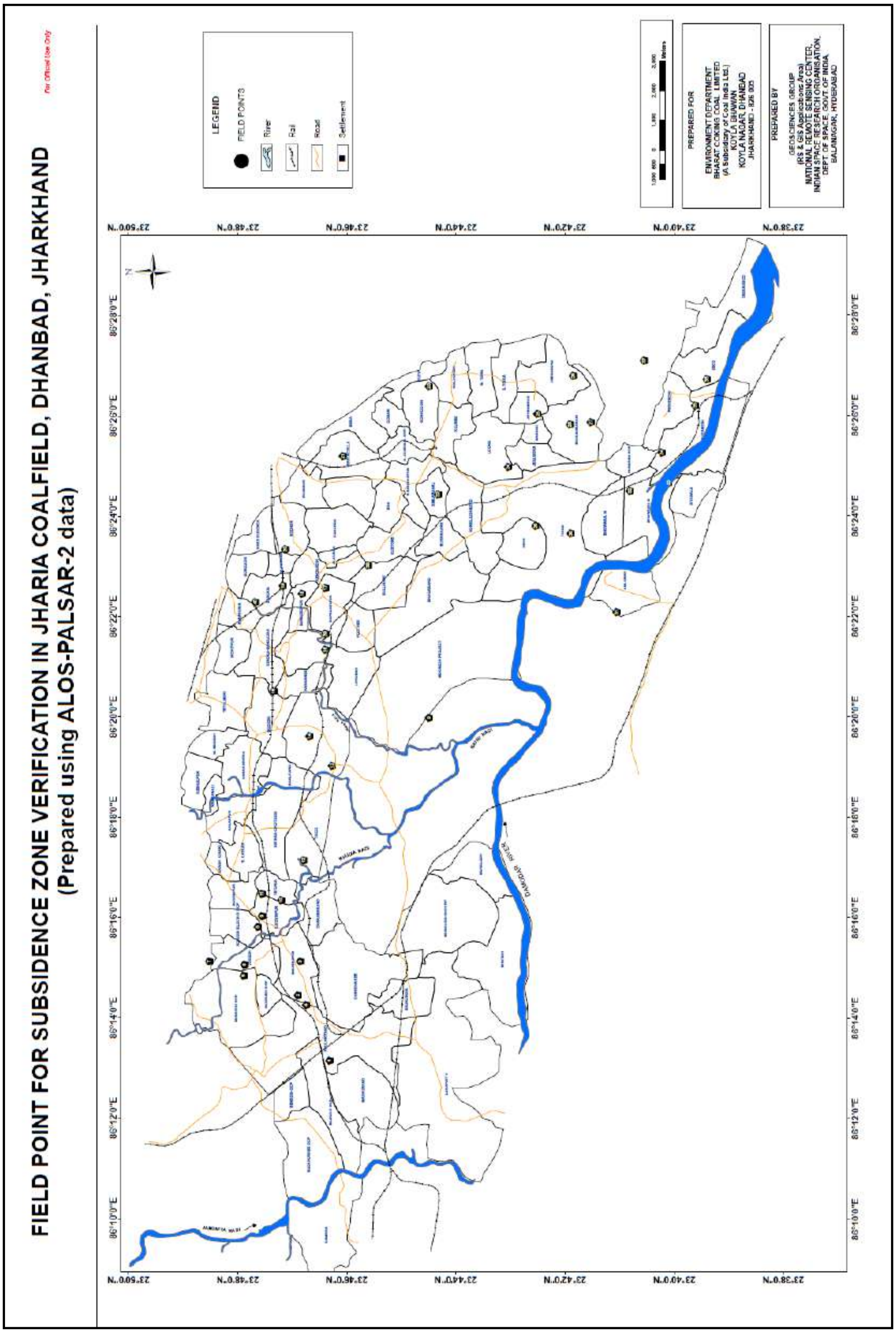


Figure 14. Field data points for subsidence verification

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

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

Annexure –III

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

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

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

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

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

Annexure –IV


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


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

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

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

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

Figure 20: Fume cracks in the Bhulanbarari area.

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 2013-14	Deposit 2014-15	Deposit 2015-16	Deposit 2016-17	Deposit 2017-18	Deposit 2018-19	Deposit 2019-20	Deposit 2020-21	Deposit 2021-22	Deposit Total	Interest 2013-14	Interest 2014-15	Interest 2015-16	Interest 2016-17	Interest 2017-18	Interest 2018-19	Interest 2019-20	Interest 2020-21	Interest 2021-22	Interest Total	G 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	**690.77**	**2,532.68**
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	**464.71**	**1,719.53**
3	DAMODA GRP OF MINES	00150100008869	109.74	115.22	120.99	127.03	133.39	140.06	147.06	233.90	44.75	**1,172.14**	3.33	10.59	20.44	28.14	33.23	44.40	57.63	72.89	46.39	**317.03**	**1,489.17**
4	AMAL MURAIDIH PHULARITAND PART	00150100012014							-	608.79	406.75	**1,015.54**							-	4.53	19.91	**24.44**	**1,039.98**
5	MADHUBAND UG MINE	469403800000280							227.89	12.65	17.77	**258.31**							0.07	12.21	13.55	**25.82**	**284.13**
	TOTAL		**565.01**	**593.26**	**622.92**	**654.07**	**686.77**	**721.12**	**374.95**	**855.35**	**469.27**	**5,542.72**	**13.63**	**54.72**	**105.16**	**144.62**	**168.81**	**224.68**	**296.03**	**322.72**	**192.40**	**1,522.77**	**7,065.49**
6	AMAL BLOCK II MINE	00150100009044	207.40	217.77	228.65	240.09	252.09	264.70	199.23	227.86	319.32	**2,157.10**	-	19.60	38.28	60.00	60.50	79.34	108.44	120.70	68.87	**555.73**	**2,712.83**
	TOTAL		**207.40**	**217.77**	**228.65**	**240.09**	**252.09**	**264.70**	**199.23**	**227.86**	**319.32**	**2,157.10**	**-**	**19.60**	**38.28**	**60.00**	**60.50**	**79.34**	**108.44**	**120.70**	**68.87**	**555.73**	**2,712.83**
8	MAHESHPUR COLLIERY	00150100008836	38.40	15.84	16.63	17.46	18.34	19.25	20.22	21.23	22.29	**189.66**	1.46	3.73	5.09	5.47	6.46	8.18	10.16	12.47	7.36	**60.37**	**250.03**
9	KHARKHAREE COLLIERY	00150100008824	16.02	16.82	17.66	18.54	19.47	20.44	21.46	22.53	23.66	**176.60**	0.61	1.56	3.00	3.75	4.84	6.49	8.40	10.62	8.61	**47.88**	**224.48**
10	JOGIDIH COLLIERY	00150100008823	39.85	8.58	9.01	9.46	9.94	10.43	10.96	11.50	12.08	**121.81**	1.52	3.87	4.61	4.55	5.05	6.12	7.34	8.77	6.79	**48.62**	**170.43**
11	GOVINDPUR UG	00150100008835	20.58	21.61	22.68	23.82	25.01	26.26	27.58	28.96	30.40	**226.90**	0.78	2.00	3.85	4.82	6.21	8.34	10.79	13.65	8.24	**58.68**	**285.58**
12	BLOCK IV /KOORIDIH MINE	00150100008834	100.83	105.87	111.16	116.72	122.56	128.68	135.12	141.88	148.97	**1,111.79**	3.84	9.80	18.85	23.62	30.45	40.85	52.86	60.69	34.82	**275.77**	**1,387.56**
13	NAKC	00150100008831	60.59	63.62	66.80	70.14	73.65	77.34	81.19	85.26	89.52	**668.11**	2.31	5.89	11.33	14.19	18.30	24.55	31.77	36.47	20.93	**165.72**	**833.83**
	TOTAL		**276.27**	**232.34**	**243.94**	**256.14**	**268.97**	**282.40**	**296.53**	**311.36**	**326.92**	**2,494.87**	**10.51**	**26.85**	**46.72**	**56.41**	**71.30**	**94.51**	**121.31**	**142.67**	**86.75**	**657.04**	**3,151.91**
14	AKWMC	00150100009051	189.04	198.50	208.42	218.84	133.38	140.05	147.05	154.40	162.12	**1,551.80**	-	17.87	34.89	54.69	55.14	66.54	85.62	93.34	52.38	**460.48**	**2,012.27**
15	AARC	00150100009053	51.05	19.48	20.45	21.48	97.27	102.13	107.24	112.60	118.23	**649.91**	-	4.82	6.48	8.62	7.47	14.42	23.00	32.32	20.43	**117.55**	**767.46**
16	SALANPUR UG MINE	00150100009050	84.13	20.08	21.09	22.14	44.47	46.69	49.02	51.47	54.05	**393.13**	-	7.95	9.65	12.05	10.61	13.91	19.03	24.10	14.17	**111.48**	**504.61**
17	KATRAS CHAITUDIH	00150100010086	-	82.12	86.23	90.54	114.64	120.37	126.39	132.71	-	**752.99**	-	-	6.09	14.12	22.62	33.77	37.45	49.05	30.03	**193.11**	**946.10**
18	GASLITAND COLLIERY	00150100011048	-	-	-	-	99.98	104.98	110.22	115.74	121.52	**552.44**	-	-	-	-	0.02	5.77	13.71	22.62	15.48	**57.60**	**610.03**
	TOTAL		**324.22**	**320.18**	**336.19**	**352.99**	**489.73**	**514.21**	**539.92**	**566.92**	**455.92**	**3,900.27**	**-**	**30.64**	**57.12**	**89.48**	**95.85**	**134.40**	**178.81**	**221.43**	**132.48**	**940.22**	**4,840.49**
19	NICHITPUR COLLIERY	00150100008825	99.66	104.64	109.88	115.37	121.14	127.20	133.56	67.81	71.20	**950.46**	3.79	9.68	18.64	23.35	30.09	40.37	52.25	63.18	35.46	**276.81**	**1,227.27**
20	TETULMARI COLLIERY	00150100008833	129.16	135.62	142.40	149.52	156.99	164.84	173.09	181.74	190.83	**1,424.19**	4.91	12.55	24.15	30.26	39.00	52.32	67.71	80.28	48.32	**359.52**	**1,783.71**
21	SENDRA BANSJORA COLLIERY	00150100008832	52.96	55.61	58.39	61.31	63.51	66.69	70.02	73.52	77.20	**579.21**	2.02	5.15	9.90	12.41	15.99	21.40	27.65	30.81	18.46	**143.78**	**722.99**
22	MUDIDIH COLLIERY	00150100008829	118.24	124.15	130.36	136.87	143.72	150.90	158.45	166.37	174.69	**1,303.75**	4.50	11.49	22.11	27.70	35.70	47.90	61.99	78.43	47.37	**337.19**	**1,640.94**
23	LOYABAD COLLIERY	00150100008826	83.75	19.73	20.72	21.75	22.84	23.98	25.18	26.44	27.76	**272.15**	3.19	8.14	9.82	9.80	10.98	13.37	16.12	19.33	11.19	**101.94**	**374.09**
24	KANKANEE COLLIERY	00150100010973	-	-	-	-	161.44	169.51	177.99	186.88	196.23	**892.05**	-	-	-	-	0.02	9.59	22.16	36.10	25.21	**93.09**	**985.14**
25	BANSDEOPUR COLLIERY	00150100011831							125.28	91.36	95.93	**312.57**							0.02	7.20	12.57	**19.79**	**332.36**
	TOTAL		**483.77**	**439.75**	**461.75**	**484.82**	**669.64**	**703.12**	**863.56**	**794.12**	**833.84**	**5,734.37**	**18.41**	**47.01**	**84.63**	**103.51**	**131.79**	**184.96**	**247.90**	**315.33**	**198.58**	**1,332.13**	**7,066.49**
26	KUSUNDA OCP	00150100008870	103.82	109.01	114.46	120.18	126.19	132.50	139.13	146.08	153.39	**1,144.77**	3.15	10.01	19.34	26.62	31.43	42.01	54.52	68.96	41.43	**297.47**	**1,442.24**
27	EAST BASSURIYA OC	00150100008876	48.31	50.72	53.26	55.92	58.72	61.65	64.73	67.97	71.37	**532.65**	1.47	4.66	9.00	12.39	14.63	19.54	25.37	32.09	19.27	**138.41**	**671.05**
28	DHANSAR(ADIC)	00150100008939	92.02	96.62	101.45	106.52	111.85	49.21	46.36	48.68	51.11	**703.83**	1.40	8.80	17.11	24.60	27.68	35.75	43.74	50.99	28.25	**238.30**	**942.13**
29	GODHUR GRP OF MINES	00150100009048	55.23	57.99	60.89	63.94	67.13	70.49	74.01	77.72	81.60	**609.01**	-	5.22	10.19	15.98	15.98	21.12	28.87	37.01	21.49	**155.87**	**764.88**
30	BASSURIYA UG MINE	00150100008944	151.88	5.91	6.21	6.52	6.85	7.19	7.55	7.92	8.32	**208.35**	2.30	14.52	15.03	15.18	13.60	14.47	16.87	18.98	10.18	**121.13**	**329.48**
31	GONDUDIH/KHAS KUSUNDA OC	00150100008875	134.40	141.12	148.18	155.59	163.37	171.53	180.11	189.12	198.57	**1,481.98**	4.08	12.96	25.04	34.46	40.69	54.38	70.58	89.28	53.63	**385.10**	**1,867.08**
32	ENA OCP	00150100008938	47.67	50.05	52.55	55.18	57.94	62.08	65.19	68.45	71.87	**530.97**	0.72	4.56	8.86	12.74	14.34	18.52	25.04	31.76	18.86	**135.40**	**666.37**
	TOTAL		**633.33**	**511.43**	**537.00**	**563.85**	**592.04**	**554.66**	**577.08**	**605.94**	**636.23**	**5,211.55**	**13.11**	**60.73**	**104.57**	**141.97**	**158.35**	**205.79**	**264.99**	**329.07**	**193.10**	**1,471.68**	**6,683.23**
33	PB GRP OF MINES	00150100009045	84.91	34.30	36.02	37.82	39.71	41.70	43.78	45.97	48.27	**412.47**	-	8.03	10.95	14.69	13.58	16.77	22.00	27.01	15.49	**128.51**	**540.98**
34	BURRAGARH UG	00150100008821	6.67	7.00	7.35	7.72	8.11	8.51	8.94	9.38	9.85	**73.53**	0.25	0.65	1.25	1.56	2.01	2.64	3.31	4.18	3.56	**19.42**	**92.95**
35	HURRLADIH UG	00150100008820	8.49	7.22	7.58	7.96	8.35	8.77	9.21	9.67	10.16	**77.41**	0.32	0.83	1.44	1.56	2.20	2.85	3.55	4.46	3.79	**20.99**	**98.40**
36	BHUTGORIA UG	00150100008818	7.43	7.80	8.19	8.60	9.03	9.48	9.95	10.45	10.97	**81.90**	0.28	0.72	1.39	1.74	2.24	2.94	3.69	4.66	3.97	**21.64**	**103.54**
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	**72.92**	**183.27**
38	GOPALICHOK MINE	00150100010972	-	-	-	-	61.76	64.85	68.09	71.49	75.07	**341.26**	-	-	-	-	0.01	3.67	8.48	13.81	9.64	**35.61**	**376.87**
39	KENDWADIH OC MINE	00150100011209						56.76	59.59	62.57	65.70	**244.62**						0.02	3.49	7.59	9.59	**20.70**	**265.32**
	TOTAL		**182.99**	**67.38**	**70.75**	**74.29**	**126.96**	**190.06**	**199.56**	**209.54**	**220.02**	**1,341.54**	**3.73**	**17.56**	**23.31**	**27.42**	**28.52**	**38.10**	**54.56**	**72.70**	**53.90**	**319.80**	**1,661.33**

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	Total	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	Total	
40	BASTACOLLA COLLIERY	00150100008877	20.63	21.67	22.75	23.89	25.08	26.33	27.65	144.06	176.27	**488.32**	0.63	1.99	3.84	5.29	6.25	8.35	10.84	13.71	12.09	**62.98**	**551.29**
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	**114.48**	**390.30**
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	**209.56**	**1,363.32**
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	**208.27**	**846.19**
44	SIMLABAHAL COLLIERY	00150100008822	11.27	8.42	8.84	9.28	9.75	364.76	127.50	133.87	140.57	**814.25**	0.43	1.10	1.82	2.15	2.69	3.54	27.57	38.67	25.11	**103.07**	**917.32**
45	KUYA GRP OF MINES	00150100008874	165.03	173.29	181.95	191.05	200.60	138.22	145.13	152.38	160.00	**1,507.65**	5.01	15.92	30.74	42.32	49.97	66.77	81.95	94.48	54.65	**441.80**	**1,949.45**
46	RAJAPUR S/JHARIA OCP	00150100008937	73.81	77.50	81.37	85.44	89.72	94.20	150.17	175.24	231.15	**1,058.60**	1.12	7.05	13.73	19.73	22.20	28.68	38.66	46.46	29.10	**206.72**	**1,265.32**
	TOTAL		**403.29**	**420.04**	**607.19**	**637.55**	**631.16**	**845.35**	**734.33**	**769.17**	**888.24**	**5,936.32**	**9.93**	**38.92**	**74.80**	**117.76**	**142.11**	**191.14**	**267.77**	**315.95**	**188.49**	**1,346.87**	**7,283.19**
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	**4,273.48**	-	36.63	71.53	112.12	113.05	148.26	202.67	222.21	129.54	**1,036.01**	**5,309.50**
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	**22.65**	**62.81**
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	**151.32**	**393.84**
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	**70.43**	**188.18**
51	KUJAMA COLLIERY	00150100008941	45.50	47.77	50.16	52.67	55.30	58.06	60.97	64.02	67.22	**501.65**	0.69	4.35	8.46	12.16	13.68	17.68	23.82	30.14	17.87	**128.85**	**630.50**
52	AMALGAMATED JOYRAMPUR OC	00150100011026	-	-	-	-	560.98	585.04	614.29	645.01	677.26	**3,082.58**	-	-	-	-	0.09	36.92	76.97	125.13	86.33	**325.44**	**3,408.02**
	TOTAL		**677.15**	**504.30**	**529.52**	**555.99**	**1,087.36**	**1,137.74**	**1,194.63**	**1,254.36**	**1,317.08**	**8,258.14**	**4.11**	**64.29**	**107.56**	**155.54**	**156.95**	**234.18**	**338.86**	**416.24**	**256.97**	**1,734.71**	**9,992.84**
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	**59.21**	**152.95**
54	BHOWRA(N) GRP OF MINES	00150100008868	136.22	143.03	150.18	6.88	7.23	7.59	7.97	73.21	-	**532.28**	4.13	13.14	25.37	34.93	31.88	34.97	38.70	35.25	19.93	**238.30**	**770.59**
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	**1,537.17**	21.44	54.76	72.88	68.24	72.74	85.13	95.39	107.17	59.00	**636.74**	**2,173.91**
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	**153.42**	**542.64**
57	AMALGAMATED SUDAMDIH PATHERDIH	00150100011524						-	13.60	50.08	52.58	**116.26**						-	0.00	0.86	3.94	**4.80**	**121.07**
58	SUDAMDIH SHAFT MINES	00150100011673							174.22	-	-	**174.22**							0.03	10.60	10.95	**21.58**	**195.80**
	TOTAL		**821.23**	**420.42**	**306.43**	**170.95**	**179.50**	**127.94**	**385.92**	**247.51**	**183.01**	**2,842.89**	**29.26**	**79.62**	**115.57**	**124.50**	**128.31**	**150.53**	**172.52**	**195.95**	**117.80**	**1,114.06**	**3,956.95**
59	MOONIDIH UG PROJECT	00150100008943	82.18	86.29	90.60	95.13	99.89	104.88	54.44	85.69	89.97	**789.08**	1.25	7.85	15.28	22.33	24.35	31.93	43.02	48.32	27.51	**221.84**	**1,010.92**
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	**346.35**	-	2.97	5.80	9.09	9.16	12.02	16.43	20.79	12.21	**88.46**	**434.81**
61	LOHAPATTY COLLIERY	00150100009043	267.70	281.08	140.03	147.03	154.38	162.10	170.21	178.72	187.65	**1,688.89**	-	25.30	49.41	64.37	59.75	76.88	90.27	109.53	64.17	**539.67**	**2,228.56**
	TOTAL		**381.28**	**400.35**	**265.26**	**278.53**	**292.45**	**307.07**	**266.74**	**308.60**	**324.03**	**2,824.32**	**1.25**	**36.13**	**70.48**	**95.78**	**93.27**	**120.82**	**149.72**	**178.63**	**103.89**	**849.97**	**3,674.28**
62	BASANTIMATA COLLIERY	00150100008827	121.88	28.90	30.34	31.86	33.45	35.12	36.88	38.72	40.66	**397.81**	4.64	12.02	14.33	14.30	16.02	19.53	23.55	28.25	16.35	**148.98**	**546.79**
63	DAHIBARI BASANTIMATA OCP	00150100008828	128.57	135.00	141.75	148.84	156.28	164.09	172.30	180.91	189.96	**1,417.70**	4.89	12.49	24.04	30.12	38.82	52.09	67.41	73.91	44.29	**348.06**	**1,765.76**
64	KALYANESHWARI GRP OF MINES	00150100009042	209.61	220.09	231.09	242.65	254.78	234.28	246.00	458.54	481.46	**2,578.50**	-	19.79	38.68	60.64	60.69	80.16	107.41	117.37	71.96	**556.69**	**3,135.19**
65	BEGUNIA COLLIERY	00150100011365					-	110.92	-	-	-	**110.92**						0.04	6.80	7.47	6.91	**21.22**	**132.15**
	TOTAL		**460.06**	**383.99**	**403.18**	**423.35**	**444.51**	**544.42**	**455.18**	**678.17**	**712.08**	**4,504.93**	**9.53**	**44.30**	**77.05**	**105.06**	**115.54**	**151.81**	**205.17**	**227.00**	**139.51**	**1,074.96**	**5,579.89**
	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**	**50,749.01**	**113.47**	**520.36**	**905.26**	**1,222.04**	**1,351.30**	**1,810.27**	**2,406.08**	**2,858.39**	**1,732.75**	**12,919.92**	**63,668.94**

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.

CHAPTER – I

INTRODUCTION

1.0 Introduction

Maheshpur colliery is situated in the Western Part of Jharia Coal Field under administrative control of Govindpur Area-III, BCCL. It lies at a distance of about 28 Km from Dhanbad Railway Station. Maheshpur Colliery has a leasehold area of 292.68 Ha. The mine is presently producing 180 TPD coal from VIIIA (IXB) seam (Sinidih Section) through 10A Seam No. I, 2 &3 Inclines by Bord & Pillar Method of Mining (Caving).

The present Maheshpur colliery has been formed after of following units from west to east:

- Maheshpur Section
- Sinidih Section
- New Sinidih section(part)
- Tundu Khas section(part)
- Kharkharee section(part)

This Mine Closure Plan has been prepared on the basis of Approved Feasibility report & TOR/Form – I and data furnished by the officials of Govindpur Area/ BCCL.

1.1 Name of mine owner / company

Project :	Maheshpur Colliery
Area :	Govindpur Area
Company :	BCCL
Mine Owner :	Director (Technical)(Operation), BCCL (Nominated)

1.2 Address for Communication with PIN and Phone nos.

PO :	Maheshpur
District :	Dhanbad
State :	Jharkhand
PIN :	828125

1.3 Location of mine:

Latitude: 23º46'30" to 23º47'15" N

Longitude: 86º14'15" to 86º15'45" E

Area : Govindpur Area

Coalfield : Jharia Coalfield

1.4 Capacity of the mine

Date of start of development work: 1946

Date of start of production: 1946

The present production of coal is 180TPD.

1.5 Method of Mining including Equipment deployment

The gradient of seam is 1in 7 suitable for deployment of SDLs. The coal is won by solid blasting method and loaded by SDL machine onto tubs. The loaded tubs are handled by a tugger haulage which consecutively feeds to main direct haulage installed on the surface which discharges the coal at the loading point.

1.6 Coal Processing/ Beneficiation Operation

No coal processing/beneficiation is envisaged for the current output of the mine.

1.7 Total Lease Area Involved :- 292.68 Ha

1.8 Type of Lease Area (Ha) :-

Table 1.1 Type of Lease Area

Sl. No.	Particulars	Mining Area(Ha)	Outside mining area(Ha)	Total(Ha)
1	BCCL land (through LA Purchase & Agreement)	19.44	Nil	19.44
2	Vested Land	156.06	Nil	156.06
3	Railway Land	5.35	Nil	5.35
4	Govt. Land	31.21	Nil	31.21
5	Forest Land	6.45	Nil	6.45
6	Private Land	71.17	Nil	71.17
	Total (Mine fed data)	**292.68**	**Nil**	**292.68**

1.9 Communication and Physiography

The colliery is about 33Km West from Dhanbad town and is well connected by rail and road. Tundu Railway Station lies in the leasehold area of the colliery.

The area has a general undulating topography with gentle slope towards southerly flowing Kali Jore. The maximum elevation in the area is around 226m is observed in the Western corner while the lowest is around 159 m, above the MSL in the south-eastern part of the project area.

1.10 Type of Present and proposed land use of mining area (Ha)

Table 1.2 Land Use of Mining Area

Sl.No.	Type of land use	Present mining land use (in Ha)	Proposed mining land use (in Ha)
1	Running Quarry	0	0
	Backfilled	0	0
	Not Backfilled	0	0
2	Abandoned Quarry	0	0
	- Backfilled	2.5	2.5
	- Not Backfilled	2.87	0
3	External OB dump	0	0
4	Service building/ Mine Infrastructure	0.8	0.8
5	Coal dump	2	2
6	Homestead Land	42	42
7	Agricultural Land	89.24	89.24
8	Forest Land	0	0
9	Plantation / reclamation	0	28
10	Water Body	6.95	9.82
11	Barren Land	146.32	118.32
12	Others	0	0
	Total	**292.68**	**292.68**

1.11 Statutory Approvals

Table 1.3 Statutory Approval Status

Sl. No	Particulars	Status
A	Mine plan / F.R / P.R	Formulated for the purpose of TOR only
B	Forestry clearance	Obtained
C	Env clearance	NA
D	Consent to operate	Existing Mine
E	Any other approval from Central / State regulatory authorities for operating mine with special reference to mine closure.	Mine closure plan to be approved by BCCL Board of Directors.

1.12 Reasons for Closure

The mine leasehold can be divided into two parts by E-W trending 90-120 m throw fault. The mine workings on north of the fault have been done in Maheshpur, Sinidih, New Sinidih and Tundu Khas Sections on B&P method. The surface area is heavily built up on north of the fault. Wherever, free area was available seams have been depillared with caving. The other areas are mostly SOP and waterlogged.

At present, B&P (SDL), depillaring with caving is going on in VIII A (IX Bot) seam (Sinidih Section). The seam has extractable reserve of only .04 MTe in free area which can last for about a year. Subsequently, it is proposed to develop V/VI/VII seam (Maheshpur Section) through a drift from VIII A seam. The reserves estimated in V/VI/VII seam (Maheshpur Section) for development are about 1.5 MT. Once these reserves are exhausted, the mine may not have reserve to continue economic
production by underground method. There may be a proposal to work the SOP reserves by opencast subject to removal of surface constraints. If so happens, a fresh new Mine Closure Plan will be submitted incorporating all the changes. Thus, keeping in view the available reserves in the seams considered for operation and present mine capacity, the remaining life of the mine will be 26 years.

The mine may be closed in future on account of exhaustion of economically recoverable coal reserves in the lease hold area. The mine may also be closed on account of other unforeseen reasons i.e. Force Majeure or directives from statutory organizations or court etc. for which information and notices shall be served to concerned Government authorities and departments. As per guidelines of Ministry of Coal, Govt. of India, Mine Closure Plan has to be submitted along with the mine plan for getting competent approval within one or two years of date of approval of mine plan.

1.12.1 Need of Mine Closure Planning

Mining is a hazardous operation as it offsets the equilibrium of natural depositional environment viz. In-situ stress field, ground water, surface drainage system as well as the socio-economic condition. Although mining activities are usually short term phenomena, they are liable to leave long lasting impacts on landscape, ecology and on the mind set of local inhabitants. Thus, it is imperative that any mining venture should have adequate closure plan addressing issues viz. reclamation and environmental protection, rehabilitation of disturbed area which should be acceptable to local community as well as regulatory authority. Community acceptable implementation of mine closure plan will incur some extra cost, neglecting this aspect will lead to future problems of attending compensation or expensive socio-economic problems.

Mine closure encompasses restoration process designed to restore physical, chemical and biological quality, disturbed by the mining activities. Mine closure is not just something that happens at the end of a mine's life rather mine closure is an ongoing series of decisions and activities beginning in the pre-mining stage of mine and ending with a creation of self sustainable site that can be returned to the community.

Thus, a mine closure plan needs to define the liabilities, responsibilities and authorities of the different agencies like the mine management, other regulatory bodies, Central and State Governments after mine closure.

Various objectives of the advance mine closure planning are as given below.

a. To allow productive and sustainable after-use of the site, which is acceptable to the mine owner and the regulatory authority
b. To protect public health and safety
c. To eliminate environmental damage and thereby encourage environmental sustainability
d. To minimize adverse socio-economic impacts of mining activities
e. To protect the flora and fauna of the area affected by the mining
f. Effective use of the assets created during the course of mining

Primarily, the mine closure activities are planned in two stages. The initial plan identifies the activities required to be executed in line with the mining activities in progress after the inception of the project i.e., progressive mine closure activities. These activities may undergo subtle changes depending upon the actual site condition during implementation. Finally, a detailed closure plan is to be prepared 4-5 years before the actual closure time of the mine depending upon the existing parameters at that point of time, i.e., final mine closure activities.

1.12.2 Mine closure planning strategy in respect of Maheshpur Colliery based on existing set of parameters

As the balance life of the mine is 26 years from now for the seam being considered for mining at present, following activities are envisaged towards mine closure programme in respect of Maheshpur Colliery.

a) Progressive mine Closure: Progressive Mine Closure Plan would include various land use activities to be done continuously and sequentially during the entire period of the mining operations. Progressive closure activities will continue as envisaged in the Feasibility report and as enumerated in the various approvals, permits, consents etc.

   The recent guidelines issued in this regard by MoC, GoI should also be followed.

b) Final Mine Closure Plan: Although, it is very difficult to foresee the likely impacts due to closure of the mining activities in the leasehold area of the project, but in the present report, the same has been estimated and some mitigating measures have been suggested based on the estimates. These suggested measures along with certain other measures, as deemed fit, at the time of closure of mining activity in the seams being worked at present shall be taken up.

c) The final closure plan carrying the finer details would be prepared at the time of preparing the mine plan for last mineable patch of coal seam in the leasehold area of the project.

1.13 Approval of Company Board of Directors or any other competent authority (Attach Copy)

The closure plan will be placed to Board of Directors of BCCL for approval.

CHAPTER – II

MINE DESCRIPTION

2.1 Geology of the Block

Geology of the mine has been established by surface and sub surface data from Geological Report of 1) Kharkharee Block, 2) Dharmaband Block & 3) Opencast Block-III. Maheshpur Colliery is located in the west central part of Jharia Coalfield. The area is occupied by strata of Barakar formations containing Coking and Non-coking coal seams. The area is mostly under soil cover and good outcrops are rare.

Altogether 20 boreholes have been drilled in Maheshpur colliery area. Out of these, 9 boreholes have been drilled by MECL in two different series i.e. DB & KH, with total meterage of 1544.60m & 2362.95m respectively. 11 boreholes of MK series have been drilled by CMPDI with total meterage of 2625.90m. The period of drilling of boreholes is from September'1976 – April' 1984 in various phases. The details of boreholes are given below in the table:-

Table-2.1: Details of Boreholes

SERIES	DRILLING AGENCY	NO. OF BOREHOLES	METERAGE
MK	CMPDI	11	2625.90
DB	MECL	4	1544.60
KH	MECL	5	2362.95
TOTAL		20	6533.45

2.1.1 Geological Structure of the area

Strike & Dip

In general, the strike of the formation is NE-SW and dip varies from 3° to 26° due south.

Faults

Six no.s of fault have been interpreted in this area. The throw of the fault varies from 10m to 120m. However, faults having throw less than 5m could not be ruled out in the area.

Table-2.2 Details of the Fault

Sl. No.	Fault	Location	Strike	Max. Throw (m)	Nature	Evidence
1.	F3-F3	Eastern part of the area	ENE-WSW	15/S	Strike fault	Reduction of parting between Seam XII & L-2 in DB-20
2.	F9-F9	East central part of the area	N-S	10/E	Dip fault	Roof of seam IX/X in MK-6
3.	F20-F20	Central part of the area	ENE-WSW	120/S	Curvilinear Oblique fault	1)Stoppage of working of seam XIII in the colliery 2)Omission of seams V/VI/VII to VIIIC in MK-7
4.	F21-F21	Central part of the area	ENE-WSW	40/S	Curvilinear Oblique fault	Drag effect seen near B.H. MK-1
5.	F23-F23	Southern part of the area	ENE-WSW	20/S	Curvilinear Oblique fault	Drag effect & high dip in the area between B.H. KH-16 & KH-17
6.	F30-F30	South western part of the area	WNW-ESE	10/S	Curvilinear Oblique fault	Omissin of seams XIV/XV (part) in B.H. No. MK-2

Igneous Intrusion / Pyrolitization

The coal seams of the area have been intruded by two dolerite dykes:

Maheshpur Dyke- 40m thick dyke located in the western part of the area dipping 80° / SE.

Tundu Dyke- 30m thick dyke located in the central part of the colliery.

2.1.2 General Description of coal seams and its quality:

In Maheshpur Colliery, detailed drilling has proved existence of number of coal seams from XVIIA to I seam.

2.1.3 Seam sequence

The generalized sequence of coal seams and the intervening partings in Maheshpur mine area is as follows

Table-2.3 Generalised Seam Sequence and Parting/Quality

SEAM	THICKNESS (m)		AVERAGE THICKNESS (m)	DEPTH RANGE (m)	NO. OF FULL SEAM INTERSECTIONS	GRADE
	MINIMUM	MAXIMUM				
XVIIA	1.98 (DB-15)	4.40 (KH-3)	3.19	0-35	2	N.A.
P	36	41	-	-	--	-
XVII	0.64 (DB-15)	1.55 (KH-8)	1.10	0-80	3	W-I to W-IV
P	64	79	-	-	-	-
XVIE	0.50 (KH-3)	1.68 (KH-15)	1.09	0-160	8	UG
P	6	20	-	-	-	-
XVIC	3.26 (MK-8)	5.81 (KH-16)	4.54	0-180	8	N.A.
P	2	3	-	-	-	-
XVIB	0.59 (DB-15)	1.10 (DB-30)	0.85	0-185	4	W-I to W-II
P (XVIC with XVIA)	27	33	-	-	-	-
P (XVIB with XVIA)	22	24	-	-	-	-
XVIA	0.24 (MK-10)	1.01 (KH-15)	0.63	0-210	10	W-III to UG
P	17	37	-	-	-	-
XVI	0.95 (DB-14)	4.59 (KH-8)	2.77	0-245	12	W-III to UG
P	16	24				
XV	0.92 (KH-15)	4.79 (KH-8)	2.86	0-270	11	S-I to W-IV
P (XVI with XIV/XV)	16	21	-	-	-	
XIV/XV	1.05 (MK-1)	4.11 (MK-2)	2.58	<270	3	W-II to W-IV
P (XV with XIV)	1	5	-	-	-	-
XIV	0.41 (KH-17)	1.63 (KH-15)	1.02	0-275	10	W-II to UG
P (XIV with XIII)	41	63	-	-	-	-
P (XIV/XV	47	53	-	-	-	-

SEAM	THICKNESS (m)		AVERAGE THICKNESS (m)	DEPTH RANGE (m)	NO. OF FULL SEAM INTERSECTIONS	GRADE
	MINIMUM	MAXIMUM				
with XIII)						
XIII	1.90 (MK-1)	4.89 (KH-15)	3.40	0-340	12	W-III to W-IV
P (XIII with XI/XII)	16	22	-	-	-	-
XI/XII	6.40 (KH-3)	7.46 (MK-2)	6.93	<365	2	W-IV
P (XIII with XII)	12	17	-	-	-	-
P (XIV with XII)	59	-	-	-	-	-
XII	0.89 (DB-15)	2.87 (KH-17)	1.88	0-365	9	W-I to W-IV
P (XV with XI)	35	-	-	-	-	-
P (XIII with XI)	38	50	-	-	-	-
P (XII with XI)	6	19	-	-	-	-
XI	0.58 (MK-1)	2.37 (MK-9)	1.48	0-385	10	W-I to UG
P (XI/XII with IX/X)	42	-	-	-	-	-
P (XII with IX/X)	65	-	-	-	-	-
P (XI with IX/X)	38	42	-	-	-	-
IX/X	3.42 (MK-8)	7.74 (KH-15)	5.58	0-425	6	W-IV to UG
P (XIII with X)	75	-	-	-	-	-
P (XII with X)	60	-	-	-	-	-
P (XI with X)	22	42	-	-	-	-
X	1.20 (DB-30)	2.11 (DB-23)	1.66	<365	6	W-IV/E
P (XI with IX)	39	45	-	-	-	-
P (X with IX)	1	9	-	-	-	-
IX	2.07 (MK-10)	8.79 (KH-17)	5.43	<375	8	W-II to UG
P (XI/XII with VIIIC)	27		-	-	-	-
P (IX/X with VIIIC)	12	21	-	-	-	-
P (IX with VIIIC)	10	19				
VIIIC	0.46 (DB-14)	3.55 (MK-2)	2.00	0-395	18	W-III to UG/D-E
P	5					

SEAM	THICKNESS (m)		AVERAGE THICKNESS (m)	DEPTH RANGE (m)	NO. OF FULL SEAM INTERSECTIONS	GRADE
	MINIMUM	MAXIMUM				
VIIIB	0.46 (MK-6)	5.70 (KH-3)	3.08	0-405	16	W-II to UG/D-F
P (IX with VIIIA)	44	-	-	-	-	-
P (VIIIC with VIIIA)	19	-	-	-	-	
P (VIIIB with VIIIA)	1	12	-	-	-	-
VIIIA	1.35 (DB-30)	4.68 (KH-15)	3.02	10-410	18	W-I to UG
P	20	31	-	-	-	-
VIII	0.56 (MK-4)	2.74 (MK-1)	1.65	40-440	7	W-IV to UG
P (VIIIA with V/VI/VII)	32	52	-	-	-	-
P (VIII with V/VI/VII)	7	14	-	-	--	-
V/VI/VII	21.21 (DB-14)	28.05 (KH-16)	24.63	50-460	15	UG/C-F
P (V/VI/VII with IV)	26	28	-	-	-	-
IV	0.32 (MK-3)	0.96 (MK-11)	0.64	105-485	2	UG
P (V/VI/VII with IVT)	10	12	-	-	-	-
IV T	1.64 (DB-23)	2.26 (DB-15)	1.95	<495	2	G
P	13					
IV B	1.64 (DB-23)		1.64	<510	1	UG
P (IV with III)	23	34	-	-	-	-
P (IV T with III)	44	-	-	-	-	-
P (IV B with III)	22	-	-	-	-	-
III	4.03 (DB-23)	4.88 (DB-15)	4.46	120-545	5	UG/F-G
P	12	22				
II	0.85 (MK-7)	1.79 (MK-11)	1.32	140-560	3	W-I to W-IV
P (III with I)	16	-	-	-	-	-
P (II with I)	2	14	-	-	-	-
I	0.20 (MK-3)	2.75 (MK-7)	1.48	150-570	4	W-II to W-IV

2.1.4 Reserves, types and quality

Balance mineable reserves for considered seam VIIA (IXB) Sinidih Section have been given in the Table 2.4

Table-2.4 Seam Thickness, Grade & Reserve

Seam	Thickness (m)	Quality	Reserve (Mte)#	Remarks
VIIIA (IXB) (Sinidih Section)	3.02	W-III	0.04	Caving
V/VI/VII (Sinidih Section) (Proposed)	27.0	W-IV	1.5	Only Development
All lower seams are virgin.				
Total			**1.54**	

Data as furnished by the mine officials

2.2 Mining Details

2.2.1 Mine boundary details

The boundary of Maheshpur colliery is outlined by following collieries:

North:- Jogidih Colliery

West :- Phularitand Colliery

South :- Kharkharee and Dharmaband Collieries

East:- South Govindpur Colliery

2.2.2 Working Seams

Table 2.5 Present Workings

Seam.	Grade	Production outlet	Method of work	Production (TPD)
VIII A(IX B)	W-III	No. I Incl	B&P Dep©	180
Total				180

2.3 Mining Methods

Transport - Combination of Direct and Tugger haulages.

Ventilation - By Exhaust Fan at surface.

The present ventilation system of the Mine is given in Table 2.6

Table 2.6 Present Ventilation System

Seam	Intake Outlet	Return Outlet	Fan Type	Quantity (m3/min)	Pressure (mm WG)
IXT & B Seams	No. 1,2 & 3 Inclines	Air Shaft	AF-65 (Exhaust)	2400	17.5

Present status

At present depillaring by Bord & Pillar method is going on in VIIIA (IXB) seam using SDLs.

Table No. 2.7 Seam wise status of Working

Seam	Status				
	Maheshpur Section	**Sinidih Section**	**New Sinidih Section**	**Tundu Khas Section**	**Kharkharee Section**
XV		The seam has been worked in two small isolated patches BN. The workings are SOP and waterlogged. No outlets exist.		NA	NA
XIV	-	NA	The seam has been worked in a small patch BN. The workings are SOP and waterlogged.	NA	NA
XIII	The seam has been worked BN in two patches and caved.	NA	The seam has been worked in an isolated small patch BN. The workings are SOP and waterlogged.	NA	NA
XI/XII	The seam has been worked BN in two patches and caved. May be waterlogged.	The seam has been worked in an isolated small patch BN. The workings are SOP and waterlogged.	The seam has been worked in an isolated small patch BN. The workings are SOP and waterlogged.		NA
IX/X	**The seam has been worked in the entire property on the north of 90 m throw fault**				NA

Seam	Status				
	Maheshpur Section	Sinidih Section	New Sinidih Section	Tundu Khas Section	Kharkharee Section
	The seam has been developed, depillared partly with caving and rest standing on stooks. The outcrop zone has been quarried out. Unapproachable	The seam has been developed, depillared partly with caving and rest standing on stooks/SOP. The outcrop zone has been quarried out. The dipside is waterlogged.Unapproachable	The seam has been developed through Pits, SOP and waterlogged. Pits are filled up. The outcrop zone has been quarried out. The dipside is waterlogged.Unapproachable	Outcrop quarried out and filled up. Quarry extended into South Govindpur mine.	
VIIIC(XA)	**The seam has been worked in the entire property on the north of 90 m throw fault**				NA
	Worked through inclines in the entire section, partly caved and rest SOP. The SOP workings are waterlogged. The inclines are filled up.	Developed through 10 A Inclines(1,2&3) and fully developed. The developed workings have been partly depillared with caving and rest SOP. SOP workings are waterlogged on dip side. The workings are unapproachable.	Virgin	Virgin	
VIII B(IX Top)	**The seam has been worked in the entire property on the north of 90 m throw fault**				NA

Seam	Status				
	Maheshpur Section	Sinidih Section	New Sinidih Section	Tundu Khas Section	Kharkharee Section
	Worked through Incline Nos. 1 & 2 in the entire section, small area depillared with caving and rest SOP. The SOP workiings are fully waterlogged upto DC Railway line. The No. I incline is open while No. 2 Incline is temporarily filled up and can be reopened if required. The galleries(3 nos.) beneath the DC Railway line are required to be filled up as per conditions stipulated by DGMS.	Developed through 10 A Inclines(1,2&3) through drift from VIII C seam. The seam has been fully developed. The developed workings have been partly depillared with caving and rest SOP. SOP workings are waterlogged on dip side.	Developed through 10 A Inclines(1,2&3) through drift from VIII C seam. The seam has been fully developed and SOP.	Developed through 10 A Inclines(1,2&3) through drift from VIII C seam. The seam has been fully developed and SOP.	
VIIIA(IX B)	Worked through Incline Nos. 1 & 2 in the entire section through drifts from VIII B Seam. A small area depillared with caving and rest SOP. The SOP workiings are fully waterlogged upto DC Railway line. The No. I incline is open while No. 2 Incline is temporarily filled up and can be reopened if required. The galleries(3 nos.) beneath the DC Railway line are required to be filled up as per conditions stipulated by DGMS.	Developed through 10 A Inclines(1,2&3) through drift from VIII C seam. The seam has been fully developed. The developed workings have been partly depillared with caving and rest SOP. SOP workings are waterlogged on dip side.	Developed through 10 A Inclines(1,2&3) through drift from VIII B seam. The seam has been fully developed and SOP.	Developed through 10 A Inclines(1,2&3) through drift from VIII B seam. The seam has been fully developed and SOP.	NA
All the lower seams below VIIIA seam are virgin.					

2.3.1 Depth of Workings

The working seams occur at depth of about 100m in the colliery.

2.3.2 Mine Entries

Table 2.8 Present Mine Entries

Name of the Outlet	Sunk in Seam	X-sec. (mXm)	Purpose	winder/ Fan
No. 1 Incline	XA	4.0X2.5	Intake, production.	Haulage – 150 HP
No. 2 Incline	XA	3.5X2.5	Intake, travelling	
No. 3 Incline	XA	3.0X2.5	Intake	
Air Shaft	IX Top	3.0 (Dia.)	Return	Fan- AF-65

Development

Bord and Pillar method of development has been proposed in the seam with SDLs loading onto tubs. Exploitation of seam has been considered as long as the developmental reserve is available in the seam. The development district will consist of 5 level headings as far as possible leaving a panel barrier of one pillar width between the panels. The development shall be carried out by blasting off the solid. The width & height of the development galleries shall be restricted to 4.8/4.2 m & 3 m respectively. The depth of working as per the provision of Regulation 99 (4) of CMR 1957 shall govern the size of the pillar.

The panels shall be laid out in a manner, as far as possible, to be self draining. The incubation period of coal seam shall be taken into account for sub-panelling, wherever required.

Coal loading at the face will be done by mean of SDL and loaded into tubs. Then the loaded tubs will be hauled by tugger haulage for onwards feeding to main level district haulage which will feed the tubs to the surface haulage line and from where tubs hauled up to the surface.

The cycle of face operation in mechanized Bord and Pillar mining would be as follows:

a. Face preparation
b. Drilling
c. Charging, blasting and smoke clearing
d. Dressing and supporting
e. Machine fitting SDL
f. Coal loading by SDL
g. Face supporting,

2.3.3 Major Equipment

Surface – Haulage-150 HP -1 No, V. Fan- AF-65- 1 No.,
Pump- 50 HP- 2No, 12HP- 1 No.
Power Transformer- 500 KVA, 11KV/550V- 2 Nos
1000 KVA-11V/550V – 1 No.
300 KVA-11V/440V – 1 No

U.G. – Tugger-50 HP.- 3 Nos, Pump-112 KW-3 Nos, E/Haulage-40 HP-1 No. Coal drill machine with panel- 3 Nos.

2.4 Infrastructure Details

Workshop & Store:

A small workshop is available in the Mine. Repairing of tubs and welding/drilling/turning etc are being done at colliery workshop. Major repair work related to pumps and motors are done at Area Level workshop.

Magazine – Location , capacity and area

There is no Magazine available in the Mine. The requirement of explosive and detonator of the mine is met from the Jogidih Magazine. The details of Jogidih Magazine is as below :

Location ; Jogidih, PO-Tundoo, Dhanbad
Capacity : Exp-900 Kg, Detonator-4400 Nos., P.fuse : 2000M.

Infrastructure facilities available (Road, water supply etc.) –

D.B Road - Katras- Mohuda DB Road passes through the Mine.

Company's Road. – Network of colliery roads exist in the leasehold of the Mine.

Water supply – Drinking water is supplied from Water Filter Plant of the Mine (156 KLD). For other miscellaneous domestic work Pit water is supplied (194 KLD).

Nos. of coal stock yard & location –

There are 1 No. of Coal stock yards in the mine. The details are as below :

I) Site No1, new VIII C incline

Existing effluent treatment plant & sewage treatment plant (Mine & Colony) – At present there is no ETP & STP available in the mine. Sewage water discharged through septic tank and soak pit.

Present power supply :

Source - D.V.C.

Feeder No. 16 (Kharkharee SS) to Sinidih Sub-station- 11KV/550V.

i) Surface lighting – 440V

ii) Pump (3 Nos) – 550 V

iii) U.G. -550 V

Feeder No. 16 (Kharkharee SS) to Maheshpur S/Stn – 11KV/550V

i) Surface lighting – 440 V

ii) Pump (3 Nos) - 550 V

Sinidih & Maheshpur Sub-stations cater the load of the Mine.

Details of transformer are as below :

1.500KVA ,11KV/550V -1 No. -UG Pumps (2 Nos.)& Surface Haulage

2. 500KVA,11KV/550V-1 No - UG(Haulage,Roto pump),Surface- Fan & Other loads

3. 300KVA,11KV/440V-1 No - Surface lighting

4. 1000KVA,11KV/550V-1 No - UG Pumps (1 No.)& Surface- Fan (Maheshpur section), Surface Pump(2), Work shop

Sl. No-1,2&3 are installed in Sinidih Sub-station and Sl. No.-4 is installed in Maheshpur Sub-station.

Spare Capacity (Total)– 500 KVA

2.5. Details of coal beneficiation plant and its use after closure of mine

No beneficiation plant is present in the leasehold area of the boundary.

CHAPTER – III

CLOSURE PLAN AND RELATED ACTIVITIES

3.1 Closure Planning details of mine

The progressive mine closure activities will continue as envisaged in the Feasibility Report prepared for the purpose of TOR and as enumerated in the various approvals, permits, consents etc. The recent Govt. guidelines in this regard would also work as guiding principles. It is very difficult to predict the various parameters which would be prevalent at the time of final mine closure and also to foresee the likely impacts due to closure of the mining activities (when the entire block reserve would get exhausted). However, broad mine closure activities need to be identified under the various heads.

Maheshpur Colliery falls in Cluster III for the purpose of EMP.

3.1.1 Mined out Land & proposed final land use

Management of mined out area

a) The mine leasehold can be divided into two parts by E-W trending 90-120 m throw fault. The mine workings on north of the fault have been done in Maheshpur, Sinidih, New Sinidih and Tundu Khas Sections on B&P method. The surface area is heavily built up on north of the fault. Wherever, free area was available seams have been depillared with caving. The other areas are mostly SOP and waterlogged.

   At present, B&P (SDL), depillaring with caving is going on in VIII A (IX Bot) seam (Sinidih Section). The seam has extractable reserve of only .04 MTe in free area which can last for about a year. Subsequently, it is proposed to develop V/VI/VII seam (Maheshpur Section) through a drift from VIII A seam. The reserves estimated in V/VI/VII seam (Maheshpur Section) for development are about 1.5 MT. Once these reserves are exhausted, the mine may not have reserve to continue production by underground method. There may be a proposal to work the SOP reserves by opencast subject to removal of surface constraints. If so happens, a fresh new Mine Closure Plan will be submitted incorporating all the changes. Thus, keeping in view the available reserves in the seams being and present mine capacity, the remaining life of the mine will be 26 years.

The proposed conceptual post-mining land use plan vis-à-vis present land use is provided in Para 1.10.

b) Mining is to be carried out in a phased manner initiating afforestation work in the mined out area of the first phase while commencing the mining in the second phase i.e. continuation of mining activities from one phase to other indicating the sequence operations depending upon the geo-mining conditions of the mine. Progressive mine closure plan shall be prepared for period of five years from the beginning of the mining operations. These plans would be examined periodically in every five years period and to be subjected to third party monitoring by the agencies approved by the Central Government for the purpose (NEERI, CMPDIL , ISM etc. as per current guidelines).

c) As regards, the underground void, if any, which will remain at the time of closure of the mine, the same will get gradually filled with water. The necessary precautions for the safety of the neighboring mine would be taken care of before deciding the voids to get water filled. Further, the water filled in UG voids will help in maintaining the water level in the nearby Area. The Pit/Shaft will be covered with RCC structure with suitable opening for inspection by competent person.

d) The existing quarries in the leasehold which have not been backfilled shall be backfilled up to the required depth and will act as water reservoir, facilitating the recharge of the ground water table in the vicinity. All the available places amenable for plantation shall be planted with appropriate species in consultation with forest department.

3.2 Water quality management

3.2.1 Drainage pattern of the area (pre and post closure)

3.2.1.1Existing drainage pattern

The area has a general undulating topography with gentle slope towards southerly flowing Kali Jore and Khudu River. The maximum elevation in the area is around 226m is observed in the Western corner while the lowest is around 159 m, above the MSL in the south-eastern part of the project area.

In course of mining, if any disturbance affecting the drainage pattern is caused, efforts shall be made to restore the normal drainage pattern as far as possible. If the restoration of original drainage profile is not feasible, efforts shall be made to achieve a drainage profile, which will ensure smooth drainage of the area with least possible surface erosion.

3.2.1.2 Post closure drainage pattern

At present only development is envisaged for the mine due to sub-surface constraints. The call on the depillaring can be taken up only these constraints are dealt with. Thus the general drainage pattern of the area is not likely to get disturbed. Depression, if any due to old workings, will be suitably filled with non -combustible rocks and cohesive soils, dozed and graded. If some minor alteration takes place, the natural drainage profile of the entire leasehold area would be kept maintained in a manner which will facilitate the normal run-off. Garland drain may be constructed to ensure the controlled drainage of the area.

3.2.2 Water Quality Status of Surface and Ground Water

3.2.2.1 Present Practice

Samples of mine water as well as drinking water are collected and were analysed for relevant physical, chemical and bacteriological parameters as per the norms stipulated by MOEF.

Water samples are collected as per standard procedure {IS: 3025 (part I) – 1987} and analyzed as per procedures outlined in relevant volume of BIS 3025 / NEERI / standard Methods (AAPHA).

If any deviation from the prescribed water quality standard is detected, the appropriate remedial actions shall immediately be enforced and frequency of sampling shall be increased till the water quality becomes normal. The source of contamination shall be identified and removed. The contaminated water bodies shall be suitably treated.

3.2.2.2 Present status of water quality

The monitoring of water quality under Baseline Environment Data Generation for Cluster III has been conducted M/S PDIL, Sindri by collecting water samples from ground water, surface water and mine water discharge / workshop discharge (if any) for the proposed project. The various purposes of the water environment monitoring are as follows:

- To assess the water quality characteristics for critical parameters;
- To evaluate the impacts on agricultural productivity, habitat conditions, creational resources and aesthetics in the vicinity ; and
- To facilitate predication of impact on water quality by project activities

The results as per PDIL Report are given subsequently.
Details of sampling location are given in Table 3.1 to 3.3 for Ground water, Surface water and effluent water.

To assess the quality of drinking water around the project area, the samples were collected from the following locations in and around the project area:

TABLE - 3.1
Sampling Location for Ground Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No.	Name of Sampling Locations	Frequency	Location Code
01.	Hand Pump – Katras Township	Once in a season	GW_1
02.	Hand Pump - Muraidih Village	Once in a season	GW_2
03.	Hand Pump - Sonardih Village	Once in a season	GW_3

To assess the quality of lotic system (surface water), water samples were collected from the locations (Refer to PDIL Report) given in Table No. 3.2.

TABLE – 3.2

Sampling Location for Surface Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No	Name of Sampling Locations	Frequency	Location Code
01.	Khudu River U/S	Once in a season	SW_1
02.	Khudu River D/S	Once in a season	SW_2
03.	Pond Water – Near Harna Village	Once in a season	SW_3
04.	Bagdigi Jore U/S	Once in a season	SW_4
05.	Bagdigi Jore D/S	Once in a season	SW_5

To assess the quality of waste water discharge, water samples were collected from the locations given in Table 3.3.

TABLE – 3.3

Sampling Location for Industrial Effluent/Mine Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No.	Name of Sampling Locations	Frequency	Location Code
01.	Mine Water Discharge- Jogidih UGP	Once in a season	MW_1
02.	Mine Water Discharge- Maheshpur UGP	Once in a season	MW_2
03.	Workshop Discharge – Block IV/ Kooridih OCP (After Oil & Grease Trap)	Once in a season	WW_1
04.	Workshop Discharge – New Akashkinari OCP (After Oil & Grease Trap)	Once in a season	WW_2

The physico-chemical characteristics of three nos. of ground water samples collected from three different locations have been presented in Table 3.4.

TABLE – 3.4

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES
(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results			Detection Limit	IS:10500 Desirable/ Permissible Limits
		GW_1	GW_2	GW_3		
PHYSICAL						
1	pH	8.2	7.6	7.8	-	6.5-8.5
2	Temperature (^OC)	29.8	30.1	30.2	-	-
3	Colour, HU	<2	<2	<2	-	5/25
4	Odour	Unobj.	Unobj.	Unobj.	-	Unobj.
5	Taste	Agreeable	Agreeable	Agreeable	-	Agreeable
6	Turbidity (NTU)	<5	<5	<5	-	5/10
7	Total Suspended Solid	4	6	6	-	-
8	Total Dissolved Solids	500	552	330	-	500/2000
CHEMICAL						
1	P- Alkalinity as $CaCO_3$	NIL	NIL	NIL	-	-
2	Total Alkalinity as $CaCO_3$	212	184	66	-	200/600
3	Chloride as Cl	44	64	26	-	250/1000
4	Sulphate as SO_4	146	168	134	-	200/400
5	Nitrate as NO_3	1.5	1.4	1.2	-	45/100
7	Fluoride as F	0.6	0.5	0.5	-	1.0/1.5
8	Total Hardness as $CaCO_3$	384	386	164	-	300/600
9	Calcium Hardness as $CaCO_3$	200	262	112	-	75/200*
10	Magnesium Hardness as $CaCO_3$	184	124	52	-	30**
11	Sodium as Na	18	27	34	-	-
12	Potassium as K	2	3	4	-	-
13	Silica as SiO_2	16	22	22	-	-
HEAVY METALS						
1	Iron as Fe	0.08	0.8	0.3	0.04	0.3/1.0
2	Manganese as Mn	<0.05	<0.05	<0.05	0.05	0.1/0.3
3	Total Chromium as Cr	NT	NT	NT	0.01	0.05
4	Lead as Pb	NT	NT	NT	0.05	0.05
5	Zinc as Zn	0.14	0.16	0.14	-	5.0/15
6	Cadmium as Cd	NT	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	NT	0.02	0.05/1.5
8	Nickel as Ni	NT	NT	NT	-	0.01
9	Arsenic as As	NT	NT	NT	0.01	0.05
10	Selenium as Se	NT	NT	NT	0.01	0.01
OTHERS						
1	Mineral Oil	NT	NT	NT	-	0.01/0.03
2	Phenolic Compound as C_6H_5OH	NT	NT	NT	0.001	0.001/0.002
3	Coliform Organisms (MPN/100ml)	< 20	< 20	< 20	-	Absent

Note: 1) BDL – Below Detectable Level. 2) NT- Not Traceable
3) *-Calcium as Ca 4) **-Magnesium as Mg

Results & Discussion

The physico-chemical characteristics of the ground water samples showed great resemblance with respect to the characteristics like temperature, turbidity, pH, colour, odour, chloride, sulphate, total alkalinity, total hardness, TDS and heavy metals, etc. The range of concentrations of drinking water parameters were observed as given in Table No. 3.5.

TABLE – 3.5
Ground Water Quality at a Glance in Comparison to Drinking Water Standard

Parameters	Range of recorded Concentration (Results expressed in mg/l except pH)		
	Minimum	Maximum	Desirable/Permissible Limits as per IS: 10500
pH	7.6	8.2	6.5-8.5
Total Suspended Solid	4	6	-
Total Dissolved Solids	330	552	500 / 2000
Total Alkalinity as $CaCO_3$	66	212	200 / 600
Total Hardness, as $CaCO_3$	164	386	300 / 600
Chloride as Cl	26	64	250 / 1000
Sulphate as SO_4	134	168	200 / 400
Nitrate as NO_3	1.2	1.5	45/ 100
Iron as Fe	0.08	0.8	0.3 / 1.0

From the results presented in Table- 3.5, the Physico-chemical characteristics of the ground water samples were in good agreement with IS: 10500. All the parameters are within the limits specified under Drinking Water Standard (IS: 10500). As regards heavy metals, only Fe and Zn have been recorded with lower concentration & rest were not traceable. The ground water can be safely used for potable purposes.

The physico-chemical characteristics of five nos. of surface water samples collected from five different locations have been presented in Table nos. 3.6(A) and 3.6(B) respectively.

TABLE – 3.6 (A)

PHYSICO-CHEMICAL CHARACTERISTICS OF SURFACE WATER QUALITY

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	PARAMETERS	ANALYSIS RESULTS			DETECTION LIMIT	Limit as per IS: 2296 Class 'C'
		SW1	SW2	SW3		
PHYSICAL						
1	pH	7.9	7.5	7.8	-	6.5-8.5
2	Temperature (^{O}C)	29.2	29.3	30.1	-	*
3	Colour, HU	<2	<2	<2	-	300
4	Odour	Unobj.	Unobj.	Unobj.	-	*
5	Turbidity (NTU)	8	10	14	-	*
6	Total Suspended Solids	6	8	12	-	
7	Total Dissolved Solids	293	297	470	-	1500
CHEMICAL						
1	P- Alkalinity as $CaCO_3$	NIL	NIL	NIL	-	*
2	Total Alkalinity as $CaCO_3$	78	64	142	-	*
3	Chloride as Cl	36	38	90	-	600
4	Sulphate as SO_4	96	104	120	-	400
5	Nitrate as NO_3	2.6	2.6	4.6	-	50
6	Fluoride as F	<0.4	<0.4	<0.4	-	1.5
7	Total Hardness as $CaCO_3$	210	214	394	-	*
8	Calcium Hardness as $CaCO_3$	136	142	226	-	*
9	Magnesium Hardness as $CaCO_3$	74	72	168	-	*
10	Dissolve Oxygen	6.6	6.4	5.8	-	4.0
11	COD	06	06	04	-	*
12	BOD (3 days at 27^{o}C)	2.4	2.4	2.2	-	3.0
13	Total Kjeldahl Nitrogen as N	0.52	0.54	0.62	-	*
14	Sodium as Na	9	6	2	-	*
15	Potassium as K	1	1	1	-	*
16	Silica as SiO_2	12	14	12	-	*
HEAVY METALS						
1	Iron as Fe	0.08	0.09	0.06	0.04	5.0
2	Manganese as Mn	<0.05	<0.05	<0.05	0.05	*
3	Total Chromium as Cr	NT	NT	NT	0.006	0.05
4	Lead as Pb	NT	NT	NT	0.04	0.1
5	Zinc as Zn	0.12	0.14	0.14	-	15.0
6	Cadmium as Cd	NT	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	NT	0.02	1.5
8	Nickel as Ni	NT	NT	NT	-	*
9	Arsenic as As	NT	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	NT	0.01	0.05
11.	Cyanide as CN	NT	NT	NT	0.02	0.05
12.	Mercury as Hg	NT	NT	NT	0.001	
OTHERS						
1	Oil & Grease	BDL	BDL	BDL	0.1	0.1
2	Phenolic Compound as C_6H_5OH	NT	NT	NT	0.001	0.005
3	Coliform Organisms (MPN/100ml)	1.9 x 10^3	2.0 x 10^3	2.3 x 10^3	-	5000

Note: 1) BDL – Below Detectable Level; 2) * - Limit Not specified; 3) NT- Not Traceable

TABLE – 3.6 (B)

PHYSICO-CHEMICAL CHARACTERISTICS OF SURFACE WATER QUALITY

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results		Detection Limit	Limit as per IS: 2296 Class 'C'
		SW4	SW5		
PHYSICAL					
1	pH	7.2	7.3	-	6.5-8.5
2	Temperature (^{O}C)	29.2	29.4	-	*
3	Colour, HU	<2	<2	-	300
4	Odour	Unobj.	Unobj.	-	*
5	Turbidity (NTU)	6	8	-	*
6	Total Suspended Solids	14	16	-	
7	Total Dissolved Solids	486	510	-	1500
CHEMICAL					
1	P- Alkalinity as $CaCO_3$	NIL	NIL	-	*
2	Total Alkalinity as $CaCO_3$	160	164	-	*
3	Chloride as Cl	68	72	-	600
4	Sulphate as SO_4	140	146	-	400
5	Nitrate as NO_3	4.6	4.8	-	50
6	Fluoride as F	<0.4	<0.4	-	1.5
7	Total Hardness as $CaCO_3$	386	390	-	*
8	Calcium Hardness as $CaCO_3$	240	244	-	*
9	Magnesium Hardness as $CaCO_3$	146	146	-	*
10	Dissolve Oxygen	6.0	5.8	-	4.0
11	COD	3.8	04	-	*
12	BOD (3 days at 27^{o}C)	<2.0	<2.0	-	3.0
13	Total Kjeldahl Nitrogen as N	BDL	BDL	-	*
14	Sodium as Na	8	13	-	*
15	Potassium as K	1	2	-	*
16	Silica as SiO_2	10	12	-	*
HEAVY METALS					
1	Iron as Fe	0.16	0.16	0.04	5.0
2	Manganese as Mn	<0.05	<0.05	0.05	*
3	Total Chromium as Cr	NT	NT	0.006	0.05
4	Lead as Pb	NT	NT	0.04	0.1
5	Zinc as Zn	0.12	0.14	-	15.0
6	Cadmium as Cd	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	0.02	1.5
8	Nickel as Ni	NT	NT	-	*
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11.	Cyanide as CN	NT	NT	0.02	0.05
12.	Mercury as Hg	NT	NT	0.001	
OTHERS					
1	Oil & Grease	BDL	BDL	0.1	0.1
2	Phenolic Compound as C_6H_5OH	NT	NT	0.001	0.005
3	Coliform Organisms (MPN/100ml)	2.0×10^3	2.0×10^3	-	5000

Note: 1) BDL – Below Detectable Level; 2) * - Limit Not specified; 3) NT- Not Traceable

Results & Discussion

The physico-chemical characteristics of the surface water samples collected from the five locations have shown great resemblance with respect to the characteristics like temperature, turbidity, pH, colour, odour, chloride, sulphate, total alkalinity, total hardness, TDS and heavy metals, etc. The range of concentrations of important parameters of surface water characteristics have been presented in Table No. 3.7.

TABLE –3.7
Surface Water at a Glance

Parameters	Range of recorded Concentration (Results expressed in mg/l except pH)		
	Minimum	Maximum	Limit as per IS: 2296 Class 'C'
pH	7.4	8.2	6.5-8.5
Total Suspended Solids	8	14	-
Total Dissolved Solids	494	610	1500
Total Hardness, as $CaCO_3$	380	452	-
Calcium Hardness, as $CaCO_3$	278	320	-
Chloride as Cl	70	82	600
Sulphate as SO_4	160	226	400
Nitrate as NO_3	3.28	4.30	50
Iron as Fe	0.08	0.16	5.0

From the results presented in Table- 3.6(A) and Table- 3.6(B), it may safely be concluded that the physico-chemical characteristics of the surface water samples had a good resemblance with respect to almost all the parameters and were well within limits specified in Surface Water Standard IS: 2296. As regards heavy metals, except Iron and Zinc, all the other were not traceable. From the above, it may be concluded that all the parameters of the surface water samples were well within the specified limits of IS: 2296 Class ‘C’.

The physico-chemical characteristics of mine water & workshop effluent discharge samples collected from different locations have been presented hereunder in Table-3.8(A) & Table-3.8(B) respectively.

TABLE – 3.8 (A)
PHYSICO-CHEMICAL CHARACTERISTICS OF WASTE WATER DISCHARGE

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results			MOEF Standard Schedule-VI
		MW1	MW2	Detection Limit	
PHYSICAL					
1	pH	6.5	6.9	-	5.5-9.0
2	Temperature (^{O}C)	29.6	30.4	-	Te<Ts+5ºC
3	Colour,HU	<2.0	<2.0	-	*
4	Odour	Unobj.	Unobj.	-	Unobjectionable
5	Turbidity (NTU)	8	10	-	*
6	Total Suspended Solids	4	6	-	100
7	Total Dissolved Solids	870	814	-	*
CHEMICAL					
1	Total Alkalinity as $CaCO_3$	146	170	-	*
2	Chloride as Cl	60	74	-	*
3	Sulphate as SO_4	448	360	-	*
4	Nitrate as N	1.2	1.3	-	10
5	Dissolve Phosphate as PO_4	BDL	BDL	-	5.0
6	Fluoride as F	<0.4	<0.4	-	2.0
7	Total Hardness as $CaCO_3$	660	614	-	*
8	Calcium Hardness as $CaCO_3$	320	364	-	*
9	COD	6.2	6.4	-	250
10	BOD (3 days at 27^{O}C)	2.4	2.2	-	30
11	Total Kjeldahl Nitrogen as N	BDL	BDL	0.01	100
12	Sodium as Na	16	15	-	*
13	Potassium as K	3	2	-	*
14	Sulphide as S	BDL	BDL	0.01	2.0
15	Ammonical Nitrogen as N	0.46	0.32	0.02	50
HEAVY METALS					
1	Iron as Fe	0.1	0.1	0.04	3.0
2	Manganese as Mn	<0.05	<0.05	0.05	2.0
3	Lead as Pb	NT	NT	0.4	0.1
4	Zinc as Zn	0.24	0.26	-	5.0
5	Copper as Cu	NT	NT	0.5	3.0
6	Nickel as Ni	NT	NT	0.1	3.0
7	Mercury as Hg	NT	NT	0.01	0.01
8	Cyanide as CN	NT	NT	0.01	0.2
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11	Vanadium as V	NT	NT	0.01	0.2
12	Cadmium as Cd	NT	NT	0.002	2.0
13	Hexavalent Chromium as Cr^{+6}	NT	NT	0.1	0.1
14	Total Chromium as Cr	NT	NT	0.006	2.0
OTHERS					
1	Oil & Grease	<2.0	<2.0	-	10
2	Phenolic Compound C_6H_5OH	NT	NT	0.001	1.0

Note: 1) BDL – Below Detectable Level; **2)** NT – Not Traceable

TABLE – 3.8 (B)

PHYSICO-CHEMICAL CHARACTERISTICS OF WASTE WATER DISCHARGE

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results			MOEF Standard Schedule-VI
		WW1	WW2	Detection Limit	
PHYSICAL					
1	pH	7.4	7.5	-	5.5-9.0
2	Temperature (^{O}C)	30.1	31.2	-	Te<Ts+5ºC
3	Colour,HU	<2.0	<2.0	-	*
4	Odour	Unobj.	Unobj.	-	Unobjectionable
5	Turbidity (NTU)	16	18	-	*
6	Total Suspended Solids	10	12	-	100
7	Total Dissolved Solids	782	840	-	*
CHEMICAL					
1	Total Alkalinity as $CaCO_3$	160	154	-	*
2	Chloride as Cl	30	36	-	*
3	Sulphate as SO_4	118	124	-	*
4	Nitrate as N	2.2	3.2	-	10
5	Dissolve Phosphate as PO_4	BDL	BDL	-	5.0
6	Fluoride as F	<0.4	<0.4	-	2.0
7	Total Hardness as $CaCO_3$	714	720	-	*
8	Calcium Hardness as $CaCO_3$	428	432	-	*
9	COD	7.6	6.4	-	250
10	BOD (3 days at 27^{O}C)	2.5	2.2	-	30
11	Total Kjeldahl Nitrogen as N	0.68	0.62	0.01	100
12	Sodium as Na	14	17	-	*
13	Potassium as K	2	3	-	*
14	Sulphide as S	BDL	BDL	0.01	2.0
15	Ammonical Nitrogen as N	1.24	1.26	0.02	50
HEAVY METALS					
1	Iron as Fe	0.08	0.09	0.04	3.0
2	Manganese as Mn	<0.05	<0.05	0.05	2.0
3	Lead as Pb	NT	NT	0.4	0.1
4	Zinc as Zn	0.14	0.16	-	5.0
5	Copper as Cu	NT	NT	0.5	3.0
6	Nickel as Ni	NT	NT	0.1	3.0
7	Mercury as Hg	NT	NT	0.01	0.01
8	Cyanide as CN	NT	NT	0.01	0.2
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11	Vanadium as V	NT	NT	0.01	0.2
12	Cadmium as Cd	NT	NT	0.002	2.0
13	Hexavalent Chromium as Cr^{+6}	NT	NT	0.1	0.1
14	Total Chromium as Cr	NT	NT	0.006	2.0
OTHERS					
1	Oil & Grease	<2.0	<2.0	-	10
2	Phenolic Compound C_6H_5OH	NT	NT	0.001	1.0

Note: 1) BDL – Below Detectable Level; **2)** NT – Not Traceable

Results & Discussion

The range of concentrations of important parameters of waste water characteristics are given in Table No. 3.9.

TABLE – 3.9
Waste Water Discharge at a Glance

Parameters	Range of recorded Concentration (Results expressed in mg/l except pH)		
	Minimum	Maximum	Limits As per MoEF Notification (Sch.-VI)
pH	6.5	7.5	5.5-9.0
Total Suspended Solids	4	12	100
Total Dissolved Solids	782	870	-
Total Hardness as $CaCO_3$	614	720	-
Chemical Oxygen Demand	6.2	7.6	250
Chloride as Cl	30	74	-
Sulphate as SO_4	118	448	-
Nitrate as N	1.2	3.2	10
Iron as Fe	0.08	0.1	3

From the results shown above, it may be safely concluded that the Physico-chemical characteristics of the discharge water samples collected from the four locations for one season had variations with respect to almost all the parameters but were well within the limits of **General Standards for Discharge of Effluents (Table 3.10).** As regards heavy metals, like Iron was also within limits

TABLE –3.10
GENERAL STANDARDS FOR DISCHARGE OF EFFLUENTS
[The Gazette of India – Extraordinary {Part II- Sec. 3(i)} Ministry of Environment and Forests Notification New Delhi, 19th May, 1993]

Sl. No.	Parameters	Standards			
		Inland Surface Water	Public Sewers	Land for irrigation	Marine coastal areas
		(a)	(b)	(c)	(d)
1	Colour and odour	Note-1	Note-1	Note-1	Note-1
2	Suspended Solids, mg/l max.	100	600	200	Note-2
3	Particle size of Suspended Solids.	Note-3	-	-	Note-4
4	Dissolved solids (inorganic) mg/l max.	2100	-	2100	-

Sl. No.	Parameters		Standards			
			Inland Surface Water	Public Sewers	Land for irrigation	Marine coastal areas
			(a)	(b)	(c)	(d)
5	pH value		5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
6	Temperature, ^{O}C		Note-5	-	-	Note-5
7	Oil & grease, mg/l max.		10	20	10	20
8	Total residual chlorine, mg/l max.		1.0	-	-	1.0
9	Ammonical Nitrogen (as N), mg/l. max.		50	50	-	50
10	Total Kjeldahl nitrogen (as NH_3), mg/l max.		100	-	-	100
11	Free ammonia (as N), mg/l max.		5	-	-	5
12	Biochemical Oxygen Demand (3 days at 27^{o}C), max.		30	350	100	100
13	Chemical Oxygen Demand, mg/l max.		250	-	-	250
14	Arsenic (as As), mg/l max.		0.2	0.2	0.2	0.2
15	Mercury (as Hg), mg/l max.		0.01	0.01	-	0.01
16	Lead (as Pb), mg/l max.		0.1	1.0	-	2.0
17	Cadmium (as Cd), mg/l max.		2.0	1.0	-	2.0
18	Hexavalent Chromium (as Cr^{+6}), mg/l. max.		0.1	2.0	-	1.0
19	Total Chromium (as Cr), mg/l max.		2.0	2.0	-	2.0
20	Copper (as Cu), mg/l max.		3.0	3.0	-	3.0
21	Zinc (as Zn), mg/l max.		5.0	15	-	15
22	Selenium (as Se), mg/l max.		0.05	0.05	-	0.05
23	Nickel (as Ni), mg/l max.		3.0	3.0	-	5.0
24	Boron (as B), mg/l max.		2.0	2.0	2.0	2.0
25	Percent Sodium, max.		-	-	60	-
26	Residual sodium carbonate, mg/l max.		-	-	5.0	-
27	Cyanide (as CN) mg/l max.		0.2	2.0	0.2	0.2
28	Chloride (as Cl) mg/l max.		1000	1000	600	-
29	Fluoride (as F) mg/l max.		2.0	15	-	15
30	Dissolved Phosphate (as P), mg/l max.		5.0	-	-	-
31	Sulphate (SO_4) mg/l max.		1000	1000	1000	-
32	Sulphide (as S), mg/l max.		2.0	-	-	5.0
33	Phenolic Compound (C_6H_5OH), mg/l max.		1.0	5.0	-	5.0
34	Radioactive materials: (a) Alpha emitters, µc/ml max. (b) Beta emitters, µc/ml max.		 10^{-7} 10^{-6}	 10^{-7} 10^{-7}	 10^{-7} 10^{-6}	 10^{-7} 10^{-7}
35	Bio-assay test		Note-6	Note-6	Note-6	Note-6
36	Manganese (as Mn) mg/l max.		2.0	2.0	-	2.0
37	Iron (as Fe) mg/l max.		2	3	-	3
38	Vanadium (as V), mg/l max.		0.2	0.2	-	0.2
39	Nitrate Nitrogen, mg/l max.		10	-	-	20
40	Pesticides, µg/l max.					
	(i)	Benzene Hexachloride				
	(ii)	Carbaryl	10	-	10	10

Sl. No.	Parameters		Standards			
			Inland Surface Water	Public Sewers	Land for irrigation	Marine coastal areas
			(a)	(b)	(c)	(d)
	(iii)	DDT	10	-	10	10
	(iv)	Endosulfan	10	-	450	450
	(v)	Dimethoate	10	-	10	10
	(vi)	Fenitrothion	10	-	10	10
	(vii)	Malathion	10	-	10	10
	(viii)	Phorate	10	-	10	10
	(ix)	Methyl Parathion	10	-	10	10
	(x)	Phenthoate	10	-	10	10
	(xi)	Pyrethrums	10	-	10	10
	(xii)	Copper oxychloride	9600	-	9600	9600
	(xiii)	Copper sulphate	50	-	50	50
	(xiv)	Ziram	1000	-	1000	1000
	(xv)	Sulphur	30	-	30	30
	(III)	Paraquat	2300	-	2300	2300
	(IIIi)	Propanil	7300	-	7300	7300
	(IIIii)	Nitrofen	780	-	780	780

Note-1: All efforts should be made to remove colour and unpleasant odour as far as practicable.

Note-2: (a) For process water – 100,

(b) For cooling water effluent, 10% above total suspended matter in influent.

Note-3: Shall pass 850 micron IS sieve.

Note-4: (a) Floatable solids-max. 3 mm.

(b) Settleable solids-max. 850microns.

Note-5: Shall not exceed 5^{0}C above the receiving water temperature.

Note-6: 90% survivals of fish after 96 hours in 100% effluent.

3.2.2.3 Practice after the closure

The above practice of monitoring of quality of water would be continued for a period of 3 years after cessation of mining activity. If required, corrective action/steps would be taken to mitigate any adverse effect on local water regime. The responsibility of maintaining the quality of drinking water will be entrusted on the State Authorities after 3 years of mine closure.

3.2.3 Measures For Control Of Pollution (Details For Pollution Control Arrangement)

3.2.3.1 Impact Due To Water Pollution And Its Management

The mine discharge water may contain high-suspended solids and other pollutants. The treatment scheme thus needs to focus on the removal of suspended solids from the water. Pit water must be treated to meet the prescribed standards before being discharged into water bodies. When the water is used for agricultural or domestic work, it shall undergo further treatment, as established by Scientific Studies conducted in this regard. The important factors to be considered in selecting the appropriate method for treatment are as follows:

(a) Settling tank will be provided to collect the mine discharged water for settling the suspended solids.

(b) The flow and the quality of pit water vary seasonally. Therefore settling tank should be able to absorb these fluctuations.

(c) The mine water must be neutral in nature and therefore necessary neutraliser may be provided to maintain the pH of the settling pond water.

(d) In order to reduce the dependence on fresh water sources for meeting the demands of water in the mining related operations, the entire mining effluents water will be utilised. The entire effluent free mine water will be utilised in water spraying for dust suppression, hydraulic stowing, equipment washing and other industrial requirements.

(e) Mine water discharge and drainage in the core zone has been planned to be regulated in a manner so that impact on surface and other water bodies of the area is not affected. No diversion of any surface drainage channel is required as other than civil constructions, surface land will not be affected. Expected increase of solids due to surface handling of coal shall be controlled by:

   a. Construction of garland drain around the coal stock area
   b. Construction of settling tanks of adequate size for removal of particulate matters
   c. De-silting of settling ponds and drains at regular intervals

d. Effluents from washing areas, garage and workshop will be collected in garlands and routed through a settling ponds and oil and grease trap. The solid wastes generated shall be treated as per the provisions of Hazardous Waste Management Act. The water shall be recirculated for washing.

3.2.4 Water Balance of The Area

Hydrogeology and Aquifer Characteristics Of The Area

Groundwater occurrence and storage in study area are mainly controlled by the geological setup of the area. The ability of geological formation to store and transmit water is dependent on its formation parameters, such as porosity and hydraulic conductivity. Based on these two parameters, the rock formation of the area may be classified as hard and soft rocks. Hard rocks (mainly crystalline and consolidated sedimentary rocks) are characterized by very little porosity. Ground water in such rocks circulated to a limited extent through the secondary openings represented by joints, cracks, fissures and such other planes of discontinuity. Soft rocks represented by sandstone, pebbles and loose sand, posses higher degree of primary porosity and as such characterized by higher water storage capacity. As greater part of the study area is underlain by Precambrian crystalline rocks, the weathered residual of the hard rocks as well as the fractures, joints, fissures, faults and other zones of discontinuity are the principle repositories of ground water in the area. The weathered zone is usually of limited thickness, fractures and joints generally close up with depth. The thickness of weathered mantle in the hard rock zone of area is about 10-20 meter in the topographic lows. Ground water in the weathered and fracture zones of hard rocks occur under unconfined condition. Ground water circulating through fracture zone is sometimes held under pressure. Depth of the water table in the hard rock of the area generally ranges from 3.0 m to 15.0 m below ground level.

The Gondwana sediments form the semi-consolidated formations and are better water potential zone. The splintery shales of Talchir and basal pebbles bed, the variegated Barren Measure shales and the sandstones are the major litho units of the Gondwana Formations. Gondwana sandstones in general, are known to constitute good aquifers at many places. Ground water occurs under unconfined condition in the weathered mantles varying depths from 4.23 – 12.34 m as observed in the dugwells and semi-confined condition in the deeper aquifers. Depth of water level for pre-monsoon period varies from 5–12m below ground level and it stretches to a deeper depth of 7-12m in some places. The pre-monsoon water level rises due to recharge and becomes 2 - 8 m below ground level around the area during post-monsoon period.

Rainfall is the principal recharge source to groundwater. The area experiences an average annual rainfall of about 1200-1400 mm. Besides rainfall, the mine water discharge from the local mining areas and existing water bodies including water logged in abundant mine quarries are also contributed to the ground water recharge as return flow. In the study area, ground water is withdrawn usually by means of open dug wells and small diameter hand operated tube wells for domestic and irrigation purposes. The tube wells are most often deeper (25m – 58m) than the dug wells and tap the aquifer below the weathered mantle. As the area is being located in the hot-tropical belt, the temperature regime is very high, the daily maximum reaches to over 45^0C. Due to excessive heat, the loss of moisture through evaporation is considerably high (60-65%). During the wet monsoon seasons, the net evaporation is less than the precipitation, resulting in surplus water which loss through either surface runoff or being part of the subsurface storage. The surface run-off and sub-surface storage of water depends upon various factors including the amount of rainfall, topography of the area, land use pattern, soil type, slope, physiographic, drainage pattern and hydro-geomorphology of the catchment/ sub-catchment. The study area is having gentle slope towards south and south east. Water received on the slopes, gets collected in low-lying area and is thus ultimately absorbed in the top soil cover and become part of the ground water flow according to the slope to form seasonal streams/nallas.

In the mining area, the water levels are bound to be affected and disturbed. The mining area of JCF area is highly disturbed and the permeability of individual geological units is spatially variable and depends on lithology, fracturing and attenuation with depth. The porous and more open-jointed sandstone members tend to form aquifers, the shaly members are aquitards, which may be leaky but are poorly permeable & form poor permeable barriers to the vertical groundwater movement

Water quality monitoring will be done for three years after closure. The sampling stations shall be one no. mine water with quarterly frequency and two numbers ground water samples in core and buffer zone with quarterly frequency.

3.2.5 Acid Mine Drainage Source

Not Applicable

3.2.6 Water Management

3.2.6.1 Existing mine water discharge details

a. Mine water is pumped out in a settling tank. Clean water coming out from the settling tank is used for dust suppression, stowing and other Industrial uses.
b. Excess pumped out mine water is allowed to flow into the surface water bodies.
c. Drains are provided around the coal stock to collect run-off for diverting into settling pond before discharge into the natural water courses.

Pumping capacity – 2500 GPM

Make of water – i) Monsoon - 1500GPM ii) Lean period – 800 GPM

Discharge point: - at surface.

Use of discharged water (quantity wise)

Table 3.11 Present use of mine discharge water:

Period	Total discharge at surface (KLD)	Use of Water (KLD)			
		Water Treatment Plant	Domestic & Industrial	Nala/Jore through resettling tank	Total
Monsoon	5443	156	194	5093	5443
Lean	4147	156	194	3797	4147

3.2.7. Post closure Mine water discharge

Once the reserve is exhausted, the entries into the mine would be securely sealed for safety purposes. However, if for the safety of the future mine or any neighboring mine, pumping is required from the worked seams, then the arrangements for pumping will be kept intact and the water shall be discharged into the surface water bodies after passing the same through settling tank on the surface. The accumulated water in underground workings may be utilized to meet water shortage in nearby areas.

3.3 Air quality management

3.3.1 Present practice

a. At present air borne dust is suppressed by:

- Sprinkling water on the various roads of the mine where vehicles ply.
- Water sprinkling at the various points where coal is handled.
- Proper loading of trucks to avoid any spillage of coal.
- Proper maintenance of I.C. engines.

The quality of air is monitored on regular basis by drawing samples from the various residential and non-residential areas of the project. The test results are compared with the standards prescribed by the MOEF and if any deviation is detected, remedial actions are immediately taken to bring the AAQ standard within the prescribed limits. The practice of air quality management would be continued throughout the project life as per the norms stipulated by MOEF.

The monitoring of air quality under Baseline Environment Data Generation for Cluster III has been conducted M/S PDIL, Sindri and test results of air samples are furnished subsequently.

Table No. 3.12

SAMPLING LOCATION FOR AIR QUALITY MONITORING

Project: Cluster III **Period:** 19th March -18th June 2011

Sl. No.	Location Name/Location Code	Direction & distance w.r.t Project Site	Height of Sampling Point (m)	Description
01.	Jogidih UGP - Core zone - SA_1	-	3.0	Industrial Area
02.	Maheshpur UGP - Core zone - SA_2	-	3.0	Industrial Area
03.	Block IV Kooridih OCP- Core Zone - SA_3	-	3.0	Industrial Area
04.	Govindpur UGP Colliery- Core Zone - SA_4	-	3.0	Industrial Area
05.	New Akashkinari OCP- Core Zone - SA_5	-	3.0	Industrial Area
06.	Katras Choitudih Village - SA_6	SE, 1.0 Km	3.0	Residential Area
07.	Muraidih Village – SA_7	NW, 0.8 Km	3.0	Residential Area
08.	Harna Village – SA_8	NW, 2.6 Km	3.0	Residential Area
09.	Sogiadih Village – SA_9	NW, 2.5 Km	3.0	Residential Area

Table No. 3.13

AIR QUALITY DATA

Period: 19th March -18th June 2011 **Location:** Maheshpur UGP - Core Zone –SA_2

WEEK	DAY	DATE	CONCENTRATION OF AIR POLLUTANTS, µg/m³				
			SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x
I	Mon/Tue	21/22.03.11	268	71	30	11.0	17.6
	Tue/ Wed	22/23.03.11	163	46	17	7.9	14.7
II	Mon/Tue	28/29.03.11	256	70	29	12.4	18.8
	Tue/ Wed	29/30.03.11	215	61	23	8.4	14.1
III	Mon/Tue	04/05.04.11	265	72	30	12.9	19.4
	Tue/ Wed	05/06.04.11	208	59	23	10.1	17.6
IV	Mon/Tue	11/12.04.11	234	66	26	11.4	19.3
	Tue/ Wed	12/13 .04.11	177	50	19	8.6	11.6
V	Mon/Tue	18/19.04.11	110	39	13	7.3	12.2
	Tue/ Wed	19/20.04.11	168	48	17	9.2	15.0
VI	Mon/Tue	25/26.04.11	251	71	28	12.2	17.5
	Tue/ Wed	26/27.04.11	196	56	21	10.5	15.9
VII	Mon/Tue	02/03.05.11	258	73	29	12.5	19.9
	Tue/ Wed	03/04.05.11	109	36	10	7.3	10.1
VIII	Mon/Tue	09/10.05.11	263	71	30	12.8	19.2
	Tue/ Wed	10/11.05.11	221	63	24	10.7	16.5
IX	Mon/Tue	16/17.05.11	266	72	30	12.9	20.4
	Tue/ Wed	17/18.05.11	245	70	27	11.9	18.1
X	Mon/Tue	23/24.05.11	178	51	19	12.6	19.7
	Tue/ Wed	24/25.05.11	169	48	18	8.2	11.1
XI	Mon/Tue	30/31.05.11	245	70	27	11.9	17.1
	Tue/ Wed	31/01.05/06.11	110	35	12	7.8	10.2
XII	Mon/Tue	06/07.06.11	246	71	27	11.9	18.1
	Tue/ Wed	07/08.06.11	211	60	23	10.2	16.8

SUMMARY

Parameters	SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x
No. of observations	**24**	**24**	**24**	**24**	**24**
Minimum Concentration	109	35	10	7.3	10.1
Maximum Concentration	268	73	30	12.9	20.4
Average	209.7	59.5	23.0	10.5	16.3
98th percentile	267.1	72.5	30.0	12.9	20.2

Table 3.14

STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011
Unit : µg/m³

SL. No.	POLLUTANT	LOCATION CODE	MIN.	PERCENTILE VALUE											MAX.	ARITH. MEAN	GEO. MEAN	STD. DEVIA-TION	STD. *	% EXCEEDING STANDARD LIMITS
				10	20	30	40	50	60	70	80	90	95	98						
01.	SPM	SA - 1	106.0	127.2	171.4	212.9	235.2	243.0	245.8	254.1	256.8	266.8	268.9	271.7	274.0	219.0	211.2	52.9	700	0
		SA - 2	109.0	125.9	168.6	177.9	208.6	218.0	242.8	246.5	256.8	264.4	265.9	267.1	268.0	209.7	202.4	51.5	700	0
		SA - 3	106.0	126.1	211.8	256.0	270.6	278.5	288.8	312.5	339.2	345.7	350.3	351.5	352.0	264.6	250.3	77.4	700	0
		SA - 4	114.0	139.0	163.2	177.0	190.0	207.0	234.6	251.1	255.4	262.7	274.9	281.9	286.0	208.4	202.0	50.8	700	0
		SA - 5	110.0	140.5	236.0	253.2	269.0	281.5	310.6	316.3	338.0	345.2	347.9	352.3	356.0	270.3	257.3	74.0	700	0
		SA - 6	96.0	110.9	137.8	153.2	158.2	201.0	217.6	223.9	233.6	243.2	245.0	245.5	246.0	184.7	177.0	51.3	200	0
		SA – 7	109.0	127.1	187.8	214.6	227.4	245.0	254.2	263.3	271.6	313.8	331.6	340.5	346.0	233.4	222.9	65.5	200	0
		SA - 8	89.0	111.1	122.0	131.9	136.4	142.0	146.0	151.1	158.2	168.0	170.6	179.1	186.0	140.2	138.2	23.7	200	0
		SA - 9	88.0	98.3	120.0	130.8	139.0	139.5	143.8	155.1	156.8	168.1	176.7	178.0	178.0	138.5	136.1	25.5	200	0

* SPM has been compared with Jharia Coal Mines standard in Core Zone and in other than Core Zone as per NAAQS.

Table – 3.14 (Contd.)

STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011 Unit : µg/m³

SL. No.	Pollutant	Location Code	Min.	Percentile Value 10	20	30	40	50	60	70	80	90	95	98	Max.	Arith. Mean	Geo. Mean	Std. Deviation	Std. *	% Exceeding Standard Limits
02.	PM_{10}	SA - 1	36.0	38.9	42.2	52.5	58.2	60.5	61.0	63.0	64.0	66.7	67.0	67.5	68.0	55.7	54.6	10.7	100	0
		SA - 2	35.0	41.1	48.0	50.9	59.2	62.0	69.2	70.1	71.0	71.7	72.0	72.5	73.0	59.5	58.1	12.5	100	0
		SA -3	36.0	42.3	52.8	64.0	67.4	69.0	72.0	78.1	81.4	83.7	84.9	85.5	86.0	67.0	65.1	15.2	100	0
		SA - 4	34.0	39.5	46.4	50.7	53.6	59.0	66.8	71.0	72.0	73.0	73.9	74.5	75.0	58.6	57.0	13.4	100	0
		SA - 5	29.0	36.5	61.0	65.8	70.0	73.5	81.0	82.1	83.0	84.0	84.0	84.5	85.0	68.9	65.9	17.8	100	0
		SA - 6	30.0	31.3	33.0	34.9	36.2	46.0	49.8	51.2	53.4	55.4	56.0	56.0	56.0	43.4	42.3	9.9	100	0
		SA - 7	40.0	44.6	48.4	59.3	64.4	69.5	73.0	75.1	77.2	81.1	82.9	83.0	83.0	65.2	63.6	14.2	100	0
		SA - 8	23.0	30.2	34.6	36.8	38.4	40.0	44.8	49.6	56.4	62.0	62.9	63.5	64.0	43.9	42.2	12.3	100	0
		SA - 9	28.0	31.3	33.6	35.9	36.4	40.5	44.2	47.0	50.8	58.8	60.9	62.6	64.0	42.5	41.4	10.5	100	0
03.	$PM_{2.5}$	SA - 1	12.0	14.3	15.6	19.8	22.0	23.0	23.8	24.1	25.0	26.0	26.0	26.5	27.0	21.2	20.6	4.7	60	0
		SA - 2	10.0	14.2	17.6	19.0	23.0	23.5	26.8	27.1	29.0	30.0	30.0	30.0	30.0	23.0	22.1	6.2	60	0
		SA -3	12.0	14.3	19.6	25.0	26.2	27.0	27.8	29.0	29.0	30.0	30.9	31.0	31.0	24.8	23.9	6.0	60	0
		SA - 4	11.0	13.9	16.6	18.8	20.0	21.5	25.4	27.1	29.0	29.7	30.9	32.1	33.0	22.3	21.3	6.4	60	0
		SA - 5	13.0	18.2	24.0	25.9	27.0	28.0	29.0	30.0	31.0	32.7	33.0	33.5	34.0	26.8	26.0	5.7	60	0
		SA - 6	12.0	13.0	13.6	14.0	14.2	18.5	20.0	21.1	22.0	22.7	23.0	23.0	23.0	17.6	17.1	4.2	60	0
		SA - 7	14.0	15.0	16.6	20.7	23.0	24.5	26.0	26.1	27.0	28.4	29.9	30.5	31.0	22.9	22.2	5.4	60	0
		SA - 8	11.0	12.0	12.6	13.0	14.2	15.0	17.0	19.3	22.4	25.0	25.0	25.5	26.0	17.1	16.4	5.1	60	0
		SA - 9	11.0	11.3	12.6	13.0	13.2	15.0	15.8	18.0	20.2	22.0	23.7	24.5	25.0	16.0	15.5	4.3	60	0

* PM10 & PM2.5 has been compared with NAAQS standard in Core Zone and Buffer Zone.

Table – 3.14 (Contd.)

STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011
Unit : $\mu g/m^3$

SL. NO.	POLLUTANT	LOCATION CODE	MIN.	PERCENTILE VALUE											MAX.	ARITH. MEAN	GEO. MEAN	STD. DEVIATION	STD. *	% EXCEEDING STANDARD LIMITS
				10	20	30	40	50	60	70	80	90	95	98						
04.	SO_2	SA - 1	7.5	8.7	9.2	9.4	10.0	10.4	11.2	11.7	12.1	12.5	12.8	13.3	13.8	10.6	10.4	1.7	120	0
		SA - 2	7.3	7.8	8.3	9.1	10.3	10.9	11.8	11.9	12.4	12.7	12.9	12.9	12.9	10.5	10.3	2.0	120	0
		SA -3	8.5	9.1	10.9	11.7	11.9	12.3	13.2	13.9	14.7	14.9	15.0	15.3	15.6	12.4	12.2	2.1	120	0
		SA - 4	7.3	7.4	7.6	8.2	9.1	9.8	11.1	11.9	12.4	12.8	13.4	13.7	13.9	10.1	9.9	2.2	120	0
		SA - 5	8.5	9.9	10.5	11.3	12.0	12.5	13.8	14.0	15.0	15.3	15.5	15.7	15.8	12.6	12.4	2.2	120	0
		SA - 6	8.2	8.9	9.5	9.8	10.0	10.3	10.5	10.6	11.0	11.4	11.6	12.0	12.3	10.2	10.2	1.0	80	0
		SA - 7	6.8	8.0	11.8	13.5	15.3	15.5	16.0	16.7	17.0	17.9	18.2	18.4	18.5	14.4	13.8	3.6	80	0
		SA - 8	7.3	8.1	8.6	9.4	9.6	10.0	10.6	10.7	10.8	11.4	11.8	11.9	11.9	9.9	9.8	1.3	80	0
		SA - 9	6.3	7.4	8.0	9.4	9.6	10.4	10.7	11.0	11.4	11.7	13.0	13.3	13.3	10.0	9.8	1.9	80	0
05.	NO_x	SA - 1	13.4	14.0	15.4	16.4	16.7	17.7	17.9	18.5	18.8	19.5	19.6	19.7	19.8	17.1	17.0	2.0	120	0
		SA - 2	10.1	11.3	13.3	15.0	16.6	17.3	17.6	18.2	19.2	19.6	19.9	20.2	20.4	16.3	15.9	3.2	120	0
		SA -3	13.4	14.0	17.0	19.3	20.1	21.8	23.4	24.6	24.8	26.6	26.8	27.0	27.1	21.1	20.6	4.5	120	0
		SA - 4	10.0	11.2	11.8	12.3	13.5	15.5	16.3	16.9	18.8	19.6	20.6	21.0	21.2	15.2	14.8	3.5	120	0
		SA - 5	13.9	15.4	16.0	18.1	19.1	19.8	20.0	21.5	22.6	23.1	23.5	23.5	23.5	19.4	19.2	3.0	120	0
		SA - 6	13.5	14.1	14.5	15.0	15.3	16.0	16.3	16.5	16.8	17.1	17.3	17.6	17.9	15.7	15.7	1.2	80	0
		SA - 7	10.2	12.1	15.9	18.2	19.3	20.7	21.2	21.7	23.0	27.0	28.0	28.5	28.7	19.9	19.1	5.3	80	0
		SA - 8	12.1	13.7	14.7	14.8	15.4	15.6	15.7	16.3	16.7	17.1	17.2	18.2	19.1	15.5	15.5	1.5	80	0
		SA - 9	11.2	12.4	13.4	14.2	15.0	15.4	15.9	16.1	17.1	17.9	18.4	18.4	18.4	15.2	15.1	2.1	80	0

* SO_2 & NO_x has been compared with Coal Mines standard in Core Zone and in other than Core Zone as per NAAQS.

3.3.2 Practice after the closure of the mine

a. As the sources of dust and fume generation would no longer be present, after the final mine closure the present practice of arresting the air pollution, as enumerated above will be discontinued. However, water sprinkling would be done on the roads, which remain in use after the final mine closure.

b. Quality of air would be monitored for a period of 3 years after cessation of mining activity. 3 samples at fortnight frequency for 3 years, one sample in core zone and one sample each in upwind and downwind direction will be collected and analysed.

3.4 Waste Disposal

This is an underground mine, therefore solid waste is not likely to be generated during the mining operation.

3.5 Details of Surface Structures proposed for dismantling

3.5.1 Infrastructure details

Details of Surface Structure proposed to be dismantled

As far as possible, industrial structures will be utilized by the adjacent mines. However, if these structures are not found fit at the end of mine life, the same will be dismantled and salvaged. The equipments will be removed and used somewhere else. Every effort will be made to restore the area to economic utilization value in line with mine closure plan.

A. **Service Buildings**: The service buildings/ structures, viz. workshop, stores, office building, cap-lamp room, Pit top office, winding rooms, etc. are to be demolished after collecting all re-useable items, or be used for some other projects and the land covered by them restored for productive use. However, it has to be ensured that as and when a service building is vacated/ abandoned, the same should be demolished to prevent any unauthorized occupation.

B. **Other Infrastructures**: All other infrastructures like sub-stations, transformers, community services, pump-houses, water-treatment/ filtration plants, waterlines, power lines, roads etc. will be utilized for the neighbouring projects.

However, possibility shall be explored for handing over the buildings and other infrastructures including the reclaimed land to the State Government for the benefit of local villagers and strengthening the area infrastructures. The end use of these facilities shall be decided by the State Government with the help of District Authorities and Village Panchayat. The peripheral village community facilities developed by the Mine Authorities will be left to the Local Body/ State Government for their management and public use.

Prior to surface demolition/ restoration, a surface audit will be undertaken on all surface structures, spoil heaps etc. to assess whether there is any hazardous material that could cause problem, i.e. explosive, asbestos, chemical, oil, etc.

A list of surface and UG assets (Plant & Machinery) will be prepared and made available to potential purchasers or transferred to other new/ working mines of the company. This will ensure that the assets perform during their economic life.

3.5.2 Post closure disposal/Re-use of the Buildings, Plants & Machineries

a. Disposal or reuse of existing HEMM, CHP, workshop and railway siding for OC

   Not Applicable

b. Disposal or reuse of haulage, ventilation, workshop and railway siding for UG

   At the time of closure of the mine, it is expected that most of the equipments would complete its rated life and would be surveyed off as per the Company’s guidelines. The surveyed off equipments would be auctioned as per prevalent norms.

However, if some of the equipment would not have covered their rated life, they would be diverted to the neighboring projects for gainful utilisation.

There is no railway siding in the leasehold.

c. Disposal or reuse of transmission lines and sub-station

As per the electricity demand of the existing neighboring Projects, an analysis would be made as to whether the existing sub-station and transmission lines could be gainfully used or not. If the scope of gainful utilization is not found, they will be dismantled and the usable items/spares/conductors etc. would be dispatched to needy Areas/Projects.

d. Disposal or reuse of residential and non-residential buildings

At the time of final closure, a list of surface buildings would be prepared in detail. Thereafter following steps would be taken in chorological order in respect of the available buildings:

- An assessment would be made to find that whether the available buildings can be used by the existing neighboring projects or any new project that might have come up in the vicinity.
- In case, the listed assets cannot be utilized by the nearby project, efforts would be made to sale these assets after making the list available to potential purchasers and asking the interested purchasers to submit sealed bids.
- Thereafter, the state agencies/local agencies may be asked to take possession of the buildings, if they required few of them.
- When there would be no takers, the buildings would be demolished and usable items would be recovered for future use.

Table 3.15 Infrastructure Details

Sl. No.	Particulars	Action Suggested
A	CHP	CHP doesn't exist in the leasehold area.
B	Workshop	-Do-
C	Railway Sidings	Railway siding doesn't exist in the leasehold area.
D	Colony	These will be handed over to the State Government if fit for use or will be dismantled.
E	Details of non-residential buildings	-Do-
F	Other facilities (ETP /STP)	-Do-

3.6 Safety and Security Arrangement

3.6.1 Mine entry:

After closure of the mining activities, all the entries to the mine will be effectively sealed off to avoid any accident and to prevent access to any unauthorized person. The area that is not reclaimed shall be properly fenced/ sealed to prevent any unauthorized entry into the area. Flags/Boards with warning signals shall be posted at vulnerable places to avoid chances of accidents. However, the guidelines / instructions from DGMS, if any, will be followed.

Sealing details and dimensions shall also be prepared for the purpose. The minimum thickness of mine sealing will be 100cm RCC (M20) with nominal reinforcement. For incline entry, the mine entry path of 5 m will be filled with debris and clay before sealing the mine.

3.6.2 Providing one time lighting arrangement

Sufficient lighting as per standard is provided at all the required places, i.e., pit office, haulage room, fan house, cap lamp room, mine entry, workshop, sub-station etc.

After closure of the mine, the lighting arrangements will be kept maintained at all locations which are not required to be demolished or dismantled like sub-stations, transformers, community services, pump-houses, water-

treatment/ filtration plants, waterlines, power lines, roads etc. to be utilised for the neighbouring projects and local communities.

3.6.3 Survey records of workings

All the mine workings including subsidence areas, roads, ponds, tanks etc. shall be resurveyed and records shall be updated. There are reports of water accumulation in IX/X (165MG), VIIIC (120MG), VIIIB (67.50MG), VIIIA (69.0MG) respectively in Maheshpur section of the mine. Copy of such records shall also be submitted to the appropriate competent authorities, such as DGMS and State Authorities.

Maintenance of records pertaining to Progressive Mine Closure

The Mine management shall maintain a Progressive mine closure plan for every 5 year period:

Progressive mine closure plan for UG activities

Similar to PMCP for surface activities, a progressive mine closure plan showing the UG activities shall be maintained. This plan shall also be updated on annual basis and signed by all the above mentioned officials.

Besides the above plan, a progressive mine closure register shall also be maintained by the mine management. This register shall carry details of the progressive mine closure activities carried out on yearly basis. The details to be maintained in the said register shall cover inter alia the name of activity, place, period of execution, executing agency, expenditure incurred, proof of expenditure incurred, final status of the area where activity was executed, plan on which such activity has been shown etc.

The entries into the said register shall be signed by the appropriate authorities from the Project and the Area. At the end of the year the said register (along with two plans) shall be placed before HOD (Env.) of the Company for scrutiny and approval.

3.6.4 Disposal management of hazardous material

At the time of closure, assessment would be made as to find whether there is any hazardous material that could cause problem. Such hazardous material e.g. explosives, chemicals, oil etc. shall be appropriately disposed off.

3.7 Entrepreneurship development Program

As the mine progresses, more and more local people gets indirectly dependent on the mine for their sustainable income. After closure of mine there would be no source of income for these people. In order to ensure that these people do not suffer in the post closure period, the Project authorities in consultation with BCCL (HQ) shall make efforts to develop entrepreneurial skills in the local people by imparting skill development/vocational training programs. It is expected that after developing adequate entrepreneurial skills, the local people would be able to run their own business in the post closure period and maintain a sustainable income for their livelihood.

3.8 Miscellaneous activities

In future, the prevalent geo-mining/environmental conditions in and around the project area may require execution of some other progressive mine closure activities not covered in the preceding paragraphs. Such activities may be carried out by the mine after observing the needful formalities and obtaining approval of HOD (Env.) of the Company.

3.9 Execution of progressive mine closure activities and 5 yearly monitoring

After observing the necessary administrative/financial formalities, the mine authorities shall execute the identified progressive mine closure activities, whenever and wherever required. The executed activities shall be shown on the above said plans and recorded in the said registers.

The executed progressive mine closure activities shall be monitored on 5-yearly basis by 3rd party (ISM, CMPDI, NEERI etc.).

The 5 yearly return from escrow fund would be equal to expenditure incurred on progressive mine closure activities during last 5 years or 80 % of total deposited amount in the escrow account (including interest) whichever is less. The said return would be subject to above said monitoring of progressive MCP by a third party (ISM/CMPDI/NEERI etc.).

As the 5 yearly return from escrow fund is linked with the expenditure incurred on progressive mine closure activities during last 5 years, it is very important that progressive mine closure records, plans, expenditure details along with proof are properly maintained.

At this juncture it is important to note that some of the progressive mine closure activities, enumerated in the preceding paragraphs, are legal obligations specified in Project reports, EMP, permissions obtained from statutory bodies such as CPCB, SPCB, DGMS etc. The Project authorities are bound to comply with these obligations.

3.10 Re-deployment of work force

The current manpower of the project is 430 and at present, it is very difficult to assess the manpower of the project, which will remain at the time of closure of mining activities in the presently worked seams. As some of the seams of the block is still virgin and is most likely to be mined in future, the remaining manpower will be gainfully utilized in continuing mining activity.

3.11 Emancipation from the community facilities and the facilities to the PAPs

3.11.1 The Project affected Persons (PAPs) and also the local communities are being provided many civic facilities, such as educational facilities, health facilities, and drinking water. As some of the seams of the block are still virgin and are most likely to be mined in future, these facilities, in all probability, will be kept maintained.

3.11.2 However, at the time of final closure after exhaustion of entire mineable reserve these facilities will be entrusted upon the local bodies/Trust of

PAPs/State bodies after consultation with local people and state authorities so that same could continue even after the mine closure. If needed, a lump sum reasonable amount would also be paid to the local bodies/Trust of PAPs/State bodies after proper approval for proper upkeep and maintenance of various community facilities.

3.11.3 To ensure that no financial loss due to the closure of mining activity in the presently worked seam occur to the local community engaged indirectly to the existing mine, following steps would be taken:

- It has been seen in past that in the event of closure of a mine, the local people indirectly dependent on the mine switch over their economic/professional activities in the existing/new or expansion mines located in the nearby area. Local management, if needed, extends some basic helps to them in such type of switching over. Hence, it is expected that in this project also the transition of the local people from one area to the other area for their sustenance would not be any problem.

- It is proposed that reclaimed and afforested land will be handed over to State Forest Dept. for the benefit of local ecosystem. The forest wealth can also be utilised by local people or tribal in the form of fruits and fodders.

- The proposed picnic spot would be handed over to a society of local people for commercial use of the picnic spot by them.

CHAPTER – IV

ECONOMIC REPURCUSSION

4.0 Economic Repercussions of closure of mine:

4.1 Manpower of the Project

The manpower of the project is 430

Table 4.1 Present Manpower

Manpower	Strength (Nos.)
EXECUTIVE	7
NON EXECUTIVE	423
TOTAL	**430**

Post Closure Manpower

It has been proposed to monitor and implement the post-closure activities departmentally. Departmental manpower will be needed after closure of the mine for monitoring and implementation of the post closure activities. Manpower required for the same is given in Table- 4.2.

Table 4.2: Manpower required for monitoring and implementation of Mine Closure Activities

Sl. No.	Category of Manpower	Requisite heads
1	Officer-in-charge/ Manager (Mining)	1
2	Overman-in-charge	1
3	Foreman-in-charge	1
TOTAL		**3**

4.2 Assessment of Income Scenario of Local People

As Maheshpur colliery is an underground mining project, no surface excavation is likely to be undertaken. Moreover, the basic mining infrastructures have been made on the company acquired land. So there will no displacement of local people for this project. Later, after closure of the mine the work force will be absorbed / re-employed / rehabilitated in operative collieries of BCCL.

After the closure of the mine, the manpower deployed in the mine will be further deployed in other mines of BCCL to make no loss of sustenance income to the eligible employee. The other secondary activities will not be affected by the closure of the mine and the mine discharge water after proper treatment will be provided to the local people for domestic and irrigational uses.

4.2.1 At present, it is very difficult to assess the manpower of the project, which will remain at the time of closure of mining activities in the existing project.

4.2.2 The local communities are being provided many civic facilities, such as educational facilities, health facilities, and drinking water. At the time of final closure after exhaustion of entire mineable reserve these facilities will be entrusted upon the local bodies/Trust of PAPs/State bodies after consultation with local people and state authorities so that same could continue even after the mine closure. If needed, a lump sum amount would also be paid to the local bodies/Trust of PAPs/State bodies for proper upkeep and maintenance of various community facilities.

4.2.3 To ensure that no financial loss due to the closure of mining activity in the presently worked seam occur to the local community engaged indirectly to the existing mine, following steps would be taken:

- It has been seen in past that in the event of closure of a mine, the local people indirectly dependent on the mine switch over their economic/professional activities in the existing/new or expansion mines located in the nearby area. Local Management, if needed, extends some basic helps to them in such type of switching over. Hence, it is expected that in the instant case also the transition of the local people from one area to the other area for their sustenance would not be any problem.

- It is proposed that reclaimed and afforested land, if any, will be handed over to State Forest Dept for the benefit of local ecosystem. The forest wealth can also be utilised by local people in the form of fruits and fodders.

CHAPTER – V

TIME SCHEDULE FOR POST-CLOSURE ACTIVITIES

5.1 It is very difficult to predict the various parameters which would be prevalent at the time of final mine closure (when the entire block reserve would get exhausted) and therefore a mine closure activity schedule cannot be rigidly prepared at this point of time.

5.2 The closure of mine involving technical aspects, environmental aspects, socio-political aspects and financial assurances as implementing post-closure activities will run for three years. The time schedule envisaged for completion of all closure activities is presented in the following table in the form of bar chart.

Table 5.1 Implementation Schedule for post-closure activities for Maheshpur UG mine

Sl. No.	Major Activities	Time Period	Year-wise Phasing			
			Y1	Y2	Y3	Y4
1	Technical aspects	2 years				
2	Environmental aspects	2 years				
3	Post closure environment monitoring	3 years				
4	Socio-political aspects	3 years				

5.2.1 Technical Aspects:

i) **Safety & security**: In the mine closure plan, action will be taken to cover all the safety aspects including management of fire & subsidence and mine inundation.

ii) **Management of pit slopes and waste dump**: Maheshpur being an underground mine, management of pit slope and waste dump will not be needed.

iii) **Management of hydrology and hydro-geology**: After closure of mining activities, the workings will be waterlogged which will help in maintaining the water table in the surrounding areas and may become a source of water supply to the neighbouring areas.

iv) **Closure of Mine Entries**: After closure of the mining activities, all the entries to the mine will be effectively sealed off to avoid any accident and to prevent access to any unauthorized person. The area that is not reclaimed shall be properly fenced/ sealed to prevent any unauthorized entry into the area. However, the guidelines / instructions from DGMS, if any, will be followed.

v) **Disposal of mining machinery**: All the underground machineries including SDLs, haulages etc. which will have residual life will be shifted to the other collieries of the area/company. The salvaging and shifting operation of mining machinery and other equipment will be done considering the ground realities during the period 1 (one) year advance of final mine closure.

vi) **Details of surface structure proposed to be dismantled**:
As far as possible, industrial structures will be utilised by the adjacent mine. However, if these structures are not found fit at the end of mine life, the same will be dismantled and salvaged. The equipments will be removed and used somewhere else. Every effort will be made to restore the area to economic utilization value in line with mine closure plan.

A. **Service Buildings**: The service buildings/ structures, viz. workshop, stores, office building, cap-lamp room, incline top office, haulage/winding rooms, etc. are to be demolished after collecting all re-useable items, or be used for some other projects and the land covered by them restored for productive use. However, it has to be ensured that as and when a service building is vacated/ abandoned, the same should be demolished to prevent any unauthorized occupation.

B. **Other Infrastructures**: All other infrastructures like sub-stations, transformers, community services, pump-houses, water-treatment/ filtration plants, waterlines, power lines, roads etc. will be utilized for the neighbouring projects.

However, possibility shall be explored for handing over the buildings and other infrastructures including the reclaimed land to the State Government for the benefit of local villagers and strengthening the area infrastructures. The end use of these facilities shall be decided by the State Government with the help of District Authorities and Village Panchayat. The peripheral village community facilities developed by the Mine Authorities will be left to the Local Body/ State Government for their management and public use.

Prior to surface demolition/ restoration, a surface audit will be undertaken on all surface structures, spoil heaps etc. to assess whether there is any hazardous material that could cause problem, i.e. explosive, asbestos, chemical, oil, etc.

A list of surface and UG assets (Plant & Machinery) will be prepared and made available to potential purchasers or transferred to other new/ working mines of the company. This will ensure that the assets perform during their economic life.

5.2.2 Environment Aspects

i) **Mined-out land and proposed final land use:** At Maheshpur Colliery it is proposed to extract coal by Bord & Pillar method. In the present stage depillaring is being carried out with caving ensuring no surface degradation. The existing infrastructures, if not usable, will be dismantled and the land will be graded & will be handed over to the local authorities for community use.

ii) **Air & Water quality management:** Appropriate air and water pollution control measures will be taken to contain the air and water pollution for maintaining the ambient air and water quality within the stipulated standards besides making the mining operation eco-friendly in the project. These

measures (both preventive and suppressive) are enumerated in Para 3.2.3 of the present report.

iii) **Management of waste:** The solid wastes generated by the mine during the coal production are non-hazardous and non-toxic in nature. The above solid wastes will be disposed off by backfilling the mined out area and then re-vegetating without causing any siltation problem on surface water bodies. However, scientific studies shall be undertaken regarding applicability of solid wastes for various uses. Toxic solid wastes like used oil, used batteries, oily sludge, besides filters and filter materials containing oil during maintenance of vehicles, will be generated by the mining project. Used oil will be stored in drums safely for disposal through auction to the authorized re-processors. Similarly, used batteries will be stored safely for auction to the authorized re-processors. The oily sludge, besides filter and filter materials, will be disposed off in impervious layer lined pits without causing environmental hazards.

iv) **Management of final voids**: The underground voids will be slowly get filled with water. However, safety of the neighbouring mines will be looked into before the entire underground void gets water filled.

v) **Land reclamation and rehabilitation:** If any cracks or void is created due to mining activities, it will be restored to original profile by filling up cracks/ voids. It is proposed that the site restoration should be kept progressive so that the restoration is more or less similar to the rate of mining.

vi) **Reclamation of forest/ vegetation and plantation:** No forest land is required for the project. However, regular plantation will be taken up during the life of the mine to create green barrier. The plant species will be selected in consultation with the state forest department.

The objective of restoration of post mining area will be determined through consultation with local community and the Government authority, so that the potential/ required end use of the mined out land is determined in advance.

Such usage may be agriculture, forestry, amenity development or nature reserve.

5.2.3 Post Closure Environment Monitoring

After cessation of mining and its related activities, there will be no effect on ambient air and water quality due to this mine as proper mitigation measures for air and water pollution control are to be taken by the authorities of the mine. However, the air and water quality parameters in the mined out area will be monitored by some external agency for next three years after closure of the mine.

Air and water samples will be taken from the specified sampling stations at regular frequency for 3 consecutive years after the closure of the mining project. 1 sample of mine water will be collected and analyzed with fortnightly frequency and 2 samples of ground water from core & buffer zones with monthly frequency. Similarly, 1 air sample will be taken at core zone, and 1 air sample each in upwind and downwind directions of the project at fortnightly frequency.

5.2.4 Socio-Political Aspects

i) **Re-deployment of work force**: Due to closure of mining operations, the persons directly employed in the mine will be surplus. Suitable manpower re-deployment plan may be formulated by the mining company sufficiently before closure of mine for re-deployment of the work force in other units of the company. Alternatively, they would be given option of voluntary retirement.

ii) **Civic facilities**: It is proposed that the civic facilities developed during the mining phase will be transferred to the local government/ municipality so that the region transforms smoothly into post mining phase. A one-time payment should be made by the mine for obtaining its release from providing these facilities, which will there from be taken care of by the local and state bodies.

iii) **Channelisation of available water**: If the mine has sufficient water, this can be used for domestic and agriculture purpose by the local community. The water from this area shall be discharged after treatment for domestic and agricultural usages.

iv) **Emancipation for project affected population**: The village/ basti which are to be rehabilitated as per Master Plan of JCF (March'08) is given in Table No. 5.2.

Table 5.2 Phasewise Rehabilitation as per Master Plan of JCF (March'08)

Village/Site	BCCL	Pvt.	Enchr	Oth	Total
PHASE-I					
Ashakhuti Phularitand 6/O3	30	0	0	1	31
Bamandih Colony/15	0	7	0	0	7
Maheshpur Colliery Office & Houses/O5	29	0	25	2	56
Sinidih Basti, Quarters & Hutments(North of DB Road)/13	18	32	0	0	50
Sinidih NHS Qtrs.& Hutment(East & West of HZL Road)/10	18	4	0	2	24
Sinidih Quarters & houses surround sub-station/12	51	0	5	0	56
Total(Phase-I)	**146**	**43**	**30**	**5**	**224**
PHASE-II					
Maheshpur Bastee/O1	0	372	0	40	412
NHS Qtrs. & House North of DB Road/11	21	114	0	0	135
Premnagar Colony Bastee etc./ 14	15	0	0	0	15
Staff Qtrs. & Hutment/O4	36	0	10	1	47
Total(Phase-II)	**72**	**486**	**10**	**41**	**609**
Total(Phase I+II)	**218**	**529**	**40**	**46**	**833**

5.3 Although, it is very difficult to conclusively predict the likely impacts due to closure of the mining activities in the in the leasehold area of the Instant Project and the likely activities that would be taken up at that point of time, but a broad mine closure activity schedule may be prepared as per guidelines of Ministry of Coal. The post closure implementing activities will run for three years. The following activities are most likely to be implemented as per the given bar chart.

IMPLEMENTATION SCHEDULE FOR MINE CLOSURE MAHESHPUR UG COLLIERY

(LIFE OF THE MINE : 26 YEARS)

S.N	Activity	Time Frame	Year								
			1st Phase	2nd Phase	3rd Phase	4th Phase	5th Phase	Final Phase	Post Closure Phase		
			1st - 5th	6th - 10th	11th - 15th	16th - 20th	21st - 25th	26th	PC1	PC2	PC3
A	**Dismantling of Structures**										
	Service Buildings	2 years									
	Residential Buildings	2 & ½ years									
	Industrial structures like CHP, Workshop, field sub-station, etc.	2 & ½ years									
B	**Permanent sealing of mine entries (incline mouth and air shaft)**										
	Sealing of incline mouths and air shafts	2 years									
C	***Subsidence Management**	Throughout the life of the mine, if required including 3 years after cessation of mining operation									
D	**Landscaping**										
	Landscaping of the cleared land for improving its esthetic	Throughout the life of the mine including 3 years after cessation of mining operation									
E	***Plantation**										
	Plantation over leasehold area and on other open spaces	Throughout the life of the mine including 3 years after cessation of mining operation									

S.N	Activity	Time Frame	Year								
			1st Phase	2nd Phase	3rd Phase	4th Phase	5th Phase	Final Phase	Post Closure Phase		
			1st - 5th	6th - 10th	11th - 15th	16th - 20th	21st - 25th	26th	PC1	PC2	PC3
F	**Post Closure Env Monitoring / testing of parameters for three years**										
	Air Quality	3 years									
	Water Quality	3 years									
G	***Entrepreneurship Development (Vocational/skill development training for sustainable income of affected people**	Throughout the life of the mine									
H	***Miscellaneous and other mitigative measures**	Throughout the life of the mine including 3 years after cessation of mining operation									
I	**Post Closure Manpower cost for supervision**	3 years after mine closure									

NOTE: *: To be covered under Progressive Mine Closure activities also.

NOTE: The progressive mine closure will be done as per the provisions made out in the Project report and as per the situation/requirement that may arise in course of execution of the Project Report.

CHAPTER – VI

MINE CLOSURE COST

6.0 Mine Closure activities would be a constant exercise for the mine which would begin with the commencement of mining operations and continue till post closure. The mine closure activities would naturally entail certain expenditures, which will have to be borne by the mine operator. There would be two types of expenditures on account of mine closure activities in respect of Maheshpur Colliery:

6.1 **Revenue expenditures**

This would cover the activities which are being executed along with normal mining operation and would continue to be executed in course of execution of the project. The cost of progressive mine closure activities is already part of the project cost.

6.2 **Expenditures to be incurred just prior to actual mine closure and in the post closure period**

6.2.1 As per MOC guidelines, a corpus escrow account @ ₹ 1.0 lakhs (August, 2009 Price Level) per Ha (for UG) and @ ₹ 6.0 lakhs(for OC) of the project area shall be opened with the coal controller organization to meet the expenses of final mine closure. The current Guidelines read as:

"It has been estimated that typically closure cost for an opencast mine will come around Rs. 6.00 lakh per Hectare of the project area and it would be Rs. 1.00 lakh per Hectare for underground mine project area at current price levels (August, 2009) and these rates will stand modified based on Wholesale Price Index as notified by Government of India from time to time".

As per the data furnished by the mine/area, the project area and leasehold area in respect of Maheshpur Colliery is the same and the closure cost is calculated accordingly.

In Maheshpur Colliery, the present project area is 292.68 Ha, out of which 2.87 Ha is abandoned quarry, not backfilled (Table No. 1.2). The remaining 289.81 Ha of project area (Excluding Abandoned Quarry) has been considered for the calculation of closure cost of the area as per Underground norms and cost of closure of 2.87 Ha (Running and Abandoned Quarry) is calculated as per Open cast norms.

The overlapping area (where UG & OC operations have been done in different vertical levels) has been considered for calculation of closure cost as per opencast norms.

The money deposited in the Escrow Account has to deal with the following:

- Cost of closure activities.
- Cost towards organization for executing the closure activities.
- Cost of the post project monitoring.
- Creation of a corpus fund for the final mine closure

6.2.2 As per the above guidelines these rates will stand modified based on Whole Price Index as notified by Government of India from time to time. Thus the total expenditure on this front may be calculated in following manner:

- The total amount for mine closure activity in respect of **Maheshpur** C**olliery (Excluding the abandoned quarry**) = 289.81 Ha X ₹1 Lakh X 1.35340*= ₹392.23 lakhs

- **The total amount for reclamation of the Running and Abandoned Quarry in the Leasehold Area of Maheshpur Colliery**= 2.87 Ha X ₹6.00 lakhs X 1.35340*= ₹ 23.31 lakhs

*** The amount has been escalated based on WPI of July 2013, (175.4) vis-à-vis WPI of August '09(129.6).**

The WPI of July 2013 is provisional as per the Govt.'s notification (Office of the Economic Adviser).

6.2.3 It is difficult to conclusively predict the mining parameters on a long term basis owing to rapidly changing mining technology, developments in the field of clean coal technologies and R&D activities in development of alternative energy sources.

As per the latest Guidelines issued by the MoC, GoI(dt. 07.01.2013) the *“annual closure cost is to be computed considering the total project area at the above mentioned rates and dividing the same by the entire life of the mine in years for new projects and balance life of mine in years for operating/existing mines.”*

Jharia Coalfield is characterized by occurrence of a number of working coal horizons, giving a leverage of extended working life of the mines. Some more seams can come in the lap of workable horizons due to improvement in mining technology in times to come. The underground mines in leasehold of RCF are generally small capacity mines, giving a false impression of very long lives due to small level of current production level. There may be a strategy in future to amalgamate the mines for higher production level to attain the economics of scale. In such a situation, the life of the mine arrived at with current level of production for the balance reserve may not be workable in the long run.

In view of the above, for the purpose of mine closure cost calculations, the life of the mine has been calculated based on the reserve available in the seams considered for production. The mine leasehold can be divided into two parts by E-W trending 90-120 m throw fault. The mine workings on north of the fault have been done in Maheshpur, Sinidih, New Sinidih and Tundu Khas Sections on B&P method. The surface area is heavily built up on north of the fault. Wherever, free area was available seams have been depillared with caving. The other areas are mostly SOP and waterlogged.

At present, B&P (SDL), depillaring with caving is going on in VIII A (IX Bot) seam (Sinidih Section). The seam has extractable reserve of only .04 MTe in free area which can last for about a year. Subsequently, it is proposed to develop V/VI/VII seam (Maheshpur Section) through a drift from VIII A seam. The reserves estimated in V/VI/VII seam (Maheshpur Section) for development are about 1.5 MT. Once these reserves are exhausted, the mine may not have reserve to continue production by underground method. There may be a proposal to work the SOP reserves by opencast subject to removal of surface constraints. If so happens, a fresh new Mine Closure Plan will be submitted incorporating all the changes. Thus, keeping in view the available reserves in the seams being and present mine capacity, the remaining life of the mine will be 26 years.

Further, the lower seams are virgin which may be mined in future subject to removal of surface constraints. If so happens, a fresh new Mine Closure Plan will be submitted incorporating all the changes.

To arrive, at the annual cost, to be deposited in each year in an escrow account, the mine closure cost **(Excluding the Cost of Abandoned Quarry)** has been divided by 26, as shown below:

- Amount to deposited in 1st year will be (**Reclamation Cost of the Abandoned Quarry in the Leasehold Area (**₹23.31 **lakhs) + Amount to be deposited in 1st year for Mine Closure of Jogidih Colliery on UG norm (**₹15.09 **lakhs)**) -------- ₹ 38.4 lakhs.
- Amount to be deposited in 2nd year will be— ₹ 15.09 (1 + 5%)^1 lakhs
- Amount to be deposited in 3rd year will be— ₹ 15.09 (1 + 5%)^2 lakhs

6.2.4 In the above fashion, an amount will be deposited every year up to the last year of mine life by applying the following formula:

- Amount to be deposited in nth year will be— ₹ 15.09 (1 + 5%) ^(n-1) lakhs

6.2.5 The amount calculated by the above formula shall be deposited every year by BCCL in the Escrow Account opened with the Coal Controller organisation in a scheduled Bank. An agreement, outlining detailed terms and conditions of operating the said Escrow Account shall be executed amongst BCCL, the Coal Controller and the commercial Bank.

6.2.6 Thus, total amount that shall be deposited for final mine closure activities **Maheshpur Colliery** stands out to be ₹ 794.40 lakhs as per the present status of the mine. The Break-Up cost of Mine Closure of Maheshpur Colliery Yearwise is given in Table No. 6.1.

Table No. 6.1 Break-Up cost of Mine Closure of Maheshpur Colliery – Yearwise (WPI July 2013)

Year	Amount to be deposited per year in ₹ Lakhs
1.	38.40
2.	15.84
3.	16.63
4.	17.46
5.	18.34
6.	19.25
7.	20.22
8.	21.23
9.	22.29
10.	23.40
11.	24.57
12.	25.80
13.	27.09
14.	28.45
15.	29.87
16.	31.36
17.	32.93
18.	34.58
19.	36.31
20.	38.12
21.	40.03
22.	42.03
23.	44.13
24.	46.34
25.	48.65
26.	51.09
Total	**794.40**

6.2.7 Based on the existing mine closure planning norms, the above calculated cost at current WPI on mine closure may be tentatively grouped under different heads as given in Table No. 6.2

Table No. 6.2 Break up Cost of Mine Closure of Maheshpur Colliery Including Abandoned Quarry

Sl. No.	Activity	Mine Closure Cost (₹ in Lakhs)
	UG Part of the leasehold	
A	**Dismantling of Structures**	
	Service Buildings	26.99
	Residential Buildings	81.58
	Industrial Structures like CHP, Workshop, field sub-station, cap lamp room, haulage, fan installation etc.	48.81
B	**Permanent Sealing of mine entries(incline mouth and air shaft)**	
	Sealing of incline mouths and air shafts	41.02
C	***Subsidence Management**	36.63
D	**LANDSCAPING**	
	Landscaping of the cleared land for improving its aesthetic	67.86
E	***Plantation**	
	Plantation over the cleared area obtained after dismantling and on other barren spaces	100.24
F	**Monitoring/Testing of parameters for three years**	
	Air Quality	52.66
	Water Quality	48.89
G	***Entrepreneurship Development(Vocational/skill development training for sustainable income of affected people**	58.99
H	***Miscellaneous and other mitigative measures**	112.58
I	***Manpower Cost for Supervision**	94.84
	Sub-Total(UG Part)	**771.08**
	***Abandoned Quarry Reclamation**	
A	**Reclamation of the abandoned quarry**	23.31
	Sub-Total(OC Part)	**23.31**
	GRAND TOTAL	**794.40**

Note: * : To be covered under Progressive Mine Closure activities also

6.2.8 *Mining is to be carried out in a phased manner initiating afforestation/reclamation work in the mined out area of the first phase while commencing the mining in the second phase i.e. continuation of mining activities from one phase to other indicating the sequence of operations depending on the geo-mining conditions of the mine. Up to 80% of the total deposited amount including interest accrued in the ESCROW account may be released after every five years in line with the periodic examination of the Closure Plan as per Clause 3.1 of the Annexure of the Guidelines. The amount released should be equal to expenditure incurred on the Progressive mine closure in past five years or 80% whichever is less. The balance amount shall be released to mine owner/leaseholder at the end of the final Mine Closure on compliance of all provisions of Closure Plan. This compliance report should be duly signed by the lessee and certify that said closure of mine complied all statutory rules, regulations, orders made by the Central or State Government, statutory organisations, court etc. and certified by the Coal Controller.*

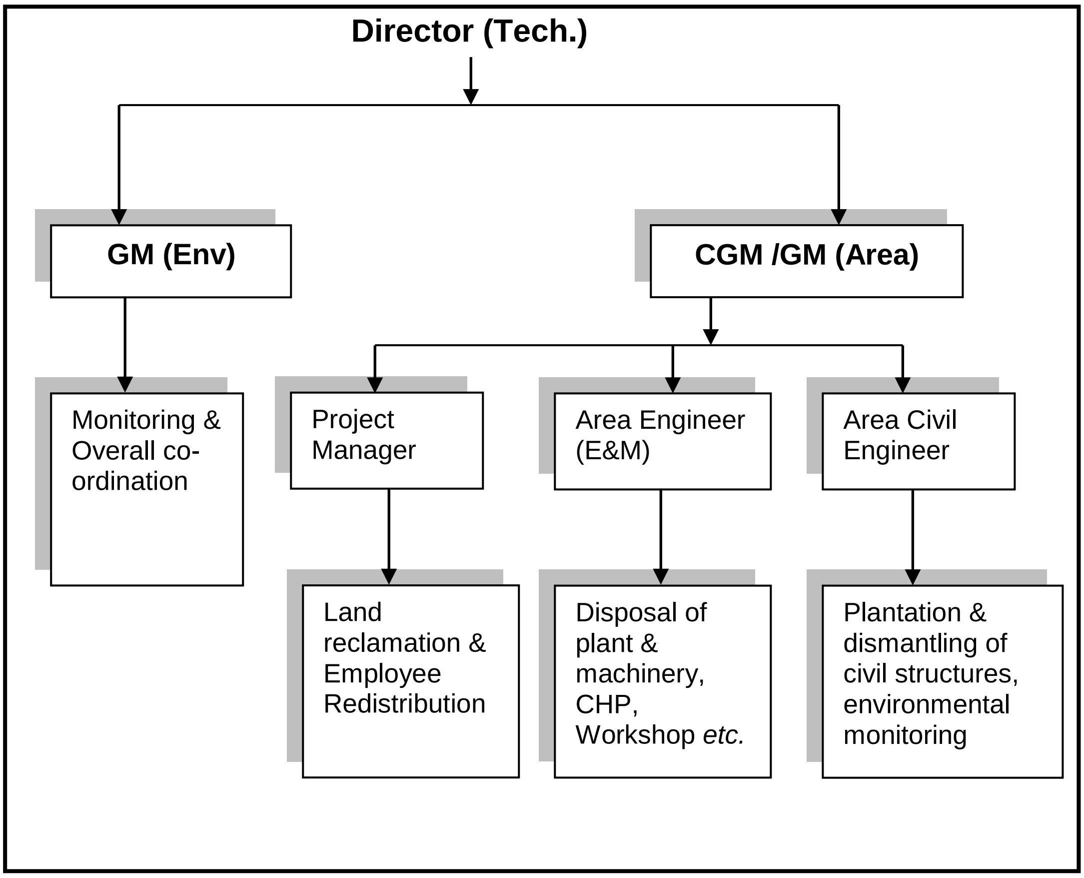
6.2.9 However, the additional amount beyond the escrow account, if any estimated later on, will be provided by the mine operator after estimating the final mine closure cost five years prior to mine closure (as per the mine closure guideline).

CHAPTER-VII

IMPLEMENTATION PROTOCOL

7.1 As the mine closure activities would continue even after cessation of mining activities, an organization consisting of different discipline would be formed to undertake the implementation of mine closure activities as well as monitoring of the same**.** Such activity shall continue for a period of three years after the closure of mining activity in the mine. Once the closed mine becomes stabilized in respect of safety, environmental and social aspects, the monitoring team would be withdrawn.

7.2 For implementing the mine closure activities and monitoring thereof, the following organisational structure at corporate level has been proposed:



7.3 Environmental monitoring for three years after closure of mine will be carried out to evaluate the environmental quality of the area. If need be, proper

mitigation measures will be taken up after evaluating the environmental quality. Before closure of the mine, Area GM will prepare survey and disposal report and the same will be submitted to DGMS for acceptance.

7.4 When the mine closure activities would take final shape and the entire are under influence is brought to an acceptable shape, BCCL would obtain a mine closure certificate from Coal Controller to the effect that the protective, reclamation and rehabilitation works in accordance with the approved mine closure plan/final mine closure plan have been carried out for surrendering the reclaimed land to the State Government concerned.

CHAPTER – VIII

PLANS ENCLOSED

The following underground and surface plans have been enclosed along with this mine closure plan:

1. Location Plan of Cluster III
2. Surface plan of Cluster III showing surface features, roads, depot/siding, OB dumps, quarries (working/old/discontinued), subsidence, plantations, habitations, vacant land (whether under agriculture or waste land), surface water bodies, natural drainage and mine discharge water channels
3. Geological Plan of Cluster III
4. UG Working plan of VIIIA Seam

CHAPTER – I

INTRODUCTION

1.0 Introduction

Block IV is a mixed mine. It constitutes Kirudih UG and Kirudih OC, which operates under Govindpur Area of BCCL. It has leasehold area of 149Ha. At present VIIIB, VIIIA and V/VI/VII Combined seam as Base Seam are being extracted by open cast method with shovel-dumper combination (Departmental). III seam is being worked by underground Bord & Pillar method with development, deploying SDLs.

Table No.1.1 Details of Working

Seam	Production Outlet	Method of work	Production (TPD)
III seam	3 Seam Incline	B&P, Dev. Manual	150
VIIIB, VIIIA and V/VI/ VII Combined seam		OC, Shovel-Dumper Combination	2700

1.1 Name of mine owner / company

Project :	Block IV Colliery
Area :	Govindpur Area
Company :	BCCL
Mine Owner :	Director (Technical)(Operation), BCCL (Nominated)

1.2 Address for Communication with PIN and Phone nos.

PO :	Sonardih
District :	Dhanbad
State :	Jharkhand
PIN :	828125
Telephone :	0326-2392011

1.3 Location of mine:

Latitude :	23º 47' 45" to 23º 48' 30" North
Longitude :	86º 15' 15" to 86º 16' 45" East
Area :	Govindpur Area
Coalfield :	Jharia Coalfield

1.4 Capacity of the mine

Date of start of development work:	Before Nationalisation
Date of start of production:	Before Nationalisation

The normative capacity for Kirudih OC works out to 1.10MT/Annum. The normative capacity for Kirudih UG works out to be 0.08 MT/Annum.

1.5 Method of Mining including Equipment deployed

At present VIIIB, VIIIA and V/ VI/ VII Combined seam are being extracted by open cast method with shovel-dumper combination (Departmental) and III seam is being worked by underground Bord & Pillar method with development, deploying SDLs.

1.6 Coal Processing / Beneficiation Operation

The present production of the Mine is mostly linked to power plants through NLG Siding (about 4 to 5 Km. away from the Mine). From pit head to the siding the coal is transported contractually through road. Part of the production is linked to private Crockery through road.

No beneficiation plant has been proposed.

1.7 Total Lease Area involved :- 149.00 Ha

1.8 Type of Lease Area (Ha) :-

Table 1.2 Type of Lease Area Area

Sl. No.	Particulars	Mining Area	Outside mining area	Total
1	BCCL land (through LA Purchase & Agreement)	98.98	Nil	98.98
2	Vested Land	42.68	Nil	42.68
3	Railway Land	Nil	Nil	Nil
4	Govt. Land	2.69	Nil	2.69
5	Forest Land	Nil	Nil	Nil
6	Private Land	4.65	Nil	4.65
	Total (Mine fed data)	**149.00**	**Nil**	**149.00**

1.9 Communication and Physiography

Block IV colliery is well connected by rail and road. The colliery is at distance of 26Km from Dhanbad Railway Station. Dhanbad-Chandrapura section of the EC Railway passes through the northern side of the block.

The area has a rugged topography. The area is generally undulating in the mineable area of the mine with surface elevation ranging from 180 mts to 240 mts. The area covered under this mining plan is mostly undulating with a significant drainage towards south, which is controlled by seasonal nallahs ultimately discharging in to Khodo and Bagdigi Jore which finally flows to Damodar river which is about 13 km in south side.

1.10 Type of Present and proposed land use of mining area (Ha)

Table 1.2 Land Use of Mining Area

Sl. No.	Type of land use	Present mining land use (in Ha)	Proposed mining land use (in Ha)
1	Running Quarry		
	Backfilled	37.22	80.34
	Not Backfilled	9.12	12
2	Abandoned Quarry		
	- Backfilled	32	0
	- Not Backfilled	0	0
3	External OB dump	7.88	0
4	Service building/ Mine Infrastructure	1	1
5	Coal dump	6.39	6.39
6	Homestead Land	3.71	3.71
7	Agricultural Land	0	0
8	Forest Land	0	0
9	Plantation	0	15
10	Water Body	2.15	2.15
11	Barren Land	49.53	28.41
12	Others	0	0
	Total	**149**	**149**

1.11 Statutory Approvals

Table 1.3 Statutory Approval Status

Sl. No	Particulars	Status
A	Mine plan / F.R / P.R	Formulated for the purpose of TOR
B	Forestry clearance	NR
C	Env clearance	Obtained
D	Consent to operate	Existing Mine
E	Any other approval from Central / State regulatory authorities for operating mine with special reference to mine closure.	Mine closure plan to be approved by BCCL Board of Directors.

1.12 Reasons for Closure

At present VIIIB, VIIIA and V/VI/VII Combined seam are being extracted by open cast method with shovel-dumper combination (Departmental) and III seam is being worked by underground Bord & Pillar method with development, deploying SDLs.

The total reserves in the seams considered for OC operation with V/VI/VII Combined Seam as base has been estimated at 7.505 MTes (mine fed data). There is also a proposal to start OC operations in a new patch covering XI/XII, IX/X, VIII B & V/VI/VII Combined seams with a total reserve of 5.732 MT. Therefore the total available reserves for opencast are 13.237 MT. Thus, keeping in view the available reserves and the departmental mine capacity of 1.1 MTY, the remaining life of the mine will be 12 years.

In case of underground working of III seam total available reserve is estimated up to 2.46 MT. But the life based on UG working is not considered for determination of Mine Closure Cost. A Project Report on Block-IV OCP (6.0 MTY) has been formulated with I seam as Base seam, which covers Block IV colliery in its entirety in addition to the other adjacent mines. If this PR is implemented, all the UG outlets of Block IV colliery will be excavated. In such a situation, it is envisaged that a New Closure Plan should be drawn up as per the revised scope of mining operations as per the relevant guidelines.

Pursuant to the quarrying, the surface and subsurface constraints will be done away with, paving the way for depillaring of the SOP reserves in the lower seams. However, the closure cost will be estimated based on the life of the proposed OC as per the prevalent norms. The underground mining can continue beneath the de-coaled area of overlying seams.

Any mines in the group may be closed in future on account of exhaustion of economically recoverable coal reserves in the lease hold area. The mine may also be closed on account of other unforeseen reasons i.e. Force Majeure or directives from statutory organizations or court etc. for which information and notices shall be served to concerned Government authorities and departments. As per guidelines of Ministry of Coal, Govt. of India, Mine Closure Plan has to be submitted along with the mine plan for getting competent approval within one or two years of date of approval of mine plan.

1.12.1 Need of Mine Closure Planning

Mining is a hazardous operation as it offsets the equilibrium of natural depositional environment viz. In-situ stress field, ground water, surface drainage system as well as the socio-economic condition. Although mining activities are usually short term phenomena, they are liable to leave long lasting impacts on landscape, ecology and on the mind set of local inhabitants. Thus, it is imperative that any mining venture should have adequate closure plan addressing issues viz. reclamation and environmental protection, rehabilitation of disturbed area which should be acceptable to local community as well as regulatory authority. Community acceptable implementation of mine closure plan will incur some extra cost, neglecting this aspect will lead to future problems of attending compensation or expensive socio-economic problems.

Mine closure encompasses restoration process designed to restore physical, chemical and biological quality, disturbed by the mining activities. Mine closure is not just something that happens at the end of a mine’s life rather mine closure is an ongoing series of decisions and activities beginning in the pre-mining stage of mine and ending with a creation of self sustainable site that can be returned to the community.

Thus, a mine closure plan needs to define the liabilities, responsibilities and authorities of the different agencies like the mine management, other regulatory bodies, Central and State Governments after mine closure.

Various objectives of the advance mine closure planning are as given below.

a. To allow productive and sustainable after-use of the site, which is acceptable to the mine owner and the regulatory authority
b. To protect public health and safety
c. To eliminate environmental damage and thereby encourage environmental sustainability
d. To minimize adverse socio-economic impacts of mining activities
e. To protect the flora and fauna of the area affected by the mining
f. Effective use of the assets created during the course of mining

Primarily, the mine closure activities are planned in two stages. The initial plan identifies the activities required to be executed in line with the mining activities in progress after the inception of the project i.e., progressive mine closure activities. These activities may undergo subtle changes depending upon the actual site condition during implementation. Finally, a detailed closure plan is to be prepared 4-5 years before the actual closure time of the mine depending upon the existing parameters at that point of time, i.e., final mine closure activities.

1.12.2 Mine closure planning strategy in respect of Block IV Colliery based on existing set of parameters

As the balance life of the mine is 7 years from now for the seams being worked at present by OC, following activities are envisaged towards mine closure programme in respect of BLOCK IV Colliery.

a. Progressive mine closure activities will continue as envisaged in the mine plan/feasibility report, if any, and as enumerated in the various approvals, permits, consents etc.

   The recent guidelines issued in this regard by MoC, GoI should also be followed.

b. Although, it is very difficult to foresee the likely impacts due to closure of the mining activities in the leasehold area of the project, but in the present report, the same has been estimated and some mitigating measures have been suggested accordingly. These suggested measures along with certain other measures, as deemed fit, at the time of closure of mining activity in the seams being worked at present shall be taken up.

c. The final closure plan carrying the finer details would be prepared at the time of preparing the mine plan for last mineable patch of coal seam in the leasehold area of the project.

1.13 Approval of Company Board of Directors or any other competent authority (Attach Copy)

The closure plan will be placed to Board of Directors of BCCL for approval.

CHAPTER – II

MINE DESCRIPTION

2.1 Geology of the block

Geology of the mine has been established by surface and sub surface data from Geological reports of (i) Opencast Block-IV (Seams VIIIC to I/II) & (ii) Opencast Block-IV. Kooridih Colliery is located in the western part of Jharia Coalfield. The area is occupied by strata of Barakar formations containing Coking and Non-coking coal seams. The coal bearing rocks of Barakar formation of Lower Permian age occur in the Colliery area under a thin cover of soil and/alluvium (5 to 10m). Altogether 14 boreholes have been drilled in Kooridih colliery area. All boreholes have been drilled by CMPDI in two different series i.e. GK & EKS, with total meterage of 1742.73m & 391.30m respectively. The period of drilling of boreholes is from May'1978 to March'1985. The details of boreholes are given below in the table:-

Table-2.1: Details of Boreholes

SERIES	DRILLING AGENCY	NO. OF BOREHOLES	METERAGE
GK	CMPDI	12	1742.73
EKS	CMPDI	2	391.30
TOTAL		14	2134.03

2.1.1 Geological Structure of the area

Strike & Dip

In general the strike of the formation is E-W and the dip varies from 5° to 14° due south.

Faults

Two major faults are encountered in this area. However, faults having throw less than 5m could not be ruled out in the area.

Table-2.2: Details of the Fault

Sl. No.	Fault	Location	Strike	Max. Throw (m)	Nature	Evidence
1.	F1-F1	Southern part of the area	E-W	25/N	Oblique fault	Roof of IX/X seam is faulted in GK-13.
2.	F2-F2	Central part of the area	N-S	5/E	Dip fault	Encountered in the working of VIIIB, VIIIA, V/VI/VII, III & I/II seam in the colliery.

2.1.2 General Description of coal seams and its quality

In Kooridih colliery, detailed drilling has proved existence of number of coal seams from XI/XII to I/II seam.

2.1.3 Seam sequence

The generalized sequence of coal seams and the intervening partings in Kooridih colliery area is as follows:-

Table-2.3: Generalized Seam Sequence and Parting/Quality

SEAM	THICKNESS (m)		AVERAGE THICKNESS (m)	DEPTH RANGE (m)	NO. OF FULL SEAM INTERSECTIONS	GRADE
	MINIMUM	MAXIMUM				
XI/XII	7.25(GK-5A)	-	7.25	0-35	1	UG
P	13	-	-	-	-	-
IX/X	9.83(GK-5A)	-	9.83	0-50	1	W-IV to UG
VIIIC	1.03(GK-13)	-	1.03	0-55	1	NA
P(IX/X with VIIIB	32	-	-	-	-	-
P(VIIIC with VIIIB)	20	-	-	-	-	-

SEAM	THICKNESS (m)		AVERAGE THICKNESS (m)	DEPTH RANGE (m)	NO. OF FULL SEAM INTERSECTIONS	GRADE
	MINIMUM	MAXIMUM				
VIIIB	1.30(GK-2)	2.55(GK-16)	1.93	0-85	5	W-IV to UG
P	8	14	-	-	-	-
VIIIA	1.85(GK-16)	3.28(GK-13)		0-105	5	UG D-E
P	30	-	-	-	-	-
VII	6.65(EKS-30)	-	6.65	80-110	1	UG
P(VIIIA with V/VI/VII)	29	33	-	-	-	-
P(VIII with V/VI/VII)	1	-	-		-	-
V/VI/VII	19.72(GK-4)	29.25(GK-2)	24.50	0-165	9	UG F
P(VII with V/VI)	3	-	-	-	-	-
V/VI	16.75(EKS-30)	-	16.75	95-125	1	UG
P(V/VI/VII with IV)	22	25	-	-	-	-
IV	2.85(GK-13)	5.55(GK-16)	4.20	0-150	3	E-F
P(V/VI/VII with IVT	20	29	-	-	-	-
P(V/VI with IVT)	22	-	-	-	-	-
IVT	0.49(GK-1)	1.50(GK-15)	1.0	0-175	6	D-F
P	1	5	-	-	-	-
IVB	0.40(GK-1)	0.88(GK-4)	0.64	0-195	4	E-F
P(IV with III)	19	24	-	-	-	-
P(IVB with III)	17	25	-	-	-	-
III	3.33(GK-22)	5.98(EKS-35)	4.66	0-215	13	D-F
P	12	28	-	-	-	-
I/II	1.10 (GK-9)	4.00(GK-5A)	2.55	0-240	11	B-D

2.1.4 Reserves, types and quality

Balance mineable reserves have been given in the Table 2.4.

Table No. 2.4(Mine Fed Data)

<table>
<tr><th rowspan="2">Seam</th><th rowspan="2">Avg. Thickness (m)</th><th rowspan="2">Grade</th><th colspan="2">Mineable Reserves (Mte)*</th></tr>
<tr><th>Current Quarry</th><th>Proposed Patch</th></tr>
<tr><td>XI/XII</td><td></td><td>W-IV</td><td>-</td><td>0.038</td></tr>
<tr><td>IX/X</td><td></td><td>W-IV</td><td>-</td><td>0.566</td></tr>
<tr><td>VIIIB</td><td>1.83</td><td>W-IV</td><td>0.796</td><td>0.332</td></tr>
<tr><td>VIII A</td><td>2.73</td><td>W-IV</td><td>0.509</td><td>-</td></tr>
<tr><td>VII/VI/V</td><td>28.00</td><td>W-IV</td><td>6.200</td><td>4.405</td></tr>
<tr><td colspan="2" rowspan="2">Total(OC)</td><td rowspan="2"></td><td>7.505</td><td>5.732</td></tr>
<tr><td colspan="2">13.237</td></tr>
<tr><td>III</td><td>3.96</td><td>D</td><td>2.46</td><td></td></tr>
<tr><td colspan="3">Total(UG)</td><td>2.46</td><td></td></tr>
</table>

2.2 Mining Details

2.2.1 Mine boundary details

North - Non–coal bearing area

South - South Govindpur Colliery

East - Govindpur Colliery

West - Jogidih Colliery

2.2.2 Working Seams

Block IV Colliery is an existing mine of Govindpur Area of BCCL. VIIIA, VIIIB, and V/VI/VIII Combine seams are being worked within the opencast with floor of V/ VI/ VII Combine seam as base of the quarry. Opencast operation is being carried out through departmental means adopting Shovel-Dumper System of mining. III seam is being worked by underground Bord & Pillar method with development.

2.3 Mining Methods

Block IV Colliery is a mixed mine. Henceforth along with Opencast system of mining operation and Bord and Pillar system of mining operations is practicised.

2.3.1 Underground Mining

Development

It is proposed to develop the virgin reserve in the seams on B & P method of development with SDL loading on to tub for the exploitation as long as the developmental reserve in the seam is available. The development district will consist of 5 level headings as far as possible leaving a panel barrier of one pillar width between the panels. The development shall be carried out by blasting off the solid with. The width & height of the development galleries shall be restricted to 4.8/4.2 m & 3 m respectively. The depth of working as per the provision of Regulation 99 (4) of CMR 1957 shall govern the size of the pillar.
The panels shall be laid out in a manner, as far as possible, to be self draining. The incubation period of coal seam shall be taken into account for sub-panneling, wherever required.

Coal loading at the face will be done by mean of SDL and loaded into tubs. Then the loaded tubs will be hauled by tugger haulage for onwards feeding to main level district haulage which will feed the tubs to the surface haulage line to be hauled up to the surface.
The cycle of face operation in mechanized Bord and Pillar mining would be as follows:

a. Face preparation
b. Drilling
c. Charging, blasting and smoke clearing
d. Dressing and supporting
e. Machine fitting SDL
f. Coal loading by SDL
g. Face supporting

Seam-wise, outlet wise present production of Block IV(UG) in Table 2.5.

Table 2.5 Seam-wise, Outlet wise Present Production

Seam	Quality	Production Outlet	Method of work	Production (TPD)
III	D	3 Seam Incl.	Bord & Pillar Dev. With SDL	150
Total				**150**

Transport - Combination of Direct and Tugger haulages.

Ventilation - By Exhaust Fan at surface.

The present ventilation system of the Mine is given in Table 2.7.

2.3.2 **Opencast Mining**

VIIIA, VIIIB, and V/VI/VIII Combine seams are being worked within the opencast with floor of V/VI/VII Combine seam as base of the quarry. Opencast operation is being carried out through departmental means adopting Shovel-Dumper System of mining.

Mining System Parameters (Departmental)

Present system of OB dumping - Total O.B. of the running Quarry is being dumped in de-coaled area of the existing quarry.

Present depth - 100- 135m.

Thickness of top soil - Min. 4.0 m, Max. 6.0 m, Avg. 5.0 m.

Height & width of OB/Coal benches

Departmental operations:

Height & width of benches - OB1 - Height -8.00 m, width - 16.0 m
OB2 - Height - 8.00 m, width - 16.00 m
OB3 - Height – 8.00 m, width - 16.00 m
OB4 - Height – 8.00 m, width - 16.00 m

Height & width of coal benches - Height - 10.00 m, width -20.00 m.
Height - 8.00 m, width - 16.00 m
Height - 8.00 m, width - 16.00 m

Type of Blasting being adopted - Deep hole blasting

Amount of Explosive - Type - L.D. & S.M.S./S.M.E. explosives
Amount - 1.35 Te. / day.

2.3.3 Present status

The status of the seam is given below: -

Table 2.6 Seam wise status of Working

Seam	Operational Status	Status	Remarks
VIIIB	Being Quarried out.	Exhausted by UG through caving and on fire	Fire exists on the eastern side of the Quarry from VIIIB to IV Seam
VIIIA		Exhausted by UG through caving and on fire	
VIII		Partly developed, SOP and rest virgin. Thin Seam. Unapproachable.	
VII		Partly developed & depillared & SOP. Partly Virgin. On fire.	
V/VI		Mostly developed & SOP. Partly Virgin.	
IV		Mostly developed & SOP. Partly Virgin.	
III	Being worked with Underground	Partly developed & depillared , SOP. Partly Virgin. Partly waterlogged.	
II Top		Partly developed & depillared , SOP. Rest Virgin.	
II Bot		Partly developed & depillared , SOP. Partly Virgin. . Partly waterlogged.	
I Seam		Partly developed and mostly Virgin. Thin Seam	

2.3.4 Depth of Workings

The working seams occur at depth exceeding 120 m in the colliery.

2.3.5 Mine Entries

Table 2.7 Present Mine Entries

Name of the Outlet	Sunk in Seam	X-sec. (mXm)	Purpose	winder/ Fan
II Seam Incline (Haulage)	II	4.2X3.0	Intake, production.	Haulage – 100 HP
II Seam Incline (Travelling)	II	4.2X3.0	Intake	
II Seam Incline (Fan)	II	4.2X3.0	Return	Fan- PV-160
VIII T Incline	VIII Top	4.0X2.5	Water level inspection	

2.3.6 Major Equipments

Underground Mine

Table 2.8 List of major district equipment within a SDL panel (UG)

III Seam

Sl. No.	Equipment	Qty/No.
1	Coal drill 1.1 KW with drill panel & 100 m trailing table	3
2	SDL, 48 KW with 550 V electrical	4
3	Direct Haulage 75 KW (at surface)	2
	Endless Haulage 30 Kw	1
4	Tugger haulage 30 KW	3
5	Pump 90 KW 600 GPM	1
6	Pump 75 KW 600 GPM	2
7	Pump 45 KW 600 GPM	1

Table 2.9 List of major district equipment within OCP (OCP- Departmental)

Sl. No.	Particulars	On Roll (No.)
A.	**EXCAVATORS**	
1	Elec. Rope Shovel 5.0 & 4.6m^3	1+1
2.	Elec. Hyd. Shovel 2.7 m^3	1
3.	Hyd. Shovel 3.2 m^3	1
4.	**Hyd. Shovel 1.70 m^3**	2
5.	**Hyd. Shovel 5.0 m^3**	3
	Total	**9**
B.	**DUMPERS**	
1.	Rear Dumper 35 t.	17
2	Rear Dumper 60 t.	0
	Total	17
C.	**DRILLS**	
1.	160 mm Drill(D)	2
2.	100 mm Drill(D)	1
	Total	**3**

Sl. No.	Particulars	On Roll (No.)
D.	**DOZERS**	
1.	Dozer 320 HP	2
2.	Dozer 410 HP	3
	Total	5
E.	**WATER SPRINKLERS**	
1.	On 35 te dumper	1
	Total	
F	**CRANES**	
1.	9 T.	1
2.	35 T.	1
3.	18T	1
	Total	**3**

2.4 Infrastructure Details

Workshop & Store:

a) Auto workshop at Area Level- Light vehicle breakdown is attended here.

b) Central workshop at Area Level- Pumps and motors are repaired here.

c) Regional Store at Area Level.

Magazine – Location , capacity and area

Blasting-off the solid is being practiced at the mine with permitted explosives. The same practice is proposed to be continued.

The magazine is situated at the boundary of Block IV and Jogidih Colliery.

Infrastructure facilities available (Road, water supply etc.) –

Company's Road. – Network of colliery roads exist in the leasehold of the Mine.
Water supply –For miscellaneous domestic work Pit water is supplied (KLD).

Apart from the above, office building, Rest shelter, are also available near II Seam incline.

Nos. of coal stock yard & location – Only one coal heap No.27 is situated within the leasehold area.

Store facilities –Store facility has been provided in the mine.

Existing effluent treatment plant & sewage treatment plant (Mine & Colony) – At present water treatment plant available in the mine. Domestic supply of water given after treatment at filter plant. Sewage water discharged through septic tank and soak pit.

Power Supply

Feeder No. 14,16 Bilbera Sub-station to Main sub station near Adarsh Colony-
Voltage Level 11KV.
Details of Transformer

1) 2 MVA, 11 KV/ 3.3 KV - OCP
2) 500 KVA 11KV/ 440 V – Lighting, Pumping.

II Seam Sub-station: Voltage Level 11 KV
Location – Near II Seam Fan Drift
Details of Transformer

1) 500KVA, 11 KV/ 550V – For Underground Installation.

Load Distribution: <u>At Surface:</u>
Haulage – 75 KW
Cap Lamp – 30 KW
Main Mechanical Ventilator – 65 KW
Lighting – 50 KVA
<u>Underground</u>
Pumping – 280 KW
Lighting & Drill – 8 KVA
Tugger Haulage – 35 KW

Bajrang Sub-station: Voltage Level 11 KV
Location – Near Bajrang Incline
Details of Transformer

1) 500KVA, 11 KV/ 440V – For Domestic Supply.

2.5. Details of coal beneficiation plant and its use after closure of mine

The present production of the Mine is mostly linked to power plants through NLG Siding (about 4 to 5 Km. away from the Mine). From pit head to the siding the coal is transported contractually through road. Part of the production is linked to private Crockeries through road.

No beneficiation plant has been proposed.

CHAPTER – III

CLOSURE PLAN AND RELATED ACTIVITIES

3.1 Closure Planning details of mine

The progressive mine closure activities will continue as envisaged in the mining plan, if any, and as enumerated in the various approvals, permits, consents etc. It is very difficult to predict the various parameters which would be prevalent at the time of final mine closure and also to foresee the likely impacts due to closure of the mining activities (when the entire block reserve would get exhausted). However, broad mine closure activities need to be identified under the various heads.

Block IV Colliery falls in Cluster III for the purpose of EMP.

3.1.1 Mined out Land & proposed final land use

Management of mined out area

a) At present VIIIB, VIIIA and V/VI/ VII Combined seam are being extracted by open cast method with shovel-dumper combination (Departmental) and III seam is being worked by underground Bord & Pillar method with development, deploying SDLs.

The total reserves in the seams considered for OC operation with V/VI/VII Combined Seam as base has been estimated at 7.505 MTes (mine fed data). There is also a proposal to start OC operations in a new patch covering XI/XII, IX/X, VIII B & V/VI/VII Combined seams with a total reserve of 5.732 MT. Therefore the total available reserves for opencast are 13.237 MT. Thus, keeping in view the available reserves and the departmental mine capacity of 1.1 MTY, the remaining life of the mine will be 12 years.

In case of underground working of III seam total available reserve is estimated up to 2.46 MT. But the life based on UG working is not considered for determination of Mine Closure Cost. A Project Report on Block-IV OCP (6.0 MTY) has been formulated with I seam as Base seam, which covers Block IV colliery in its entirety in addition to the other adjacent mines. If this

PR is implemented, all the UG outlets of Block IV colliery will be excavated. In such a situation, it is envisaged that a New Closure Plan should be drawn up as per the revised scope of mining operations as per the relevant guidelines.

The proposed post-mining land use plan vis-à-vis present land use is provided in Para 1.10.

a. Total Mined out area (Ha) – Present + Proposed----120.03Ha
b. Backfilled area (Ha) ----------108.03 Ha
c. Balance left mined out area (Ha) which will not be backfilled---12.00Ha
d. Land use of this balanced left mined out area: may be water filled in monsoon based on future mine plans.

The water filled area will be handed over to State Authorities for conversion into a picnic spot with proper fencing and security**.** If necessary the lagoon may also be used by the State authority for supplying water to local community after proper treatment of the same.

b) Mining is to be carried out in a phased manner initiating afforestation work in the mined out area of the first phase while commencing the mining in the second phase i.e. continuation of mining activities from one phase to other indicating the sequence operations depending upon the geo-mining conditions of the mine. Progressive mine closure plan shall be prepared for period of five years from the beginning of the mining operations. These plans would be examined periodically in every five years period and to be subjected to third party monitoring by the agencies approved by the Central Government for the purpose (NEERI, CMPDIL , ISM etc. as per current guidelines).

c) As regards, the underground void, if any, which will remain at the time of closure of the mine, the same will get gradually filled with water. The necessary precautions for the safety of the neighboring mine would be taken care of before deciding the voids to get water filled. Further, the water filled in UG voids will help in maintaining the water level in the nearby Area. The inclines will be covered with RCC structure with suitable opening for inspection by competent person.

d) The existing quarries shall act as water reservoir to help recharge the ground water table in the vicinity. All the available places amenable for plantation shall be planted with appropriate species in consultation with forest department.

3.2 Water quality management

3.2.1 Drainage pattern of the area (pre and post closure)

3.2.1.1Existing drainage pattern

The area has a rugged topography. The area is generally undulating in the mineable area of the mine with surface elevation ranging from 180 mts to 240 mts. The area covered under this mining plan is mostly undulating with a significant drainage towards south, which is controlled by seasonal nallahs ultimately discharging in to Khodo and Bagdigi Jore which finally flows to Damodar River which is about 13 km in south side.

In course of mining, if any disturbance affecting the drainage pattern is caused, efforts shall be made to restore the normal drainage pattern as far as possible. If the restoration of original drainage profile is not feasible, efforts shall be made to achieve a drainage profile, which will ensure smooth drainage of the area with least possible surface erosion.

3.2.1.2 Post closure drainage pattern

Major area of the mine will be depillared with stowing. As mining of the property is associated with stowing, the general drainage pattern of the area would not get disturbed. Depression, if any, will be suitably filled with non - combustible rocks and cohesive soils, dozed and graded. If some minor alteration takes place, the natural drainage profile of the entire leasehold area would be kept maintained in a manner which will facilitate the normal run-off. Garland drain may be constructed to ensure the controlled drainage of the area.

3.2.2 Water Quality Status of Surface and Ground Water

3.2.2.1 Present Practice

Samples of mine water as well as drinking water are collected and were analysed for relevant physical, chemical and bacteriological parameters as per the norms stipulated by MOEF.

Water samples are collected as per standard procedure {IS: 3025 (part I) – 1987} and analyzed as per procedures outlined in relevant volume of BIS 3025 / NEERI / standard Methods (AAPHA).

If any deviation from the prescribed water quality standard is detected, the appropriate remedial actions shall immediately be enforced and frequency of sampling shall be increased till the water quality becomes normal. The source of contamination shall be identified and removed. The contaminated water bodies shall be suitably treated.

3.2.2.2 Present status of water quality

The monitoring of water quality under Baseline Environment Data Generation for Cluster III has been conducted M/S PDIL, Sindri by collecting water samples from ground water, surface water and mine water discharge / workshop discharge (if any) for the proposed project. The various purposes of the water environment monitoring are as follows:

- To assess the water quality characteristics for critical parameters;
- To evaluate the impacts on agricultural productivity, habitat conditions, creational resources and aesthetics in the vicinity ; and
- To facilitate predication of impact on water quality by project activities

The results as per PDIL Report are given subsequently.

Details of sampling location are given in Table 3.1 to 3.3 for Ground water, Surface water and effluent water.

To assess the quality of drinking water around the project area, the samples were collected from the following locations in and around the project area:

TABLE - 3.1
Sampling Location for Ground Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No.	Name of Sampling Locations	Frequency	Location Code
01.	Hand Pump – Katras Township	Once in a season	GW_1
02.	Hand Pump - Muraidih Village	Once in a season	GW_2
03.	Hand Pump - Sogiadih Village	Once in a season	GW_3

To assess the quality of lotic system (surface water), water samples were collected from the locations (Refer to PDIL Report) given in Table No. 3.2.

TABLE – 3.2
Sampling Location for Surface Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No	Name of Sampling Locations	Frequency	Location Code
01.	Khudia Nala U/S	Once in a season	SW_1
02.	Khudia Nala D/S	Once in a season	SW_2
03.	Pond Water – Near Harna Village	Once in a season	SW_3
04.	Bagdigi Jore U/S	Once in a season	SW_4
05.	Bagdigi Jore D/S	Once in a season	SW_5

To assess the quality of waste water discharge, water samples were collected from the locations given in Table 3.3.

TABLE – 3.3

Sampling Location for Industrial Effluent/Mine Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No.	Name of Sampling Locations	Frequency	Location Code
01.	Mine Water Discharge- Jogidih UGP	Once in a season	MW_1
02.	Mine Water Discharge- Maheshpur UGP	Once in a season	MW_2
03.	Workshop Discharge – Block IV/ Kooridih OCP (After Oil & Grease Trap)	Once in a season	WW_1
04.	Workshop Discharge – New Akashkinari OCP (After Oil & Grease Trap)	Once in a season	WW_2

The physico-chemical characteristics of three nos. of ground water samples collected from three different locations have been presented in Table 3.4.

TABLE – 3.4
PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES
(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results			Detection Limit	IS:10500 Desirable/ Permissible Limits
		GW_1	GW_2	GW_3		
PHYSICAL						
1	pH	8.2	7.6	7.8	-	6.5-8.5
2	Temperature (^{O}C)	29.8	30.1	30.2	-	-
3	Colour, HU	<2	<2	<2	-	5/25
4	Odour	Unobj.	Unobj.	Unobj.	-	Unobj.
5	Taste	Agreeable	Agreeable	Agreeable	-	Agreeable
6	Turbidity (NTU)	<5	<5	<5	-	5/10
7	Total Suspended Solid	4	6	6	-	-
8	Total Dissolved Solids	500	552	330	-	500/2000
CHEMICAL						
1	P- Alkalinity as $CaCO_3$	NIL	NIL	NIL	-	-
2	Total Alkalinity as $CaCO_3$	212	184	66	-	200/600
3	Chloride as Cl	44	64	26	-	250/1000
4	Sulphate as SO_4	146	168	134	-	200/400
5	Nitrate as NO_3	1.5	1.4	1.2	-	45/100
7	Fluoride as F	0.6	0.5	0.5	-	1.0/1.5
8	Total Hardness as $CaCO_3$	384	386	164	-	300/600
9	Calcium Hardness as $CaCO_3$	200	262	112	-	75/200*
10	Magnesium Hardness as $CaCO_3$	184	124	52	-	30**
11	Sodium as Na	18	27	34	-	-
12	Potassium as K	2	3	4	-	-
13	Silica as SiO_2	16	22	22	-	-
HEAVY METALS						
1	Iron as Fe	0.08	0.8	0.3	0.04	0.3/1.0
2	Manganese as Mn	<0.05	<0.05	<0.05	0.05	0.1/0.3
3	Total Chromium as Cr	NT	NT	NT	0.01	0.05
4	Lead as Pb	NT	NT	NT	0.05	0.05
5	Zinc as Zn	0.14	0.16	0.14	-	5.0/15
6	Cadmium as Cd	NT	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	NT	0.02	0.05/1.5
8	Nickel as Ni	NT	NT	NT	-	0.01
9	Arsenic as As	NT	NT	NT	0.01	0.05
10	Selenium as Se	NT	NT	NT	0.01	0.01
OTHERS						
1	Mineral Oil	NT	NT	NT	-	0.01/0.03
2	Phenolic Compound as C_6H_5OH	NT	NT	NT	0.001	0.001/0.002
3	Coliform Organisms (MPN/100ml)	< 20	< 20	< 20	-	Absent

Note: 1) BDL – Below Detectable Level. 2) NT- Not Traceable
3) *-Calcium as Ca 4) **-Magnesium as Mg

Results & Discussion

The physico-chemical characteristics of the ground water samples showed great resemblance with respect to the characteristics like temperature, turbidity, pH, colour, odour, chloride, sulphate, total alkalinity, total hardness, TDS and heavy metals, etc. The range of concentrations of drinking water parameters were observed as given in Table No. 3.5.

TABLE – 3.5
Ground Water Quality at a Glance in Comparison to Drinking Water Standard

Parameters	Range of recorded Concentration (Results expressed in mg/l except pH)		
	Minimum	Maximum	Desirable/Permissible Limits as per IS: 10500
pH	7.6	8.2	6.5-8.5
Total Suspended Solid	4	6	-
Total Dissolved Solids	330	552	500 / 2000
Total Alkalinity as $CaCO_3$	66	212	200 / 600
Total Hardness, as $CaCO_3$	164	386	300 / 600
Chloride as Cl	26	64	250 / 1000
Sulphate as SO_4	134	168	200 / 400
Nitrate as NO_3	1.2	1.5	45/ 100
Iron as Fe	0.08	0.8	0.3 / 1.0

From the results presented in Table- 3.5, the Physico-chemical characteristics of the ground water samples were in good agreement with IS: 10500. All the parameters are within the limits specified under Drinking Water Standard (IS: 10500). As regards heavy metals, only Fe and Zn have been recorded with lower concentration & rest were not traceable. The ground water can be safely used for potable purposes.

The physico-chemical characteristics of five nos. of surface water samples collected from five different locations have been presented in Table nos. 3.6(A) and 3.6(B) respectively.

TABLE – 3.6 (A)

PHYSICO-CHEMICAL CHARACTERISTICS OF SURFACE WATER QUALITY

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	PARAMETERS	ANALYSIS RESULTS			DETECTION LIMIT	Limit as per IS: 2296 Class 'C'
		SW1	SW2	SW3		
PHYSICAL						
1	pH	7.9	7.5	7.8	-	6.5-8.5
2	Temperature (^{O}C)	29.2	29.3	30.1	-	*
3	Colour, HU	<2	<2	<2	-	300
4	Odour	Unobj.	Unobj.	Unobj.	-	*
5	Turbidity (NTU)	8	10	14	-	*
6	Total Suspended Solids	6	8	12	-	
7	Total Dissolved Solids	293	297	470	-	1500
CHEMICAL						
1	P- Alkalinity as $CaCO_3$	NIL	NIL	NIL	-	*
2	Total Alkalinity as $CaCO_3$	78	64	142	-	*
3	Chloride as Cl	36	38	90	-	600
4	Sulphate as SO_4	96	104	120	-	400
5	Nitrate as NO_3	2.6	2.6	4.6	-	50
6	Fluoride as F	<0.4	<0.4	<0.4	-	1.5
7	Total Hardness as $CaCO_3$	210	214	394	-	*
8	Calcium Hardness as $CaCO_3$	136	142	226	-	*
9	Magnesium Hardness as $CaCO_3$	74	72	168	-	*
10	Dissolve Oxygen	6.6	6.4	5.8	-	4.0
11	COD	06	06	04	-	*
12	BOD (3 days at 27^{o}C)	2.4	2.4	2.2	-	3.0
13	Total Kjeldahl Nitrogen as N	0.52	0.54	0.62	-	*
14	Sodium as Na	9	6	2	-	*
15	Potassium as K	1	1	1	-	*
16	Silica as SiO_2	12	14	12	-	*
HEAVY METALS						
1	Iron as Fe	0.08	0.09	0.06	0.04	5.0
2	Manganese as Mn	<0.05	<0.05	<0.05	0.05	*
3	Total Chromium as Cr	NT	NT	NT	0.006	0.05
4	Lead as Pb	NT	NT	NT	0.04	0.1
5	Zinc as Zn	0.12	0.14	0.14	-	15.0
6	Cadmium as Cd	NT	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	NT	0.02	1.5
8	Nickel as Ni	NT	NT	NT	-	*
9	Arsenic as As	NT	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	NT	0.01	0.05
11.	Cyanide as CN	NT	NT	NT	0.02	0.05
12.	Mercury as Hg	NT	NT	NT	0.001	
OTHERS						
1	Oil & Grease	BDL	BDL	BDL	0.1	0.1
2	Phenolic Compound as C_6H_5OH	NT	NT	NT	0.001	0.005
3	Coliform Organisms (MPN/100ml)	1.9 x 10^3	2.0 x 10^3	2.3 x 10^3	-	5000

Note: 1) BDL – Below Detectable Level; 2) * - Limit Not specified; 3) NT- Not Traceable

TABLE – 3.6 (B)

PHYSICO-CHEMICAL CHARACTERISTICS OF SURFACE WATER QUALITY

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results		Detection Limit	Limit as per IS: 2296 Class 'C'
		SW4	SW5		
PHYSICAL					
1	pH	7.2	7.3	-	6.5-8.5
2	Temperature (^{O}C)	29.2	29.4	-	*
3	Colour, HU	<2	<2	-	300
4	Odour	Unobj.	Unobj.	-	*
5	Turbidity (NTU)	6	8	-	*
6	Total Suspended Solids	14	16	-	
7	Total Dissolved Solids	486	510	-	1500
CHEMICAL					
1	P- Alkalinity as $CaCO_3$	NIL	NIL	-	*
2	Total Alkalinity as $CaCO_3$	160	164	-	*
3	Chloride as Cl	68	72	-	600
4	Sulphate as SO_4	140	146	-	400
5	Nitrate as NO_3	4.6	4.8	-	50
6	Fluoride as F	<0.4	<0.4	-	1.5
7	Total Hardness as $CaCO_3$	386	390	-	*
8	Calcium Hardness as $CaCO_3$	240	244	-	*
9	Magnesium Hardness as $CaCO_3$	146	146	-	*
10	Dissolve Oxygen	6.0	5.8	-	4.0
11	COD	3.8	04	-	*
12	BOD (3 days at $27^{o}C$)	<2.0	<2.0	-	3.0
13	Total Kjeldahl Nitrogen as N	BDL	BDL	-	*
14	Sodium as Na	8	13	-	*
15	Potassium as K	1	2	-	*
16	Silica as SiO_2	10	12	-	*
HEAVY METALS					
1	Iron as Fe	0.16	0.16	0.04	5.0
2	Manganese as Mn	<0.05	<0.05	0.05	*
3	Total Chromium as Cr	NT	NT	0.006	0.05
4	Lead as Pb	NT	NT	0.04	0.1
5	Zinc as Zn	0.12	0.14	-	15.0
6	Cadmium as Cd	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	0.02	1.5
8	Nickel as Ni	NT	NT	-	*
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11.	Cyanide as CN	NT	NT	0.02	0.05
12.	Mercury as Hg	NT	NT	0.001	
OTHERS					
1	Oil & Grease	BDL	BDL	0.1	0.1
2	Phenolic Compound as C_6H_5OH	NT	NT	0.001	0.005
3	Coliform Organisms (MPN/100ml)	2.0×10^3	2.0×10^3	-	5000

Note: 1) BDL – Below Detectable Level; 2) * - Limit Not specified; 3) NT- Not Traceable

Results & Discussion

The physico-chemical characteristics of the surface water samples collected from the five locations have shown great resemblance with respect to the characteristics like temperature, turbidity, pH, colour, odour, chloride, sulphate, total alkalinity, total hardness, TDS and heavy metals, etc. The range of concentrations of important parameters of surface water characteristics have been presented in Table No. 3.7.

TABLE –3.7
Surface Water at a Glance

Parameters	Range of recorded Concentration (Results expressed in mg/l except pH)		
	Minimum	Maximum	Limit as per IS: 2296 Class 'C'
pH	7.4	8.2	6.5-8.5
Total Suspended Solids	8	14	-
Total Dissolved Solids	494	610	1500
Total Hardness, as $CaCO_3$	380	452	-
Calcium Hardness, as $CaCO_3$	278	320	-
Chloride as Cl	70	82	600
Sulphate as SO_4	160	226	400
Nitrate as NO_3	3.28	4.30	50
Iron as Fe	0.08	0.16	5.0

From the results presented in Table- 3.6(A) and Table- 3.6(B), it may safely be concluded that the physico-chemical characteristics of the surface water samples had a good resemblance with respect to almost all the parameters and were well within limits specified in Surface Water Standard IS: 2296. As regards heavy metals, except Iron and Zinc, all the other were not traceable. From the above, it may be concluded that all the parameters of the surface water samples were well within the specified limits of IS: 2296 Class 'C'.

The physico-chemical characteristics of mine water & workshop effluent discharge samples collected from different locations have been presented hereunder in Table-3.8(A) & Table-3.8(B) respectively.

TABLE – 3.8 (A)
PHYSICO-CHEMICAL CHARACTERISTICS OF WASTE WATER DISCHARGE

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results			MOEF Standard Schedule-VI
		MW1	MW2	Detection Limit	
PHYSICAL					
1	pH	6.5	6.9	-	5.5-9.0
2	Temperature (^{O}C)	29.6	30.4	-	Te<Ts+5ºC
3	Colour,HU	<2.0	<2.0	-	*
4	Odour	Unobj.	Unobj.	-	Unobjectionable
5	Turbidity (NTU)	8	10	-	*
6	Total Suspended Solids	4	6	-	100
7	Total Dissolved Solids	870	814	-	*
CHEMICAL					
1	Total Alkalinity as $CaCO_3$	146	170	-	*
2	Chloride as Cl	60	74	-	*
3	Sulphate as SO_4	448	360	-	*
4	Nitrate as N	1.2	1.3	-	10
5	Dissolve Phosphate as PO_4	BDL	BDL	-	5.0
6	Fluoride as F	<0.4	<0.4	-	2.0
7	Total Hardness as $CaCO_3$	660	614	-	*
8	Calcium Hardness as $CaCO_3$	320	364	-	*
9	COD	6.2	6.4	-	250
10	BOD (3 days at 27^{O}C)	2.4	2.2	-	30
11	Total Kjeldahl Nitrogen as N	BDL	BDL	0.01	100
12	Sodium as Na	16	15	-	*
13	Potassium as K	3	2	-	*
14	Sulphide as S	BDL	BDL	0.01	2.0
15	Ammonical Nitrogen as N	0.46	0.32	0.02	50
HEAVY METALS					
1	Iron as Fe	0.1	0.1	0.04	3.0
2	Manganese as Mn	<0.05	<0.05	0.05	2.0
3	Lead as Pb	NT	NT	0.4	0.1
4	Zinc as Zn	0.24	0.26	-	5.0
5	Copper as Cu	NT	NT	0.5	3.0
6	Nickel as Ni	NT	NT	0.1	3.0
7	Mercury as Hg	NT	NT	0.01	0.01
8	Cyanide as CN	NT	NT	0.01	0.2
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11	Vanadium as V	NT	NT	0.01	0.2
12	Cadmium as Cd	NT	NT	0.002	2.0
13	Hexavalent Chromium as Cr^{+6}	NT	NT	0.1	0.1
14	Total Chromium as Cr	NT	NT	0.006	2.0
OTHERS					
1	Oil & Grease	<2.0	<2.0	-	10
2	Phenolic Compound C_6H_5OH	NT	NT	0.001	1.0

Note: 1) BDL – Below Detectable Level; **2)** NT – Not Traceable

TABLE – 3.8 (B)

PHYSICO-CHEMICAL CHARACTERISTICS OF WASTE WATER DISCHARGE

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results			MOEF Standard Schedule-VI
		WW1	WW2	Detection Limit	
PHYSICAL					
1	pH	7.4	7.5	-	5.5-9.0
2	Temperature (^{O}C)	30.1	31.2	-	Te<Ts+5ºC
3	Colour,HU	<2.0	<2.0	-	*
4	Odour	Unobj.	Unobj.	-	Unobjectionable
5	Turbidity (NTU)	16	18	-	*
6	Total Suspended Solids	10	12	-	100
7	Total Dissolved Solids	782	840	-	*
CHEMICAL					
1	Total Alkalinity as $CaCO_3$	160	154	-	*
2	Chloride as Cl	30	36	-	*
3	Sulphate as SO_4	118	124	-	*
4	Nitrate as N	2.2	3.2	-	10
5	Dissolve Phosphate as PO_4	BDL	BDL	-	5.0
6	Fluoride as F	<0.4	<0.4	-	2.0
7	Total Hardness as $CaCO_3$	714	720	-	*
8	Calcium Hardness as $CaCO_3$	428	432	-	*
9	COD	7.6	6.4	-	250
10	BOD (3 days at 27^{O}C)	2.5	2.2	-	30
11	Total Kjeldahl Nitrogen as N	0.68	0.62	0.01	100
12	Sodium as Na	14	17	-	*
13	Potassium as K	2	3	-	*
14	Sulphide as S	BDL	BDL	0.01	2.0
15	Ammonical Nitrogen as N	1.24	1.26	0.02	50
HEAVY METALS					
1	Iron as Fe	0.08	0.09	0.04	3.0
2	Manganese as Mn	<0.05	<0.05	0.05	2.0
3	Lead as Pb	NT	NT	0.4	0.1
4	Zinc as Zn	0.14	0.16	-	5.0
5	Copper as Cu	NT	NT	0.5	3.0
6	Nickel as Ni	NT	NT	0.1	3.0
7	Mercury as Hg	NT	NT	0.01	0.01
8	Cyanide as CN	NT	NT	0.01	0.2
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11	Vanadium as V	NT	NT	0.01	0.2
12	Cadmium as Cd	NT	NT	0.002	2.0
13	Hexavalent Chromium as Cr^{+6}	NT	NT	0.1	0.1
14	Total Chromium as Cr	NT	NT	0.006	2.0
OTHERS					
1	Oil & Grease	<2.0	<2.0	-	10
2	Phenolic Compound C_6H_5OH	NT	NT	0.001	1.0

Note: 1) BDL – Below Detectable Level; **2)** NT – Not Traceable

Results & Discussion

The range of concentrations of important parameters of waste water characteristics are given in Table No. 3.9.

TABLE – 3.9
Waste Water Discharge at a Glance

Parameters	Range of recorded Concentration (Results expressed in mg/l except pH)		
	Minimum	Maximum	Limits As per MoEF Notification (Sch.-VI)
pH	6.5	7.5	5.5-9.0
Total Suspended Solids	4	12	100
Total Dissolved Solids	782	870	-
Total Hardness as $CaCO_3$	614	720	-
Chemical Oxygen Demand	6.2	7.6	250
Chloride as Cl	30	74	-
Sulphate as SO_4	118	448	-
Nitrate as N	1.2	3.2	10
Iron as Fe	0.08	0.1	3

From the results shown above, it may be safely concluded that the Physico-chemical characteristics of the discharge water samples collected from the four locations for one season had variations with respect to almost all the parameters but were well within the limits of **General Standards for Discharge of Effluents (Table 3.10).** As regards heavy metals, like Iron was also within limits.

TABLE –3.10

GENERAL STANDARDS FOR DISCHARGE OF EFFLUENTS

[The Gazette of India – Extraordinary {Part II- Sec. 3(i)} Ministry of Environment and Forests Notification New Delhi, 19th May, 1993]

Sl. No.	Parameters	Standards			
		Inland Surface Water	Public Sewers	Land for irrigation	Marine coastal areas
		(a)	(b)	(c)	(d)
1	Colour and odour	Note-1	Note-1	Note-1	Note-1
2	Suspended Solids, mg/l max.	100	600	200	Note-2
3	Particle size of Suspended Solids.	Note-3	-	-	Note-4
4	Dissolved solids (inorganic) mg/l max.	2100	-	2100	-
5	pH value	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
6	Temperature, ^{O}C	Note-5	-	-	Note-5
7	Oil & grease, mg/l max.	10	20	10	20
8	Total residual chlorine, mg/l max.	1.0	-	-	1.0
9	Ammonical Nitrogen (as N), mg/l. max.	50	50	-	50
10	Total Kjeldahl nitrogen (as NH_3), mg/l max.	100	-	-	100
11	Free ammonia (as N), mg/l max.	5	-	-	5
12	Biochemical Oxygen Demand (3 days at 27^{o}C), max.	30	350	100	100
13	Chemical Oxygen Demand, mg/l max.	250	-	-	250
14	Arsenic (as As), mg/l max.	0.2	0.2	0.2	0.2
15	Mercury (as Hg), mg/l max.	0.01	0.01	-	0.01
16	Lead (as Pb), mg/l max.	0.1	1.0	-	2.0
17	Cadmium (as Cd), mg/l max.	2.0	1.0	-	2.0
18	Hexavalent Chromium (as Cr^{+6}), mg/l. max.	0.1	2.0	-	1.0
19	Total Chromium (as Cr), mg/l max.	2.0	2.0	-	2.0
20	Copper (as Cu), mg/l max.	3.0	3.0	-	3.0
21	Zinc (as Zn), mg/l max.	5.0	15	-	15
22	Selenium (as Se), mg/l max.	0.05	0.05	-	0.05
23	Nickel (as Ni), mg/l max.	3.0	3.0	-	5.0
24	Boron (as B), mg/l max.	2.0	2.0	2.0	2.0
25	Percent Sodium, max.	-	-	60	-
26	Residual sodium carbonate, mg/l max.	-	-	5.0	-
27	Cyanide (as CN) mg/l max.	0.2	2.0	0.2	0.2
28	Chloride (as Cl) mg/l max.	1000	1000	600	-
29	Fluoride (as F) mg/l max.	2.0	15	-	15
30	Dissolved Phosphate (as P), mg/l max.	5.0	-	-	-
31	Sulphate (SO_4) mg/l max.	1000	1000	1000	-
32	Sulphide (as S), mg/l max.	2.0	-	-	5.0
33	Phenolic Compound (C_6H_5OH), mg/l max.	1.0	5.0	-	5.0
34	Radioactive materials: (a) Alpha emitters, µc/ml max. (b) Beta emitters, µc/ml max.	 10^{-7} 10^{-6}	 10^{-7} 10^{-7}	 10^{-7} 10^{-6}	 10^{-7} 10^{-7}

Sl. No.	Parameters		Standards			
			Inland Surface Water	Public Sewers	Land for irrigation	Marine coastal areas
			(a)	(b)	(c)	(d)
35	Bio-assay test		Note-6	Note-6	Note-6	Note-6
36	Manganese (as Mn) mg/l max.		2.0	2.0	-	2.0
37	Iron (as Fe) mg/l max.		2	3	-	3
38	Vanadium (as V), mg/l max.		0.2	0.2	-	0.2
39	Nitrate Nitrogen, mg/l max.		10	-	-	20
40	Pesticides, µg/l max.					
	(i)	Benzene Hexachloride				
	(ii)	Carbaryl	10	-	10	10
	(iii)	DDT	10	-	10	10
	(iv)	Endosulfan	10	-	450	450
	(v)	Dimethoate	10	-	10	10
	(vi)	Fenitrothion	10	-	10	10
	(vii)	Malathion	10	-	10	10
	(viii)	Phorate	10	-	10	10
	(ix)	Methyl Parathion	10	-	10	10
	(x)	Phenthoate	10	-	10	10
	(xi)	Pyrethrums	10	-	10	10
	(xii)	Copper oxychloride	9600	-	9600	9600
	(xiii)	Copper sulphate	50	-	50	50
	(xiv)	Ziram	1000	-	1000	1000
	(xv)	Sulphur	30	-	30	30
	(III)	Paraquat	2300	-	2300	2300
	(IIIi)	Propanil	7300	-	7300	7300
	(IIIii)	Nitrofen	780	-	780	780

Note-1: All efforts should be made to remove colour and unpleasant odour as far as practicable.

Note-2: (a) For process water – 100,

(b) For cooling water effluent, 10% above total suspended matter in influent.

Note-3: Shall pass 850 micron IS sieve.

Note-4: (a) Floatable solids-max. 3 mm.

(b) Settleable solids-max. 850microns.

Note-5: Shall not exceed 5^{0}C above the receiving water temperature.

Note-6: 90% survivals of fish after 96 hours in 100% effluent.

3.2.2.3 Practice after the closure

The above practice of monitoring of quality of water would be continued for a period of 3 years after cessation of mining activity. If required, corrective action/steps would be taken to mitigate any adverse effect on local water regime. The responsibility of maintaining the quality of drinking water will be entrusted on the State Authorities after 3 years of mine closure.

3.2.3 MEASURES FOR CONTROL OF POLLUTION (DETAILS FOR POLLUTION CONTROL ARRANGEMENT)

3.2.3.1 IMPACT DUE TO WATER POLLUTION AND ITS MANAGEMENT

The mine discharge water may contain high-suspended solids and other pollutants. The treatment scheme thus needs to focus on the removal of suspended solids from the water. Pit water must be treated to meet the prescribed standards before being discharged into water bodies. When the water is used for agricultural or domestic work, it shall undergo further treatment, as established by Scientific Studies conducted in this regard. The important factors to be considered in selecting the appropriate method for treatment are as follows:

(a) Settling tank will be provided to collect the mine discharged water for settling the suspended solids.

(b) The flow and the quality of pit water vary seasonally. Therefore settling tank should be able to absorb these fluctuations.

(c) The mine water must be neutral in nature and therefore necessary neutraliser may be provided to maintain the pH of the settling pond water.

(d) In order to reduce the dependence on fresh water sources for meeting the demands of water in the mining related operations, the entire mining effluents water will be utilised. The entire effluent free mine water will be utilised in water spraying for dust suppression, hydraulic stowing, equipment washing and other industrial requirements.

(e) Mine water discharge and drainage in the core zone has been planned to be regulated in a manner so that impact on surface and other water bodies of the area is not affected. No diversion of any surface drainage channel is required as other than civil constructions, surface land will not be affected. Expected increase of solids due to surface handling of coal shall be controlled by:

a. Construction of garland drain around the coal stock area
b. Construction of settling tanks of adequate size for removal of particulate matters
c. De-silting of settling ponds and drains at regular intervals
d. Effluents from washing areas, garage and workshop will be collected in garlands and routed through a settling ponds and oil and grease trap. The solid wastes generated shall be treated as per the provisions of Hazardous Waste Management Act. The water shall be recirculated for washing.

3.2.4 WATER BALANCE OF THE AREA

HYDROGEOLOGY AND AQUIFER CHARACTERISTICS OF THE AREA

Groundwater occurrence and storage in study area are mainly controlled by the geological setup of the area. The ability of geological formation to store and transmit water is dependent on its formation parameters, such as porosity and hydraulic conductivity. Based on these two parameters, the rock formation of the area may be classified as hard and soft rocks. Hard rocks (mainly crystalline and consolidated sedimentary rocks) are characterized by very little porosity. Ground water in such rocks circulated to a limited extent through the secondary openings represented by joints, cracks, fissures and such other planes of discontinuity. Soft rocks represented by sandstone, pebbles and loose sand, posses higher degree of primary porosity and as such characterized by higher water storage capacity. As greater part of the study area is underlain by Precambrian crystalline rocks, the weathered residual of the hard rocks as well as the fractures, joints, fissures, faults and other zones of discontinuity are the principle repositories of ground water in the area. The weathered zone is usually of limited thickness, fractures and joints generally close up with depth. The thickness of weathered mantle in the hard rock zone of area is about 10-20 meter in the topographic lows. Ground water in the weathered and fracture zones of hard rocks occur under unconfined condition. Ground water circulating through fracture zone is sometimes held under pressure. Depth of the water table in the hard rock of the area generally ranges from 3.0 m to 15.0 m below ground level.

The Gondwana sediments form the semi-consolidated formations and are better water potential zone. The splintery shales of Talchir and basal pebbles bed, the variegated Barren Measure shales and the sandstones are the major litho units of the Gondwana Formations. Gondwana sandstones in general, are known to constitute good aquifers at many places. Ground water occurs under unconfined condition in the weathered mantles varying depths from 4.23 – 12.34 m as observed in the dugwells and semi-confined condition in the deeper aquifers. Depth of water level for pre-monsoon period varies from 5–12m below ground level and it stretches to a deeper depth of 7-12m in some places. The pre-monsoon water level rises due to recharge and becomes 2 - 8 m below ground level around the area during post-monsoon period.

Rainfall is the principal recharge source to groundwater. The area experiences an average annual rainfall of about 1200-1400 mm. Besides rainfall, the mine water discharge from the local mining areas and existing water bodies including water logged in abundant mine quarries are also contributed to the ground water recharge as return flow. In the study area, ground water is withdrawn usually by means of open dug wells and small diameter hand operated tube wells for domestic and irrigation purposes. The tube wells are most often deeper (25m – 58m) than the dug wells and tap the aquifer below the weathered mantle. As the area is being located in the hot-tropical belt, the temperature regime is very high, the daily maximum reaches to over 45^0C. Due to excessive heat, the loss of moisture through evaporation is considerably high (60-65%). During the wet monsoon seasons, the net evaporation is less than the precipitation, resulting in surplus water which loss through either surface runoff or being part of the subsurface storage. The surface run-off and sub-surface storage of water depends upon various factors including the amount of rainfall, topography of the area, land use pattern, soil type, slope, physiographic, drainage pattern and hydro-geomorphology of the catchment/ sub-catchment. The study area is having gentle slope towards south and south east. Water received on the slopes, gets collected in low-lying area and is thus ultimately absorbed in the top soil cover and become part of the ground water flow according to the slope to form seasonal streams/nallas.

In the mining area, the water levels are bound to be affected and disturbed. The mining area of JCF area is highly disturbed and the permeability of individual geological units is spatially variable and depends on lithology, fracturing and attenuation with depth. The porous and more open-jointed sandstone members tend to form aquifers, the shaly members are aquitards, which may be leaky but are poorly permeable & form poor permeable barriers to the vertical groundwater movement

Water quality monitoring will be done for three years after closure. The sampling stations shall be one no. mine water with quarterly frequency and two numbers ground water samples in core and buffer zone with quarterly frequency.

3.2.5 Acid Mine Drainage Source

Not Applicable

3.2.6 Water Management

3.2.6.1 Existing mine water discharge details

a. Mine water is pumped out in a settling tank. Clean water coming out from the settling tank is used for dust suppression, stowing and other Industrial uses.
b. Excess pumped out mine water is allowed to flow into the surface water bodies.
c. Drains are provided around the coal stock to collect run-off for diverting into settling pond before discharge into the natural water courses.

Block IV (Kooridih UG)

Make of water:
Monsoon - 500 GPM
Lean Period - 400 GPM

Installed capacity of main pumps discharging water to surface–1000 GPM

Discharge point: - at surface.

Use of discharged water (quantity wise)

Table 3.11A Present use of mine discharge water:

Seam	Pump	Running Hrs.	Details of pump			Location DCP/ level	Delivery Through Pit/Inc / BH	Discharge at settling tank/Nala/ River
			GPM	*Head (m)*	*KW*			
II Seam	1 2 3	15 15 6	600 400 400	180 50 125	135 45 90	36L/1WD 45L/8WD 18L/9WD	Incline 36Lsump Incline	Nala Sump Pond

Block IV (Kooridih OC)

Make of water :
Monsoon - 1000 GPM
Lean Period - 300 GPM

Discharge point: - at surface.

Use of discharged water (quantity wise)

Table 3.11B Present use of mine discharge water:

Seam	Pump	Running Hrs.	Details of pump			Location DCP/ level	Delivery Through Pit/Inc / BH	Discharge at settling tank/Nala/ River
			GPM	*Head (m)*	*KW*			
V/VI/VII Seam	1(sub.) 2(sub.)	15 15	500 500	120 120	90 65	NCC coal face, 5 seam bottom	OCP & BH	Nala
XSeam	1(sub.)	15	500	120	65	10 seam dev. gallery	BH	Nala

3.2.7. Post closure Mine water discharge

Once the reserve is exhausted, the entries into the mine would be securely sealed for safety purposes. However, if for the safety of the future mine or any neighboring mine, pumping is required from the worked seams, then the arrangements for pumping will be kept intact and the water shall be discharged into the surface water bodies after passing the same through settling tank on the surface. The accumulated water in underground workings may be utilized to meet water shortage in nearby areas.

3.3 Air quality management

3.3.1 Present practice

a. At present air borne dust is suppressed by:

- Sprinkling water on the various roads of the mine where vehicles ply.
- Water sprinkling at the various points where coal is handled.
- Proper loading of trucks to avoid any spillage of coal.
- Proper maintenance of I.C. engines.

The quality of air is monitored on regular basis by drawing samples from the various residential and non-residential areas of the project. The test results are compared with the standards prescribed by the MOEF and if any deviation is detected, remedial actions are immediately taken to bring the AAQ standard within the prescribed limits. The practice of air quality management would be continued throughout the project life as per the norms stipulated by MOEF.

The monitoring of air quality under Baseline Environment Data Generation for Cluster III has been conducted M/S PDIL, Sindri and test results of air samples are furnished subsequently.

Table No. 3.12

SAMPLING LOCATION FOR AIR QUALITY MONITORING

Project: Cluster III **Period:** 19th March -18th June 2011

Sl. No.	Location Name/Location Code	Direction & distance w.r.t Project Site	Height of Sampling Point (m)	Description
01.	Jogidih UGP - Core zone - SA_1	-	3.0	Industrial Area
02.	Maheshpur UGP - Core zone - SA_2	-	3.0	Industrial Area
03.	Block IV Kooridih OCP- Core Zone - SA_3	-	3.0	Industrial Area
04.	Govindpur UGP Colliery- Core Zone - SA_4	-	3.0	Industrial Area
05.	New Akashkinari OCP- Core Zone - SA_5	-	3.0	Industrial Area
06.	Katras Choitudih Village - SA_6	SE, 1.0 Km	3.0	Residential Area
07.	Muraidih Village – SA_7	NW, 0.8 Km	3.0	Residential Area
08.	Harna Village – SA_8	NW, 2.6 Km	3.0	Residential Area
09.	Sogiadih Village – SA_9	NW, 2.5 Km	3.0	Residential Area

Table No. 3.13

AIR QUALITY DATA

Period: 19th March -18th June 2011 **Location:** Block IV Kooridih OCP- Core Zone - SA_3

WEEK	DAY	DATE	CONCENTRATION OF AIR POLLUTANTS, µg/m³				
			SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x
I	Mon/Tue	21/22.03.11	336	83	27	11.3	23.6
	Tue/ Wed	22/23.03.11	217	54	20	10.2	21.7
II	Mon/Tue	28/29.03.11	288	72	28	12.2	26.8
	Tue/ Wed	29/30.03.11	256	64	25	13.9	24.6
III	Mon/Tue	04/05.04.11	345	84	29	14.7	27.1
	Tue/ Wed	05/06.04.11	258	64	25	12.0	21.8
IV	Mon/Tue	11/12.04.11	352	85	30	15.0	23.8
	Tue/ Wed	12/13 .04.11	269	67	26	11.4	15.9
V	Mon/Tue	18/19.04.11	112	43	15	8.8	13.4
	Tue/ Wed	19/20.04.11	145	36	12	9.2	14.5
VI	Mon/Tue	25/26.04.11	346	86	29	14.7	24.6
	Tue/ Wed	26/27.04.11	278	69	27	11.8	17.8
VII	Mon/Tue	02/03.05.11	312	78	31	13.3	25.2
	Tue/ Wed	03/04.05.11	118	42	12	9.0	13.8
VIII	Mon/Tue	09/10.05.11	296	74	29	12.6	19.6
	Tue/ Wed	10/11.05.11	256	64	25	13.9	24.6
IX	Mon/Tue	16/17.05.11	351	81	29	14.9	22.7
	Tue/ Wed	17/18.05.11	277	69	27	14.8	20.7
X	Mon/Tue	23/24.05.11	344	82	30	15.6	26.4
	Tue/ Wed	24/25.05.11	289	72	28	12.3	17.9
XI	Mon/Tue	30/31.05.11	279	69	27	11.9	19.9
	Tue/ Wed	31/01.05/06.11	106	41	14	8.5	13.6
XII	Mon/Tue	06/07.06.11	317	79	31	13.5	26.7
	Tue/ Wed	07/08.06.11	204	51	19	11.7	19.4

SUMMARY

Parameters	**SPM**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**NO_x**
No. of observations	**24**	**24**	**24**	**24**	**24**
Minimum Concentration	106	36	12	8.5	13.4
Maximum Concentration	352	86	31	15.6	27.1
Average	264.6	67.0	24.8	12.4	21.1
98th percentile	351.5	85.5	31.0	15.3	27.0

Table 3.14

STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011
Unit : µg/m^3

SL. No.	POLLUTANT	LOCATION CODE	MIN.	PERCENTILE VALUE											MAX.	ARITH. MEAN	GEO. MEAN	STD. DEVIA-TION	STD. *	% EXCEEDING STANDARD LIMITS
				10	20	30	40	50	60	70	80	90	95	98						
01.	**SPM**	SA - 1	106.0	127.2	171.4	212.9	235.2	243.0	245.8	254.1	256.8	266.8	268.9	271.7	274.0	219.0	211.2	52.9	700	0
		SA - 2	109.0	125.9	168.6	177.9	208.6	218.0	242.8	246.5	256.8	264.4	265.9	267.1	268.0	209.7	202.4	51.5	700	0
		SA - 3	106.0	126.1	211.8	256.0	270.6	278.5	288.8	312.5	339.2	345.7	350.3	351.5	352.0	264.6	250.3	77.4	700	0
		SA - 4	114.0	139.0	163.2	177.0	190.0	207.0	234.6	251.1	255.4	262.7	274.9	281.9	286.0	208.4	202.0	50.8	700	0
		SA - 5	110.0	140.5	236.0	253.2	269.0	281.5	310.6	316.3	338.0	345.2	347.9	352.3	356.0	270.3	257.3	74.0	700	0
		SA - 6	96.0	110.9	137.8	153.2	158.2	201.0	217.6	223.9	233.6	243.2	245.0	245.5	246.0	184.7	177.0	51.3	200	0
		SA – 7	109.0	127.1	187.8	214.6	227.4	245.0	254.2	263.3	271.6	313.8	331.6	340.5	346.0	233.4	222.9	65.5	200	0
		SA - 8	89.0	111.1	122.0	131.9	136.4	142.0	146.0	151.1	158.2	168.0	170.6	179.1	186.0	140.2	138.2	23.7	200	0
		SA - 9	88.0	98.3	120.0	130.8	139.0	139.5	143.8	155.1	156.8	168.1	176.7	178.0	178.0	138.5	136.1	25.5	200	0

* SPM has been compared with Jharia Coal Mines standard in Core Zone and in other than Core Zone as per NAAQS.

Table – 3.14 (Contd.)

STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011 Unit : µg/m³

SL. NO.	POLLUTANT	LOCATION CODE	MIN.	PERCENTILE VALUE											MAX.	ARITH. MEAN	GEO. MEAN	STD. DEVIATION	STD. *	% EXCEEDING STANDARD LIMITS
				10	20	30	40	50	60	70	80	90	95	98						
02.	PM_{10}	SA - 1	36.0	38.9	42.2	52.5	58.2	60.5	61.0	63.0	64.0	66.7	67.0	67.5	68.0	55.7	54.6	10.7	100	0
		SA - 2	35.0	41.1	48.0	50.9	59.2	62.0	69.2	70.1	71.0	71.7	72.0	72.5	73.0	59.5	58.1	12.5	100	0
		SA -3	36.0	42.3	52.8	64.0	67.4	69.0	72.0	78.1	81.4	83.7	84.9	85.5	86.0	67.0	65.1	15.2	100	0
		SA - 4	34.0	39.5	46.4	50.7	53.6	59.0	66.8	71.0	72.0	73.0	73.9	74.5	75.0	58.6	57.0	13.4	100	0
		SA - 5	29.0	36.5	61.0	65.8	70.0	73.5	81.0	82.1	83.0	84.0	84.0	84.5	85.0	68.9	65.9	17.8	100	0
		SA - 6	30.0	31.3	33.0	34.9	36.2	46.0	49.8	51.2	53.4	55.4	56.0	56.0	56.0	43.4	42.3	9.9	100	0
		SA - 7	40.0	44.6	48.4	59.3	64.4	69.5	73.0	75.1	77.2	81.1	82.9	83.0	83.0	65.2	63.6	14.2	100	0
		SA - 8	23.0	30.2	34.6	36.8	38.4	40.0	44.8	49.6	56.4	62.0	62.9	63.5	64.0	43.9	42.2	12.3	100	0
		SA - 9	28.0	31.3	33.6	35.9	36.4	40.5	44.2	47.0	50.8	58.8	60.9	62.6	64.0	42.5	41.4	10.5	100	0
03.	$PM_{2.5}$	SA - 1	12.0	14.3	15.6	19.8	22.0	23.0	23.8	24.1	25.0	26.0	26.0	26.5	27.0	21.2	20.6	4.7	60	0
		SA - 2	10.0	14.2	17.6	19.0	23.0	23.5	26.8	27.1	29.0	30.0	30.0	30.0	30.0	23.0	22.1	6.2	60	0
		SA -3	12.0	14.3	19.6	25.0	26.2	27.0	27.8	29.0	29.0	30.0	30.9	31.0	31.0	24.8	23.9	6.0	60	0
		SA - 4	11.0	13.9	16.6	18.8	20.0	21.5	25.4	27.1	29.0	29.7	30.9	32.1	33.0	22.3	21.3	6.4	60	0
		SA - 5	13.0	18.2	24.0	25.9	27.0	28.0	29.0	30.0	31.0	32.7	33.0	33.5	34.0	26.8	26.0	5.7	60	0
		SA - 6	12.0	13.0	13.6	14.0	14.2	18.5	20.0	21.1	22.0	22.7	23.0	23.0	23.0	17.6	17.1	4.2	60	0
		SA - 7	14.0	15.0	16.6	20.7	23.0	24.5	26.0	26.1	27.0	28.4	29.9	30.5	31.0	22.9	22.2	5.4	60	0
		SA - 8	11.0	12.0	12.6	13.0	14.2	15.0	17.0	19.3	22.4	25.0	25.0	25.5	26.0	17.1	16.4	5.1	60	0
		SA - 9	11.0	11.3	12.6	13.0	13.2	15.0	15.8	18.0	20.2	22.0	23.7	24.5	25.0	16.0	15.5	4.3	60	0

* PM10 & PM2.5 has been compared with NAAQS standard in Core Zone and Buffer Zone.

Table – 3.14 (Contd.)

STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011
Unit : µg/m³

Sl. No.	Pollutant	Location Code	Min.	Percentile Value											Max.	Arith. Mean	Geo. Mean	Std. Deviation	Std. *	% Exceeding Standard Limits
				10	20	30	40	50	60	70	80	90	95	98						
04.	SO_2	SA - 1	7.5	8.7	9.2	9.4	10.0	10.4	11.2	11.7	12.1	12.5	12.8	13.3	13.8	10.6	10.4	1.7	120	0
		SA - 2	7.3	7.8	8.3	9.1	10.3	10.9	11.8	11.9	12.4	12.7	12.9	12.9	12.9	10.5	10.3	2.0	120	0
		SA -3	8.5	9.1	10.9	11.7	11.9	12.3	13.2	13.9	14.7	14.9	15.0	15.3	15.6	12.4	12.2	2.1	120	0
		SA - 4	7.3	7.4	7.6	8.2	9.1	9.8	11.1	11.9	12.4	12.8	13.4	13.7	13.9	10.1	9.9	2.2	120	0
		SA - 5	8.5	9.9	10.5	11.3	12.0	12.5	13.8	14.0	15.0	15.3	15.5	15.7	15.8	12.6	12.4	2.2	120	0
		SA - 6	8.2	8.9	9.5	9.8	10.0	10.3	10.5	10.6	11.0	11.4	11.6	12.0	12.3	10.2	10.2	1.0	80	0
		SA - 7	6.8	8.0	11.8	13.5	15.3	15.5	16.0	16.7	17.0	17.9	18.2	18.4	18.5	14.4	13.8	3.6	80	0
		SA - 8	7.3	8.1	8.6	9.4	9.6	10.0	10.6	10.7	10.8	11.4	11.8	11.9	11.9	9.9	9.8	1.3	80	0
		SA - 9	6.3	7.4	8.0	9.4	9.6	10.4	10.7	11.0	11.4	11.7	13.0	13.3	13.3	10.0	9.8	1.9	80	0
05.	NO_x	SA - 1	13.4	14.0	15.4	16.4	16.7	17.7	17.9	18.5	18.8	19.5	19.6	19.7	19.8	17.1	17.0	2.0	120	0
		SA - 2	10.1	11.3	13.3	15.0	16.6	17.3	17.6	18.2	19.2	19.6	19.9	20.2	20.4	16.3	15.9	3.2	120	0
		SA -3	13.4	14.0	17.0	19.3	20.1	21.8	23.4	24.6	24.8	26.6	26.8	27.0	27.1	21.1	20.6	4.5	120	0
		SA - 4	10.0	11.2	11.8	12.3	13.5	15.5	16.3	16.9	18.8	19.6	20.6	21.0	21.2	15.2	14.8	3.5	120	0
		SA - 5	13.9	15.4	16.0	18.1	19.1	19.8	20.0	21.5	22.6	23.1	23.5	23.5	23.5	19.4	19.2	3.0	120	0
		SA - 6	13.5	14.1	14.5	15.0	15.3	16.0	16.3	16.5	16.8	17.1	17.3	17.6	17.9	15.7	15.7	1.2	80	0
		SA - 7	10.2	12.1	15.9	18.2	19.3	20.7	21.2	21.7	23.0	27.0	28.0	28.5	28.7	19.9	19.1	5.3	80	0
		SA - 8	12.1	13.7	14.7	14.8	15.4	15.6	15.7	16.3	16.7	17.1	17.2	18.2	19.1	15.5	15.5	1.5	80	0
		SA - 9	11.2	12.4	13.4	14.2	15.0	15.4	15.9	16.1	17.1	17.9	18.4	18.4	18.4	15.2	15.1	2.1	80	0

* SO_2 & NO_x has been compared with Coal Mines standard in Core Zone and in other than Core Zone as per NAAQS.

Block IV Kooridih OCP-Core Zone (SA - 3)

At this location, SPM, PM_{10} and $PM_{2.5}$ concentration were observed in the range of 106 to 352µg/m^3, 36 to 86µg/m^3 and 12 to 31µg/m^3 respectively. SO_2 and NO_x concentration were in the range of 8.5 to 15.6µg/m^3 and 13.4 to 27.1µg/m^3 respectively.

3.3.2 Practice after the closure of the mine

a. As the sources of dust and fume generation would no longer be present, the present practice of arresting the air pollution, as enumerated above at However, water sprinkling would be done on the roads, which remain in use after the mine closure.

b. Quality of air would be monitored for a period of 3 years after cessation of mining activity. 3 samples at fortnight frequency for 3 years, one sample in core zone and one sample each in upwind and downwind direction will be collected and analysed.

3.4 Dump Reclamation

External dump

The external OB dumps shall be formed in suitable lifts of appropriate height keeping an overall slope not exceeding 36^0 from the horizontal. In course of mining and after the completion of the final lift, the external OB dump shall be biologically reclaimed. The dumps shall be afforested by selecting proper plant species in consultation with State Forest Department.

As per new Guidelines for Preparation of Mine Closure Plan GOI (Ministry for Coal) Dated 7th January, 2013 all efforts should be made and reflected (in the Project Report/Mining Plan) to keep land requirement bare minimum for external OB dumping to minimise land degradation. This may necessitate increase of dump height to the maximum extent keeping in view the safety requirement with special emphasis on stability analysis. After back filling of quarry voids, the left out void may be allowed to be filled with water. This will help to recharge and stabilize the water table in the neighbourhood and the local populace will benefit from it.

Internal Dumps

The residual voids, if any, will serve as a lagoon and may be utilised as water reservoir for the locality. The entire area shall be suitably fenced. Most of the back filled area shall be afforested by selecting proper plant species in consultation with State Forest Department. A part of the back filled area would also be developed for agricultural purpose with the help of the concerned State Authority.

The underground unit is not likely to generate any solid waste during the mining operation.

3.5 Details of Surface Structures proposed for dismantling

3.5.1 Infrastructure details

As far as possible, industrial structures will be utilized by the adjacent mine. However, if these structures are not found fit at the end of mine life, the same will be dismantled and salvaged. The equipments will be removed and used somewhere else. Every effort will be made to restore the area to economic utilization value in line with mine closure plan.

A. SERVICE BUILDINGS: The service buildings/ structures, viz. workshop, stores, office building, cap-lamp room, Pit top office, winding rooms, etc. are to be demolished after collecting all re-useable items, or be used for some other projects and the land covered by them restored for productive use. However, it has to be ensured that as and when a service building is vacated/ abandoned, the same should be demolished to prevent any unauthorized occupation.

B.OTHER INFRASTRUCTURES: All other infrastructures like sub-stations, transformers, community services, pump-houses, water-treatment/ filtration plants, waterlines, power lines, roads etc. will be utilized for the neighbouring projects.

However, possibility shall be explored for handing over the buildings and other infrastructures including the reclaimed land to the State Government for the benefit of local villagers and strengthening the area infrastructures.

The end use of these facilities shall be decided by the State Government with the help of District Authorities and Village Panchayat. The peripheral village community facilities developed by the Mine Authorities will be left to the Local Body/ State Government for their management and public use.

Prior to surface demolition/ restoration, a surface audit will be undertaken on all surface structures, spoil heaps etc. to assess whether there is any hazardous material that could cause problem, i.e. explosive, asbestos, chemical, oil, etc.

A list of surface and UG assets (Plant & Machinery) will be prepared and made available to potential purchasers or transferred to other new/ working mines of the company. This will ensure that the assets perform during their economic life.

3.5.2 Post closure disposal/Re-use of the Buildings, Plants & Machineries

a. Disposal or reuse of existing HEMM, CHP, workshop and railway siding for OC

Since the opencast is being operated through departmental/outsourced HEMM, after closing of the mine the departmental HEMM may be transferred to other running projects of BCCL.

b. Disposal or reuse of haulage, ventilation, workshop and railway siding for UG

At the time of closure of the mine, it is expected that most of the equipments would complete its rated life and would be surveyed off as per the Company’s guidelines. The surveyed off equipments would be auctioned as per prevalent norms.

However, if some of the equipments would not have covered their rated life, they would be diverted to the neighbouring projects for gainful utilisation.

There is no railway siding in the leasehold.

c. Disposal or reuse of transmission lines and sub-station

As per the electricity demand of the existing neighbouring projects, an analysis would be made as to whether the existing sub-station and transmission lines could be gainfully used or not. If the scope of gainful utilization is not found, they will be dismantled and the usable items/spares/conductors etc. would be dispatched to needy Areas/Projects.

d. Disposal or reuse of residential and non-residential buildings

At the time of final closure, a list of surface buildings would be prepared in detail. Thereafter following steps would be taken in chorological order in respect of the available buildings:

- An assessment would be made to find that whether the available buildings can be used by the existing neighboring projects or any new project that might have come up in the vicinity.
- In case, the listed assets cannot be utilized by the nearby project, efforts would be made to sale these assets after making the list available to potential purchasers and asking the interested purchasers to submit sealed bids.
- Thereafter, the state agencies/local agencies may be asked to take possession of the buildings, if they required few of them.
- When there would be no takers, the buildings would be demolished and usable items would be recovered for future use.

Table 3.15 Proposals for Infrastructures

Sl. No.	Particulars	Action Suggested
A	CHP	This will be dismantled and land covered with plantation
B	Workshop	-Do-
C	Railway Sidings	There is no railway siding.
D	Colony	These will be handed over to the State Government if fit for use or will be dismantled.
E	Details of non-residential buildings	-Do-
F	Other facilities (ETP /STP)	-Do-

3.6 Safety and Security Arrangement

3.6.1 Mine entry

After closure of the mining activities, all the entries to the mine will be effectively sealed off to avoid any accident and to prevent access to any unauthorized person. The area that is not reclaimed shall be properly fenced/ sealed to prevent any unauthorized entry into the area. Flags/Boards with warning signals shall be posted at vulnerable places to avoid chances of accidents. However, the guidelines / instructions from DGMS, if any, will be followed.

Sealing details and dimensions shall also be prepared for the purpose. The minimum thickness of mine sealing will be 100cm RCC (M20) with nominal reinforcement. For incline entry, the mine entry path of 5 m will be filled with debris and clay before sealing the mine.

Details of fencing around abandoned quarry, indicating the length of the fencing

As explained earlier the proposed OCP patches will not be backfilled and the void will act as water reservoir. It is proposed to develop a water lagoon in the area. The water lagoon may be handed over to State Authorities for conversion into a picnic spot.

The void of the quarry would be properly fenced to avoid any inadvertent entry of animals or human beings. Sufficient Boards and danger signs shall be placed all around.

Later on, the responsibility of keeping the fencing secured would be entrusted on the State Authorities.

The entry into the mine is the haul road. This haul road will remain for entry into the picnic spot. Both side of this haul road will be afforested.

3.6.2 Slope stability arrangement for high wall and back filled dumps

During operation of the mine, overall slope will be maintained at an angle not exceeding 22^0- 28^0. Vegetation cover will also be provided along the slopes to arrest any failure.

As regards stability of back-filled dumps, the final level of reclaimed backfill will be matched with the levels of surrounding areas leaving a final residual void which will serve as a lagoon which may be utilised as water reservoir for the locality.

During operation, the external and internal OB dump will be developed with 40 m berm width and maximum height of 60m in case of external OB dump and the overall dump slope shall not exceed **22^0- 28^0**. The waste dumps will be provided with toe wall and garland drains. The dump will be technically reclaimed and vegetation will be grown after spreading the top soil. The above measures will prevent slope failure and improve the aesthetic value.

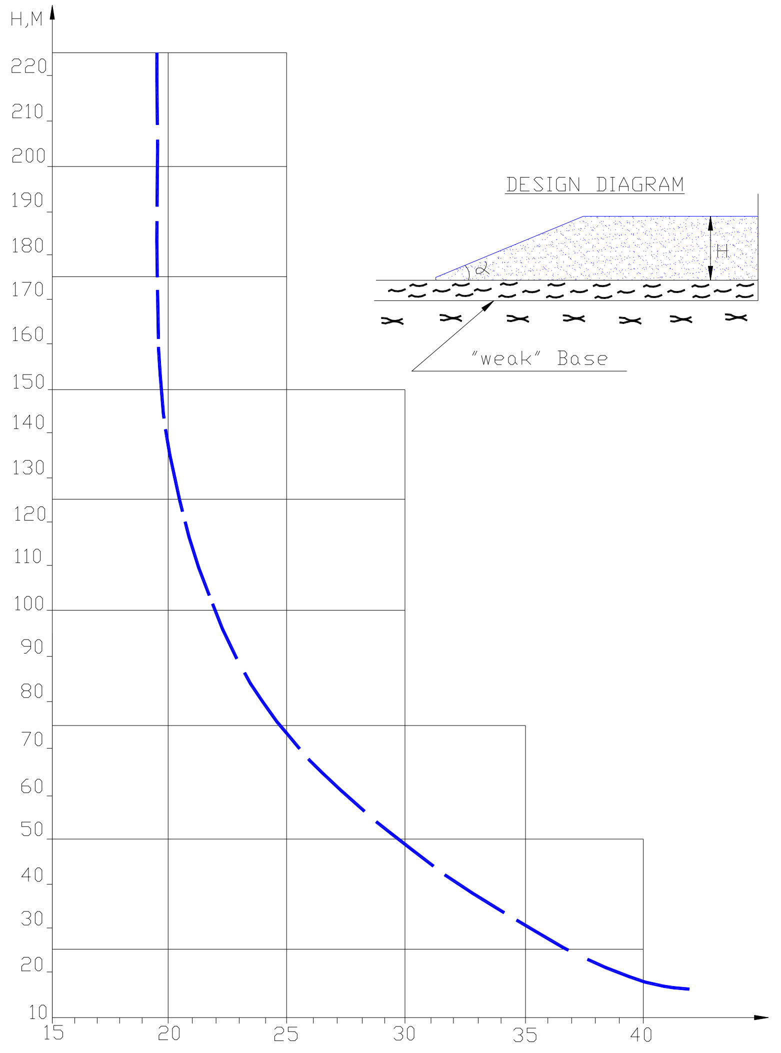


Fig. 5.5.4. Graph illustrating dependence of stable slope angle (α) on height (H) of ex-site dumps formed on "weak" Base

3.6.3 Providing one time lighting arrangement

Sufficient lighting as per standard is provided at all the required places, i.e., pit office, haulage room, fan house, cap lamp room, mine entry, workshop, sub-station haul road in quarry etc.

After closure of the mine, the lighting arrangements will be kept maintained at all locations which are not required to be demolished or dismantled like sub-stations, transformers, community services, pump-houses, water-

treatment/ filtration plants, waterlines, power lines, roads etc. to be utilised for the neighbouring projects and local communities.

3.6.4 Survey records of workings

All the mine workings including subsidence areas, roads, ponds, tanks etc. shall be resurveyed and records shall be updated. Copy of such records shall also be submitted to the appropriate competent authorities, such as DGMS and State Authorities.

Maintenance of records pertaining to Progressive Mine Closure

The Mine management shall maintain following 2 Nos. of Progressive mine closure plans for every 5 year period:

A. **A Progressive mine closure plan for surface activities**

This plan shall be maintained at a scale of 1: 4000 showing the entire progressive mine closure activities (surface) carried out on yearly basis. The plan shall be updated on annual basis and shall be signed by appropriate authorities from the Project and the Area. After every annual renewal, the plan shall be placed before HOD (Env.) of the Company for scrutiny and approval.

B. **A Progressive mine closure plan for UG activities**

Similar to PMCP for surface activities, a progressive mine closure plan showing the UG activities shall be maintained. This plan shall also be updated on annual basis and signed by all the above mentioned officials.

Besides the above plan, a progressive mine closure register shall also be maintained by the mine management. This register shall carry details of the progressive mine closure activities carried out on yearly basis. The details to be maintained in the said register shall cover inter alia the name of activity, place, period of execution, executing agency, expenditure incurred, proof of expenditure incurred, final status of the area where activity was executed, plan on which such activity has been shown etc.

The entries into the said register shall be signed by the appropriate authorities from the Project and the Area. At the end of the year the said register (along with two plans) shall be placed before HOD (Env.) of the Company for scrutiny and approval.

3.6.5 Disposal management of hazardous material

At the time of closure, assessment would be made as to find whether there is any hazardous material that could cause problem. Such hazardous material e.g. explosives, chemicals, oil etc. shall be appropriately disposed off.

3.7 Entrepreneurship development Program

As the mine progresses, more and more local people gets indirectly dependent on the mine for their sustainable income. After closure of mine there would be no source of income for these people. In order to ensure that these people do not suffer in the post closure period, the Project authorities in consultation with BCCL (HQ) shall make efforts to develop entrepreneurial skills in the local people by imparting skill development/vocational training programs. It is expected that after developing adequate entrepreneurial skills, the local people would be able to run their own business in the post closure period and maintain a sustainable income for their livelihood.

3.8 Miscellaneous activities

In future, the prevalent geo-mining/environmental conditions in and around the project area may require execution of some other progressive mine closure activities not covered in the preceding paragraphs. Such activities may be carried out by the mine after observing the needful formalities and obtaining approval of HOD (Env.) of the Company.

3.9 Execution of progressive mine closure activities and 5 yearly monitoring

After observing the necessary administrative/financial formalities, the mine authorities shall execute the identified progressive mine closure activities, whenever and wherever required. The executed activities shall be shown on the above said plans and recorded in the said registers.

The executed progressive mine closure activities shall be monitored on 5-yearly basis by 3rd party (ISM, CMPDI, NEERI etc.).

The 5 yearly return from escrow fund would be equal to expenditure incurred on progressive mine closure activities during last 5 years or 80 % of total deposited amount in the escrow account (including interest) whichever is less. The said return would be subject to above said monitoring of progressive MCP by a third party (ISM/CMPDI/NEERI etc.).

As the 5 yearly return from escrow fund is linked with the expenditure incurred on progressive mine closure activities during last 5 years, it is very important that progressive mine closure records, plans, expenditure details along with proof are properly maintained.

At this juncture it is important to note that some of the progressive mine closure activities, enumerated in the preceding paragraphs, are legal obligations specified in Project reports, EMP, permissions obtained from statutory bodies such as CPCB, SPCB, DGMS etc. The Project authorities are bound to comply with these obligations.

3.10 Re-deployment of work force

The current manpower of the project is 891. And at present, it is very difficult to assess the manpower of the project, which will remain at the time of closure of mining activities in the presently worked seams. As some of the seams of the block is still virgin and is most likely to be mined in future, the remaining manpower will be gainfully utilized in continuing mining activity.

3.11 Emancipation from the community facilities and the facilities to the PAPs

3.11.1 The Project affected Persons (PAPs) and also the local communities are being provided many civic facilities, such as educational facilities, health facilities, and drinking water. As some of the seams of the block are still virgin and are most likely to be mined in future, these facilities, in all probability, will be kept maintained.

3.11.2 However, at the time of final closure after exhaustion of entire mineable reserve these facilities will be entrusted upon the local bodies/Trust of PAPs/State bodies after consultation with local people and state authorities so that same could continue even after the mine closure. If needed, a lump sum reasonable amount would also be paid to the local bodies/Trust of PAPs/State bodies after proper approval for proper upkeep and maintenance of various community facilities.

3.11.3 To ensure that no financial loss due to the closure of mining activity in the presently worked seam occur to the local community engaged indirectly to the existing mine, following steps would be taken:

- It has been seen in past that in the event of closure of a mine, the local people indirectly dependent on the mine switch over their economic/professional activities in the existing/new or expansion mines located in the nearby area. Local management, if needed, extends some basic helps to them in such type of switching over. Hence, it is expected that in this project also the transition of the local people from one area to the other area for their sustenance would not be any problem.

- It is proposed that reclaimed and afforested land will be handed over to State Forest Dept. for the benefit of local ecosystem. The forest wealth can also be utilised by local people or tribal in the form of fruits and fodders.

- The proposed picnic spot would be handed over to a society of local people for commercial use of the picnic spot by them.

CHAPTER – IV

ECONOMIC REPURCUSSION

4.0 Economic Repercussions of closure of mine:

4.1 Manpower of the Project

The total manpower strength of BLOCK IV Colliery is 891.

Manpower	No.
Executive	28
Supervisory and Clerical Staff TR/PR Worker	863
TOTAL	891

POST CLOSURE MANPOWER

It has been proposed to monitor and implement the post-closure activities departmentally. Departmental manpower will be needed after closure of the mine for monitoring and implementation of the post closure activities. Manpower required for the same is given in Table- 4.2.

Table 4.2: Manpower required for monitoring and implementation of Mine Closure Activities

Sl. No.	Category of Manpower	Requisite heads
1	Officer-in-charge/ Manager (Mining)	1
2	Overman-in-charge	2
3	Foreman-in-charge	2
TOTAL		**5**

4.2 ASSESSMENT OF INCOME SCENARIO OF LOCAL PEOPLE

As BLOCK IV colliery is a mixed mine, there will be surface excavation which shall be undertaken on company acquired land only. Moreover, the basic mining infrastructures have been made on the company acquired land. So there will no displacement of local people for this project. Later, after closure of the mine the work force will be absorbed / re-employed / rehabilitated in operative collieries of BCCL.

After the closure of the mine, the manpower deployed in the mine will be further deployed in other mines of BCCL to make no loss of sustenance income to the eligible employee. The other secondary activities will not be affected by the closure of the mine and the mine discharge water after proper treatment will be provided to the local people for domestic and irrigational uses.

4.2.1 At present, it is very difficult to assess the manpower of the project, which will remain at the time of closure of mining activities in the instant project.

4.2.2 The local communities are being provided many civic facilities, such as educational facilities, health facilities, and drinking water. At the time of final closure after exhaustion of entire mineable reserve these facilities will be entrusted upon the local bodies/Trust of PAPs/State bodies after consultation with local people and state authorities so that same could continue even after the mine closure. If needed, a lump sum amount would also be paid to the local bodies/Trust of PAPs/State bodies for proper upkeep and maintenance of various community facilities.

4.2.3 To ensure that no financial loss due to the closure of mining activity in the presently worked seam occur to the local community engaged indirectly to the existing mine, following steps would be taken:

- It has been seen in past that in the event of closure of a mine, the local people indirectly dependent on the mine switch over their economic/professional activities in the existing/new or expansion mines located in the nearby area. Local Management, if needed, extends some basic helps to them in such type of switching over. Hence, it is expected that in the instant case also the transition of the local people from one area to the other area for their sustenance would not be any problem.

- It is proposed that reclaimed and afforested land, if any, will be handed over to State Forest Dept for the benefit of local ecosystem. The forest wealth can also be utilised by local people in the form of fruits and fodders.

CHAPTER – V

TIME SCHEDULE FOR POST-CLOSURE ACTIVITIES

5.1 It is very difficult to predict the various parameters which would be prevalent at the time of final mine closure (when the entire block reserve would get exhausted) and therefore a mine closure activity schedule cannot be rigidly prepared at this point of time.

5.2 The closure of mine involving technical aspects, environmental aspects, socio-political aspects and financial assurances as implementing post-closure activities will run for three years. The time schedule envisaged for completion of all closure activities is presented in the following table in the form of bar chart.

Table 5.2: Implementation Schedule for post-closure activities for BLOCK IVC

Sl. No.	Major Activities	Time Period	Year-wise Phasing			
			Y1	**Y2**	**Y3**	**Y4**
1	Technical aspects	2 years				
2	Environmental aspects	2 years				
3	Post closure environment monitoring	3 years				
4	Socio-political aspects	3 years				

5.2.1 TECHNICAL ASPECTS:

i) **Safety & security**: In the mine closure plan, action will be taken to cover all the safety aspects including management of fire & subsidence and mine inundation.

ii) **Management of pit slopes and waste dump**: BLOCK IV Colliery being a mixed mine, management of pit slope and waste dump will be needed.

iii) **Management of hydrology and hydro-geology**: After closure of mining activities, the workings will be waterlogged which will help in maintaining the water table in the surrounding areas and may become a source of water supply to the neighbouring areas.

iv) **Closure of Mine Entries**: After closure of the mining activities, all the entries to the mine will be effectively sealed off/fenced to avoid any accident and to prevent access to any unauthorized person. The area that is not reclaimed shall be properly fenced/ sealed to prevent any unauthorized entry into the area. However, the guidelines / instructions from DGMS, if any, will be followed.

v) **Disposal of mining machinery**: All the opencast/underground machineries including HEMMs, SDLs, haulages etc. which will have residual life will be shifted to the other collieries of the area/company. The salvaging and shifting operation of mining machinery and other equipment will be done considering the ground realities during the period 1 (one) year advance of final mine closure.

vi) **Details of surface structure proposed to be dismantled**:
As far as possible, industrial structures will be utilised by the adjacent mine. However, if these structures are not found fit at the end of mine life, the same will be dismantled and salvaged. The equipments will be removed and used somewhere else. Every effort will be made to restore the area to economic utilization value in line with mine closure plan.

A. **Service Buildings**: The service buildings/ structures, viz. workshop, stores, office building, cap-lamp room, incline top office, haulage/winding rooms, etc. are to be demolished after collecting all re-useable items, or be used for some other projects and the land covered by them restored for productive use. However, it has to be ensured that as and when a service building is vacated/ abandoned, the same should be demolished to prevent any unauthorized occupation.

B. **Other Infrastructures**: All other infrastructures like sub-stations, transformers, community services, pump-houses, water-treatment/ filtration plants, waterlines, power lines, roads etc. will be utilized for the neighbouring projects.

However, possibility shall be explored for handing over the buildings and other infrastructures including the reclaimed land to the State Government for the benefit of local villagers and strengthening the area infrastructures. The end use of these facilities shall be decided by the State Government with the help of District Authorities and Village Panchayat. The peripheral village community facilities developed by the Mine Authorities will be left to the Local Body/ State Government for their management and public use.

Prior to surface demolition/ restoration, a surface audit will be undertaken on all surface structures, spoil heaps etc. to assess whether there is any hazardous material that could cause problem, i.e. explosive, asbestos, chemical, oil, etc.

A list of surface and UG assets (Plant & Machinery) will be prepared and made available to potential purchasers or transferred to other new/ working mines of the company. This will ensure that the assets perform during their economic life.

5.2.2 ENVIRONMENT ASPECTS

i) **Mined-out land and proposed final land use:** As Block IV is a mixed mine, the mined out land will properly be reclaimed as per the existing guideline of environment management plan. The existing infrastructures, if not usable, will be dismantled and the land will be graded & will be handed over to the local authorities for community use.

ii) **Air & Water quality management:** Appropriate air and water pollution control measures will be taken to contain the air and water pollution for maintaining the ambient air and water quality within the stipulated standards besides making the mining operation eco-friendly in the project. These measures (both preventive and suppressive) are enumerated in Para 3.2.3 of the present report.

iii) **Management of waste:** The solid wastes generated by the mine during the coal production are non-hazardous and non-toxic in nature. The above solid wastes will be disposed off by backfilling the mined out area and then re-vegetating without causing any siltation problem on surface water bodies. However, scientific studies shall be undertaken regarding applicability of solid wastes for various uses. Toxic solid wastes like used oil, used batteries, oily sludge, besides filters and filter materials containing oil during maintenance of vehicles, will be generated by the mining project. Used oil will be stored in drums safely for disposal through auction to the authorized re-processors. Similarly, used batteries will be stored safely for auction to the authorized re-processors. The oily sludge, besides filter and filter materials, will be disposed off in impervious layer lined pits without causing environmental hazards.

iv) **Management of final voids**: The underground voids will be slowly get filled with water. However, safety of the neighbouring mines will be looked into before the entire underground void gets water filled.

v) **Land reclamation and rehabilitation:** If any cracks or void is created due to underground mining activities, it will be restored to original profile by filling up cracks/ voids. In case of opencast working it should be properly reclaimed. It is proposed that the site restoration should be kept progressive so that the restoration is more or less similar to the rate of mining.

vi) **Reclamation of forest/ vegetation and plantation:** No forest land is required for the project. However, regular plantation will be taken up during the life of the mine to create green barrier. The plant species will be selected in consultation with the state forest department.

The objective of restoration of post mining area will be determined through consultation with local community and the Government authority, so that the potential/ required end use of the mined out land is determined in advance. Such usage may be agriculture, forestry, amenity development or nature reserve.

5.2.3 POST CLOSURE ENVIRONMENT MONITORING

After cessation of mining and its related activities, there will be no effect on ambient air and water quality due to this mine as proper mitigation measures for air and water pollution control are to be taken by the authorities of the mine. However, the air and water quality parameters in the mined out area will be monitored by some external agency for next three years after closure of the mine.

Air and water samples will be taken from the specified sampling stations at regular frequency for 3 consecutive years after the closure of the mining project. 1 sample of mine water will be collected and analyzed with fortnightly frequency and 2 samples of ground water from core & buffer zones with monthly frequency. Similarly, 1 air sample will be taken at core zone, and 1 air sample each in upwind and downwind directions of the project at fortnightly frequency.

5.2.4 SOCIO-POLITICAL ASPECTS

i) **Re-deployment of work force**: Due to closure of mining operations, the persons directly employed in the mine will be surplus. Suitable manpower re-deployment plan may be formulated by the mining company sufficiently before closure of mine for re-deployment of the work force in other units of the company. Alternatively, they would be given option of voluntary retirement.

ii) **Civic facilities**: It is proposed that the civic facilities developed during the mining phase will be transferred to the local government/ municipality so that the region transforms smoothly into post mining phase. A one-time payment should be made by the mine for obtaining its release from providing these facilities, which will there from be taken care of by the local and state bodies.

iii) **Channelisation of available water**: If the mine has sufficient water, this can be used for domestic and agriculture purpose by the local community. The water from this area shall be discharged after treatment for domestic and agricultural usages.

iv) **Emancipation for project affected population**: The village/ basti which are to be rehabilitated as per Master Plan of JCF (March'08) is given in Table No. 5.2.

TABLE 5.2

Village/Site	BCCL	Pvt.	Enchr	Oth	Total
PHASE-I					
Total(Phase-I)	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**
PHASE-II					
Kooridih 3 seam Area Hutment/ O4	6	10	10	0	26
LCH Dhowrah Govindpur/18	12	0	10	0	22
Near Block-IV Office/15	18	0	0	4	22
Near Gobindpur Hospital/14	9	28	0	0	37
NHS Qrts/12	3	0	0	0	3
South Gobindpur Bastee/16	12	21	0	0	33
South Gobindpur Dhowra/17	3	0	0	0	3
Total(Phase-II)	**63**	**59**	**20**	**4**	**146**
Total(Phase I+II)	**63**	**59**	**20**	**4**	**146**

5.3 Although, it is very difficult to conclusively predict the likely impacts due to closure of the mining activities in the in the leasehold area of the Instant Project and the likely activities that would be taken up at that point of time, but a broad mine closure activity schedule may be prepared as per guidelines of Ministry of Coal. The post closure implementing activities will run for three years. The following activities are most likely to be implemented as per the given bar chart.

IMPLEMENTATION SCHEDULE FOR MINE CLOSURE IN BLOCK IV OC MINE

(LIFE OF THE MINE : 12 YEARS)

S.N	Activity	Time Frame	Year					
			Pre Closure Phase		Final Phase	Post Closure Phase		
			1st - 5th	6th - 7th	11th - 12th	PC1	PC2	PC3
A	**Dismantling of Structures**							
	Service Buildings	2 years						
	Residential Buildings	2 & ½ years						
	Industrial structures like CHP, Workshop, field sub-station, etc.	2 & ½ years						
B	**Permanent Fencing of mine void and other dangerous area**							
	Random rubble masonry of height 1.2 metre including leveling up in cement concrete 1:6:12 in mud mortar	2 years						
C	**Grading of highwall slopes**							
	Levelling and grading of highwall slopes	2 years						
D	***OB Dump Reclamation**							
	Handling/Dozing of OB Dump and backfilling	Throughout the life of the mine including 3 years after cessation of mining operation						
	Technical and Bio-reclamation including plantation and post care	Throughout the life of the mine including 3 years after cessation of mining operation						
E	**Permanent sealing of mine entries (incline mouth and air shaft)**							
	Sealing of incline mouths and air shafts	2 years						
F	***Subsidence Management**	Throughout the life of the mine, if required including 3 years after cessation of mining operation						
G	***Landscaping**							

S.N	Activity	Time Frame	Year					
			Pre Closure Phase		Final Phase	Post Closure Phase		
			1st - 5th	6th - 7th	11th - 12th	PC1	PC2	PC3
	Landscaping of the open space in the leasehold area for improving its esthetics and eco value	Throughout the life of the mine including 3 years after cessation of mining operation						
H	***Plantation**							
	Plantation over cleared area obtained after dismantling	2 years						
	Plantation around the quarry area and in safety zone	Throughout the life of the mine including 3 years after cessation of mining operation						
	Plantation over the external OB Dump	Throughout the life of the mine						
I	**Post Closure Env Monitoring / testing of parameters for three years**							
	Air Quality	3 years						
	Water Quality	3 years						
J	***Entrepreneurship Development (Vocational/skill development training for sustainable income of affected people**	Throughout the life of the mine						
K	***Miscellaneous and other mitigative measures**	Throughout the life of the mine including 3 years after cessation of mining operation						
L	**Post Closure Manpower cost for supervision**	3 years						

NOTE: *: To be covered under Progressive Mine Closure activities also**.**

NOTE: The progressive mine closure will be done as per the provisions made out in the Project report and as per the situation/requirement that may arise in course of execution of the Project Report.

CHAPTER – VI

MINE CLOSURE COST

6.0 Mine Closure activities would be a constant exercise for the mine which would begin with the commencement of mining operations and continue till post closure. The mine closure activities would naturally entail certain expenditures, which will have to be borne by the mine operator. There would be two types of expenditures on account of mine closure activities in respect of BLOCK IV Colliery.

6.1 **Revenue expenditures**

This would cover the activities which are being executed along with normal mining operation and would continue to be executed in course of execution of the project. The cost of progressive mine closure activities is already part of the project cost.

6.2 **Expenditures to be incurred just prior to actual mine closure and in the post closure period**

6.2.1 As As per MOC guidelines, a corpus escrow account @ ₹ 1.0 lakhs (August, 2009 Price Level) per Ha (for UG) and @ ₹ 6.0 lakhs(for OC) of the project area shall be opened with the coal controller organization to meet the expenses of final mine closure. The current Guidelines read as:

"It has been estimated that typically closure cost for an opencast mine will come around Rs. 6.00 lakh per Hectare of the project area and it would be Rs. 1.00 lakh per Hectare for underground mine project area at current price levels (August, 2009) and these rates will stand modified based on Wholesale Price Index as notified by Government of India from time to time".

As per the data furnished by the mine/area, the project area and leasehold area in respect of Block IV Colliery is the same and the closure cost is calculated accordingly.

In Block IV Colliery, the existing leasehold area is 149.0 Ha. The entire 149.0 Ha of leasehold area has been considered for the calculation of closure cost of the area as per Open cast norms. However mining by underground method would continue beneath the decoaled area of the OC.

The overlapping area (where UG & OC operations have been done in different vertical levels) has been considered for calculation of closure cost as per opencast norms.

The money deposited in the Escrow Account has to deal with the following:

- Cost of closure activities.
- Cost towards organization for executing the closure activities.
- Cost of the post project monitoring.
- Creation of a corpus fund for the final mine closure

6.2.2 As per the above guidelines these rates will stand modified based on Whole Price Index as notified by Government of India from time to time. Thus the total expenditure on this front may be calculated in the manner described overleaf.

- The total amount for mine closure activity in respect of BLOCK IV Colliery =149.0 Ha X ₹ 6.0 Lakhs X 1.35340*= ₹ 1209.94 lakhs

*** The amount has been escalated based on WPI of July 2013 (175.4) vis-à-vis WPI of August '09(129.6).**

The WPI of July 2013 is provisional as per the Govt.'s notification (Office of the Economic Adviser).

6.2.3 It is difficult to conclusively predict the mining parameters on a long term basis owing to rapidly changing mining technology, developments in the field of clean coal technologies and R&D activities in development of alternative energy sources.

As per the latest Guidelines issued by the MoC, GoI(dt. 07.01.2013) the *"annual closure cost is to be computed considering the total project area at the above mentioned rates and dividing the same by the entire life of the mine in years for new projects and balance life of mine in years for operating/existing mines."*

Jharia Coalfield is characterized by occurrence of a number of working coal horizons, giving a leverage of extended working life of the mines. Some more seams can come in the lap of workable horizons due to improvement in mining technology in times to come. The underground mines in leasehold of JCF are generally small capacity mines, giving a false impression of very long lives due to small level of current production level. There may be a strategy in future to amalgamate the mines for higher production level to attain the economics of scale. In such a situation, the life of the mine arrived at with current level of production for the balance reserve may not be workable in the long run.

In view of the above and as discussed in para 1.12, for the purpose of mine closure cost calculations, the life of the mine has been calculated based on the development reserve available in the currently producing seams, proposed OCP patches and surface constraints. At present VIIIB, VIIIA and V/VI/VII Combined seam are being extracted by open cast method with shovel-dumper combination (Departmental) and III seam is being worked by underground Bord & Pillar method with development, deploying SDLs.

The total reserves in the seams considered for OC operation with V/VI/VII Combined Seam as base has been estimated at 7.505 MTes (mine fed data). There is also a proposal to start OC operations in a new patch covering XI/XII, IX/X, VIII B & V/VI/VII Combined seams with a total reserve of 5.732 MT. Therefore the total available reserves for opencast are 13.237 MT. Thus, keeping in view the available reserves and the departmental mine capacity of 1.1 MTY, the remaining life of the mine will be 12 years.

In case of underground working of III seam total available reserve is estimated up to 2.46 MT. But the life based on UG working is not considered for determination of Mine Closure Cost. A Project Report on Block-IV OCP (6.0 MTY) has been formulated with I seam as Base seam, which covers Block IV colliery in its entirety in addition to the other adjacent mines. If this PR is implemented, all the UG outlets of Block IV colliery will be excavated. In such a situation, it is envisaged that a New Closure Plan should be drawn up as per the revised scope of mining operations as per the relevant guidelines.

The life of this mine will be 12 years. To arrive, at the annual cost, to be deposited in each year in an escrow account, the mine closure cost has been divided by 12, as shown below:

- Amount to deposited in 1st year will be-----₹ 100.83 lakhs
- Amount to be deposited in 2nd year will be—₹. 100.83 (1 + 5%)^1 lakhs
- Amount to be deposited in 3rd year will be—₹. 100.83 (1 + 5%)^2 lakhs

6.2.4 In the above fashion, an amount will be deposited every year up to the last year of mine life by applying the following formula:

- Amount to be deposited in N_{th} year = ₹ 100.83 (1 + 5%) ^(n-1) lakhs

6.2.5 Thus, total amount that shall be deposited for final mine closure activities **BLOCK IVC** stands out to be **₹1604.89 lakhs** as per the present status of the mine.

Table No. 6.1 Break-Up cost of Mine Closure of BLOCK IV Colliery

Year	Amount (₹ in Lakhs)
1	100.83
2	105.87
3	111.16
4	116.72
5	122.56
6	128.68
7	135.12
8	141.88
9	148.97

10	156.42
11	164.24
12	172.45
Total	**1604.89**

6.2.6 Based on the existing mine closure planning norms, the above calculated cost at current WPI on mine closure may be tentatively grouped under following heads:

Table No. 6.2 Break up Cost of Mine Closure of Block IV Colliery

Sl. No.	Activity	Mine Closure Cost (₹ in Lakhs)
A	**Dismantling of Structures**	
	Service Buildings	3.21
	Residential Buildings	42.85
	Industrial Structures like CHP, Workshop, field sub-station, etc.	4.81
B	**Permanent Fencing of Mine Void and other dangerous area**	
	Random Ruble masonry of height 1.2 metre including levelling up in cement concrete 1:6:12 in mud mortar	24.07
C	**Grading of Highwall slopes**	
	Levelling and grading of highwall slopes	28.41
D	**OB Dump Reclamation**	
	*Handling/Dozing of external OB Dump into mine void	1422.90
	*Bio-Reclamation including soil spreading, plantation and maintenance	6.42
E	**LANDSCAPING**	
	Landscaping of the cleared land for improving its esthetic	4.81
F	**Plantation**	
	Plantation over area obtained after dismantling	8.02
	*Plantation around fencing	3.21
	*Plantation over the cleared external OB Dump	0.32
G	**Monitoring/Testing of parameters for three years**	
	Air Quality	3.53
	Water Quality	3.21
H	***Enterpreneuship Development(Vocational/skill development training for sustainable income of affected people**	4.17
I	***Miscellaneous and other mitigative measures**	32.10

Sl. No.	Activity	Mine Closure Cost (₹ in Lakhs)
J	***Manpower Cost for Supervision**	12.84
	TOTAL	**1604.89**

Note: * :To be covered under Progressive Mine Closure activities also.

6.2.7 Thus, total amount that shall be deposited for final mine closure activities during the period of 12 years has been estimated as **₹ 1604.89 lakhs**.

6.2.8 *Mining is to be carried out in a phased manner initiating afforestation/reclamation work in the mined out area of the first phase while commencing the mining in the second phase i.e. continuation of mining activities from one phase to other indicating the sequence of operations depending on the geo-mining conditions of the mine. Up to 80% of the total deposited amount including interest accrued in the ESCROW account may be released after every five years in line with the periodic examination of the Closure Plan as per Clause 3.1 of the Annexure of the Guidelines. The amount released should be equal to expenditure incurred on the Progressive mine closure in past five years or 80% whichever is less. The balance amount shall be released to mine owner/leaseholder at the end of the final Mine Closure on compliance of all provisions of Closure Plan. This compliance report should be duly signed by the lessee and certify that said closure of mine complied all statutory rules, regulations, orders made by the Central or State Government, statutory organisations, court etc. and certified by the Coal Controller.*

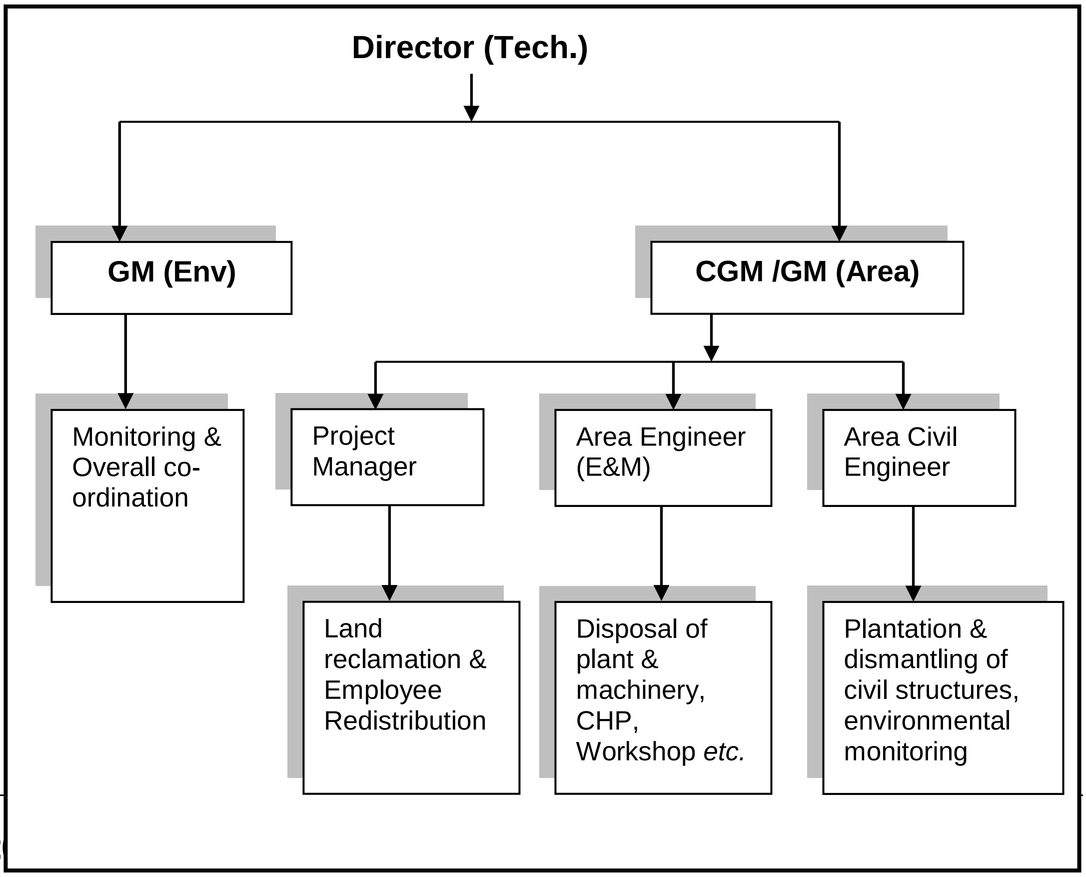
6.2.9 However, the additional amount beyond the escrow account, if any estimated later on, will be provided by the mine operator after estimating the final mine closure cost five years prior to mine closure (as per the mine closure guideline)**.**

CHAPTER-VII

IMPLEMENTATION PROTOCOL

7.1 As the mine closure activities would continue even after cessation of mining activities, an organization consisting of different discipline would be formed to undertake the implementation of mine closure activities as well as monitoring of the same**.** Such activity shall continue for a period of three years after the closure of mining activity in the mine. Once the closed mine becomes stabilized in respect of safety, environmental and social aspects, the monitoring team would be withdrawn.

7.2 For implementing the mine closure activities and monitoring thereof, the following organisational structure at corporate level has been proposed:



7.3 Environmental monitoring for three years after closure of mine will be carried out to evaluate the environmental quality of the area. If need be, proper mitigation measures will be taken up after evaluating the environmental quality. Before closure of the mine, Area GM will prepare survey and disposal report and the same will be submitted to DGMS for acceptance.

7.4 When the mine closure activities would take final shape and the entire are under influence is brought to an acceptable shape, BCCL would obtain a mine closure certificate from Coal Controller to the effect that the protective, reclamation and rehabilitation works in accordance with the approved mine closure plan/final mine closure plan have been carried out for surrendering the reclaimed land to the State Government concerned.

CHAPTER – VIII

PLANS ENCLOSED

The following underground and surface plans have been enclosed along with this mine closure report plan:

a. Location Plan
b. Surface plan showing surface features, contours, roads, depot/siding, OB dumps, quarries (working/old/discontinued), subsidence, plantations, habitations, vacant land , surface water bodies, natural drainage and mine discharge water channels
c. Geological Plan
d. Working seam plans

CHAPTER – I

INTRODUCTION

1.0 Introduction

Govindpur Colliery is a mixed mine. Govindpur Colliery started in 1949. It covers a leasehold area of 159.55 Ha. Govindpur colliery is located in the north western part of Jharia Coalfield in Dhanbad district of Jharkhand. The mine/ colliery is about 26 kms west from Dhanbad town and connected by all weather roads.

Table No. 1.1 Details of Present Working

Seam	Prodn. Outlet	Method	Grade	TPD
IV Seam	Incline	B&P, Development, Manual	D	150
XIT – IV seam (IV seam as base seam)	Incline	SDL Combination (Outsourced)	D	500
Total				650

1.1 Name of mine owner / company

Project: Govindpur colliery

Area: Govindpur Area

Company: BCCL

Mine Owner: Director (Technical)(P & P), BCCL (Nominated)

1.2 Address for Communication with PIN and Phone nos.

PO : Sonardih

District : Dhanbad

State : Jharkhand

PIN : 828125

Mob Agent : +91-9470596354

1.3 Location of mine:

Latitude : $23^o48'30"$ to $23^o78'30"$ North

Longitude : $86^o16'00"$ to $86^o17'00"$ East

Area : Govindpur Area

Coalfield : Jharia Coalfield

1.4 Capacity of the mine

Date of start of development work: 1949

Date of start of production: 1949

The normative mine capacity stands out to be 0.040MTY.

1.5 Method of Mining including Equipment deployed

The gradient of the seam 1 in 4.5 is suitable for deployment of SDLs. The loaded tubs are handled by a tugger haulage which consecutively feeds to endless and thereafter from endless to main direct haulage installed on the surface which discharges the coal at the coal depot.

1.6 COAL PROCESSING / BENEFICIATION OPERATION

No coal processing/ beneficiation plants envisaged for the current output of the mine.

1.7 Total Lease Area involved : - 159.55 Ha

1.8 Type of Lease Area (Ha):-

Table 1.1 Type of Lease Area Area

Sl. No.	Particulars	Mining Area(Ha)	Outside mining area(Ha)	Total(Ha)
1	BCCL land (through LA Purchase & Agreement)	3.92	Nil	3.92
2	Vested Land	64.03	Nil	64.03
3	Railway Land	0.0	Nil	0.0
4	Govt. Land	22.77	Nil	22.77
5	Forest Land	Nil	Nil	Nil
6	Private Land	68.83	Nil	68.83
	Total (Mine fed data)	**159.55**	**Nil**	**159.55**

1.9 Communication and Physiography

The Govindpur colliery is situated about 5 kms western side of NH-32 and is about 26 KM from Dhanbad railway station. Baghdighi Jore flows from North to

South direction through centre of the property. PWD road runs from South-West to North-east direction of the property.

The area has a rugged topography. The area is generally undulating in the mineable area of the mine with surface elevation ranging from 196 Mts to 208 mts. The area covered under this mining plan is mostly undulating with a significant drainage towards south-east, which is controlled by seasonal nallahs ultimately discharging in to Bagdigi Jore which falls in to Khudo river which finally falls in to Damodar River.

1.10 Type of Present and proposed land use of mining area (Ha)

Table 1.2 Land Use of Mining Area

Sl.No.	Type of land use	Present mining land use (in Ha)	Proposed mining land use (in Ha)	Post-mining land use (in Ha)	Remarks
1	Running Quarry	Nil	Nil	Nil	The abandoned quarry will be physically and biologically reclamed. Plantation will be carried out on coal dump areas (after clearing of coal) and barren land available in the cluster.
	Backfilled	Nil	Nil	Nil	
	Not Backfilled	Nil	Nil	Nil	
2	Abandoned Quarry				
	- Backfilled	32	39.5	0	
	- Not Backfilled	7.5	0	Nil	
3	External OB dump	Nil	Nil	Nil	
4	Service building/ Mine Infrastructure	0.76	0.76	0	
5	Coal dump	1.1	1.1	0	
6	Homestead Land	11.7	11.7	11.7	
7	Agricultural Land	26	26	26	
8	Forest Land	Nil	NIL	Nil	
9	Plantation / reclamation	Nil	21	85.36	
10	Water Body	Nil	Nil	Nil	
11	Barren Land	80.49	59.49	36.49	
12	Others	Nil	Nil	Nil	
	Total	**159.55**	**159.55**	**159.55**	

1.11 Statutory Approvals

Table 1.3 Statutory Approval Status

Sl. No	Particulars	Status
A	Mine plan / F.R / P.R	Formulated
B	Forestry clearance	NA
C	Env clearance	Under process
D	Consent to operate	Existing(closed) Mine
E	Any other approval from Central / State regulatory authorities for operating mine with special reference to mine closure.	Mine closure plan to be approved by BCCL Board of Directors.

1.12 Reasons for Closure

The present OC operations are being carried out with IV Seam as base on South side of the property on the east of the Bagdigi jore in the Agardih section of the mine. It is proposed to quarry our XI T to IV Seams in the area through outsourced HEMM. Though the present production is is 500 TPD, it is proposed to enhance the same to the level of 1000TPD. The patch has a mineable reserve of 6.72 MTe. With the production level of 1000 TPD, the life works out to 19 years.

The development with SDLs is being carried out in IV Seam @ 150 TPD at present on the west side of the jore. It is proposed to open up II & I Seams for balance development. Due to surface and sub-surface constraints, depillaring is possible in isolated sections in IV, II & I seams at present. The total extractable reserve in these three seams has been worked out at 4.46 MTe by the mine officials. With the production target of 500 TPD, the life works out to 30 years.

A Project Report on Block-IV OCP (6.0 MTY) has been formulated with I seam as Base seam, which covers Govindpur colliery entirely. If this PR is implemented, all the UG outlets of the mine will be excavated. In such a situation, it is envisaged that a New Closure Plan should be drawn up as per the revised scope of mining operations as per the relevant guidelines.

Pursuant to the reopening, the mine may be closed in future on account of exhaustion of economically recoverable coal reserves in the lease hold area. The mine may also be closed on account of other unforeseen reasons i.e.

Force Majeure or directives from statutory organizations or court etc. for which information and notices shall be served to concerned Government authorities and departments. As per guidelines of Ministry of Coal, Govt. of India, Mine Closure Plan has to be submitted along with the mine plan for getting competent approval within one or two years of date of approval of mine plan.

1.12.1 Need of Mine Closure Planning

Mining is a hazardous operation as it offsets the equilibrium of natural depositional environment viz. In-situ stress field, ground water, surface drainage system as well as the socio-economic condition. Although mining activities are usually short term phenomena, they are liable to leave long lasting impacts on landscape, ecology and on the mind set of local inhabitants. Thus, it is imperative that any mining venture should have adequate closure plan addressing issues viz. reclamation and environmental protection, rehabilitation of disturbed area which should be acceptable to local community as well as regulatory authority. Community acceptable implementation of mine closure plan will incur some extra cost, neglecting this aspect will lead to future problems of attending compensation or expensive socio-economic problems.

Mine closure encompasses restoration process designed to restore physical, chemical and biological quality, disturbed by the mining activities. Mine closure is not just something that happens at the end of a mine's life rather mine closure is an ongoing series of decisions and activities beginning in the pre-mining stage of mine and ending with a creation of self sustainable site that can be returned to the community.

Thus, a mine closure plan needs to define the liabilities, responsibilities and authorities of the different agencies like the mine management, other regulatory bodies, Central and State Governments after mine closure.

Various objectives of the advance mine closure planning are as given below.

a. To allow productive and sustainable after-use of the site, which is acceptable to the mine owner and the regulatory authority
b. To protect public health and safety

c. To eliminate environmental damage and thereby encourage environmental sustainability
d. To minimize adverse socio-economic impacts of mining activities
e. To protect the flora and fauna of the area affected by the mining
f. Effective use of the assets created during the course of mining

Primarily, the mine closure activities are planned in two stages. The initial plan identifies the activities required to be executed in line with the mining activities in progress after the inception of the project i.e., progressive mine closure activities. These activities may undergo subtle changes depending upon the actual site condition during implementation. Finally, a detailed closure plan is to be prepared 4-5 years before the actual closure time of the mine depending upon the existing parameters at that point of time, i.e., final mine closure activities.

1.12.2 Mine closure planning strategy in respect of Govindpur Colliery based on existing set of parameters

As the balance life of the mine is 30 years for UG (only development considered due to geo-mining constraints) and 19 years for OC operations for the considered area, following activities are envisaged towards mine closure programme in respect of Govindpur Colliery.

a. Progressive mine closure activities will continue as envisaged in the mine plan/feasibility report, if any, and as enumerated in the various approvals, permits, consents etc.

   The recent guidelines issued in this regard by MoC, GoI should also be followed.

b. Although, it is very difficult to foresee the likely impacts due to closure of the mining activities in the leasehold area of the project, but in the present report, the same has been estimated and some mitigating measures have been suggested accordingly. These suggested measures along with certain other measures, as deemed fit, at the time of closure of mining activity in the seams being worked at present shall be taken up.

c. The final closure plan carrying the finer details would be prepared at the time of preparing the mine plan for last mineable patch of coal seam in the leasehold area of the project.

1.13 Approval of Company Board of Directors or any other competent authority (Attach Copy)

The closure plan will be placed to Board of Directors of BCCL for approval.

CHAPTER – II

MINE DESCRIPTION

2.1 Geology of the block

Geology of the mine has been established by surface and sub surface data from Geological reports of (i) Opencast Block-IV (Seams VIIIC to I/II) & (ii) Opencast Block-IV. Gobindpur Colliery is located in the western part of Jharia Coalfield. The area is occupied by strata of Barakar formations containing Coking and Non-coking coal seams. The coal bearing rocks of Barakar formation of Lower Permian age occur in the Colliery area under a thin cover of soil and/alluvium (5 to 10m). A dyke trending E-W is present in this area. By and large the coal seams are free from pyrolitisation.

Altogether 8 boreholes have been drilled in Gobindpur colliery area. All boreholes have been drilled by CMPDI in two different series i.e. GK & EKS, with total meterage of 949.90m & 203.30m respectively. The period of drilling of boreholes is from May'1978 to March'1985. The details of boreholes are given below in the table:-

Table-2.1: Details of Boreholes

SERIES	DRILLING AGENCY	NO. OF BOREHOLES	METERAGE
GK	CMPDI	6	949.90
EKS	CMPDI	2	203.30
TOTAL		8	1153.20

2.1.1 Geological Structure of the area

Strike & Dip

In general the strike of the formation is E-W and the dip varies from 5° to 16° due south.

Faults

One major fault is encountered in this area. However, faults having throw less than 5m could not be ruled out in the area.

Table-2.2 Details of the Faults

Sl. No.	Fault	Location	Strike	Max. Throw (m)	Nature	Evidence
1.	F3-F3	South-east corner of the area	NE-SW	6/SE	Dip fault	Abatement of working of seam VIIIA in the colliery.

Note: Nomenclature of faults are as per Geological Report

2.1.2 General Description of coal seams and its quality

In Govindpur colliery, detailed drilling has proved existence of number of coal seams from XIIIT to I/II seam.

2.1.3 Seam sequence

Table- 2.3 Generalised Seam Sequence and Parting/Quality

SEAM	THICKNESS (m)		AVERAGE THICKNESS (m)	DEPTH RANGE (m)	NO. OF FULL SEAM INTERSECTIONS	GRADE
	MINIMUM	MAXIMUM				
XIII T	2.50 (GK-8)	-	2.50	0-15	1	W-I
P	4	-	-	-	-	-
XIIIB	1.25 (GK-8)	-	1.25	0-20	1	S-II
P	22	-	-	-	-	-
XI/XII	7.96 (GK-8)	-	7.96	0-50	1	W-IV
P	10	-	-	-	-	-
X	0.90 (GK-8)	-	0.90	0-60	1	W-IV
P	17	-	-	-	-	-
IX	4.15 (GK-8)	-	4.15	0-80	1	W-IV
P	25	-	-	-	-	-
VIIIC	0.21 (GK-8)	-	0.21	100-105	1	NA
P	22	-	-	-	-	-
VIIIB	2.85 (GK-3)	3.82 (GK-8)	6.67	0-140	2	W-IV to UG
P	5	8	-	-	-	-
VIIIA	1.99 (GK-7)	2.80 (GK-3)	2.4	0-150	3	W-IV to UG
VIIIA	1.72 (EKS-	-	1.72	0-140	1	NA

L.S.	32)					
P(VIIIA with V/VI/VII)	25	28	-	-	-	-
P (VIIIA L.S. with V/VI/VII)	17	-	-	-	-	-
V/VI/VII	20.94 (GK-6)	29.16 (EKS-32)	25.05	0-180	5	UG/ F-G
P(V/VI/VII with IVT)	19	21	-	-	-	-
IV T	0.50 (GK-7)	1.15 (EKS-39)	0.83	0-210	4	UG/ E-G
P	4	5	-			-
IVB	0.35 (GK-7)	1.74 (GK-8)	1.05	0-230	2	W-IV to UG/ E-G
P(IV with III)	18	19	-	-	-	-
P(IVT with III)	22		-	-	-	
P(IVB with III)	15	23	-	-	-	-
III	4.00 (GK-3)	5.37 (EKS-32)	4.69	0-250	7	UG/ E-G
P	15	18	-	-	-	-
I/II				0-270	7	W-III to UG/ C-F

2.1.4 Reserves, types and quality

Seamwise balance geological reserves assessed by the mine for worked seams and geological reserves of virgin seams estimated on the basis of average seam thickness and grade are given in Table No. 2.4

Table 2.4 Balance reserves

Seam	Av. Th.(m)	Av. Gr.	Reserve (Mte)	Remarks
Reserves furnished by the Mine for worked Seams				
XVII	1.46	W-IV	0.045	
XVI T	1.32	S-II	0.321	
XVI B	2.40	S-II	0.434	

Seam	Av. Th.(m)	Av. Gr.	Reserve (Mte)	Remarks
XV T	2.55	S-II	0.264	
XV B	2.55	S-II	0.274	
XIV	7.00	S-II	2.013	
XIII	3.60	S-II	1.291	
XII	2.70	W-IV	0.614	
XI	3.12	W-IV	0.730	
X	8.10	W-IV	3.494	
IX	2.40	W-IV	1.434	
VIII B	3.35	W-IV	4.175	
VIII A	3.04	W-IV	3.796	
Total			**18.885**	
Reserve as per Borehole Average Thickness basis for Virgin Seams				
				The seams are virgin and their grading on GCV System may be worked out at the time of exploitation.
VIII TOP	2.74	D/E	5.44	
VIII BOT	1.15	E/F	2.28	
VII	5.45	UG/E	10.83	
COMB VIII BOT / VII & V/VI	10.14	W-IV/UG/E	20.15	
IV	17.69	E/F	36.91	
III	5.48	F/G	11.43	
II TOP	0.77		0.04	Seam not developed in major part, negligible reserve
II MID	4.19	F/G	8.74	
II BOT	0.52	D/E	0.26	Seam not developed In major part
II TOP				Seam not developed In Govindpur
I MID	2.17		4.31	
I BOT	0.54		0.11	Thickness <0.5 in major part
‘O’	0.87		0.99	Part area thickness <0.5m
Total		Total	101.49	
Grand Total			**142.96**	

2.2 Mining Details

2.2.1 Mine boundary details

- North: Non Coal Bearing Area
- South: Teturia Colliery & South Govindpur Colliery
- East: New Akashkinaree Colliery
- West: Block IV Colliery

2.2.2 Working Seams

The details of the present working seams are given below in Table No 2.5:

Table No 2.5: Details of Present Working Seams

Seam	Prodn. Outlet	Method	Grade	TPD
IV Seam	Incline	B&P, development Manual	D	150
XIT – IV seam(IV seam as base seam)	Incline	SDL Combination(outsourced)	D	500
Total				650

2.3 Mining Methods

Govindpur Colliery is a mixed mine. Henceforth along with Opencast system of mining operation and Bord and Pillar system of mining operations is practicized.

2.3.1 Underground Mining

Development

It is proposed to develop the virgin reserve in the seams on B & P method of development with SDL loading on to tub for the exploitation as long as the developmental reserve in the seam is available. The development district will consist of 5 level headings as far as possible leaving a panel barrier of one pillar width between the panels. The development shall be carried out by blasting off the solid with. The width & height of the development galleries shall be restricted to 4.8/4.2 m & 3 m respectively. The depth of working as per the provision of Regulation 99 (4) of CMR 1957 shall govern the size of the pillar.

The panels shall be laid out in a manner, as far as possible, to be self draining. The incubation period of coal seam shall be taken into account for sub-panneling, wherever required.

Coal loading at the face will be done by mean of SDL and loaded into tubs. Then the loaded tubs will be hauled by tugger haulage for onwards feeding to main level district haulage which will feed the tubs to the surface haulage line to be hauled up to the surface.

The cycle of face operation in mechanized Bord and Pillar mining would be as follows:

a. Face preparation
b. Drilling
c. Charging, blasting and smoke clearing
d. Dressing and supporting
e. Machine fitting SDL
f. Coal loading by SDL
g. Face supporting

Seam-wise, outlet wise present production of Govindpur (UG) in Table 2.6.

Table 2.6 Seam-wise, Outlet wise Present Production

Seam	Grade	Production Outlet	Method of Work	Production(TPD)
IV	WIV	Incline	B&P Dev. - SDL	150
Total				**150**

Transport - Combination of Direct and Tugger haulages & Endless.
Ventilation - By Exhaust Fan at surface.
Stowing - Presently development is under progress. No stowing is being done.

The present ventilation system of the Mine is given in Table 2.7.

Table 2.7 Present Ventilation System

Seam	Intake outlet	Return Outlet	Fan type & Quantity	Pressure

IV Seam	2/IV & 1/IV incline	Air Shaft	Exhaust type PV-160 Fan	25 mm of WG

2.3.2 **Opencast Mining**

IX/X, VIIIB,VIIIA,V/VI/VII and IV seams are being worked within the opencast with floor of IV seam as base of the quarry. Opencast operation is being carried out through hired HEMM adopting Shovel-Dumper System of mining.

Mining System Parameters ()

Present system of OB dumping - Total O.B. of the running Quarry is being dumped in decoaled area of the existing quarry.

Present depth - 18-20 m.

Thickness of top soil - Min. 4.0 m, Max. 6.0 m, Avg. 5.0 m.

Height & width of OB/Coal benches

Hired HEMM operations:

Height & width of benches - OB1 - Height -8.00 m, width - 18.0 m
- OB2 - Height - 8.00 m, width - 16.00 m

Height & width of coal benches - Height – 2.50 m, width -16.00 m.
Height - 7.00 m, width - 16.00 m

Type of Blasting being adopted - Deep hole blasting

Explosive - Type - L.D. & S.M.S./S.M.E. explosives

Present status

The status of the seam is given in Table No. 2.8

Table 2.8 Seam wise status of Working

Seam	Status
XITOP	Mostly Quarried out and Exhausted

XIBOT	Mostly Quarried out and Exhausted
XA	Mostly Quarried out and Exhausted
XTOP	Quarried out and Exhausted
XBOT	Quarried out and Exhausted
VIIITOP	Quarried out and Exhausted
VIII BOT	Quarried out and Exhausted
VII TOP	Quarried out and Exhausted
VII BOT	Quarried out and Exhausted
VI	Partly depillared , mostly standing on pillar and virgin
V/VI/VII	Partly depillared , mostly standing on pillar and virgin
IV	Partly depillared / standing on pillar/ partly virgin
II	Partly depillared / standing on pillar/ partly virgin
I	Standing on pillar and rest virgin

2.3.1 Depth of Workings

The working seams occur at depth exceeding 220 m in the colliery.

2.3.2 MINE ENTRIES

The details of existing outlets and their present status is given in Table 2.9

Table 2.9: Present Mine Entries

Name of Incline	Sunk up to seam	Dia. / X-sec. (m)	Purpose (Production/ intake Return)
1/4	IV seam	4.5	Production & intake purpose. (Winder – 75 KW)
1/2	II seam	3.5X2.4	Return & 2nd outlet PV-120 (Exhaust)

2.3.3 Major Equipments

Details of equipment (OC and UG) are given below in Table no- 2.10A and 2.10B

Table 2.10A: Details of equipment in Govindpur UG Colliery

Sl. No.	Equipment	Qty/No.
	SURFACE	
1	Haulage 100HP	1

2	MMV-AF65(60HP)	1
3	Lighting transformer(500KVA, 11KV/440)	1
	UNDERGROUND	
1	Standard Height SDL	2
2	Haulage 100KW	1
3	Coal Drill (1.5HP)	4
4	Pumps (150HP)	3
5	Roto Pump(12.5 HP)	2
6	5KVA L/TransformaR	1
7	Endless	1

Table 2.10B: Details of equipment in Govindpur OC Colliery

Sl. No.	Particulars	On Roll (No.)
1	Volvo(Dump)	11
2.	Volvo-460	2
3.	PC-360	2
4	Dozer	1
5	Pay loader	1
6	Drill Machine (150 mm)	1
7	Drill Machine (100 mm)	1
8	Jack Hammer	2
	Total	**21**

2.4 Infrastructure Details

Workshop & Store:

Workshop & Store:

a) Auto workshop at Area Level-Light vehicle breakdown is attended here.

b) Regional Store at Area Level.

c) Colliery workshop.

Magazine – Location , capacity and area

There is no magazine in the leasehold. The requirements are sourced from the New Akash Kinaree Colliery magazine.

Infrastructure facilities available (Road, water supply etc.) –

PWD Road from Katras to Phularitand passes throgh the property.
Nos. of coal stock yard & location –

Heap No.3 (Near II seam Incline)
Heap No.13 (Near IV seam Incline)

Heap No. H.P.- I (Behind sonardih P.O)

Store facilities – Store facility exists.

Existing effluent treatment plant & sewage treatment plant (Mine & Colony) – At present there is no ETP & STP available in the mine. Mine water discharged through settling tank.

Power Supply

- Source-DVC, installed capacity- From Bilbara substation 11 KV to K. M. Substation and 4 Seam Sub Station through 16No. Feeder.

Details of Transformer

1) 1MVA, 11KV/550V - 1 No.
2) 630 KVA, 3.32KV/ 440 V - 1 No. (Lighting,) K.M. Sec.
3) 500KVA, 11KV/ 550 V - 1 No. Power transformer 2 seam
4) 1 MVA, IIKV/440V/550V - 1 No.(Lighting) 4 seam colony

2.5. Details of coal beneficiation plant and its use after closure of mine

No beneficiation plant has been proposed.

CHAPTER – III

CLOSURE PLAN AND RELATED ACTIVITIES

3.1 Closure Planning details of mine

The progressive mine closure activities will continue as envisaged in the mining plan, if any, and as enumerated in the various approvals, permits, consents etc. It is very difficult to predict the various parameters which would be prevalent at the time of final mine closure and also to foresee the likely impacts due to closure of the mining activities (when the entire block reserve would get exhausted). However, broad mine closure activities need to be identified under the various heads.

Govindpur mine falls in Cluster IV for the purpose of EMP.

3.1.1 Mined out Land & proposed final land use

Management of mined out area

a) The present OC operations are being carried out with IV Seam as base on South side of the property on the east of the Bagdigi jore in the Agardih section of the mine. It is proposed to quarry our XI T to IV Seams in the area through outsourced HEMM. Though the present production is is 500 TPD, it is proposed to enhance the same to the level of 1000TPD. The patch has a mineable reserve of 6.72 MTe. With the production level of 1000 TPD, the life works out to 19 years.

The development with SDLs is being carried out in IV Seam @ 150 TPD at present on the west side of the jore. It is proposed to open up II & I Seams for balance development. Due to surface and sub-surface constraints, depillaring is possible in isolated sections in IV, II & I seams at present. The total extractable reserve in these three seams has been worked out at 4.46 MTe by the mine officials. With the production target of 500 TPD, the life works out to 30 years.

A Project Report on Block-IV OCP (6.0 MTY) has been formulated with I seam as Base seam, which covers Govindpur colliery entirely. If this PR is implemented, all the UG outlets of the mine will be excavated. In such a situation, it is envisaged that a New Closure Plan should be drawn up as per the revised scope of mining operations as per the relevant guidelines.

The proposed conceptual post-mining land use plan vis-à-vis present land use is provided in Para 1.10.

b) Mining is to be carried out in a phased manner initiating afforestation work in the mined out area of the first phase while commencing the mining in the second phase i.e. continuation of mining activities from one phase to other indicating the sequence operations depending upon the geo-mining conditions of the mine. Progressive mine closure plan shall be prepared for period of five years from the beginning of the mining operations. These plans would be examined periodically in every five years period and to be subjected to third party monitoring by the agencies approved by the Central Government for the purpose (NEERI, CMPDIL , ISM etc. as per current guidelines).

c) As regards, the underground void, if any, which will remain at the time of closure of the mine, the same will get gradually filled with water. The necessary precautions for the safety of the neighboring mine would be taken care of before deciding the voids to get water filled. Further, the water filled in UG voids will help in maintaining the water level in the nearby Area. The inclines will be covered with RCC structure with suitable opening for inspection by competent person.

d) The existing quarries shall act as water reservoir to help recharge the ground water table in the vicinity. All the available places amenable for plantation shall be planted with appropriate species in consultation with forest department.

3.2 Water quality management

3.2.1 Drainage pattern of the area (pre and post closure)

3.2.1.1Existing drainage pattern

The area has a rugged topography. The area is generally undulating in the mineable area of the mine with surface elevation ranging from 196 Mts to 208 mts. The area covered under this mining plan is mostly undulating with a significant drainage towards south-east, which is controlled by seasonal nallahs ultimately discharging in to Bagdigi Jore which falls in to Khudo river which finally falls in to Damodar River

In course of mining, if any disturbance affecting the drainage pattern is caused, efforts shall be made to restore the normal drainage pattern as far as possible. If the restoration of original drainage profile is not feasible, efforts shall be made to achieve a drainage profile, which will ensure smooth drainage of the area with least possible surface erosion.

3.2.1.2 Post closure drainage pattern

Major area of the mine will be depillared with stowing. As mining of the property is associated with stowing, the general drainage pattern of the area would not get disturbed. Depression, if any, will be suitably filled with non - combustible rocks and cohesive soils, dozed and graded. If some minor alteration takes place, the natural drainage profile of the entire leasehold area would be kept maintained in a manner which will facilitate the normal run-off. Garland drain may be constructed to ensure the controlled drainage of the area.

3.2.2 WATER QUALITY STATUS OF SURFACE AND GROUND WATER

3.2.2.1 Present Practice

Samples of mine water as well as drinking water are collected and were analysed for relevant physical, chemical and bacteriological parameters as per the norms stipulated by MOEF.

Water samples are collected as per standard procedure {IS: 3025 (part I) – 1987} and analyzed as per procedures outlined in relevant volume of BIS 3025 / NEERI / standard Methods (AAPHA).

If any deviation from the prescribed water quality standard is detected, the appropriate remedial actions shall immediately be enforced and frequency of sampling shall be increased till the water quality becomes normal. The source of contamination shall be identified and removed. The contaminated water bodies shall be suitably treated.

3.2.2.2 Present status of water quality

The monitoring of water quality under Baseline Environment Data Generation for Cluster III has been conducted M/S PDIL, Sindri by collecting water samples from ground water, surface water and mine water discharge / workshop discharge (if any) for the proposed project. The various purposes of the water environment monitoring are as follows:

- To assess the water quality characteristics for critical parameters;
- To evaluate the impacts on agricultural productivity, habitat conditions, creational resources and aesthetics in the vicinity ; and
- To facilitate predication of impact on water quality by project activities

The results as per PDIL Report are given subsequently. Details of sampling location are given in Table 3.1 to 3.3 for Ground water, Surface water and effluent water.

To assess the quality of drinking water around the project area, the samples were collected from the following locations in and around the project area:

TABLE - 3.1
Sampling Location for Ground Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No.	Name of Sampling Locations	Frequency	Location Code
01.	Hand Pump – Katras Township	Once in a season	GW_1
02.	Hand Pump - Muraidih Village	Once in a season	GW_2
03.	Hand Pump - Sogiadih Village	Once in a season	GW_3

To assess the quality of lotic system (surface water), water samples were collected from the locations (Refer to PDIL Report) given in Table No. 3.2.

TABLE – 3.2
Sampling Location for Surface Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No	Name of Sampling Locations	Frequency	Location Code
01.	Khudia Nala U/S	Once in a season	SW_1
02.	Khudia Nala D/S	Once in a season	SW_2
03.	Pond Water – Near Harna Village	Once in a season	SW_3
04.	Bagdigi Jore U/S	Once in a season	SW_4
05.	Bagdigi Jore D/S	Once in a season	SW_5

To assess the quality of waste water discharge, water samples were collected from the locations given in Table 3.3.

TABLE – 3.3

Sampling Location for Industrial Effluent/Mine Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No	Name of Sampling Locations	Frequency	Location Code
01.	Mine Water Discharge- Jogidih UGP	Once in a season	MW_1
02.	Mine Water Discharge- Maheshpur UGP	Once in a season	MW_2
03.	Workshop Discharge – Block IV/ Kooridih OCP (After Oil & Grease Trap)	Once in a season	WW_1
04.	Workshop Discharge – New Akashkinari OCP (After Oil & Grease Trap)	Once in a season	WW_2

The physico-chemical characteristics of three nos. of ground water samples collected from three different locations have been presented in Table 3.4.

TABLE – 3.4

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES
(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results			Detection Limit	IS:10500 Desirable/ Permissible Limits
		GW_1	GW_2	GW_3		
PHYSICAL						
1	pH	8.2	7.6	7.8	-	6.5-8.5
2	Temperature (^{O}C)	29.8	30.1	30.2	-	-
3	Colour, HU	<2	<2	<2	-	5/25
4	Odour	Unobj.	Unobj.	Unobj.	-	Unobj.
5	Taste	Agreeable	Agreeable	Agreeable	-	Agreeable
6	Turbidity (NTU)	<5	<5	<5	-	5/10
7	Total Suspended Solid	4	6	6	-	-
8	Total Dissolved Solids	500	552	330	-	500/2000
CHEMICAL						
1	P- Alkalinity as $CaCO_3$	NIL	NIL	NIL	-	-
2	Total Alkalinity as $CaCO_3$	212	184	66	-	200/600
3	Chloride as Cl	44	64	26	-	250/1000
4	Sulphate as SO_4	146	168	134	-	200/400
5	Nitrate as NO_3	1.5	1.4	1.2	-	45/100
7	Fluoride as F	0.6	0.5	0.5	-	1.0/1.5
8	Total Hardness as $CaCO_3$	384	386	164	-	300/600
9	Calcium Hardness as $CaCO_3$	200	262	112	-	75/200*
10	Magnesium Hardness as $CaCO_3$	184	124	52	-	30**
11	Sodium as Na	18	27	34	-	-
12	Potassium as K	2	3	4	-	-
13	Silica as SiO_2	16	22	22	-	-
HEAVY METALS						
1	Iron as Fe	0.08	0.8	0.3	0.04	0.3/1.0
2	Manganese as Mn	<0.05	<0.05	<0.05	0.05	0.1/0.3
3	Total Chromium as Cr	NT	NT	NT	0.01	0.05
4	Lead as Pb	NT	NT	NT	0.05	0.05
5	Zinc as Zn	0.14	0.16	0.14	-	5.0/15
6	Cadmium as Cd	NT	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	NT	0.02	0.05/1.5
8	Nickel as Ni	NT	NT	NT	-	0.01
9	Arsenic as As	NT	NT	NT	0.01	0.05
10	Selenium as Se	NT	NT	NT	0.01	0.01
OTHERS						
1	Mineral Oil	NT	NT	NT	-	0.01/0.03

Sl. No.	Parameters	Analysis Results			Detection Limit	IS:10500 Desirable/ Permissible Limits
		GW_1	GW_2	GW_3		
2	Phenolic Compound as C_6H_5OH	NT	NT	NT	0.001	0.001/0.002
3	Coliform Organisms (MPN/100ml)	< 20	< 20	< 20	-	Absent

Note: 1) BDL – Below Detectable Level. 2) NT- Not Traceable
3) *-Calcium as Ca 4) **-Magnesium as Mg

Results & Discussion

The physico-chemical characteristics of the ground water samples showed great resemblance with respect to the characteristics like temperature, turbidity, pH, colour, odour, chloride, sulphate, total alkalinity, total hardness, TDS and heavy metals, etc. The range of concentrations of drinking water parameters were observed as given in Table No. 3.5.

TABLE – 3.5
Ground Water Quality at a Glance in Comparison to Drinking Water Standard

Parameters	Range of recorded Concentration (Results expressed in mg/l except pH)		
	Minimum	Maximum	Desirable/Permissible Limits as per IS: 10500
pH	7.6	8.2	6.5-8.5
Total Suspended Solid	4	6	-
Total Dissolved Solids	330	552	500 / 2000
Total Alkalinity as $CaCO_3$	66	212	200 / 600
Total Hardness, as $CaCO_3$	164	386	300 / 600
Chloride as Cl	26	64	250 / 1000
Sulphate as SO_4	134	168	200 / 400
Nitrate as NO_3	1.2	1.5	45/ 100
Iron as Fe	0.08	0.8	0.3 / 1.0

From the results presented in Table- 3.5, the Physico-chemical characteristics of the ground water samples were in good agreement with IS: 10500. All the parameters are within the limits specified under Drinking Water Standard (IS: 10500). As regards heavy metals, only Fe and Zn have been recorded with lower concentration & rest were not traceable. The ground water can be safely used for potable purposes.

The physico-chemical characteristics of five nos. of surface water samples collected from five different locations have been presented in Table nos. 3.6(A) and 3.6(B) respectively.

TABLE – 3.6 (A)

PHYSICO-CHEMICAL CHARACTERISTICS OF SURFACE WATER QUALITY

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19^{th} March-18^{th} June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	PARAMETERS	ANALYSIS RESULTS			DETECTION LIMIT	Limit as per IS: 2296 Class 'C'
		SW1	SW2	SW3		
PHYSICAL						
1	pH	7.9	7.5	7.8	-	6.5-8.5
2	Temperature (^{O}C)	29.2	29.3	30.1	-	*
3	Colour, HU	<2	<2	<2	-	300
4	Odour	Unobj.	Unobj.	Unobj.	-	*
5	Turbidity (NTU)	8	10	14	-	*
6	Total Suspended Solids	6	8	12	-	
7	Total Dissolved Solids	293	297	470	-	1500
CHEMICAL						
1	P- Alkalinity as $CaCO_3$	NIL	NIL	NIL	-	*
2	Total Alkalinity as $CaCO_3$	78	64	142	-	*
3	Chloride as Cl	36	38	90	-	600
4	Sulphate as SO_4	96	104	120	-	400
5	Nitrate as NO_3	2.6	2.6	4.6	-	50
6	Fluoride as F	<0.4	<0.4	<0.4	-	1.5
7	Total Hardness as $CaCO_3$	210	214	394	-	*
8	Calcium Hardness as $CaCO_3$	136	142	226	-	*
9	Magnesium Hardness as $CaCO_3$	74	72	168	-	*
10	Dissolve Oxygen	6.6	6.4	5.8	-	4.0
11	COD	06	06	04	-	*
12	BOD (3 days at 27^{o}C)	2.4	2.4	2.2	-	3.0
13	Total Kjeldahl Nitrogen as N	0.52	0.54	0.62	-	*
14	Sodium as Na	9	6	2	-	*
15	Potassium as K	1	1	1	-	*
16	Silica as SiO_2	12	14	12	-	*
HEAVY METALS						
1	Iron as Fe	0.08	0.09	0.06	0.04	5.0
2	Manganese as Mn	<0.05	<0.05	<0.05	0.05	*
3	Total Chromium as Cr	NT	NT	NT	0.006	0.05
4	Lead as Pb	NT	NT	NT	0.04	0.1
5	Zinc as Zn	0.12	0.14	0.14	-	15.0
6	Cadmium as Cd	NT	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	NT	0.02	1.5
8	Nickel as Ni	NT	NT	NT	-	*
9	Arsenic as As	NT	NT	NT	0.01	0.2

Sl. No.	PARAMETERS	ANALYSIS RESULTS			DETECTION LIMIT	Limit as per IS: 2296 Class 'C'
		SW1	SW2	SW3		
10	Selenium as Se	NT	NT	NT	0.01	0.05
11.	Cyanide as CN	NT	NT	NT	0.02	0.05
12.	Mercury as Hg	NT	NT	NT	0.001	
OTHERS						
1	Oil & Grease	BDL	BDL	BDL	0.1	0.1
2	Phenolic Compound as C_6H_5OH	NT	NT	NT	0.001	0.005
3	Coliform Organisms (MPN/100ml)	1.9×10^3	2.0×10^3	2.3×10^3	-	5000

Note: 1) BDL – Below Detectable Level; 2) * - Limit Not specified; 3) NT- Not Traceable

TABLE – 3.6 (B)

PHYSICO-CHEMICAL CHARACTERISTICS OF SURFACE WATER QUALITY

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	PARAMETERS	ANALYSIS RESULTS		DETECTION LIMIT	Limit as per IS: 2296 Class 'C'
		SW4	SW5		
PHYSICAL					
1	pH	7.2	7.3	-	6.5-8.5
2	Temperature (^{O}C)	29.2	29.4	-	*
3	Colour, HU	<2	<2	-	300
4	Odour	Unobj.	Unobj.	-	*
5	Turbidity (NTU)	6	8	-	*
6	Total Suspended Solids	14	16	-	
7	Total Dissolved Solids	486	510	-	1500
CHEMICAL					
1	P- Alkalinity as $CaCO_3$	NIL	NIL	-	*
2	Total Alkalinity as $CaCO_3$	160	164	-	*
3	Chloride as Cl	68	72	-	600
4	Sulphate as SO_4	140	146	-	400
5	Nitrate as NO_3	4.6	4.8	-	50
6	Fluoride as F	<0.4	<0.4	-	1.5
7	Total Hardness as $CaCO_3$	386	390	-	*
8	Calcium Hardness as $CaCO_3$	240	244	-	*
9	Magnesium Hardness as $CaCO_3$	146	146	-	*
10	Dissolve Oxygen	6.0	5.8	-	4.0
11	COD	3.8	04	-	*
12	BOD (3 days at 27^{o}C)	<2.0	<2.0	-	3.0
13	Total Kjeldahl Nitrogen as N	BDL	BDL	-	*
14	Sodium as Na	8	13	-	*
15	Potassium as K	1	2	-	*
16	Silica as SiO_2	10	12	-	*
HEAVY METALS					
1	Iron as Fe	0.16	0.16	0.04	5.0
2	Manganese as Mn	<0.05	<0.05	0.05	*
3	Total Chromium as Cr	NT	NT	0.006	0.05
4	Lead as Pb	NT	NT	0.04	0.1

Sl. No.	PARAMETERS	ANALYSIS RESULTS		DETECTION LIMIT	Limit as per IS: 2296 Class 'C'
		SW4	SW5		
5	Zinc as Zn	0.12	0.14	-	15.0
6	Cadmium as Cd	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	0.02	1.5
8	Nickel as Ni	NT	NT	-	*
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11.	Cyanide as CN	NT	NT	0.02	0.05
12.	Mercury as Hg	NT	NT	0.001	
OTHERS					
1	Oil & Grease	BDL	BDL	0.1	0.1
2	Phenolic Compound as C_6H_5OH	NT	NT	0.001	0.005
3	Coliform Organisms (MPN/100ml)	2.0×10^3	2.0×10^3	-	5000

Note: 1) BDL – Below Detectable Level; 2) * - Limit Not specified; 3) NT- Not Traceable

Results & Discussion

The physico-chemical characteristics of the surface water samples collected from the five locations have shown great resemblance with respect to the characteristics like temperature, turbidity, pH, colour, odour, chloride, sulphate, total alkalinity, total hardness, TDS and heavy metals, etc. The range of concentrations of important parameters of surface water characteristics have been presented in Table No. 3.7.

TABLE –3.7
Surface Water at a Glance

Parameters	Range of recorded Concentration (Results expressed in mg/l except pH)		
	Minimum	Maximum	Limit as per IS: 2296 Class 'C'
pH	7.2	7.9	6.5-8.5
Total Suspended Solids	6	16	-
Total Dissolved Solids	293	510	1500
Total Hardness, as $CaCO_3$	210	394	-
Calcium Hardness, as $CaCO_3$	136	244	-
Chloride as Cl	36	90	600
Sulphate as SO_4	96	146	400
Nitrate as NO_3	2.6	4.8	50
Iron as Fe	0.06	0.16	5.0

From the results presented in Table- 3.6(A) and Table- 3.6(B), it may safely be concluded that the physico-chemical characteristics of the surface water samples had a good resemblance with respect to almost all the parameters and were well within limits specified in Surface Water Standard IS: 2296. As regards heavy metals, except Iron and Zinc, all the other were not traceable. From the above, it may be concluded that all the parameters of the surface water samples were well within the specified limits of IS: 2296 Class 'C'.

The physico-chemical characteristics of mine water & workshop effluent discharge samples collected from different locations have been presented hereunder in Table-3.8(A) & Table-3.8(B) respectively.

TABLE – 3.8 (A)

PHYSICO-CHEMICAL CHARACTERISTICS OF WASTE WATER DISCHARGE

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results			MOEF Standard Schedule-VI
		MW1	MW2	Detection Limit	
PHYSICAL					
1	pH	6.5	6.9	-	5.5-9.0
2	Temperature (^{O}C)	29.6	30.4	-	Te<Ts+5°C
3	Colour,HU	<2.0	<2.0	-	*
4	Odour	Unobj.	Unobj.	-	Unobjectionable
5	Turbidity (NTU)	8	10	-	*
6	Total Suspended Solids	4	6	-	100
7	Total Dissolved Solids	870	814	-	*
CHEMICAL					
1	Total Alkalinity as $CaCO_3$	146	170	-	*
2	Chloride as Cl	60	74	-	*
3	Sulphate as SO_4	448	360	-	*
4	Nitrate as N	1.2	1.3	-	10
5	Dissolve Phosphate as PO_4	BDL	BDL	-	5.0
6	Fluoride as F	<0.4	<0.4	-	2.0
7	Total Hardness as $CaCO_3$	660	614	-	*
8	Calcium Hardness as $CaCO_3$	320	364	-	*
9	COD	6.2	6.4	-	250
10	BOD (3 days at 27°C)	2.4	2.2	-	30
11	Total Kjeldahl Nitrogen as N	BDL	BDL	0.01	100
12	Sodium as Na	16	15	-	*
13	Potassium as K	3	2	-	*
14	Sulphide as S	BDL	BDL	0.01	2.0
15	Ammonical Nitrogen as N	0.46	0.32	0.02	50
HEAVY METALS					
1	Iron as Fe	0.1	0.1	0.04	3.0

Sl. No.	Parameters	Analysis Results			MOEF Standard Schedule-VI
		MW1	MW2	Detection Limit	
2	Manganese as Mn	<0.05	<0.05	0.05	2.0
3	Lead as Pb	NT	NT	0.4	0.1
4	Zinc as Zn	0.24	0.26	-	5.0
5	Copper as Cu	NT	NT	0.5	3.0
6	Nickel as Ni	NT	NT	0.1	3.0
7	Mercury as Hg	NT	NT	0.01	0.01
8	Cyanide as CN	NT	NT	0.01	0.2
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11	Vanadium as V	NT	NT	0.01	0.2
12	Cadmium as Cd	NT	NT	0.002	2.0
13	Hexavalent Chromium as Cr^{+6}	NT	NT	0.1	0.1
14	Total Chromium as Cr	NT	NT	0.006	2.0
OTHERS					
1	Oil & Grease	<2.0	<2.0	-	10
2	Phenolic Compound C_6H_5OH	NT	NT	0.001	1.0

Note: 1) BDL – Below Detectable Level; **2)** NT – Not Traceable

TABLE – 3.8 (B)
PHYSICO-CHEMICAL CHARACTERISTICS OF WASTE WATER DISCHARGE

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results			MOEF Standard Schedule-VI
		WW1	WW2	Detection Limit	
PHYSICAL					
1	pH	7.4	7.5	-	5.5-9.0
2	Temperature (^{O}C)	30.1	31.2	-	Te<Ts+5^{o}C
3	Colour,HU	<2.0	<2.0	-	*
4	Odour	Unobj.	Unobj.	-	Unobjectionable
5	Turbidity (NTU)	16	18	-	*
6	Total Suspended Solids	10	12	-	100
7	Total Dissolved Solids	782	840	-	*
CHEMICAL					
1	Total Alkalinity as $CaCO_3$	160	154	-	*
2	Chloride as Cl	30	36	-	*
3	Sulphate as SO_4	118	124	-	*
4	Nitrate as N	2.2	3.2	-	10
5	Dissolve Phosphate as PO_4	BDL	BDL	-	5.0
6	Fluoride as F	<0.4	<0.4	-	2.0
7	Total Hardness as $CaCO_3$	714	720	-	*
8	Calcium Hardness as $CaCO_3$	428	432	-	*
9	COD	7.6	6.4	-	250
10	BOD (3 days at 27^{O}C)	2.5	2.2	-	30
11	Total Kjeldahl Nitrogen as N	0.68	0.62	0.01	100
12	Sodium as Na	14	17	-	*
13	Potassium as K	2	3	-	*
14	Sulphide as S	BDL	BDL	0.01	2.0

Sl. No.	Parameters	Analysis Results			MOEF Standard Schedule-VI
		WW1	WW2	Detection Limit	
15	Ammonical Nitrogen as N	1.24	1.26	0.02	50
HEAVY METALS					
1	Iron as Fe	0.08	0.09	0.04	3.0
2	Manganese as Mn	<0.05	<0.05	0.05	2.0
3	Lead as Pb	NT	NT	0.4	0.1
4	Zinc as Zn	0.14	0.16	-	5.0
5	Copper as Cu	NT	NT	0.5	3.0
6	Nickel as Ni	NT	NT	0.1	3.0
7	Mercury as Hg	NT	NT	0.01	0.01
8	Cyanide as CN	NT	NT	0.01	0.2
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11	Vanadium as V	NT	NT	0.01	0.2
12	Cadmium as Cd	NT	NT	0.002	2.0
13	Hexavalent Chromium as Cr^{+6}	NT	NT	0.1	0.1
14	Total Chromium as Cr	NT	NT	0.006	2.0
OTHERS					
1	Oil & Grease	<2.0	<2.0	-	10
2	Phenolic Compound C_6H_5OH	NT	NT	0.001	1.0

Note: 1) BDL – Below Detectable Level; **2)** NT – Not Traceable

Results & Discussion

The range of concentrations of important parameters of waste water characteristics are given in Table No. 3.9.

TABLE – 3.9

Waste Water Discharge at a Glance

Parameters	Range of recorded Concentration (Results expressed in mg/l except pH)		
	Minimum	Maximum	Limits As per MoEF Notification (Sch.-VI)
pH	6.5	7.5	5.5-9.0
Total Suspended Solids	4	12	100
Total Dissolved Solids	782	870	-
Total Hardness as $CaCO_3$	614	720	-
Chemical Oxygen Demand	6.2	7.6	250
Chloride as Cl	30	74	-
Sulphate as SO_4	118	448	-
Nitrate as N	1.2	3.2	10
Iron as Fe	0.08	0.1	3

From the results shown above, it may be safely concluded that the Physico-chemical characteristics of the discharge water samples collected from the four locations for one season had variations with respect to almost all the parameters but were well within the limits of **General Standards for Discharge of Effluents (Table 3.10).** As regards heavy metals, like Iron was also within limits

TABLE –3.10

GENERAL STANDARDS FOR DISCHARGE OF EFFLUENTS

[The Gazette of India – Extraordinary {Part II- Sec. 3(i)} Ministry of Environment and Forests Notification New Delhi, 19th May, 1993]

Sl. No.	Parameters	Standards			
		Inland Surface Water	Public Sewers	Land for irrigation	Marine coastal areas
		(a)	(b)	(c)	(d)
1	Colour and odour	Note-1	Note-1	Note-1	Note-1
2	Suspended Solids, mg/l max.	100	600	200	Note-2
3	Particle size of Suspended Solids.	Note-3	-	-	Note-4
4	Dissolved solids (inorganic) mg/l max.	2100	-	2100	-
5	pH value	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
6	Temperature, ^{O}C	Note-5	-	-	Note-5
7	Oil & grease, mg/l max.	10	20	10	20
8	Total residual chlorine, mg/l max.	1.0	-	-	1.0
9	Ammonical Nitrogen (as N), mg/l. max.	50	50	-	50
10	Total Kjeldahl nitrogen (as NH_3), mg/l max.	100	-	-	100
11	Free ammonia (as N), mg/l max.	5	-	-	5
12	Biochemical Oxygen Demand (3 days at 27^{o}C), max.	30	350	100	100
13	Chemical Oxygen Demand, mg/l max.	250	-	-	250
14	Arsenic (as As), mg/l max.	0.2	0.2	0.2	0.2
15	Mercury (as Hg), mg/l max.	0.01	0.01	-	0.01
16	Lead (as Pb), mg/l max.	0.1	1.0	-	2.0
17	Cadmium (as Cd), mg/l max.	2.0	1.0	-	2.0
18	Hexavalent Chromium (as Cr^{+6}), mg/l. max.	0.1	2.0	-	1.0
19	Total Chromium (as Cr), mg/l max.	2.0	2.0	-	2.0
20	Copper (as Cu), mg/l max.	3.0	3.0	-	3.0
21	Zinc (as Zn), mg/l max.	5.0	15	-	15
22	Selenium (as Se), mg/l max.	0.05	0.05	-	0.05
23	Nickel (as Ni), mg/l max.	3.0	3.0	-	5.0
24	Boron (as B), mg/l max.	2.0	2.0	2.0	2.0
25	Percent Sodium, max.	-	-	60	-
26	Residual sodium carbonate, mg/l max.	-	-	5.0	-
27	Cyanide (as CN) mg/l max.	0.2	2.0	0.2	0.2
28	Chloride (as Cl) mg/l max.	1000	1000	600	-

Sl. No.	Parameters		Standards			
			Inland Surface Water	Public Sewers	Land for irrigation	Marine coastal areas
			(a)	(b)	(c)	(d)
29	Fluoride (as F) mg/l max.		2.0	15	-	15
30	Dissolved Phosphate (as P), mg/l max.		5.0	-	-	-
31	Sulphate (SO_4) mg/l max.		1000	1000	1000	-
32	Sulphide (as S), mg/l max.		2.0	-	-	5.0
33	Phenolic Compound (C_6H_5OH), mg/l max.		1.0	5.0	-	5.0
34	Radioactive materials: (a) Alpha emitters, µc/ml max. (b) Beta emitters, µc/ml max.		 10^{-7} 10^{-6}	 10^{-7} 10^{-7}	 10^{-7} 10^{-6}	 10^{-7} 10^{-7}
35	Bio-assay test		Note-6	Note-6	Note-6	Note-6
36	Manganese (as Mn) mg/l max.		2.0	2.0	-	2.0
37	Iron (as Fe) mg/l max.		2	3	-	3
38	Vanadium (as V), mg/l max.		0.2	0.2	-	0.2
39	Nitrate Nitrogen, mg/l max.		10	-	-	20
40	Pesticides, µg/l max.					
	(i)	Benzene Hexachloride				
	(ii)	Carbaryl	10	-	10	10
	(iii)	DDT	10	-	10	10
	(iv)	Endosulfan	10	-	450	450
	(v)	Dimethoate	10	-	10	10
	(vi)	Fenitrothion	10	-	10	10
	(vii)	Malathion	10	-	10	10
	(viii)	Phorate	10	-	10	10
	(ix)	Methyl Parathion	10	-	10	10
	(x)	Phenthoate	10	-	10	10
	(xi)	Pyrethrums	10	-	10	10
	(xii)	Copper oxychloride	9600	-	9600	9600
	(xiii)	Copper sulphate	50	-	50	50
	(xiv)	Ziram	1000	-	1000	1000
	(xv)	Sulphur	30	-	30	30
	(III)	Paraquat	2300	-	2300	2300
	(IIIi)	Propanil	7300	-	7300	7300
	(IIIii)	Nitrofen	780	-	780	780

Note-1: All efforts should be made to remove colour and unpleasant odour as far as practicable.

Note-2: (a) For process water – 100,
(b) For cooling water effluent, 10% above total suspended matter in influent.

Note-3: Shall pass 850 micron IS sieve.

Note-4: (a) Floatable solids-max. 3 mm.
(b) Settleable solids-max. 850microns.

Note-5: Shall not exceed 5^{0}C above the receiving water temperature.

Note-6: 90% survivals of fish after 96 hours in 100% effluent.

3.2.2.3 Practice after the closure

The above practice of monitoring of quality of water would be continued for a period of 3 years after cessation of mining activity. If required, corrective action/steps would be taken to mitigate any adverse effect on local water regime. The responsibility of maintaining the quality of drinking water will be entrusted on the State Authorities after 3 years of mine closure.

3.2.3 MEASURES FOR CONTROL OF POLLUTION (DETAILS FOR POLLUTION CONTROL ARRANGEMENT)

3.2.3.1 IMPACT DUE TO WATER POLLUTION AND ITS MANAGEMENT

The mine discharge water may contain high-suspended solids and other pollutants. The treatment scheme thus needs to focus on the removal of suspended solids from the water. Pit water must be treated to meet the prescribed standards before being discharged into water bodies. When the water is used for agricultural or domestic work, it shall undergo further treatment, as established by Scientific Studies conducted in this regard. The important factors to be considered in selecting the appropriate method for treatment are as follows:

(a) Settling tank will be provided to collect the mine discharged water for settling the suspended solids.

(b) The flow and the quality of pit water vary seasonally. Therefore settling tank should be able to absorb these fluctuations.

(c) The mine water must be neutral in nature and therefore necessary neutraliser may be provided to maintain the pH of the settling pond water.

(d) In order to reduce the dependence on fresh water sources for meeting the demands of water in the mining related operations, the entire mining effluents water will be utilised. The entire effluent free mine water will be utilised in water spraying for dust suppression, hydraulic stowing, equipment washing and other industrial requirements.

(e) Mine water discharge and drainage in the core zone has been planned to be regulated in a manner so that impact on surface and other water bodies of the area is not affected. No diversion of any surface drainage channel is required as other than civil constructions, surface land will not be affected. Expected increase of solids due to surface handling of coal shall be controlled by:

a. Construction of garland drain around the coal stock area
b. Construction of settling tanks of adequate size for removal of particulate matters
c. De-silting of settling ponds and drains at regular intervals
d. Effluents from washing areas, garage and workshop will be collected in garlands and routed through a settling ponds and oil and grease trap. The solid wastes generated shall be treated as per the provisions of Hazardous Waste Management Act. The water shall be recirculated for washing.

3.2.4 WATER BALANCE OF THE AREA

HYDROGEOLOGY AND AQUIFER CHARACTERISTICS OF THE AREA

Groundwater occurrence and storage in study area are mainly controlled by the geological setup of the area. The ability of geological formation to store and transmit water is dependent on its formation parameters, such as porosity and hydraulic conductivity. Based on these two parameters, the rock formation of the area may be classified as hard and soft rocks. Hard rocks (mainly crystalline and consolidated sedimentary rocks) are characterized by very little porosity. Ground water in such rocks circulated to a limited extent through the secondary openings represented by joints, cracks, fissures and such other planes of discontinuity. Soft rocks represented by sandstone, pebbles and loose sand, posses higher degree of primary porosity and as such characterized by higher water storage capacity. As greater part of the study area is underlain by Precambrian crystalline rocks, the weathered residual of the hard rocks as well as the fractures, joints, fissures, faults and other zones of discontinuity are the principle repositories of ground water in the area. The weathered zone is usually of limited thickness, fractures and joints generally close up with depth. The thickness of weathered mantle in the hard rock zone of area is about 10-20 meter in the topographic lows. Ground water in the weathered and fracture zones of hard rocks occur under unconfined condition.

Ground water circulating through fracture zone is sometimes held under pressure. Depth of the water table in the hard rock of the area generally ranges from 3.0 m to 15.0 m below ground level.

The Gondwana sediments form the semi-consolidated formations and are better water potential zone. The splintery shales of Talchir and basal pebbles bed, the variegated Barren Measure shales and the sandstones are the major litho units of the Gondwana Formations. Gondwana sandstones in general, are known to constitute good aquifers at many places. Ground water occurs under unconfined condition in the weathered mantles varying depths from 4.23 – 12.34 m as observed in the dugwells and semi-confined condition in the deeper aquifers. Depth of water level for pre-monsoon period varies from 5–12m below ground level and it stretches to a deeper depth of 7-12m in some places. The pre-monsoon water level rises due to recharge and becomes 2 - 8 m below ground level around the area during post-monsoon period.

Rainfall is the principal recharge source to groundwater. The area experiences an average annual rainfall of about 1200-1400 mm. Besides rainfall, the mine water discharge from the local mining areas and existing water bodies including water logged in abundant mine quarries are also contributed to the ground water recharge as return flow. In the study area, ground water is withdrawn usually by means of open dug wells and small diameter hand operated tube wells for domestic and irrigation purposes. The tube wells are most often deeper (25m – 58m) than the dug wells and tap the aquifer below the weathered mantle. As the area is being located in the hot-tropical belt, the temperature regime is very high, the daily maximum reaches to over 45^0C. Due to excessive heat, the loss of moisture through evaporation is considerably high (60-65%). During the wet monsoon seasons, the net evaporation is less than the precipitation, resulting in surplus water which loss through either surface runoff or being part of the subsurface storage. The surface run-off and sub-surface storage of water depends upon various factors including the amount of rainfall, topography of the area, land use pattern, soil type, slope, physiographic, drainage pattern and hydro-geomorphology of the catchment/ sub-catchment. The study area is having gentle slope towards south and south east. Water received on the slopes, gets collected in low-lying area and is thus ultimately absorbed in the top soil cover and become part of the ground water flow according to the slope to form seasonal streams/nallas.

In the mining area, the water levels are bound to be affected and disturbed. The mining area of JCF area is highly disturbed and the permeability of individual geological units is spatially variable and depends on lithology, fracturing and attenuation with depth. The porous and more open-jointed sandstone members tend to form aquifers, the shaly members are aquitards, which may be leaky but are poorly permeable & form poor permeable barriers to the vertical groundwater movement

Water quality monitoring will be done for three years after closure. The sampling stations shall be one no. mine water with quarterly frequency and two numbers ground water samples in core and buffer zone with quarterly frequency.

3.2.5 Acid Mine Drainage Source

Not Applicable

3.2.6 Water Management

3.2.6.1 Existing mine water discharge details

a. Mine water is pumped out in a settling tank. Clean water coming out from the settling tank is used for dust suppression, stowing and other Industrial uses.
b. Excess pumped out mine water is allowed to flow into the surface water bodies.
c. Drains are provided around the coal stock to collect run-off for diverting into settling pond before discharge into the natural water courses.

Present pumping arrangement :

- Pumping capacity: 1800 gpm
- Make of water
  Monsoon Period - Approx. 3000 GPM
  Lean period - Approx. 1200 GPM

- Quantity of water being discharged to surface.

Seam-wise pumping details of the mine are given in Table 3.11A:

Table 3.11A: Seam wise pumping details of the mine

Seam	Pump No.	Details of pump			Location Dip/ level	Delivery through pit / inc. / BH	Discharge at settling Tank/Nala/ River	Present use (domestic/ stowing/ industrial etc)
		GPM	Head	KW				
II	**1**	**600**	150		41/Main dip	Borehole	Tank	Domestic
IV	**1**	**600**	150		31/main dip	1st part through incline and 2nd part through borehole	Reservoir	Domestic
V B	**1(submersible pump)**	**600**	150		Near Sonardih P.O.	Borehole	Through Drain to Bagdigi jore	Dewatering of VB
Sub total	**3**	**1600**						

Table 3.11B Present use of mine discharge water (Mine fed data)

Period	Total Discharge in (GPM)	Quantity wise use (GPM)				
		Domestic	Stowing	Boiler	Nala/Jore through resetting tank	Total
Monsoon	3000	1200			1000	2200
Lean	1200	1200				1200

3.2.7. Post closure Mine water discharge

Once the reserve is exhausted, the entries into the mine would be securely sealed for safety purposes. However, if for the safety of the future mine or any neighboring mine, pumping is required from the worked seams, then the arrangements for pumping will be kept intact and the water shall be discharged into the surface water bodies after passing the same through settling tank on the surface. The accumulated water in underground workings may be utilized to meet water shortage in nearby areas.

3.3 Air quality management

3.3.1 Present practice

a. At present air borne dust is suppressed by:

- Sprinkling water on the various roads of the mine where vehicles ply.
- Water sprinkling at the various points where coal is handled.
- Proper loading of trucks to avoid any spillage of coal.
- Proper maintenance of I.C. engines.

The quality of air is monitored on regular basis by drawing samples from the various residential and non-residential areas of the project. The test results are compared with the standards prescribed by the MOEF and if any deviation is detected, remedial actions are immediately taken to bring the AAQ standard within the prescribed limits. The practice of air quality management would be continued throughout the project life as per the norms stipulated by MOEF.

The monitoring of air quality under Baseline Environment Data Generation for Cluster III has been conducted M/S PDIL, Sindri and test results of air samples are furnished subsequently.

Table No. 3.12
SAMPLING LOCATION FOR AIR QUALITY MONITORING
Project: Cluster III **Period:** 19th March -18th June 2011

Sl. No.	Location Name/Location Code	Direction & distance w.r.t Project Site	Height of Sampling Point (m)	Description
01.	Jogidih UGP - Core zone - SA_1	-	3.0	Industrial Area
02.	Maheshpur UGP - Core zone - SA_2	-	3.0	Industrial Area
03.	Block IV Kooridih OCP-Core Zone - SA_3	-	3.0	Industrial Area
04.	Govindpur UGP Colliery-Core Zone - SA_4	-	3.0	Industrial Area
05.	New Akashkinari OCP-Core Zone - SA_5	-	3.0	Industrial Area
06.	Katras Choitudih Village - SA_6	SE, 1.0 Km	3.0	Residential Area
07.	Muraidih Village – SA_7	NW, 0.8 Km	3.0	Residential Area

Sl. No.	Location Name/Location Code	Direction & distance w.r.t Project Site	Height of Sampling Point (m)	Description
08.	Harna Village – SA_8	NW, 2.6 Km	3.0	Residential Area
09.	Sogiadih Village – SA_9	NW, 2.5 Km	3.0	Residential Area

Table No. 3.13

AIR QUALITY DATA

Period: 19th March -18th June 2011 **Location:** Govindpur UGP- Core Zone - SA_4

WEEK	DAY	DATE	CONCENTRATION OF AIR POLLUTANTS, µg/m³				
			SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x
I	Mon/Tue	21/22.03.11	188	53	20	9.1	16.3
	Tue/ Wed	22/23.03.11	156	44	16	7.6	14.2
II	Mon/Tue	28/29.03.11	277	71	31	13.5	21.2
	Tue/ Wed	29/30.03.11	178	51	19	8.6	15.7
III	Mon/Tue	04/05.04.11	286	72	33	13.9	20.8
	Tue/ Wed	05/06.04.11	255	72	29	12.4	19.7
IV	Mon/Tue	11/12.04.11	263	75	30	12.8	19.2
	Tue/ Wed	12/13 .04.11	211	60	23	10.2	16.8
V	Mon/Tue	18/19.04.11	133	38	13	7.5	10.7
	Tue/ Wed	19/20.04.11	153	43	16	7.4	12.0
VI	Mon/Tue	25/26.04.11	188	53	20	9.1	12.3
	Tue/ Wed	26/27.04.11	251	71	28	12.2	18.5
VII	Mon/Tue	02/03.05.11	262	74	29	12.7	19.2
	Tue/ Wed	03/04.05.11	129	37	12	7.3	11.5
VIII	Mon/Tue	09/10.05.11	168	48	17	8.2	12.0
	Tue/ Wed	10/11.05.11	256	73	29	12.4	17.8
IX	Mon/Tue	16/17.05.11	235	67	26	11.4	16.4
	Tue/ Wed	17/18.05.11	198	56	21	9.6	13.0
X	Mon/Tue	23/24.05.11	245	70	27	11.9	16.1
	Tue/ Wed	24/25.05.11	168	48	17	8.2	11.0
XI	Mon/Tue	30/31.05.11	252	73	20	7.4	10.0
	Tue/ Wed	31/01.05/06.11	114	34	11	7.5	11.5
XII	Mon/Tue	06/07.06.11	233	66	26	11.3	15.3

	Tue/ Wed	07/08.06.11	203	58	22	9.9	13.3

SUMMARY

Parameters	**SPM**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**NO_x**
No. of observations	**24**	**24**	**24**	**24**	**24**
Minimum Concentration	114	34	11	7.3	10.0
Maximum Concentration	286	75	33	13.9	21.2
Average	208.4	58.6	22.3	10.1	15.2
98^{th} percentile	281.9	74.5	32.1	13.7	21.0

Table 3.14

STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011
Unit : µg/m³

SL. No.	Pollutant	Location Code	Min.	Percentile Value											Max.	Arith. Mean	Geo. Mean	Std. Deviation	Std. *	% Exceeding Standard Limits
				10	20	30	40	50	60	70	80	90	95	98						
01.	SPM	SA - 1	106.0	127.2	171.4	212.9	235.2	243.0	245.8	254.1	256.8	266.8	268.9	271.7	274.0	219.0	211.2	52.9	700	0
		SA - 2	109.0	125.9	168.6	177.9	208.6	218.0	242.8	246.5	256.8	264.4	265.9	267.1	268.0	209.7	202.4	51.5	700	0
		SA - 3	106.0	126.1	211.8	256.0	270.6	278.5	288.8	312.5	339.2	345.7	350.3	351.5	352.0	264.6	250.3	77.4	700	0
		SA - 4	114.0	139.0	163.2	177.0	190.0	207.0	234.6	251.1	255.4	262.7	274.9	281.9	286.0	208.4	202.0	50.8	700	0
		SA - 5	110.0	140.5	236.0	253.2	269.0	281.5	310.6	316.3	338.0	345.2	347.9	352.3	356.0	270.3	257.3	74.0	700	0
		SA - 6	96.0	110.9	137.8	153.2	158.2	201.0	217.6	223.9	233.6	243.2	245.0	245.5	246.0	184.7	177.0	51.3	200	0
		SA – 7	109.0	127.1	187.8	214.6	227.4	245.0	254.2	263.3	271.6	313.8	331.6	340.5	346.0	233.4	222.9	65.5	200	0
		SA - 8	89.0	111.1	122.0	131.9	136.4	142.0	146.0	151.1	158.2	168.0	170.6	179.1	186.0	140.2	138.2	23.7	200	0
		SA - 9	88.0	98.3	120.0	130.8	139.0	139.5	143.8	155.1	156.8	168.1	176.7	178.0	178.0	138.5	136.1	25.5	200	0

* SPM has been compared with Jharia Coal Mines standard in Core Zone and in other than Core Zone as per NAAQS.

Table – 3.14 (Contd.)

STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011 Unit : µg/m³

SL. NO.	POLLUTANT	LOCATION CODE	MIN.	PERCENTILE VALUE											MAX.	ARITH. MEAN	GEO. MEAN	STD. DEVIATION	STD. *	% EXCEEDING STANDARD LIMITS
				10	20	30	40	50	60	70	80	90	95	98						
02.	PM_{10}	SA - 1	36.0	38.9	42.2	52.5	58.2	60.5	61.0	63.0	64.0	66.7	67.0	67.5	68.0	55.7	54.6	10.7	100	0
		SA - 2	35.0	41.1	48.0	50.9	59.2	62.0	69.2	70.1	71.0	71.7	72.0	72.5	73.0	59.5	58.1	12.5	100	0
		SA -3	36.0	42.3	52.8	64.0	67.4	69.0	72.0	78.1	81.4	83.7	84.9	85.5	86.0	67.0	65.1	15.2	100	0
		SA - 4	34.0	39.5	46.4	50.7	53.6	59.0	66.8	71.0	72.0	73.0	73.9	74.5	75.0	58.6	57.0	13.4	100	0
		SA - 5	29.0	36.5	61.0	65.8	70.0	73.5	81.0	82.1	83.0	84.0	84.0	84.5	85.0	68.9	65.9	17.8	100	0
		SA - 6	30.0	31.3	33.0	34.9	36.2	46.0	49.8	51.2	53.4	55.4	56.0	56.0	56.0	43.4	42.3	9.9	100	0
		SA - 7	40.0	44.6	48.4	59.3	64.4	69.5	73.0	75.1	77.2	81.1	82.9	83.0	83.0	65.2	63.6	14.2	100	0
		SA - 8	23.0	30.2	34.6	36.8	38.4	40.0	44.8	49.6	56.4	62.0	62.9	63.5	64.0	43.9	42.2	12.3	100	0
		SA - 9	28.0	31.3	33.6	35.9	36.4	40.5	44.2	47.0	50.8	58.8	60.9	62.6	64.0	42.5	41.4	10.5	100	0
03.	$PM_{2.5}$	SA - 1	12.0	14.3	15.6	19.8	22.0	23.0	23.8	24.1	25.0	26.0	26.0	26.5	27.0	21.2	20.6	4.7	60	0
		SA - 2	10.0	14.2	17.6	19.0	23.0	23.5	26.8	27.1	29.0	30.0	30.0	30.0	30.0	23.0	22.1	6.2	60	0
		SA -3	12.0	14.3	19.6	25.0	26.2	27.0	27.8	29.0	29.0	30.0	30.9	31.0	31.0	24.8	23.9	6.0	60	0
		SA - 4	11.0	13.9	16.6	18.8	20.0	21.5	25.4	27.1	29.0	29.7	30.9	32.1	33.0	22.3	21.3	6.4	60	0
		SA - 5	13.0	18.2	24.0	25.9	27.0	28.0	29.0	30.0	31.0	32.7	33.0	33.5	34.0	26.8	26.0	5.7	60	0
		SA - 6	12.0	13.0	13.6	14.0	14.2	18.5	20.0	21.1	22.0	22.7	23.0	23.0	23.0	17.6	17.1	4.2	60	0
		SA - 7	14.0	15.0	16.6	20.7	23.0	24.5	26.0	26.1	27.0	28.4	29.9	30.5	31.0	22.9	22.2	5.4	60	0
		SA - 8	11.0	12.0	12.6	13.0	14.2	15.0	17.0	19.3	22.4	25.0	25.0	25.5	26.0	17.1	16.4	5.1	60	0
		SA - 9	11.0	11.3	12.6	13.0	13.2	15.0	15.8	18.0	20.2	22.0	23.7	24.5	25.0	16.0	15.5	4.3	60	0

* PM10 & PM2.5 has been compared with NAAQS standard in Core Zone and Buffer Zone.

Table – 3.14 (Contd.)

STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011
Unit : µg/m³

SL. NO.	POLLUTANT	LOCATION CODE	MIN.	PERCENTILE VALUE											MAX.	ARITH. MEAN	GEO. MEAN	STD. DEVIATION	STD. *	% EXCEEDING STANDARD LIMITS
				10	20	30	40	50	60	70	80	90	95	98						
04.	SO_2	SA - 1	7.5	8.7	9.2	9.4	10.0	10.4	11.2	11.7	12.1	12.5	12.8	13.3	13.8	10.6	10.4	1.7	120	0
		SA - 2	7.3	7.8	8.3	9.1	10.3	10.9	11.8	11.9	12.4	12.7	12.9	12.9	12.9	10.5	10.3	2.0	120	0
		SA -3	8.5	9.1	10.9	11.7	11.9	12.3	13.2	13.9	14.7	14.9	15.0	15.3	15.6	12.4	12.2	2.1	120	0
		SA - 4	7.3	7.4	7.6	8.2	9.1	9.8	11.1	11.9	12.4	12.8	13.4	13.7	13.9	10.1	9.9	2.2	120	0
		SA - 5	8.5	9.9	10.5	11.3	12.0	12.5	13.8	14.0	15.0	15.3	15.5	15.7	15.8	12.6	12.4	2.2	120	0
		SA - 6	8.2	8.9	9.5	9.8	10.0	10.3	10.5	10.6	11.0	11.4	11.6	12.0	12.3	10.2	10.2	1.0	80	0
		SA - 7	6.8	8.0	11.8	13.5	15.3	15.5	16.0	16.7	17.0	17.9	18.2	18.4	18.5	14.4	13.8	3.6	80	0
		SA - 8	7.3	8.1	8.6	9.4	9.6	10.0	10.6	10.7	10.8	11.4	11.8	11.9	11.9	9.9	9.8	1.3	80	0
		SA - 9	6.3	7.4	8.0	9.4	9.6	10.4	10.7	11.0	11.4	11.7	13.0	13.3	13.3	10.0	9.8	1.9	80	0
05.	NO_x	SA - 1	13.4	14.0	15.4	16.4	16.7	17.7	17.9	18.5	18.8	19.5	19.6	19.7	19.8	17.1	17.0	2.0	120	0
		SA - 2	10.1	11.3	13.3	15.0	16.6	17.3	17.6	18.2	19.2	19.6	19.9	20.2	20.4	16.3	15.9	3.2	120	0
		SA -3	13.4	14.0	17.0	19.3	20.1	21.8	23.4	24.6	24.8	26.6	26.8	27.0	27.1	21.1	20.6	4.5	120	0
		SA - 4	10.0	11.2	11.8	12.3	13.5	15.5	16.3	16.9	18.8	19.6	20.6	21.0	21.2	15.2	14.8	3.5	120	0
		SA - 5	13.9	15.4	16.0	18.1	19.1	19.8	20.0	21.5	22.6	23.1	23.5	23.5	23.5	19.4	19.2	3.0	120	0
		SA - 6	13.5	14.1	14.5	15.0	15.3	16.0	16.3	16.5	16.8	17.1	17.3	17.6	17.9	15.7	15.7	1.2	80	0
		SA - 7	10.2	12.1	15.9	18.2	19.3	20.7	21.2	21.7	23.0	27.0	28.0	28.5	28.7	19.9	19.1	5.3	80	0
		SA - 8	12.1	13.7	14.7	14.8	15.4	15.6	15.7	16.3	16.7	17.1	17.2	18.2	19.1	15.5	15.5	1.5	80	0
		SA - 9	11.2	12.4	13.4	14.2	15.0	15.4	15.9	16.1	17.1	17.9	18.4	18.4	18.4	15.2	15.1	2.1	80	0

* SO_2 & NO_x has been compared with Coal Mines standard in Core Zone and in other than Core Zone as per NAAQS.

Govindpur UGP – Core Zone (SA - 4)

At this location, SPM, PM10 and PM2.5 concentration were observed in the range of 114 to 286µg/m3, 34 to 75µg/m3 and 11 to 33µg/m3 respectively. SO2 and NOx concentration were in the range of 7.3 to 13.9µg/m3 and 10.0 to 21.2µg/m3 respectively.

3.3.2 Practice after the closure of the mine

a. As the sources of dust and fume generation would no longer be present, the present practice of arresting the air pollution, as enumerated above at However, water sprinkling would be done on the roads, which remain in use after the mine closure.

b. Quality of air would be monitored for a period of 3 years after cessation of mining activity. 3 samples at fortnight frequency for 3 years, one sample in core zone and one sample each in upwind and downwind direction will be collected and analysed.

3.4 Waste Disposal

The present mine is an underground unit and generally no solid waste is generated during the mining operation.

3.5 Details of Surface Structures proposed for dismantling

3.5.1 Infrastructure details

As far as possible, the industrial structures will be utilized by the adjacent mine. However, if these structures are not found fit at the end of mine life, the same will be dismantled and salvaged. The equipments will be removed and used somewhere else. Every effort will be made to restore the area to economic utilization value in line with mine closure plan.

A. SERVICE BUILDINGS: The service buildings/ structures, viz. workshop, stores, office building, cap-lamp room, Pit top office, winding rooms, etc. are to be demolished after collecting all re-useable items, or be used for some other projects and the land covered by them restored for productive use. However, it has to be ensured that as and when a service building is vacated/ abandoned, the same should be demolished to prevent any unauthorized occupation.

B.OTHER INFRASTRUCTURES: All other infrastructures like sub-stations, transformers, community services, pump-houses, water-treatment/ filtration plants, waterlines, power lines, roads etc. will be utilized for the neighbouring projects.

However, possibility shall be explored for handing over the buildings and other infrastructures including the reclaimed land to the State Government for the benefit of local villagers and strengthening the area infrastructures. The end use of these facilities shall be decided by the State Government with the help of District Authorities and Village Panchayat. The peripheral village community facilities developed by the Mine Authorities will be left to the Local Body/ State Government for their management and public use.

Prior to surface demolition/ restoration, a surface audit will be undertaken on all surface structures, spoil heaps etc. to assess whether there is any hazardous material that could cause problem, i.e. explosive, asbestos, chemical, oil, etc.

A list of surface and UG assets (Plant & Machinery) will be prepared and made available to potential purchasers or transferred to other new/ working mines of the company. This will ensure that the assets perform during their economic life.

3.5.2. Post closure disposal/Re-use of the Buildings, Plants & Machineries

i) Disposal or reuse of existing HEMM, CHP, workshop and railway siding for OC

NA

b. Disposal or reuse of haulage, ventilation, workshop and railway siding for UG

At the time of closure of the mine, it is expected that most of the equipments would complete its rated life and would be surveyed off as per the

Company's guidelines. The surveyed off equipments would be auctioned as per prevalent norms.

However, if some of the equipments would not have covered their rated life, they would be diverted to the neighbouring projects for gainful utilisation.

There is no railway siding in the leasehold.

c. Disposal or reuse of transmission lines and sub-station

As per the electricity demand of the existing neighbouring projects, an analysis would be made as to whether the existing sub-station and transmission lines could be gainfully used or not. If the scope of gainful utilization is not found, they will be dismantled and the usable items/spares/conductors etc. would be dispatched to needy Areas/Projects.

d. Disposal or reuse of residential and non-residential buildings

At the time of final closure, a list of surface buildings would be prepared in detail. Thereafter following steps would be taken in chorological order in respect of the available buildings:

- An assessment would be made to find that whether the available buildings can be used by the existing neighboring projects or any new project that might have come up in the vicinity.
- In case, the listed assets cannot be utilized by the nearby project, efforts would be made to sale these assets after making the list available to potential purchasers and asking the interested purchasers to submit sealed bids.
- Thereafter, the state agencies/local agencies may be asked to take possession of the buildings, if they required few of them.
- When there would be no takers, the buildings would be demolished and usable items would be recovered for future use.

Table 3.15 Proposals for Infrastructures

Sl. No.	Particulars	Action Suggested
A	CHP	No CHP exists in the leasehold of the mine.
B	Workshop	-Do-
C	Railway Sidings	There is no railway siding.
D	Colony	These will be handed over to the State Government if fit for use or will be dismantled.
E	Details of non-residential buildings	-Do-
F	Other facilities (ETP /STP)	-Do-

3.6 Safety and Security Arrangement

3.6.1 Mine entry

After closure of the mining activities, all the entries to the mine will be effectively sealed off to avoid any accident and to prevent access to any unauthorized person. The area that is not reclaimed shall be properly fenced/ sealed to prevent any unauthorized entry into the area. Flags/Boards with warning signals shall be posted at vulnerable places to avoid chances of accidents. However, the guidelines / instructions from DGMS, if any, will be followed.

Sealing details and dimensions shall also be prepared for the purpose. The minimum thickness of mine sealing will be 100cm RCC (M20) with nominal reinforcement. For incline entry, the mine entry path of 5 m will be filled with debris and clay before sealing the mine.

Details of fencing around abandoned quarry, indicating the length of the fencing

As explained earlier the proposed OCP patches will not be backfilled and the void will act as water reservoir. It is proposed to develop a water lagoon in the area. The water lagoon may be handed over to State Authorities for conversion into a picnic spot.

The void of the quarry would be properly fenced to avoid any inadvertent entry of animals or human beings. Sufficient Boards and danger signs shall be placed all around.

Later on, the responsibility of keeping the fencing secured would be entrusted on the State Authorities.

The entry into the mine is the haul road. This haul road will remain for entry into the picnic spot. Both side of this haul road will be afforested.

3.6.2 Slope stability arrangement for high wall and back filled dumps

During operation of the mine, overall slope will be maintained at an angle not exceeding 22^0- 28^0. Vegetation cover will also be provided along the slopes to arrest any failure.

As regards stability of back-filled dumps, the final level of reclaimed backfill will be matched with the levels of surrounding areas leaving a final residual void which will serve as a lagoon which may be utilised as water reservoir for the locality.

During operation, the external and internal OB dump will be developed with 40 m berm width and maximum height of 60m in case of external OB dump and the overall dump slope shall not exceed **22^0- 28^0**. The waste dumps will be provided with toe wall and garland drains. The dump will be technically reclaimed and vegetation will be grown after spreading the top soil. The above measures will prevent slope failure and improve the aesthetic value.

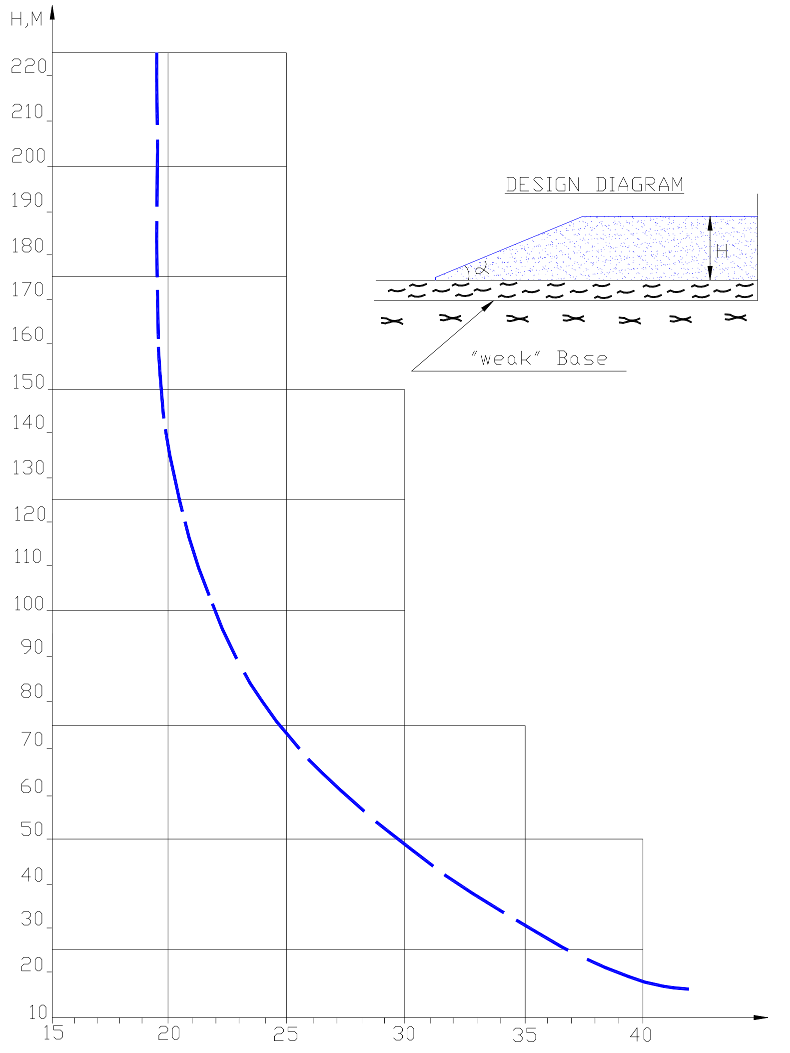


Fig. 5.5.4. Graph illustrating dependence of stable slope angle (α) on height (H) of ex-site dumps formed on "weak" Base

3.6.3 Providing one time lighting arrangement

Sufficient lighting as per standard is provided at all the required places, i.e., pit office, haulage room, fan house, cap lamp room, mine entry, workshop, sub-station haul road in quarry etc.

After closure of the mine, the lighting arrangements will be kept maintained at all locations which are not required to be demolished or dismantled like sub-stations, transformers, community services, pump-houses, water-

treatment/ filtration plants, waterlines, power lines, roads etc. to be utilised for the neighbouring projects and local communities.

3.6.4 Survey records of workings

All the mine workings including subsidence areas, roads, ponds, tanks etc. shall be resurveyed and records shall be updated. Copy of such records shall also be submitted to the appropriate competent authorities, such as DGMS and State Authorities.

Maintenance of records pertaining to Progressive Mine Closure

The Mine management shall maintain following 2 Nos. of Progressive mine closure plans for every 5 year period:

A. **A Progressive mine closure plan for surface activities**

This plan shall be maintained at a scale of 1: 4000 showing the entire progressive mine closure activities (surface) carried out on yearly basis. The plan shall be updated on annual basis and shall be signed by appropriate authorities from the Project and the Area. After every annual renewal, the plan shall be placed before HOD (Env.) of the Company for scrutiny and approval.

B. **A Progressive mine closure plan for UG activities**

Similar to PMCP for surface activities, a progressive mine closure plan showing the UG activities shall be maintained. This plan shall also be updated on annual basis and signed by all the above mentioned officials.

Besides the above plan, a progressive mine closure register shall also be maintained by the mine management. This register shall carry details of the progressive mine closure activities carried out on yearly basis. The details to be maintained in the said register shall cover inter alia the name of activity, place, period of execution, executing agency, expenditure incurred, proof of expenditure incurred, final status of the area where activity was executed, plan on which such activity has been shown etc.

The entries into the said register shall be signed by the appropriate authorities from the Project and the Area. At the end of the year the said register (along with two plans) shall be placed before HOD (Env.) of the Company for scrutiny and approval.

3.6.5 Disposal management of hazardous material

At the time of closure, assessment would be made as to find whether there is any hazardous material that could cause problem. Such hazardous material e.g. explosives, chemicals, oil etc. shall be appropriately disposed off.

3.7 Entrepreneurship development Program

As the mine progresses, more and more local people gets indirectly dependent on the mine for their sustainable income. After closure of mine there would be no source of income for these people. In order to ensure that these people do not suffer in the post closure period, the Project authorities in consultation with BCCL (HQ) shall make efforts to develop entrepreneurial skills in the local people by imparting skill development/vocational training programs. It is expected that after developing adequate entrepreneurial skills, the local people would be able to run their own business in the post closure period and maintain a sustainable income for their livelihood.

3.8 Miscellaneous activities

In future, the prevalent geo-mining/environmental conditions in and around the project area may require execution of some other progressive mine closure activities not covered in the preceding paragraphs. Such activities may be carried out by the mine after observing the needful formalities and obtaining approval of HOD (Env.) of the Company.

3.9 Execution of progressive mine closure activities and 5 yearly monitoring

After observing the necessary administrative/financial formalities, the mine authorities shall execute the identified progressive mine closure activities, whenever and wherever required. The executed activities shall be shown on the above said plans and recorded in the said registers.

The executed progressive mine closure activities shall be monitored on 5-yearly basis by 3rd party (ISM, CMPDI, NEERI etc.).

The 5 yearly return from escrow fund would be equal to expenditure incurred on progressive mine closure activities during last 5 years or 80 % of total deposited amount in the escrow account (including interest) whichever is less. The said return would be subject to above said monitoring of progressive MCP by a third party (ISM/CMPDI/NEERI etc.).

As the 5 yearly return from escrow fund is linked with the expenditure incurred on progressive mine closure activities during last 5 years, it is very important that progressive mine closure records, plans, expenditure details along with proof are properly maintained.

At this juncture it is important to note that some of the progressive mine closure activities, enumerated in the preceding paragraphs, are legal obligations specified in Project reports, EMP, permissions obtained from statutory bodies such as CPCB, SPCB, DGMS etc. The Project authorities are bound to comply with these obligations.

3.10 Re-deployment of work force

The current manpower of the project is 680. And at present, it is very difficult to assess the manpower of the project, which will remain at the time of closure of mining activities in the presently worked seams. As some of the seams of the block is still virgin and is most likely to be mined in future, the remaining manpower will be gainfully utilized in continuing mining activity.

3.11 Emancipation from the community facilities and the facilities to the PAPs

3.11.1 The Project affected Persons (PAPs) and also the local communities are being provided many civic facilities, such as educational facilities, health facilities, and drinking water. As some of the seams of the block are still virgin and are most likely to be mined in future, these facilities, in all probability, will be kept maintained.

3.11.2 However, at the time of final closure after exhaustion of entire mineable reserve these facilities will be entrusted upon the local bodies/Trust of PAPs/State bodies after consultation with local people and state authorities so that same could continue even after the mine closure. If needed, a lump sum reasonable amount would also be paid to the local bodies/Trust of PAPs/State bodies after proper approval for proper upkeep and maintenance of various community facilities.

3.11.3 To ensure that no financial loss due to the closure of mining activity in the presently worked seam occur to the local community engaged indirectly to the existing mine, following steps would be taken:

- It has been seen in past that in the event of closure of a mine, the local people indirectly dependent on the mine switch over their economic/professional activities in the existing/new or expansion mines located in the nearby area. Local management, if needed, extends some basic helps to them in such type of switching over. Hence, it is expected that in this project also the transition of the local people from one area to the other area for their sustenance would not be any problem.

- It is proposed that reclaimed and afforested land will be handed over to State Forest Dept. for the benefit of local ecosystem. The forest wealth can also be utilised by local people or tribal in the form of fruits and fodders.

- The proposed picnic spot would be handed over to a society of local people for commercial use of the picnic spot by them.

CHAPTER – IV

ECONOMIC REPURCUSSION

4.0 Economic Repercussions of closure of mine:

4.1 Manpower of the Project

The total manpower strength of Govindpur colliery is 680.

Manpower	No.
EXECUTIVE	10
NON EXECUTIVE	670
TOTAL	**680**

POST CLOSURE MANPOWER

It has been proposed to monitor and implement the post-closure activities departmentally. Departmental manpower will be needed after closure of the mine for monitoring and implementation of the post closure activities. Manpower required for the same is given in Table- 4.2.

Table 4.2: Manpower required for monitoring and implementation of Mine Closure Activities

Sl. No.	Category of Manpower	Requisite heads
1	Officer-in-charge/ Manager (Mining)	1
2	Overman-in-charge	10
3	Foreman-in-charge	2
TOTAL		**13**

4.2 ASSESSMENT OF INCOME SCENARIO OF LOCAL PEOPLE

As Govindpur colliery is a mixed mine at present, surface excavation will be undertaken. Moreover, the basic mining infrastructures have been made on the company acquired land. So there will no displacement of local people for this project. Later, after closure of the mine the work force will be absorbed / re-employed / rehabilitated in operative collieries of BCCL.

After the closure of the mine, the manpower deployed in the mine will be further deployed in other mines of BCCL to make no loss of sustenance income to the eligible employee. The other secondary activities will not be affected by the closure of the mine and the mine discharge water after proper treatment will be provided to the local people for domestic and irrigational uses.

4.2.1 At present, it is very difficult to assess the manpower of the project, which will remain at the time of closure of mining activities in the instant project.

4.2.2 The local communities are being provided many civic facilities, such as educational facilities, health facilities, and drinking water. At the time of final closure after exhaustion of entire mineable reserve these facilities will be entrusted upon the local bodies/Trust of PAPs/State bodies after consultation with local people and state authorities so that same could continue even after the mine closure. If needed, a lump sum amount would also be paid to the local bodies/Trust of PAPs/State bodies for proper upkeep and maintenance of various community facilities.

4.2.3 To ensure that no financial loss due to the closure of mining activity in the presently worked seam occur to the local community engaged indirectly to the existing mine, following steps would be taken:

- It has been seen in past that in the event of closure of a mine, the local people indirectly dependent on the mine switch over their economic/professional activities in the existing/new or expansion mines located in the nearby area. Local Management, if needed, extends some basic helps to them in such type of switching over. Hence, it is expected that in the instant case also the transition of the local people from one area to the other area for their sustenance would not be any problem.

- It is proposed that reclaimed and afforested land, if any, will be handed over to State Forest Dept for the benefit of local ecosystem. The forest wealth can also be utilised by local people in the form of fruits and fodders.

CHAPTER – V

TIME SCHEDULE FOR POST-CLOSURE ACTIVITIES

5.1 It is very difficult to predict the various parameters which would be prevalent at the time of final mine closure (when the entire block reserve would get exhausted) and therefore a mine closure activity schedule cannot be rigidly prepared at this point of time.

5.2 The closure of mine involving technical aspects, environmental aspects, socio-political aspects and financial assurances as implementing post-closure activities will run for three years. The time schedule envisaged for completion of all closure activities is presented in the following table in the form of bar chart.

Table 5.1: Implementation Schedule for post-closure activities for Govindpur mine

Sl. No.	Major Activities	Time Period	Year-wise Phasing			
			Y1	Y2	Y3	Y4
1	Technical aspects	2 years				
2	Environmental aspects	2 years				
3	Post closure environment monitoring	3 years				
4	Socio-political aspects	3 years				

5.2.1 TECHNICAL ASPECTS:

i) **Safety & security**: In the mine closure plan, action will be taken to cover all the safety aspects including management of fire & subsidence and mine inundation.

ii) **Management of pit slopes and waste dump**: Govindpur being mixed mine, management of pit slope and waste dump will be needed.

iii) **Management of hydrology and hydro-geology**: After closure of mining activities, the workings will be waterlogged which will help in maintaining the water table in the surrounding areas and may become a source of water supply to the neighbouring areas.

iv) **Closure of Mine Entries**: After closure of the mining activities, all the entries to the mine will be effectively sealed off/fenced to avoid any accident and to prevent access to any unauthorized person. The area that is not reclaimed shall be properly fenced/ sealed to prevent any unauthorized entry into the area. However, the guidelines / instructions from DGMS, if any, will be followed.

v) **Disposal of mining machinery**: All the surface/underground machineries including pumps, SDLs, haulages etc. which will have residual life will be shifted to the other collieries of the area/company. The salvaging and shifting operation of mining machinery and other equipment will be done considering the ground realities during the period 1 (one) year advance of final mine closure.

vi) **Details of surface structure proposed to be dismantled**:

As far as possible, the industrial structures will be utilised by the adjacent mine. However, if these structures are not found fit at the end of mine life, the same will be dismantled and salvaged. The equipments will be removed and used somewhere else. Every effort will be made to restore the area to economic utilization value in line with mine closure plan.

A. **Service Buildings**: The service buildings/ structures, viz. workshop, stores, office building, cap-lamp room, incline top office, haulage/winding rooms, etc. are to be demolished after collecting all re-useable items, or be used for some other projects and the land covered by them restored for productive use. However, it has to be ensured that as and when a service building is vacated/ abandoned, the same should be demolished to prevent any unauthorized occupation.

B. **Other Infrastructures**: All other infrastructures like sub-stations, transformers, community services, pump-houses, water-treatment/ filtration plants, waterlines, power lines, roads etc. will be utilized for the neighbouring projects.

However, possibility shall be explored for handing over the buildings and other infrastructures including the reclaimed land to the State Government for the benefit of local villagers and strengthening the area infrastructures. The end use of these facilities shall be decided by the State Government with the help of District Authorities and Village Panchayat. The peripheral village community facilities developed by the Mine Authorities will be left to the Local Body/ State Government for their management and public use.

Prior to surface demolition/ restoration, a surface audit will be undertaken on all surface structures, spoil heaps etc. to assess whether there is any hazardous material that could cause problem, i.e. explosive, asbestos, chemical, oil, etc.

A list of surface and UG assets (Plant & Machinery) will be prepared and made available to potential purchasers or transferred to other new/ working mines of the company. This will ensure that the assets perform during their economic life.

5.2.2 ENVIRONMENT ASPECTS

i) **Mined-out land and proposed final land use:** As Govindpur is a mixed mine, the mined out land will properly be reclaimed as per the existing guideline of environment management plan. The existing infrastructures, if not usable, will be dismantled and the land will be graded & will be handed over to the local authorities for community use.

ii) **Air & Water quality management:** Appropriate air and water pollution control measures will be taken to contain the air and water pollution for maintaining the ambient air and water quality within the stipulated standards besides making the mining operation eco-friendly in the project. These

measures (both preventive and suppressive) are enumerated in Para 3.2.3 of the present report.

iii) **Management of waste:** The solid wastes generated by the mine during the coal production are non-hazardous and non-toxic in nature. The above solid wastes will be disposed off by backfilling the mined out area and then re-vegetating without causing any siltation problem on surface water bodies. However, scientific studies shall be undertaken regarding applicability of solid wastes for various uses. Toxic solid wastes like used oil, used batteries, oily sludge, besides filters and filter materials containing oil during maintenance of vehicles, will be generated by the mining project. Used oil will be stored in drums safely for disposal through auction to the authorized re-processors. Similarly, used batteries will be stored safely for auction to the authorized re-processors. The oily sludge, besides filter and filter materials, will be disposed off in impervious layer lined pits without causing environmental hazards.

iv) **Management of final voids**: The underground voids will be slowly get filled with water. However, safety of the neighbouring mines will be looked into before the entire underground void gets water filled.

v) **Land reclamation and rehabilitation:** If any cracks or void is created due to underground mining activities, it will be restored to original profile by filling up cracks/ voids. In case of opencast working it should be properly reclaimed. It is proposed that the site restoration should be kept progressive so that the restoration is more or less similar to the rate of mining.

vi) **Reclamation of forest/ vegetation and plantation:** No forest land is required for the project. However, regular plantation will be taken up during the life of the mine to create green barrier. The plant species will be selected in consultation with the state forest department.

The objective of restoration of post mining area will be determined through consultation with local community and the Government authority, so that the potential/ required end use of the mined out land is determined in advance. Such usage may be agriculture, forestry, amenity development or nature reserve.

5.2.3 POST CLOSURE ENVIRONMENT MONITORING

After cessation of mining and its related activities, there will be no effect on ambient air and water quality due to this mine as proper mitigation measures for air and water pollution control are to be taken by the authorities of the mine. However, the air and water quality parameters in the mined out area will be monitored by some external agency for next three years after closure of the mine.

Air and water samples will be taken from the specified sampling stations at regular frequency for 3 consecutive years after the closure of the mining project. 1 sample of mine water will be collected and analyzed with fortnightly frequency and 2 samples of ground water from core & buffer zones with monthly frequency. Similarly, 1 air sample will be taken at core zone, and 1 air sample each in upwind and downwind directions of the project at fortnightly frequency.

5.2.4 SOCIO-POLITICAL ASPECTS

i) **Re-deployment of work force**: Due to closure of mining operations, the persons directly employed in the mine will be surplus. Suitable manpower re-deployment plan may be formulated by the mining company sufficiently before closure of mine for re-deployment of the work force in other units of the company. Alternatively, they would be given option of voluntary retirement.

ii) **Civic facilities**: It is proposed that the civic facilities developed during the mining phase will be transferred to the local government/ municipality so that the region transforms smoothly into post mining phase. A one-time payment should be made by the mine for obtaining its release from providing these facilities, which will there from be taken care of by the local and state bodies.

iii) **Channelisation of available water**: If the mine has sufficient water, this can be used for domestic and agriculture purpose by the local community. The water from this area shall be discharged after treatment for domestic and agricultural usages.

iv) **Emancipation for project affected population**: This is not applicable, as, if there is any village/ basti which are to be resettled, it has been taken care by the Master Plan of JCF (March'08) as given in Table No. 5.2.

Table 5.2

Village/Site	BCCL	Pvt.	Enchr	Oth	Total
PHASE-I					
Tiwari Bastee /O2	**0**	**63**	**0**	**0**	**63**
Total(Phase-I)	**0**	**63**	**0**	**0**	**63**
PHASE-II					
Agardih Labour Qtrs/O7	40	0	0	0	40
Darpan Bastee/O5	3	13	0	0	16
Imli Dhowrah/O3	14	0	0	1	15
IV Seam Colony/O1	231	24	53	0	308
Labour Qrts./O6	21	0	0	0	21
Mehtadih Colony & Bunglow/O4	31	0	100	5	136
Total(Phase-II)	**340**	**37**	**153**	**6**	**536**
Total(Phase I+II)	**340**	**100**	**153**	**6**	**599**

5.3 Although, it is very difficult to conclusively predict the likely impacts due to closure of the mining activities in the in the leasehold area of the Instant Project and the likely activities that would be taken up at that point of time, but a broad mine closure activity schedule may be prepared as per guidelines of Ministry of Coal. The post closure implementing activities will run for three years. The following activities are most likely to be implemented as per the given bar chart.

IMPLEMENTATION SCHEDULE FOR MINE CLOSURE OF GOVINDPUR UG MINE

(LIFE OF THE MINE : 30 YEARS)

S.N	Activity	Time Frame	Year								
			1st Phase	2nd Phase	3rd Phase	4th Phase	5th Phase	Final Phase	Post Closure Phase		
			1st - 5th	6th - 10th	11th - 15th	16th - 20th	21st - 25th	26th - 30th	PC1	PC2	PC3
A	**Dismantling of Structures**										
	Service Buildings	2 years									
	Residential Buildings	2 & ½ years									
	Industrial structures like CHP, Workshop, field sub-station, etc.	2 & ½ years									
B	**Permanent sealing of mine entries (incline mouth and air shaft)**										
	Sealing of incline mouths and air shafts	2 years									
C	***Subsidence Management**	Throughout the life of the mine, if required including 3 years after cessation of mining operation									
D	**Landscaping**										
	Landscaping of the cleared land for improving its esthetic	Throughout the life of the mine including 3 years after cessation of mining operation									
E	***Plantation**										
	Plantation over leasehold area and on other open spaces	Throughout the life of the mine including 3 years after cessation of mining operation									

S.N	Activity	Time Frame	Year								
			1st Phase	2nd Phase	3rd Phase	4th Phase	5th Phase	Final Phase	Post Closure Phase		
			1st - 5th	6th - 10th	11th - 15th	16th - 20th	21st - 25th	26th - 30th	PC1	PC2	PC3
F	**Post Closure Env Monitoring / testing of parameters for three years**										
	Air Quality	3 years									
	Water Quality	3 years									
G	***Entrepreneurship Development (Vocational/skill development training for sustainable income of affected people**	Throughout the life of the mine									
H	***Miscellaneous and other mitigative measures**	Throughout the life of the mine including 3 years after cessation of mining operation									
I	**Post Closure Manpower cost for supervision**	3 years after mine closure									

NOTE: *: To be covered under Progressive Mine Closure activities also**.**

NOTE: The progressive mine closure will be done as per the provisions made out in the Project report and as per the situation/requirement that may arise in course of execution of the Project Report.

IMPLEMENTATION SCHEDULE FOR MINE CLOSURE OF GOVINDPUR OC MINE

(LIFE OF THE MINE : 19 YEARS)

S.N	Activity	Time Frame	Year						
			1st Phase	2nd Phase	3rd Phase	Final Phase	Post Closure Phase		
			1st - 5th	6th - 10th	10th - 15th	16th - 19th	PC1	PC2	PC3
A	**Dismantling of Structures**								
	Service Buildings	2 years							
	Residential Buildings	2 & ½ years							
	Industrial structures like CHP, Workshop, field sub-station, etc.	2 & ½ years							
B	**Permanent Fencing of mine void and other dangerous area**								
	Random rubble masonry of height 1.2 metre including leveling up in cement concrete 1:6:12 in mud mortar	2 years							
C	**Grading of highwall slopes**								
	Levelling and grading of highwall slopes	2 years							
D	**OB Dump Reclamation**								
	*Handling/Dozing of OB Dump and backfilling	Throughout the life of the mine including 3 years after cessation of mining operation							
	*Technical and Bio-reclamation including plantation and post care	Throughout the life of the mine including 3 years after cessation of mining operation							
E	**Landscaping**								
	Landscaping of the open space in the leasehold area for improving its esthetics and eco value	Throughout the life of the mine including 3 years after cessation of mining operation							
F	**Plantation**								

S.N	Activity	Time Frame	Year						
			1st Phase	2nd Phase	3rd Phase	Final Phase	Post Closure Phase		
			1st - 5th	6th - 10th	10th - 15th	16th - 19th	PC1	PC2	PC3
	Plantation over cleared area obtained after dismantling	2 years							
	*Plantation around the quarry area and in safety zone	Throughout the life of the mine including 3 years after cessation of mining operation							
	*Plantation over the external OB Dump	Throughout the life of the mine							
G	**Post Closure Env Monitoring / testing of parameters for three years**								
	Air Quality	3 years							
	Water Quality	3 years							
H	***Entrepreneurship Development (Vocational/skill development training for sustainable income of affected people**	Throughout the life of the mine							
I	***Miscellaneous and other mitigative measures**	Throughout the life of the mine including 3 years after cessation of mining operation							
J	**Post Closure Manpower cost for supervision**	3 years							

NOTE: *: To be covered under Progressive Mine Closure activities also**.**

NOTE: The progressive mine closure will be done as per the provisions made out in the Project report and as per the situation/requirement that may arise in course of execution of the Project Report.

CHAPTER – VI

MINE CLOSURE COST

6.0 Mine Closure activities would be a constant exercise for the mine which would begin with the commencement of mining operations and continue till post closure. The mine closure activities would naturally entail certain expenditures, which will have to be borne by the mine operator. There would be two types of expenditures on account of mine closure activities in respect of Govindpur Colliery.

6.1 Revenue expenditures

This would cover the activities which are being executed along with normal mining operation and would continue to be executed in course of execution of the project. The cost of progressive mine closure activities is already part of the project cost.

6.2 Expenditures to be incurred just prior to actual mine closure and in the post closure period

6.2.1 As per MOC guidelines, a corpus escrow account @ ₹ 1.0 lakhs (August, 2009 Price Level) per Ha (for UG) and @ ₹ 6.0 lakhs(for OC) of the Project Area shall be opened with the coal controller organization to meet the expenses of final mine closure. The current guidelines read as follows:

"It has been estimated that typically closure cost for an opencast mine will come around Rs. 6.00 lakh per Hectare of the project area and it would be Rs. 1.00 lakh per Hectare for underground mine project area at current price levels (August, 2009) and these rates will stand modified based on Wholesale Price Index as notified by Government of India from time to time".

As per the data furnished by the mine/area, leasehold area in respect of Govindpur Colliery is 159.55 Ha and the present project area is 159.55 Ha and the closure cost is calculated accordingly.

In Govindpur Colliery, the existing leasehold area is 159.55 Ha. The entire area of 159.0 Ha is considered as project area, out of which 35.0 Ha is for opencast project and 124.55 Ha is for underground workings. Thus, 35.0 Ha area has been considered for calculation of closure cost as per opencast norms and 124.55 Ha area has been considered for calculation of closure cost as per underground norms.

The overlapping area (where UG & OC operations have been done in different vertical levels) has been considered for calculation of closure cost as per opencast norms.

The money deposited in the Escrow Account has to deal with the following:

- Cost of closure activities.
- Cost towards organization for executing the closure activities.
- Cost of the post project monitoring.
- Creation of a corpus fund for the final mine closure

6.2.2 As per the above guidelines these rates will stand modified based on Whole Price Index as notified by Government of India from time to time. Thus the total expenditure on this front may be calculated in the manner described overleaf.

- The total amount for mine closure activity in respect of **Govindpur Colliery UG (Excluding Opencast Project**) = 124.55 Ha X ₹ 1 Lakh X 1.35340* = ₹ 168.57 lakhs

- The total amount for mine closure activity in respect of **Govindpur Colliery (OC**) = 35.0 Ha X ₹ 6 Lakh X 1.35340* = ₹284.21 lakhs

*** The amount has been escalated based on WPI of July 2013 (175.4) vis-à-vis WPI of August ‘09(129.6).**

The WPI of July 2013 is provisional as per the Govt.’s notification (Office of the Economic Adviser).

6.2.2 It is difficult to conclusively predict the mining parameters on a long term basis owing to rapidly changing mining technology, developments in the field of clean coal technologies and R&D activities in development of alternative energy sources.

As per the latest Guidelines issued by the MoC, GoI(dt. 07.01.2013) the *"annual closure cost is to be computed considering the total project area at the above mentioned rates and dividing the same by the entire life of the mine in years for new projects and balance life of mine in years for operating/existing mines."*

Jharia Coalfield is characterized by occurrence of a number of working coal horizons, giving a leverage of extended working life of the mines. Some more seams can come in the lap of workable horizons due to improvement in mining technology in times to come. The underground mines in leasehold of JCF are generally small capacity mines, giving a false impression of very long lives due to small level of current production level. There may be a strategy in future to amalgamate the mines for higher production level to attain the economics of scale. In such a situation, the life of the mine arrived at with current level of production for the balance reserve may not be workable in the long run.

In view of the above and as discussed in para 1.12, for the purpose of mine closure cost calculations, the life of the mine has been calculated based on the development reserve available in the currently producing seams, proposed OCP patches, surface and sub-surface constraints.

The present OC operations are being carried out with IV Seam as base on South side of the property on the east of the Bagdigi jore in the Agardih section of the mine. It is proposed to quarry our XI T to IV Seams in the area through outsourced HEMM. Though the present production is is 500 TPD, it is proposed to enhance the same to the level of 1000TPD. The patch has a mineable reserve of 6.72 MTe. With the production level of 1000 TPD, the life works out to 19 years.

The development with SDLs is being carried out in IV Seam @ 150 TPD at present on the west side of the jore. It is proposed to open up II & I Seams for balance development. Due to surface and sub-surface constraints, depillaring is possible in isolated sections in IV, II & I seams at present. The total extractable reserve in these three seams has been worked out at 4.46 MTe by the mine officials. With the production target of 500 TPD, the life works out to 30 years.

A Project Report on Block-IV OCP (6.0 MTY) has been formulated with I seam as Base seam, which covers Govindpur colliery entirely. If this PR is implemented, all the UG outlets of the mine will be excavated. In such a situation, it is envisaged that a New Closure Plan should be drawn up as per the revised scope of mining operations as per the relevant guidelines.

The life of **Govindpur UG mine** will be 30 years. To arrive, at the annual cost, to be deposited in each year in an escrow account, the mine closure cost has been divided by 30, as shown below:

- Amount to deposited in 1st year will be-----₹ 5.62 lakhs
- Amount to be deposited in 2nd year will be—₹. 5.62 (1 + 5%)^1 lakhs
- Amount to be deposited in 3rd year will be—₹. 5.62 (1 + 5%)^2 lakhs

6.2.4 In the above fashion, an amount will be deposited every year up to the last year of mine life by applying the following formula:

- Amount to be deposited in Nth year will be --- ₹ 5.62 (1 + 5%) ^(n-1) lakh

Thus, total amount that shall be deposited for final mine closure activities **Govindpur UG Colliery** stands out to be ₹**373.31** lakhs at current WPI as per the present status of the mine based on UG norms.

6.2.5 The life of **Govindpur OC mine** will be 19 years. To arrive, at the annual cost, to be deposited in each year in an escrow account, the mine closure cost has been divided by 19, as shown below:

- Amount to deposited in 1st year will be-----₹ 14.96 lakhs
- Amount to be deposited in 2nd year will be—₹. 14.96 (1 + 5%)^1 lakhs
- Amount to be deposited in 3rd year will be—₹. 14.96 (1 + 5%)^2 lakhs

6.2.6 In the above fashion, an amount will be deposited every year up to the last year of mine life by applying the following formula:

- Amount to be deposited in Nth year = ₹ 14.96 (1 + 5%) ^(n-1) lakhs

6.2.7 Thus, total amount that shall be deposited for final mine closure activities **Govindpur OC mine** stands out to be ₹ **456.82** lakhs as per the present status of the mine.

Table No. 6.1 Break-Up cost of Mine Closure of Govindpur Colliery Year-wise (WPI July 2013)

Year	Amount (₹ in Lakhs)		
	Govindpur UG	Govindpur OC	Total
1	5.62	14.96	**20.58**
2	5.90	15.71	**21.61**
3	6.19	16.49	**22.68**
4	6.50	17.32	**23.82**
5	6.83	18.18	**25.01**
6	7.17	19.09	**26.26**
7	7.53	20.05	**27.58**
8	7.91	21.05	**28.96**
9	8.30	22.10	**30.40**
10	8.72	23.21	**31.93**
11	9.15	24.37	**33.52**
12	9.61	25.58	**35.19**
13	10.09	26.86	**36.95**
14	10.60	28.21	**38.81**
15	11.12	29.62	**40.74**
16	11.68	31.10	**42.78**
17	12.27	32.65	**44.92**
18	12.88	34.29	**47.17**
19	13.52	36.00	**49.52**
20	14.20		**14.20**
21	14.91		**14.91**
22	15.65		**15.65**
23	16.44		**16.44**
24	17.26		**17.26**
25	18.12		**18.12**
26	19.03		**19.03**
27	19.98		**19.98**
28	20.98		**20.98**
29	22.03		**22.03**
30	23.13		**23.13**
Total	**373.31**	**456.82**	**830.13**

6.2.8 Based on the existing mine closure planning norms, the above calculated cost at current WPI on mine closure may be tentatively grouped under following heads as per guidelines of CMPDI(HQ).

Table No. 6.2A Break up Cost of Mine Closure of Govindpur UG Colliery

Sl. No.	Activity	Mine Closure Cost (₹ in Lakhs)
A	**Dismantling of Structures**	
	Service Buildings	13.07
	Residential Buildings	39.50
	Industrial Structures like CHP, Workshop, field sub-station, cap lamp room, haulage, fan installation etc.	23.63
B	**Permanent Sealing of mine entries(incline mouth and air shaft)**	
	Sealing of incline mouths and air shafts	19.86
C	***Subsidence Management**	17.73
D	***LANDSCAPING**	
	Landscaping of the cleared land for improving its esthetic	32.85
E	***Plantation**	
	Plantation over the cleared area obtained after dismantling and on other barren spaces	48.53
F	**Monitoring/Testing of parameters for three years**	
	Air Quality	25.50
	Water Quality	23.67
G	***Enterpreneuship Development(Vocational/skill development training for sustainable income of affected people**	28.56
H	***Miscellaneous and other mitigative measures**	54.50
I	**Manpower Cost for Supervision**	45.92
	TOTAL	**373.31**

Note: * :To be covered under Progressive Mine Closure activities also.

Table No. 6.2B Break up Cost of Mine Closure of Govindpur OC Colliery

Sl. No.	Activity	Mine Closure Cost (₹ in Lakhs)
A	**Dismantling of Structures**	
	Service Buildings	0.91
	Residential Buildings	12.20
	Industrial Structures like CHP, Workshop, field sub-station, etc.	1.37
B	**Permanent Fencing of Mine Void and other dangerous area**	
	Random Ruble masonry of height 1.2 metre including levelling up in cement concrete 1:6:12 in mud mortar	6.85
C	**Grading of Highwall slopes**	
	Levelling and grading of highwall slopes	8.09
D	**OB Dump Reclamation**	
	*Handling/Dozing of external OB Dump into mine void	405.02
	*Bio-Reclamation including soil spreading, plantation and maintenance	1.83
E	**LANDSCAPING**	
	Landscaping of the cleared land for improving its esthetic	1.37
F	**Plantation**	
	Plantation over area obtained after dismantling	2.28
	*Plantation around fencing	0.91
	*Plantation over the cleared external OB Dump	0.09
G	**Monitoring/Testing of parameters for three years**	
	Air Quality	1.01
	Water Quality	0.91
H	***Enterpreneuship Development(Vocational/skill development training for sustainable income of affected people**	1.19
I	***Miscellaneous and other mitigative measures**	9.14
J	***Manpower Cost for Supervision**	3.65
	TOTAL	**456.82**

Note: * :To be covered under Progressive Mine Closure activities also.

6.2.9 Thus, total amount that shall be deposited for final mine closure activities (**Govindpur OC Colliery**) during the period of 19 years has been estimated as ₹ **456.82** lakhs and total amount that shall be deposited for mine closure activities (**Govindpur UG Colliery**) during the period of 30 years has been estimated as ₹ **373.31** lakhs.

6.2.10 *Mining is to be carried out in a phased manner initiating afforestation/reclamation work in the mined out area of the first phase while commencing the mining in the second phase i.e. continuation of mining activities from one phase to other indicating the sequence of operations depending on the geo-mining conditions of the mine. Up to 80% of the total deposited amount including interest accrued in the ESCROW account may be released after every five years in line with the periodic examination of the Closure Plan as per Clause 3.1 of the Annexure of the Guidelines. The amount released should be equal to expenditure incurred on the Progressive mine closure in past five years or 80% whichever is less. The balance amount shall be released to mine owner/leaseholder at the end of the final Mine Closure on compliance of all provisions of Closure Plan. This compliance report should be duly signed by the lessee and certify that said closure of mine complied all statutory rules, regulations, orders made by the Central or State Government, statutory organisations, court etc. and certified by the Coal Controller.*

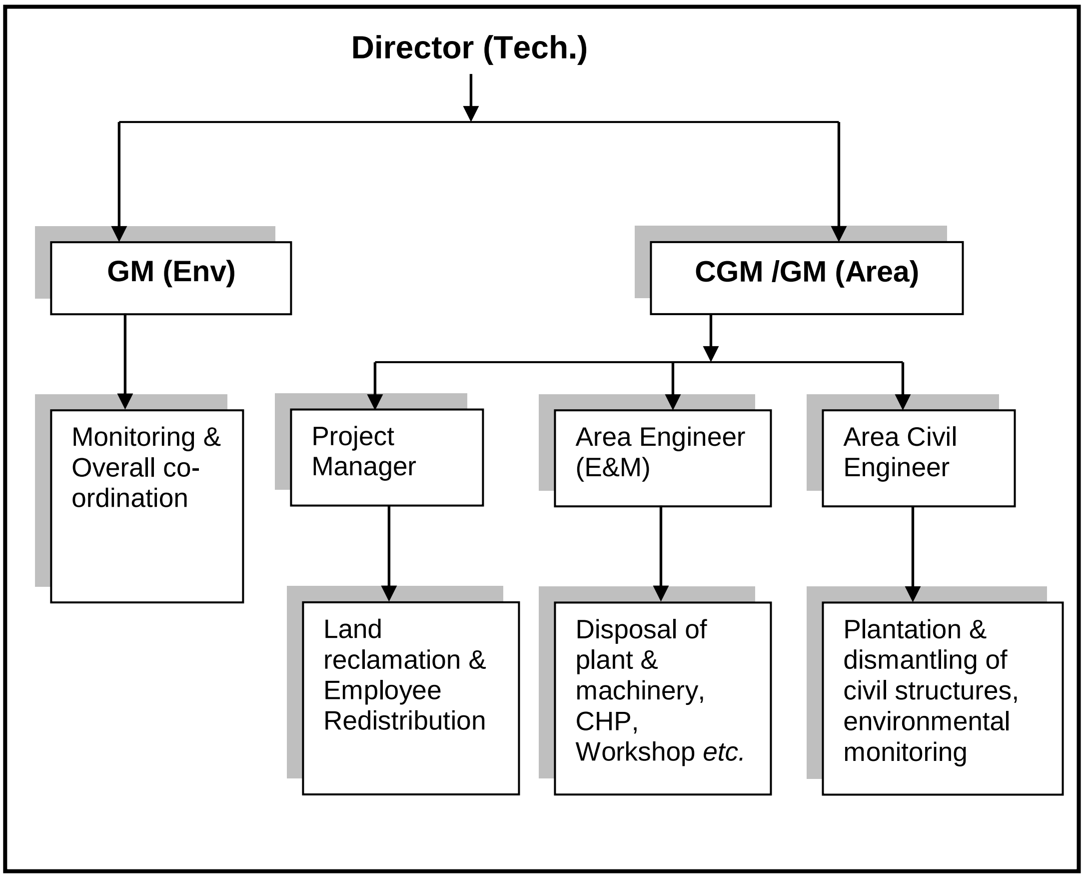
6.2.11 However, the additional amount beyond the escrow account, if any estimated later on, will be provided by the mine operator after estimating the final mine closure cost five years prior to mine closure (as per the mine closure guideline)**.**

CHAPTER-VII

IMPLEMENTATION PROTOCOL

7.1 As the mine closure activities would continue even after cessation of mining activities, an organization consisting of different discipline would be formed to undertake the implementation of mine closure activities as well as monitoring of the same**.** Such activity shall continue for a period of three years after the closure of mining activity in the mine. Once the closed mine becomes stabilized in respect of safety, environmental and social aspects, the monitoring team would be withdrawn.

7.2 For implementing the mine closure activities and monitoring thereof, the following organisational structure at corporate level has been proposed:



7.3 Environmental monitoring for three years after closure of mine will be carried out to evaluate the environmental quality of the area. If need be, proper

mitigation measures will be taken up after evaluating the environmental quality. Before closure of the mine, Area GM will prepare survey and disposal report and the same will be submitted to DGMS for acceptance.

7.4 When the mine closure activities would take final shape and the entire are under influence is brought to an acceptable shape, BCCL would obtain a mine closure certificate from Coal Controller to the effect that the protective, reclamation and rehabilitation works in accordance with the approved mine closure plan/final mine closure plan have been carried out for surrendering the reclaimed land to the State Government concerned.

CHAPTER – VIII

PLANS ENCLOSED

The following underground and surface plans have been enclosed along with this mine closure report plan:

a. Location Plan
b. Surface plan showing surface features, contours, roads, depot/siding, OB dumps, quarries (working/old/discontinued), subsidence, plantations, habitations, vacant land , surface water bodies, natural drainage and mine discharge water channels
c. Geological Plan

CHAPTER – I

INTRODUCTION

1.0 Introduction

Jogidih Colliery had come into existence since 1949. It is located in south-eastern part of the Jharia Coalfield. It is about 26Kms. West from Dhanbad it covers a leasehold area of 167 Ha and adjoining mines are as follows:-

Jogidih mine area has been distinctly divided into two sections by NW-SE flowing Khudia river. Both the sections have been affected by dykes which has guided the mine development pattern.

At present producing coal from I seam through Incline. Present production is about 170TPD, using Bord & Pillar method of underground mining with Low height SDLs (development).

This Mine Closure Plan has been prepared on the basis of Approved Feasibility report & TOR/Form – I and data furnished by the officials of Govindpur Area/ BCCL.

1.1 Name of mine owner / company

Project :	Jogidih Colliery
Area :	Govindpur Area
Company :	BCCL
Mine Owner :	Director (Technical)(Operation), BCCL (Nominated)

1.2 Address for Communication with PIN and Phone nos.

PO :	Tundu
District :	Dhanbad
State :	Jharkhand
PIN :	828128
Mob. Agent:	+91-9470596434

1.3 Location of mine:

Latitude:	23º17’30” N to 23º48’30” N
Longitude:	86º00’00” E to 86º15’15” E.

Area : Govindpur Area

Coalfield : Jharia Coalfield

1.4 Capacity of the mine

Date of start of development work: 1949

Date of start of production: 1949

The present mine capacity works out to 700 TPD.

1.5 Method of Mining including Equipment deployment

The gradient of seam is suitable for deployment of SDLs. The coal is won by solid blasting method and loaded by SDL machine onto tubs. The loaded tubs are handled by a tugger haulage which consecutively feeds to main direct haulage installed on the surface which discharges the coal at the loading point.

1.6 Coal Processing/ Beneficiation Operation

No coal processing/beneficiation is envisaged for the current output of the mine.

1.7 Total Lease Area Involved :- 167.0 Ha

1.8 Type of Lease Area (Ha) :-

Table 1.1 Type of Lease Area

Sl. No.	Particulars	Mining Area(Ha)	Outside mining area(Ha)	Total(Ha)
1	BCCL land (through LA Purchase & Agreement)	11.03	Nil	11.03
2	Vested Land	32.54	Nil	32.54
3	Railway Land	5.3	Nil	5.3
4	Govt. Land	11.27	Nil	11.27
5	Forest Land	Nil	Nil	Nil
6	Private Land	106.86	Nil	106.86
	Total (Mine fed data)	**167.00**	**Nil**	**167.00**

1.9 Communication and Physiography

The Jogidih colliery is situated about 3Kms western side of NH-32 and is about 26 KM from Dhanbad railway station. D.C. Railway (E.C.R) runs East to west of the Southern side boundary of the property.

Khudoo River flows from North-West to South-East direction through centre of the property.

1.10 Type of Present and proposed land use of mining area (Ha)

Table 1.2 Land Use of Mining Area

Sl.No.	Type of land use	Present mining land use (in Ha)	Proposed mining land use (in Ha)	Post-mining land use (in Ha)	Remarks
1	Running Quarry				The abandoned quarry will be physically and biologically reclamed. Plantation will be carried out on coal dump areas (after clearing of coal) and barren land available in the cluster.
	Backfilled				
	Not Backfilled				
2	Abandoned quarry				
	Backfilled	22.8	26.7	0	
	Not Backfilled	3.9	0	0	
3	External OB dump				
4	Service building/ Mine Infrastructure	0.72	0.72	0	
5	Coal dump	2.69	2.69	0	
6	Homestead Land	33.15	33.15	33.15	
7	Agricultural Land	50	50	50	
8	Forest Land	0	0	0	
9	Plantation / reclamation	0	10	50.11	
10	Water Body	4.83	4.83	4.83	
11	Barren Land	44.7	34.7	24.7	
12	Others (rail/road/ siding)	4.21	4.21	4.21	
	Total	**167**	**167**	**167**	

1.11 Statutory Approvals

Table 1.3 Statutory Approval Status

Sl. No	Particulars	Status
A	Mine plan / F.R / P.R	Formulated for the purpose of TOR only
B	Forestry clearance	NA
C	Env clearance	Obtained
D	Consent to operate	Existing Mine
E	Any other approval from Central / State regulatory authorities for operating mine with special reference to mine closure.	Mine closure plan to be approved by BCCL Board of Directors.

1.12 Reasons for Closure

At present, B&P (SDL), development is going on in I seam through Inclines which have balance extractable reserve of about 0.46MT (development only) upto the dyke(on north of Khudia river). As discussed in para 1.0, Jogidih mine area has been distinctly divided into two sections by NW-SE flowing Khudia river. In both the sections, the overlying developed seams are developed and SOP except 10 Seam. On the south of Khudia river, all the seams beneath 9 Bot are virgin. On the north of Khudia river, the developed seams are SOP. V/VI/VII Seam has been quarried out along the outcrop. The SOP workings are waterlogged at places. The surface area is heavily built-up. In view of the surface and sub-surface constraints, depillaring is possible only in III and I Seams beyond the outcrop of V/VI/VII Seam. As per the estimates, about 2.8 MTe of depillaring reserve is available in III & I seams in area free of constraints. With the total reserve of 3.26 MTe, the life of mine works out to 27 years based on production considered.

A PR for Block-III Opencast for a target capacity of 8.0 Mty was prepared by CMPDI, RI-II in November 2009. In the above PR , an area of 0.20 sq. km of Jogidih mine is proposed to be included. A PR for Block-IV Opencast(Recast) for a target capacity of 6.0 Mty was prepared by CMPDI, RI-II in November 2009. In the above PR, an area of 0.51 sq. km of Jogidih mine is proposed to be included. If the above PRs are implemented, all the outlets of Jogidih will be excavated and underground operations will be stopped. In such a situation, it is envisaged that a new Mine Closure Plan shall be prepared based on the relevant guidelines and submitted for approval.

The mine may be closed in future on account of exhaustion of economically recoverable coal reserves in the lease hold area. The mine may also be closed on account of other unforeseen reasons i.e. Force Majeure or directives from statutory organizations or court etc. for which information and notices shall be served to concerned Government authorities and departments. As per guidelines of Ministry of Coal, Govt. of India, Mine Closure Plan has to be submitted along with the mine plan for getting competent approval within one or two years of date of approval of mine plan.

1.12.1 Need of Mine Closure Planning

Mining is a hazardous operation as it offsets the equilibrium of natural depositional environment viz. In-situ stress field, ground water, surface drainage system as well as the socio-economic condition. Although mining activities are usually short term phenomena, they are liable to leave long lasting impacts on landscape, ecology and on the mind set of local inhabitants. Thus, it is imperative that any mining venture should have adequate closure plan addressing issues viz. reclamation and environmental protection, rehabilitation of disturbed area which should be acceptable to local community as well as regulatory authority. Community acceptable implementation of mine closure plan will incur some extra cost, neglecting this aspect will lead to future problems of attending compensation or expensive socio-economic problems.
Mine closure encompasses restoration process designed to restore physical, chemical and biological quality, disturbed by the mining activities. Mine closure is not just something that happens at the end of a mine’s life rather mine closure is an ongoing series of decisions and activities beginning in the pre-mining stage of mine and ending with a creation of self sustainable site that can be returned to the community.

Thus, a mine closure plan needs to define the liabilities, responsibilities and authorities of the different agencies like the mine management, other regulatory bodies, Central and State Governments after mine closure.

Various objectives of the advance mine closure planning are as given below.

a. To allow productive and sustainable after-use of the site, which is acceptable to the mine owner and the regulatory authority
b. To protect public health and safety
c. To eliminate environmental damage and thereby encourage environmental sustainability
d. To minimize adverse socio-economic impacts of mining activities
e. To protect the flora and fauna of the area affected by the mining
f. Effective use of the assets created during the course of mining

Primarily, the mine closure activities are planned in two stages. The initial plan identifies the activities required to be executed in line with the mining activities in progress after the inception of the project i.e., progressive mine closure activities. These activities may undergo subtle changes depending upon the actual site condition during implementation. Finally, a detailed closure plan is to be prepared 4-5 years before the actual closure time of the mine depending upon the existing parameters at that point of time, i.e., final mine closure activities.

1.12.2 Mine closure planning strategy in respect of Jogidih Colliery based on existing set of parameters

As the balance life of the mine is 27 years from now for the seams being considered for mining at present, following activities are envisaged towards mine closure programme in respect of Jogidih Colliery.

a. Progressive mine Closure: Progressive Mine Closure Plan would include various land use activities to be done continuously and sequentially during the entire period of the mining operations. Progressive closure activities will continue as envisaged in the Feasibility report and as enumerated in the various approvals, permits, consents etc.

   The recent guidelines issued in this regard by MoC, GoI should also be followed.

b. Final Mine Closure Plan: Although, it is very difficult to foresee the likely impacts due to closure of the mining activities in the leasehold area of the project, but in the present report, the same has been estimated and some mitigating measures have been suggested based on the estimates. These suggested measures along with certain other measures, as deemed fit, at the time of closure of mining activity in the seams being worked at present shall be taken up.

c. The final closure plan carrying the finer details would be prepared at the time of preparing the mine plan for last mineable patch of coal seam in the leasehold area of the project.

1.13 Approval of Company Board of Directors or any other competent authority (Attach Copy)

The closure plan will be placed to Board of Directors of BCCL for approval.

CHAPTER – II

MINE DESCRIPTION

2.1 Geology of the Block

Geology of the mine has been established by surface and sub surface data from Geological reports of (i) Opencast Block-IV (Seams VIIIC to I/II) & (ii) Opencast Block-III. Jogidih Colliery is located in the western part of Jharia Coalfield. The area is occupied by strata of Barakar formations containing Coking and Non-coking coal seams. The coal bearing rocks of Barakar formation of Lower Permian age occur in the Colliery area under a thin cover of soil and/alluvium (5 to 10m).

Altogether 13 boreholes have been drilled in Jogidih colliery area. All boreholes have been drilled by CMPDI in three different series i.e. GK, MR & BA with total meterage of 431.80m, 1113.50 & 618.65m respectively. The period of drilling of boreholes is from October'1976 to April'1980 in different phases. The details of boreholes are given below in the table:-

Table-2.1: Details of Boreholes

SERIES	DRILLING AGENCY	NO. OF BOREHOLES	METERAGE
GK	CMPDI	3	431.80
MR	CMPDI	7	1113.50
BA	CMPDI	3	618.65
TOTAL		13	2163.95

2.1.1 Geological Structure of the area

Strike & Dip

In general the strike of the formation is E-W and swerves to N-S in the south-central part. Dip varies from 2° to 12° due south.

Faults

One major fault is encountered in this area. However, faults having throw less than 5m could not be ruled out in the area.

Table-2.2: Details of the Fault

Sl. No.	Fault	Location	Strike	Max. Throw (m)	Nature	Evidence
1.	F1-F1	Western part of the area	NW-SE	15/NE	-	Encountered in the workings of VIIIB & V/VI/VII seam in the colliery.

Igneous Intrusion

The coal seams of the area have been intruded by three dolerite dykes:

1. **Maheshpur Dyke**- 40m thick dyke ocated in the western part of the area dipping 80° / SE.
2. **Tundu Dyke**- 30m thick dyke located in the S-W corner and joins the Maheshpur Dyke in the colliery.
3. **Jogidih Dyke**- 20m thick dyke, runs almost N-S and forms the eastern boundary.

2.1.2 General Description of coal seams and its quality:

In Jogidih colliery, detailed drilling has proved existence of number of coal seams from IX/X to I seam.

2.1.3 Seam sequence

The generalized sequence of coal seams and the intervening partings in Jogidih colliery area is given in Table No. 2.3.

Table-2.3: Generalized Seam Sequence and Parting/Quality

SEAM	THICKNESS (m)		AVERAGE THICKNESS (m)	DEPTH RANGE (m)	NO. OF FULL SEAM INTERSECTIONS	GRADE
	MINIMUM	MAXIMUM				
IX/X	7.53(BA-25)	-	7.53	0-30	1	W-IV
P	10	-	10	-	-	-
VIIIC	0.94(MR-23)	1.77(BA-23)	1.36	0-40	4	W-IV to UG D to E
P	18	21	19	-	-	-
VIIIB	1.53(MR-26)	3.57(BA-24)	2.55	0-65	7	W-IV to UG E to F
P	6	10	8	-	-	-
VIIIA	2.57(BA-23)	5.45(MR-17)	4.01	0-75	7	W-III to UG

SEAM	THICKNESS (m)		AVERAGE THICKNESS (m)	DEPTH RANGE (m)	NO. OF FULL SEAM INTERSECTIONS	GRADE
	MINIMUM	MAXIMUM				
						C to G
VIII	0.61(MR-27)	0.85(GK-12)	0.73	0-80	2	E
P(VIIIA with V/VI/VII)	33	38	36	-	-	-
P(VIII with V/VI/VII)	2	4	3	-	-	-
V/VI/VII	21.70(MR-26)	28.93(GK-11)	25.32	0-140	10	E to F
P	29	32	30	-	-	-
IV	0.13(GK-12)	0.70(MR-17&23)	0.42	75-170	4	G
P(V/VI/VII with IVT	26	31	28	-	-	-
IVT	0.60(MR-26)	1.05(MR-21)	0.82	0-135	6	E to G
P	1	5	3	-	-	-
IVB	0.15(MR-27)	0.73(BA-25)	0.44	0-140	4	G
P(V/VI/VII with III)	51	58	55	-	-	-
P(IV with III)	26	28	27	-	-	-
P(IVB with III)	18	27	22	-	-	-
III	4.42(GK-11)	6.45(BA-25)	5.44	35-190	13	E to G
P	12	17	15	-	-	-
II	0.32(GK-14)	1.50(GK-11)	0.91	55-210	13	A to E
P	5	8	7	-	-	-
I	1.45(GK-11)	2.91(MR-29)	2.18	65-215	13	D to G

2.1.4 Reserves, types and quality

The net geological reserve of all the seams of the colliery comes under proved category except for a small patch in SE corner.

Balance mineable reserves for considered seams have been given in the Table 2.4

Table-2.4 Seam Thickness, Grade & Reserve

Seam	Thickness (m)	Quality	Reserve (Mte)#	
			Development	Depillaring
III	5.0	G 7	-	2.8
I	3.52	W - IV	0.46	
Total			**3.26**	

 # Data as furnished by the mine officials

2.2 Mining Details

2.2.1 Mine boundary details

The boundary of Jogidih colliery is outlined by following collieries:

North:- Non Coal Bearing Area

West :- Muraidih Colliery

South :- Maheshpur Colliery

East:- Block-IV/ Kooridih Colliery

2.2.2 Working Seams

Table 2.5 Present Workings

Seam.	Grade	Production outlet	Method of work	Production (TPD)
I	WIV	Incline	B&P Dev.- SDL	170
Total				170

2.3 Mining Methods

Transport - Combination of Direct and Tugger haulages.

Ventilation - By Exhaust Fan at surface.

Stowing - Presently development is under progress. No stowing is being done.

The present ventilation system of the Mine is given in Table 2.6

Table 2.6 Present Ventilation System

Seams	Intake outlet	Return Outlet	Fan type & Quantity	Pressure
I Seam	2/1 Incline	Fan drift (Incline)	Exhaust type PV-160 Fan ,	55mm of WG

Present status

At present development by Bord & Pillar method is going on in I seam using SDLs.

STATUS OF EXPLOITATION

Seam	Present Status		Remarks
	South of Jore	North of Jore	
10(IX/X)	The seam has been worked on east of dyke near the mine boundary and exhausted by caving. Outcrop zone quarried.	NA	
10 A (VIII C)	The seam has been developed in the entire area on east of dyke, small area depillared and rest SOP. Workings are inaccessible.	NA	
9 Top	The seam has been developed in the entire area through inclines 4 &7 and rest SOP. Waterlogged upto 27L.		The seams designated as 8 Top and 8 Bot on the north of Khudia river
9 Bot	The seam has been developed in the entire area through 9 Top and SOP. Waterlogged upto 27L.		
8 Top (VIII B)	NA	The seam has been developed in two patches on either side of dyke and SOP.	
8 Top (VIII A)	NA	The seam has been developed in two patches on either side of dyke and SOP.	
V/VI/VII	Virgin	The seam has been developed in three sections, desisgnated as 2nd, 3rd and 4th sections on west of dyke and SOP and waterlogged. Outcrop zone quarried and inclines driven through quarry bed.	The workings of second section now fall within the leasehold of Muraidih colliery.
IVT/IV B	Virgin	Virgin	
3	Virgin	Fully developed through Inclines upto the dyke, SOP and waterlogged upto 17th level.	
2	Virgin	Virgin	Thin seam
I	Virgin	Being developed on B&P method through inclines. 3 Low height SDLs deployed producing 170 TPD.	

2.3.1 Depth of Workings

The working seams occur at depth of about 100m in the colliery.

2.3.2 Mine Entries

Table 2.7 Present Mine Entries

Name of Incline	Sunk up to seam	Depth/ (m)	Dia. / X-sec. (m)	Purpose (Production/ intake Return)
2/1 Incline	I seam	96.27	4.5	Production & intake purpose. (Winder – 75 KW)
Fan drift (Incline)	IX seam		3.5X2.4	Return & 2nd outlet PV-120 (Exhaust)

Development

Bord and Pillar method of development has been proposed in the seam with SDLs loading onto tubs. Exploitation of seam has been considered as long as the developmental reserve is available in the seam. The development district will consist of 5 level headings as far as possible leaving a panel barrier of one pillar width between the panels. The development shall be carried out by blasting off the solid . The width & height of the development galleries shall be restricted to 4.8/4.2 m & 3 m respectively. The depth of working as per the provision of Regulation 99 (4) of CMR 1957 shall govern the size of the pillar.

The panels shall be laid out in a manner, as far as possible, to be self draining. The incubation period of coal seam shall be taken into account for sub-panelling, wherever required.

Coal loading at the face will be done by mean of SDL and loaded into tubs. Then the loaded tubs will be hauled by tugger haulage for onwards feeding to main level district haulage which will feed the tubs to the surface haulage line and from where tubs hauled up to the surface.

The cycle of face operation in mechanized Bord and Pillar mining would be as follows:

a. Face preparation
b. Drilling
c. Charging, blasting and smoke clearing
d. Dressing and supporting
e. Machine fitting SDL
f. Coal loading by SDL
g. Face supporting,

2.3.3 Major Equipment

Table No. 2.8 List of Major Equipment

Sl. No.	Equipment	Nos.	Remarks
	SURFACE		
1	Haulage 100HP	1	
2	MMV-AF65(60HP)	1	
3	Lighting Transformer(500KVA,11KV/440)	1	
	UNDERGROUND		
1	Lower Height SDL	2	
2	Tugger Haulage 37 KW	2	
3	Coal Drill(1.5HP)	4	
4	Pumps(90HP)	2	
5	Roto Pump(12.5HP)	2	
6	5KVA L/Transforma	1	

2.4 Workshop & Store:

a) Auto workshop at Area Level-Light vehicle breakdown is attended here.

b) Regional Store at Area Level.

Magazine – Location , capacity and area

There is no magazine available in the Mine. The requirement of explosives and detonators are met from the magazine of Block-IV colliery (about 1 Km away from the Mine).

Infrastructure facilities available (Road, water supply etc.) –

Only colliery road is available within the lease hold area of the mine. Pit water to the colonies is supplied through V/VI/VII Quarry Pump, V/VI/VII Submersible Pump & 9 Seam U/G Pump.

Nos. of coal stock yard & location –

Heap No.8(Near IX Seam Incline)

Heap No.12(Near I Seam Incline)

Heap No. 13(Near V,VI,VII Seam OCP)

Existing effluent treatment plant & sewage treatment plant (Mine & Colony) – At present there is no ETP & STP available in the mine. Mine water discharged through Settling tank.

Existing effluent treatment plant & sewage treatment plant (Mine & Colony) – At present there is no ETP & STP available in the mine. Sewage water discharged through septic tank and soak pit.

Present power supply :

Source-DVC, installed capacity- From Bilbara sub station 11 KV to I Seam Sub Station through 14No. Feeder.

Details of Transformer

1) 1MVA,11KV/550V - 1 No.
2) 500 KVA ,11KV/ 440 V –1 No.(Lighting,)
3) 5KVA ,11KV/ 440 V 1 No.(Lighting,)

2.5. Details of coal beneficiation plant and its use after closure of mine

No beneficiation plant is present in the leasehold area of the boundary.

CHAPTER – III

CLOSURE PLAN AND RELATED ACTIVITIES

3.1 Closure Planning details of mine

The progressive mine closure activities will continue as envisaged in the Feasibility Report prepared for the purpose of TOR and as enumerated in the various approvals, permits, consents etc. The recent Govt. guidelines in this regard would also work as guiding principles. It is very difficult to predict the various parameters which would be prevalent at the time of final mine closure and also to foresee the likely impacts due to closure of the mining activities (when the entire block reserve would get exhausted). However, broad mine closure activities need to be identified under the various heads.

Jogidih Colliery falls in Cluster III for the purpose of EMP.

3.1.1 Mined out Land & proposed final land use

Management of mined out area

a) At present, B&P (SDL), development is going on in I seam through Inclines, which have balance development reserve of about 0.46 MTe. Further, the SOP reserves in III & I seam (2.8 MTe) in the free area is proposed to be mined in future. Thus, keeping in view the available reserves in the seams to be the remaining life of the mine will be 27 years (Development@200 TPD and Depillaring@500 TPD).

   The proposed conceptual post-mining land use plan vis-à-vis present land use is provided in Para 1.10.

b) Mining is to be carried out in a phased manner initiating afforestation work in the mined out area of the first phase while commencing the mining in the second phase i.e. continuation of mining activities from one phase to other indicating the sequence operations depending upon the geo-mining conditions of the mine. Progressive mine closure plan shall be prepared for period of five years from the beginning of the mining operations. These plans would be examined periodically in every five years period and to be subjected to third party monitoring by the agencies approved by the Central Government for the purpose (NEERI, CMPDIL , ISM etc. as per current guidelines).

c) As regards, the underground void, if any, which will remain at the time of closure of the mine, the same will get gradually filled with water. The necessary precautions for the safety of the neighboring mine would be taken care of before deciding the voids to get water filled. Further, the water filled in UG voids will help in maintaining the water level in the nearby Area. The Pit/Shaft will be covered with RCC structure with suitable opening for inspection by competent person.

d) The existing quarries in the leasehold which have not been backfilled shall be backfilled up to the required depth and will act as water reservoir, facilitating the recharge of the ground water table in the vicinity. All the available places amenable for plantation shall be planted with appropriate species in consultation with forest department.

3.2 Water quality management

3.2.1 Drainage pattern of the area (pre and post closure)

3.2.1.1 Existing drainage pattern

The area has a general undulating topography with gentle slope towards southerly flowing Chatkari Jore. The maximum elevation in the area is around 183 m just NW of borehole No. MJ-10 drilled in the North-Western part and the minimum is around 159 m, above the MSL in the south-eastern part of the project area.

In course of mining, if any disturbance affecting the drainage pattern is caused, efforts shall be made to restore the normal drainage pattern as far as possible. If the restoration of original drainage profile is not feasible, efforts shall be made to achieve a drainage profile, which will ensure smooth drainage of the area with least possible surface erosion.

3.2.1.2 Post closure drainage pattern

At present only development is envisaged for the mine due to sub-surface constraints. The call on the depillaring can be taken up only these constraints are dealt with. Thus the general drainage pattern of the area is not likely to get disturbed. Depression, if any due to old workings, will be suitably filled with non -combustible rocks and cohesive soils, dozed and graded. If some minor alteration takes place, the natural drainage profile of the entire leasehold area would be kept maintained in a manner which will facilitate the normal run-off. Garland drain may be constructed to ensure the controlled drainage of the area.

3.2.2 Water Quality Status of Surface and Ground Water

3.2.2.1 Present Practice

Samples of mine water as well as drinking water are collected and were analysed for relevant physical, chemical and bacteriological parameters as per the norms stipulated by MOEF.

Water samples are collected as per standard procedure {IS: 3025 (part I) – 1987} and analyzed as per procedures outlined in relevant volume of BIS 3025 / NEERI / standard Methods (AAPHA).

If any deviation from the prescribed water quality standard is detected, the appropriate remedial actions shall immediately be enforced and frequency of sampling shall be increased till the water quality becomes normal. The source of contamination shall be identified and removed. The contaminated water bodies shall be suitably treated.

3.2.2.2 Present status of water quality

The monitoring of water quality under Baseline Environment Data Generation for Cluster III has been conducted M/S PDIL, Sindri by collecting water samples from ground water, surface water and mine water discharge / workshop discharge (if any) for the proposed project. The various purposes of the water environment monitoring are as follows:

- To assess the water quality characteristics for critical parameters;

- To evaluate the impacts on agricultural productivity, habitat conditions, creational resources and aesthetics in the vicinity ; and
- To facilitate predication of impact on water quality by project activities

The results as per PDIL Report are given subsequently.
Details of sampling location are given in Table 3.1 to 3.3 for Ground water, Surface water and effluent water.

To assess the quality of drinking water around the project area, the samples were collected from the following locations in and around the project area:

TABLE - 3.1
Sampling Location for Ground Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No.	Name of Sampling Locations	Frequency	Location Code
01.	Hand Pump – Katras Township	Once in a season	GW_1
02.	Hand Pump - Muraidih Village	Once in a season	GW_2
03.	Hand Pump - Sogiadih Village	Once in a season	GW_3

To assess the quality of lotic system (surface water), water samples were collected from the locations (Refer to PDIL Report) given in Table No. 3.2.

TABLE – 3.2
Sampling Location for Surface Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No	Name of Sampling Locations	Frequency	Location Code
01.	Khudia Nala U/S	Once in a season	SW_1
02.	Khudia Nala D/S	Once in a season	SW_2
03.	Pond Water – Near Harna Village	Once in a season	SW_3
04.	Bagdigi Jore U/S	Once in a season	SW_4
05.	Bagdigi Jore D/S	Once in a season	SW_5

To assess the quality of waste water discharge, water samples were collected from the locations given in Table 3.3.

TABLE – 3.3

Sampling Location for Industrial Effluent/Mine Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No.	Name of Sampling Locations	Frequency	Location Code
01.	Mine Water Discharge- Jogidih UGP	Once in a season	MW_1
02.	Mine Water Discharge- Jogidih UGP	Once in a season	MW_2
03.	Workshop Discharge – Block IV/ Kooridih OCP (After Oil & Grease Trap)	Once in a season	WW_1
04.	Workshop Discharge – New Akashkinari OCP (After Oil & Grease Trap)	Once in a season	WW_2

The physico-chemical characteristics of three nos. of ground water samples collected from three different locations have been presented in Table 3.4.

TABLE – 3.4

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results			Detection Limit	IS:10500 Desirable/ Permissible Limits
		GW_1	GW_2	GW_3		
PHYSICAL						
1	pH	8.2	7.6	7.8	-	6.5-8.5
2	Temperature (^{O}C)	29.8	30.1	30.2	-	-
3	Colour, HU	<2	<2	<2	-	5/25
4	Odour	Unobj.	Unobj.	Unobj.	-	Unobj.
5	Taste	Agreeable	Agreeable	Agreeable	-	Agreeable
6	Turbidity (NTU)	<5	<5	<5	-	5/10
7	Total Suspended Solid	4	6	6	-	-
8	Total Dissolved Solids	500	552	330	-	500/2000
CHEMICAL						
1	P- Alkalinity as $CaCO_3$	NIL	NIL	NIL	-	-
2	Total Alkalinity as $CaCO_3$	212	184	66	-	200/600
3	Chloride as Cl	44	64	26	-	250/1000
4	Sulphate as SO_4	146	168	134	-	200/400
5	Nitrate as NO_3	1.5	1.4	1.2	-	45/100
7	Fluoride as F	0.6	0.5	0.5	-	1.0/1.5
8	Total Hardness as $CaCO_3$	384	386	164	-	300/600
9	Calcium Hardness as $CaCO_3$	200	262	112	-	75/200*
10	Magnesium Hardness as $CaCO_3$	184	124	52	-	30**
11	Sodium as Na	18	27	34	-	-
12	Potassium as K	2	3	4	-	-
13	Silica as SiO_2	16	22	22	-	-
HEAVY METALS						

Sl. No.	Parameters	Analysis Results			Detection Limit	IS:10500 Desirable/ Permissible Limits
		GW_1	GW_2	GW_3		
1	Iron as Fe	0.08	0.8	0.3	0.04	0.3/1.0
2	Manganese as Mn	<0.05	<0.05	<0.05	0.05	0.1/0.3
3	Total Chromium as Cr	NT	NT	NT	0.01	0.05
4	Lead as Pb	NT	NT	NT	0.05	0.05
5	Zinc as Zn	0.14	0.16	0.14	-	5.0/15
6	Cadmium as Cd	NT	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	NT	0.02	0.05/1.5
8	Nickel as Ni	NT	NT	NT	-	0.01
9	Arsenic as As	NT	NT	NT	0.01	0.05
10	Selenium as Se	NT	NT	NT	0.01	0.01
OTHERS						
1	Mineral Oil	NT	NT	NT	-	0.01/0.03
2	Phenolic Compound as C_6H_5OH	NT	NT	NT	0.001	0.001/0.002
3	Coliform Organisms (MPN/100ml)	< 20	< 20	< 20	-	Absent

Note: 1) BDL – Below Detectable Level. 2) NT- Not Traceable
3) *-Calcium as Ca 4) **-Magnesium as Mg

Results & Discussion

The physico-chemical characteristics of the ground water samples showed great resemblance with respect to the characteristics like temperature, turbidity, pH, colour, odour, chloride, sulphate, total alkalinity, total hardness, TDS and heavy metals, etc. The range of concentrations of drinking water parameters were observed as given in Table No. 3.5.

TABLE – 3.5
Ground Water Quality at a Glance in Comparison to Drinking Water Standard

Parameters	Range of recorded Concentration (Results expressed in mg/l except pH)		
	Minimum	Maximum	Desirable/Permissible Limits as per IS: 10500
pH	7.6	8.2	6.5-8.5
Total Suspended Solid	4	6	-
Total Dissolved Solids	330	552	500 / 2000
Total Alkalinity as $CaCO_3$	66	212	200 / 600
Total Hardness, as $CaCO_3$	164	386	300 / 600
Chloride as Cl	26	64	250 / 1000
Sulphate as SO_4	134	168	200 / 400
Nitrate as NO_3	1.2	1.5	45/ 100
Iron as Fe	0.08	0.8	0.3 / 1.0

From the results presented in Table- 3.5, the Physico-chemical characteristics of the ground water samples were in good agreement with IS: 10500. All the parameters are within the limits specified under Drinking Water Standard (IS: 10500). As regards heavy metals, only Fe and Zn have been recorded with lower concentration & rest were not traceable. The ground water can be safely used for potable purposes.

The physico-chemical characteristics of five nos. of surface water samples collected from five different locations have been presented in Table nos. 3.6(A) and 3.6(B) respectively.

TABLE – 3.6 (A)

PHYSICO-CHEMICAL CHARACTERISTICS OF SURFACE WATER QUALITY

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19^{th} March-18^{th} June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	PARAMETERS	ANALYSIS RESULTS			DETECTION LIMIT	Limit as per IS: 2296 Class 'C'
		SW1	SW2	SW3		
PHYSICAL						
1	pH	7.9	7.5	7.8	-	6.5-8.5
2	Temperature (^{O}C)	29.2	29.3	30.1	-	*
3	Colour, HU	<2	<2	<2	-	300
4	Odour	Unobj.	Unobj.	Unobj.	-	*
5	Turbidity (NTU)	8	10	14	-	*
6	Total Suspended Solids	6	8	12	-	
7	Total Dissolved Solids	293	297	470	-	1500
CHEMICAL						
1	P- Alkalinity as $CaCO_3$	NIL	NIL	NIL	-	*
2	Total Alkalinity as $CaCO_3$	78	64	142	-	*
3	Chloride as Cl	36	38	90	-	600
4	Sulphate as SO_4	96	104	120	-	400
5	Nitrate as NO_3	2.6	2.6	4.6	-	50
6	Fluoride as F	<0.4	<0.4	<0.4	-	1.5
7	Total Hardness as $CaCO_3$	210	214	394	-	*
8	Calcium Hardness as $CaCO_3$	136	142	226	-	*
9	Magnesium Hardness as $CaCO_3$	74	72	168	-	*
10	Dissolve Oxygen	6.6	6.4	5.8	-	4.0
11	COD	06	06	04	-	*
12	BOD (3 days at $27^{o}C$)	2.4	2.4	2.2	-	3.0
13	Total Kjeldahl Nitrogen as N	0.52	0.54	0.62	-	*
14	Sodium as Na	9	6	2	-	*
15	Potassium as K	1	1	1	-	*
16	Silica as SiO_2	12	14	12	-	*
HEAVY METALS						
1	Iron as Fe	0.08	0.09	0.06	0.04	5.0
2	Manganese as Mn	<0.05	<0.05	<0.05	0.05	*

Sl. No.	PARAMETERS	ANALYSIS RESULTS			DETECTION LIMIT	Limit as per IS: 2296 Class 'C'
		SW1	SW2	SW3		
3	Total Chromium as Cr	NT	NT	NT	0.006	0.05
4	Lead as Pb	NT	NT	NT	0.04	0.1
5	Zinc as Zn	0.12	0.14	0.14	-	15.0
6	Cadmium as Cd	NT	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	NT	0.02	1.5
8	Nickel as Ni	NT	NT	NT	-	*
9	Arsenic as As	NT	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	NT	0.01	0.05
11.	Cyanide as CN	NT	NT	NT	0.02	0.05
12.	Mercury as Hg	NT	NT	NT	0.001	
OTHERS						
1	Oil & Grease	BDL	BDL	BDL	0.1	0.1
2	Phenolic Compound as C_6H_5OH	NT	NT	NT	0.001	0.005
3	Coliform Organisms (MPN/100ml)	1.9 x 10^3	2.0 x 10^3	2.3 x 10^3	-	5000

Note: 1) BDL – Below Detectable Level; 2) * - Limit Not specified; 3) NT- Not Traceable

TABLE – 3.6 (B)

PHYSICO-CHEMICAL CHARACTERISTICS OF SURFACE WATER QUALITY

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	PARAMETERS	ANALYSIS RESULTS		DETECTION LIMIT	Limit as per IS: 2296 Class 'C'
		SW4	SW5		
PHYSICAL					
1	pH	7.2	7.3	-	6.5-8.5
2	Temperature (^{O}C)	29.2	29.4	-	*
3	Colour, HU	<2	<2	-	300
4	Odour	Unobj.	Unobj.	-	*
5	Turbidity (NTU)	6	8	-	*
6	Total Suspended Solids	14	16	-	
7	Total Dissolved Solids	486	510	-	1500
CHEMICAL					
1	P- Alkalinity as $CaCO_3$	NIL	NIL	-	*
2	Total Alkalinity as $CaCO_3$	160	164	-	*
3	Chloride as Cl	68	72	-	600
4	Sulphate as SO_4	140	146	-	400
5	Nitrate as NO_3	4.6	4.8	-	50
6	Fluoride as F	<0.4	<0.4	-	1.5
7	Total Hardness as $CaCO_3$	386	390	-	*
8	Calcium Hardness as $CaCO_3$	240	244	-	*
9	Magnesium Hardness as $CaCO_3$	146	146	-	*
10	Dissolve Oxygen	6.0	5.8	-	4.0
11	COD	3.8	04	-	*
12	BOD (3 days at 27^{o}C)	<2.0	<2.0	-	3.0
13	Total Kjeldahl Nitrogen as N	BDL	BDL	-	*
14	Sodium as Na	8	13	-	*
15	Potassium as K	1	2	-	*
16	Silica as SiO_2	10	12	-	*

Sl. No.	PARAMETERS	ANALYSIS RESULTS		DETECTION LIMIT	Limit as per IS: 2296 Class 'C'
		SW4	SW5		
HEAVY METALS					
1	Iron as Fe	0.16	0.16	0.04	5.0
2	Manganese as Mn	<0.05	<0.05	0.05	*
3	Total Chromium as Cr	NT	NT	0.006	0.05
4	Lead as Pb	NT	NT	0.04	0.1
5	Zinc as Zn	0.12	0.14	-	15.0
6	Cadmium as Cd	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	0.02	1.5
8	Nickel as Ni	NT	NT	-	*
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11.	Cyanide as CN	NT	NT	0.02	0.05
12.	Mercury as Hg	NT	NT	0.001	
OTHERS					
1	Oil & Grease	BDL	BDL	0.1	0.1
2	Phenolic Compound as C_6H_5OH	NT	NT	0.001	0.005
3	Coliform Organisms (MPN/100ml)	2.0×10^3	2.0×10^3	-	5000

Note: 1) BDL – Below Detectable Level; 2) * - Limit Not specified; 3) NT- Not Traceable

Results & Discussion

The physico-chemical characteristics of the surface water samples collected from the five locations have shown great resemblance with respect to the characteristics like temperature, turbidity, pH, colour, odour, chloride, sulphate, total alkalinity, total hardness, TDS and heavy metals, etc. The range of concentrations of important parameters of surface water characteristics have been presented in Table No. 3.7.

TABLE –3.7
Surface Water at a Glance

Parameters	Range of recorded Concentration (Results expressed in mg/l except pH)		
	Minimum	Maximum	Limit as per IS: 2296 Class 'C'
pH	7.4	8.2	6.5-8.5
Total Suspended Solids	8	14	-
Total Dissolved Solids	494	610	1500
Total Hardness, as $CaCO_3$	380	452	-
Calcium Hardness, as $CaCO_3$	278	320	-
Chloride as Cl	70	82	600
Sulphate as SO_4	160	226	400
Nitrate as NO_3	3.28	4.30	50
Iron as Fe	0.08	0.16	5.0

From the results presented in Table- 3.6(A) and Table- 3.6(B), it may safely be concluded that the physico-chemical characteristics of the surface water samples had a good resemblance with respect to almost all the parameters and were well within limits specified in Surface Water Standard IS: 2296. As regards heavy metals, except Iron and Zinc, all the other were not traceable. From the above, it may be concluded that all the parameters of the surface water samples were well within the specified limits of IS: 2296 Class 'C'.

The _physico-chemical characteristics of mine water & workshop effluent discharge samples collected from different locations have been presented hereunder in Table-3.8(A) & Table-3.8(B) respectively.

TABLE – 3.8 (A)

PHYSICO-CHEMICAL CHARACTERISTICS OF WASTE WATER DISCHARGE

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

SI. No.	PARAMETERS	ANALYSIS RESULTS			MOEF STANDARD SCHEDULE-VI
		MW1	MW2	DETECTION LIMIT	
PHYSICAL					
1	pH	6.5	6.9	-	5.5-9.0
2	Temperature (^{O}C)	29.6	30.4	-	Te<Ts+5ºC
3	Colour,HU	<2.0	<2.0	-	*
4	Odour	Unobj.	Unobj.	-	Unobjectionable
5	Turbidity (NTU)	8	10	-	*
6	Total Suspended Solids	4	6	-	100
7	Total Dissolved Solids	870	814	-	*
CHEMICAL					
1	Total Alkalinity as $CaCO_3$	146	170	-	*
2	Chloride as Cl	60	74	-	*
3	Sulphate as SO_4	448	360	-	*
4	Nitrate as N	1.2	1.3	-	10
5	Dissolve Phosphate as PO_4	BDL	BDL	-	5.0
6	Fluoride as F	<0.4	<0.4	-	2.0
7	Total Hardness as $CaCO_3$	660	614	-	*
8	Calcium Hardness as $CaCO_3$	320	364	-	*
9	COD	6.2	6.4	-	250
10	BOD (3 days at 27^{O}C)	2.4	2.2	-	30
11	Total Kjeldahl Nitrogen as N	BDL	BDL	0.01	100
12	Sodium as Na	16	15	-	*
13	Potassium as K	3	2	-	*
14	Sulphide as S	BDL	BDL	0.01	2.0
15	Ammonical Nitrogen as N	0.46	0.32	0.02	50

HEAVY METALS					
1	Iron as Fe	0.1	0.1	0.04	3.0
2	Manganese as Mn	<0.05	<0.05	0.05	2.0
3	Lead as Pb	NT	NT	0.4	0.1
4	Zinc as Zn	0.24	0.26	-	5.0
5	Copper as Cu	NT	NT	0.5	3.0
6	Nickel as Ni	NT	NT	0.1	3.0
7	Mercury as Hg	NT	NT	0.01	0.01
8	Cyanide as CN	NT	NT	0.01	0.2
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11	Vanadium as V	NT	NT	0.01	0.2
12	Cadmium as Cd	NT	NT	0.002	2.0
13	Hexavalent Chromium as Cr^{+6}	NT	NT	0.1	0.1
14	Total Chromium as Cr	NT	NT	0.006	2.0
OTHERS					
1	Oil & Grease	<2.0	<2.0	-	10
2	Phenolic Compound C_6H_5OH	NT	NT	0.001	1.0

Note: 1) BDL – Below Detectable Level; **2)** NT – Not Traceable

TABLE – 3.8 (B)
PHYSICO-CHEMICAL CHARACTERISTICS OF WASTE WATER DISCHARGE

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

SI. No.	Parameters	Analysis Results			MOEF Standard Schedule-VI
		WW1	WW2	Detection Limit	
PHYSICAL					
1	pH	7.4	7.5	-	5.5-9.0
2	Temperature (^{O}C)	30.1	31.2	-	Te<Ts+5ºC
3	Colour,HU	<2.0	<2.0	-	*
4	Odour	Unobj.	Unobj.	-	Unobjectionable
5	Turbidity (NTU)	16	18	-	*
6	Total Suspended Solids	10	12	-	100
7	Total Dissolved Solids	782	840	-	*
CHEMICAL					
1	Total Alkalinity as $CaCO_3$	160	154	-	*
2	Chloride as Cl	30	36	-	*
3	Sulphate as SO_4	118	124	-	*
4	Nitrate as N	2.2	3.2	-	10
5	Dissolve Phosphate as PO_4	BDL	BDL	-	5.0
6	Fluoride as F	<0.4	<0.4	-	2.0
7	Total Hardness as $CaCO_3$	714	720	-	*
8	Calcium Hardness as $CaCO_3$	428	432	-	*
9	COD	7.6	6.4	-	250
10	BOD (3 days at 27^{O}C)	2.5	2.2	-	30
11	Total Kjeldahl Nitrogen as N	0.68	0.62	0.01	100
12	Sodium as Na	14	17	-	*
13	Potassium as K	2	3	-	*

14	Sulphide as S	BDL	BDL	0.01	2.0
15	Ammonical Nitrogen as N	1.24	1.26	0.02	50
HEAVY METALS					
1	Iron as Fe	0.08	0.09	0.04	3.0
2	Manganese as Mn	<0.05	<0.05	0.05	2.0
3	Lead as Pb	NT	NT	0.4	0.1
4	Zinc as Zn	0.14	0.16	-	5.0
5	Copper as Cu	NT	NT	0.5	3.0
6	Nickel as Ni	NT	NT	0.1	3.0
7	Mercury as Hg	NT	NT	0.01	0.01
8	Cyanide as CN	NT	NT	0.01	0.2
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11	Vanadium as V	NT	NT	0.01	0.2
12	Cadmium as Cd	NT	NT	0.002	2.0
13	Hexavalent Chromium as Cr^{+6}	NT	NT	0.1	0.1
14	Total Chromium as Cr	NT	NT	0.006	2.0
OTHERS					
1	Oil & Grease	<2.0	<2.0	-	10
2	Phenolic Compound C_6H_5OH	NT	NT	0.001	1.0

Note: 1) BDL – Below Detectable Level; **2)** NT – Not Traceable

Results & Discussion

The range of concentrations of important parameters of waste water characteristics are given in Table No. 3.9.

TABLE – 3.9
Waste Water Discharge at a Glance

Parameters	**Range of recorded Concentration (Results expressed in mg/l except pH)**		
	Minimum	**Maximum**	**Limits As per MoEF Notification (Sch.-VI)**
pH	6.5	7.5	5.5-9.0
Total Suspended Solids	4	12	100
Total Dissolved Solids	782	870	-
Total Hardness as $CaCO_3$	614	720	-
Chemical Oxygen Demand	6.2	7.6	250
Chloride as Cl	30	74	-
Sulphate as SO_4	118	448	-
Nitrate as N	1.2	3.2	10
Iron as Fe	0.08	0.1	3

From the results shown above, it may be safely concluded that the Physico-chemical characteristics of the discharge water samples collected from the four locations for one season had variations with respect to almost all the parameters but were well within the limits of **General Standards for Discharge of Effluents (Table 3.10).** As regards heavy metals, like Iron was also within limits

TABLE –3.10

GENERAL STANDARDS FOR DISCHARGE OF EFFLUENTS

[The Gazette of India – Extraordinary {Part II- Sec. 3(i)} Ministry of Environment and Forests Notification New Delhi, 19th May, 1993]

Sl. No.	Parameters	Standards			
		Inland Surface Water	Public Sewers	Land for irrigation	Marine coastal areas
		(a)	(b)	(c)	(d)
1	Colour and odour	Note-1	Note-1	Note-1	Note-1
2	Suspended Solids, mg/l max.	100	600	200	Note-2
3	Particle size of Suspended Solids.	Note-3	-	-	Note-4
4	Dissolved solids (inorganic) mg/l max.	2100	-	2100	-
5	pH value	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
6	Temperature, ^{O}C	Note-5	-	-	Note-5
7	Oil & grease, mg/l max.	10	20	10	20
8	Total residual chlorine, mg/l max.	1.0	-	-	1.0
9	Ammonical Nitrogen (as N), mg/l. max.	50	50	-	50
10	Total Kjeldahl nitrogen (as NH_3), mg/l max.	100	-	-	100
11	Free ammonia (as N), mg/l max.	5	-	-	5
12	Biochemical Oxygen Demand (3 days at 27^{o}C), max.	30	350	100	100
13	Chemical Oxygen Demand, mg/l max.	250	-	-	250
14	Arsenic (as As), mg/l max.	0.2	0.2	0.2	0.2
15	Mercury (as Hg), mg/l max.	0.01	0.01	-	0.01
16	Lead (as Pb), mg/l max.	0.1	1.0	-	2.0
17	Cadmium (as Cd), mg/l max.	2.0	1.0	-	2.0
18	Hexavalent Chromium (as Cr^{+6}), mg/l. max.	0.1	2.0	-	1.0
19	Total Chromium (as Cr), mg/l max.	2.0	2.0	-	2.0
20	Copper (as Cu), mg/l max.	3.0	3.0	-	3.0
21	Zinc (as Zn), mg/l max.	5.0	15	-	15
22	Selenium (as Se), mg/l max.	0.05	0.05	-	0.05
23	Nickel (as Ni), mg/l max.	3.0	3.0	-	5.0
24	Boron (as B), mg/l max.	2.0	2.0	2.0	2.0
25	Percent Sodium, max.	-	-	60	-
26	Residual sodium carbonate, mg/l max.	-	-	5.0	-
27	Cyanide (as CN) mg/l max.	0.2	2.0	0.2	0.2
28	Chloride (as Cl) mg/l max.	1000	1000	600	-

Sl. No.	Parameters		Standards			
			Inland Surface Water	Public Sewers	Land for irrigation	Marine coastal areas
			(a)	(b)	(c)	(d)
29	Fluoride (as F) mg/l max.		2.0	15	-	15
30	Dissolved Phosphate (as P), mg/l max.		5.0	-	-	-
31	Sulphate (SO_4) mg/l max.		1000	1000	1000	-
32	Sulphide (as S), mg/l max.		2.0	-	-	5.0
33	Phenolic Compound (C_6H_5OH), mg/l max.		1.0	5.0	-	5.0
34	Radioactive materials: (a) Alpha emitters, µc/ml max. (b) Beta emitters, µc/ml max.		 10^{-7} 10^{-6}	 10^{-7} 10^{-7}	 10^{-7} 10^{-6}	 10^{-7} 10^{-7}
35	Bio-assay test		Note-6	Note-6	Note-6	Note-6
36	Manganese (as Mn) mg/l max.		2.0	2.0	-	2.0
37	Iron (as Fe) mg/l max.		2	3	-	3
38	Vanadium (as V), mg/l max.		0.2	0.2	-	0.2
39	Nitrate Nitrogen, mg/l max.		10	-	-	20
40	Pesticides, µg/l max.					
	(i)	Benzene Hexachloride				
	(ii)	Carbaryl	10	-	10	10
	(iii)	DDT	10	-	10	10
	(iv)	Endosulfan	10	-	450	450
	(v)	Dimethoate	10	-	10	10
	(vi)	Fenitrothion	10	-	10	10
	(vii)	Malathion	10	-	10	10
	(viii)	Phorate	10	-	10	10
	(ix)	Methyl Parathion	10	-	10	10
	(x)	Phenthoate	10	-	10	10
	(xi)	Pyrethrums	10	-	10	10
	(xii)	Copper oxychloride	9600	-	9600	9600
	(xiii)	Copper sulphate	50	-	50	50
	(xiv)	Ziram	1000	-	1000	1000
	(xv)	Sulphur	30	-	30	30
	(III)	Paraquat	2300	-	2300	2300
	(IIIi)	Propanil	7300	-	7300	7300
	(IIIii)	Nitrofen	780	-	780	780

Note-1: All efforts should be made to remove colour and unpleasant odour as far as practicable.

Note-2: (a) For process water – 100,

(b) For cooling water effluent, 10% above total suspended matter in influent.

Note-3: Shall pass 850 micron IS sieve.

Note-4: (a) Floatable solids-max. 3 mm.

(b) Settleable solids-max. 850microns.

Note-5: Shall not exceed 5^{0}C above the receiving water temperature.

Note-6: 90% survivals of fish after 96 hours in 100% effluent.

3.2.2.3 Practice after the closure

The above practice of monitoring of quality of water would be continued for a period of 3 years after cessation of mining activity. If required, corrective action/steps would be taken to mitigate any adverse effect on local water regime. The responsibility of maintaining the quality of drinking water will be entrusted on the State Authorities after 3 years of mine closure.

3.2.3 MEASURES FOR CONTROL OF POLLUTION (DETAILS FOR POLLUTION CONTROL ARRANGEMENT)

3.2.3.1 IMPACT DUE TO WATER POLLUTION AND ITS MANAGEMENT

The mine discharge water may contain high-suspended solids and other pollutants. The treatment scheme thus needs to focus on the removal of suspended solids from the water. Pit water must be treated to meet the prescribed standards before being discharged into water bodies. When the water is used for agricultural or domestic work, it shall undergo further treatment, as established by Scientific Studies conducted in this regard. The important factors to be considered in selecting the appropriate method for treatment are as follows:

(a) Settling tank will be provided to collect the mine discharged water for settling the suspended solids.

(b) The flow and the quality of pit water vary seasonally. Therefore settling tank should be able to absorb these fluctuations.

(c) The mine water must be neutral in nature and therefore necessary neutraliser may be provided to maintain the pH of the settling pond water.

(d) In order to reduce the dependence on fresh water sources for meeting the demands of water in the mining related operations, the entire mining effluents water will be utilised. The entire effluent free mine water will be utilised in water spraying for dust suppression, hydraulic stowing, equipment washing and other industrial requirements.

(e) Mine water discharge and drainage in the core zone has been planned to be regulated in a manner so that impact on surface and other water bodies of the area is not affected. No diversion of any surface drainage channel is required as other than civil constructions, surface land will not be affected. Expected increase of solids due to surface handling of coal shall be controlled by:

a. Construction of garland drain around the coal stock area
b. Construction of settling tanks of adequate size for removal of particulate matters
c. De-silting of settling ponds and drains at regular intervals
d. Effluents from washing areas, garage and workshop will be collected in garlands and routed through a settling ponds and oil and grease trap. The solid wastes generated shall be treated as per the provisions of Hazardous Waste Management Act. The water shall be recirculated for washing.

3.2.4 WATER BALANCE OF THE AREA

HYDROGEOLOGY AND AQUIFER CHARACTERISTICS OF THE AREA

Groundwater occurrence and storage in study area are mainly controlled by the geological setup of the area. The ability of geological formation to store and transmit water is dependent on its formation parameters, such as porosity and hydraulic conductivity. Based on these two parameters, the rock formation of the area may be classified as hard and soft rocks. Hard rocks (mainly crystalline and consolidated sedimentary rocks) are characterized by very little porosity. Ground water in such rocks circulated to a limited extent through the secondary openings represented by joints, cracks, fissures and such other planes of discontinuity. Soft rocks represented by sandstone, pebbles and loose sand, posses higher degree of primary porosity and as such characterized by higher water storage capacity. As greater part of the study area is underlain by Precambrian crystalline rocks, the weathered residual of the hard rocks as well as the fractures, joints, fissures, faults and other zones of discontinuity are the principle repositories of ground water in the area. The weathered zone is usually of limited thickness, fractures and joints generally close up with depth. The thickness of weathered mantle in the hard rock zone of area is about 10-20 meter in the topographic lows. Ground water in the weathered and fracture zones of hard rocks occur under unconfined condition. Ground water circulating through fracture zone is sometimes held under pressure. Depth of the water table in the hard rock of the area generally ranges from 3.0 m to 15.0 m below ground level.

The Gondwana sediments form the semi-consolidated formations and are better water potential zone. The splintery shales of Talchir and basal pebbles bed, the variegated Barren Measure shales and the sandstones are the major litho units of the Gondwana Formations. Gondwana sandstones in general, are known to constitute good aquifers at many places. Ground water occurs under unconfined condition in the weathered mantles varying depths from 4.23 – 12.34 m as observed in the dugwells and semi-confined condition in the deeper aquifers. Depth of water level for pre-monsoon period varies from 5–12m below ground level and it stretches to a deeper depth of 7-12m in some places. The pre-monsoon water level rises due to recharge and becomes 2 - 8 m below ground level around the area during post-monsoon period.

Rainfall is the principal recharge source to groundwater. The area experiences an average annual rainfall of about 1200-1400 mm. Besides rainfall, the mine water discharge from the local mining areas and existing water bodies including water logged in abundant mine quarries are also contributed to the ground water recharge as return flow. In the study area, ground water is withdrawn usually by means of open dug wells and small diameter hand operated tube wells for domestic and irrigation purposes. The tube wells are most often deeper (25m – 58m) than the dug wells and tap the aquifer below the weathered mantle. As the area is being located in the hot-tropical belt, the temperature regime is very high, the daily maximum reaches to over 45^0C. Due to excessive heat, the loss of moisture through evaporation is considerably high (60-65%). During the wet monsoon seasons, the net evaporation is less than the precipitation, resulting in surplus water which loss through either surface runoff or being part of the subsurface storage. The surface run-off and sub-surface storage of water depends upon various factors including the amount of rainfall, topography of the area, land use pattern, soil type, slope, physiographic, drainage pattern and hydro-geomorphology of the catchment/ sub-catchment. The study area is having gentle slope towards south and south east. Water received on the slopes, gets collected in low-lying area and is thus ultimately absorbed in the top soil cover and become part of the ground water flow according to the slope to form seasonal streams/nallas.

In the mining area, the water levels are bound to be affected and disturbed. The mining area of JCF area is highly disturbed and the permeability of individual geological units is spatially variable and depends on lithology, fracturing and attenuation with depth. The porous and more open-jointed sandstone members tend to form aquifers, the shaly members are aquitards, which may be leaky but are poorly permeable & form poor permeable barriers to the vertical groundwater movement

Water quality monitoring will be done for three years after closure. The sampling stations shall be one no. mine water with quarterly frequency and two numbers ground water samples in core and buffer zone with quarterly frequency.

3.2.5 Acid Mine Drainage Source

Not Applicable

3.2.6 Water Management

3.2.6.1 Existing mine water discharge details

a. Mine water is pumped out in a settling tank. Clean water coming out from the settling tank is used for dust suppression, stowing and other Industrial uses.
b. Excess pumped out mine water is allowed to flow into the surface water bodies.
c. Drains are provided around the coal stock to collect run-off for diverting into settling pond before discharge into the natural water courses.

Pumping capacity – 2500 GPM

Make of water – i) Monsoon - 3000 GPM ii) Lean period – 2000 GPM

Quantity of water discharged into surface – Monsoon - 3000 GPM for 18 hours

Lean period – 2000 GPM for 18 hours

Discharge point: - at surface.

Use of discharged water (quantity wise)

Table 3.11 Present use of mine discharge water:

Period	Total discharge at surface (GPM)	Use of Water (GPM)				Total
		Domestic	Stowing	Boiler	Nala/Jore through resettling tank	
Monsoon	3000	2000			1000	2000
Lean	2000	2000				2000

3.2.7. Post closure Mine water discharge

Once the reserve is exhausted, the entries into the mine would be securely sealed for safety purposes. However, if for the safety of the future mine or any neighboring mine, pumping is required from the worked seams, then the arrangements for pumping will be kept intact and the water shall be discharged into the surface water bodies after passing the same through settling tank on the surface. The accumulated water in underground workings may be utilized to meet water shortage in nearby areas.

3.3 Air quality management

3.3.1 Present practice

a. At present air borne dust is suppressed by:

- Sprinkling water on the various roads of the mine where vehicles ply.
- Water sprinkling at the various points where coal is handled.
- Proper loading of trucks to avoid any spillage of coal.
- Proper maintenance of I.C. engines.

The quality of air is monitored on regular basis by drawing samples from the various residential and non-residential areas of the project. The test results are compared with the standards prescribed by the MOEF and if any deviation is detected, remedial actions are immediately taken to bring the AAQ standard within the prescribed limits. The practice of air quality management would be continued throughout the project life as per the norms stipulated by MOEF.

The monitoring of air quality under Baseline Environment Data Generation for Cluster III has been conducted M/S PDIL, Sindri and test results of air samples are furnished subsequently.

Table No. 3.12

SAMPLING LOCATION FOR AIR QUALITY MONITORING

Project: Cluster III **Period:** 19th March -18th June 2011

Sl. No.	Location Name/Location Code	Direction & distance w.r.t Project Site	Height of Sampling Point (m)	Description
01.	Jogidih UGP - Core zone - SA_1	-	3.0	Industrial Area
02.	Jogidih UGP - Core zone - SA_2	-	3.0	Industrial Area
03.	Block IV Kooridih OCP- Core Zone - SA_3	-	3.0	Industrial Area
04.	Govindpur UGP Colliery- Core Zone - SA_4	-	3.0	Industrial Area
05.	New Akashkinari OCP- Core Zone - SA_5	-	3.0	Industrial Area
06.	Katras Choitudih Village - SA_6	SE, 1.0 Km	3.0	Residential Area
07.	Muraidih Village – SA_7	NW, 0.8 Km	3.0	Residential Area
08.	Harna Village – SA_8	NW, 2.6 Km	3.0	Residential Area
09.	Sogiadih Village – SA_9	NW, 2.5 Km	3.0	Residential Area

Table No. 3.13

AIR QUALITY DATA

Period: 19th March -18th June 2011 **Location:** Jogidih UGP - Core Zone –SA_1

WEEK	DAY	DATE	CONCENTRATION OF AIR POLLUTANTS, µg/m³				
			SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x
I	Mon/Tue	21/22.03.11	264	66	26	9.2	16.4
	Tue/ Wed	22/23.03.11	218	54	20	11.3	17.8
II	Mon/Tue	28/29.03.11	255	63	25	12.8	18.5
	Tue/ Wed	29/30.03.11	236	59	22	10.0	19.2
III	Mon/Tue	04/05.04.11	256	64	25	11.9	15.6
	Tue/ Wed	05/06.04.11	245	61	23	11.4	18.5
IV	Mon/Tue	11/12.04.11	274	68	27	12.6	19.5
	Tue/ Wed	12/13 .04.11	269	67	26	10.4	17.9
V	Mon/Tue	18/19.04.11	109	37	13	8.6	13.4
	Tue/ Wed	19/20.04.11	165	41	14	9.0	16.5
VI	Mon/Tue	25/26.04.11	258	64	25	12.0	19.8
	Tue/ Wed	26/27.04.11	241	60	23	12.2	18.1
VII	Mon/Tue	02/03.05.11	254	63	24	13.8	17.1
	Tue/ Wed	03/04.05.11	111	38	15	7.7	13.9
VIII	Mon/Tue	09/10.05.11	252	63	24	11.7	15.2

WEEK	DAY	DATE	CONCENTRATION OF AIR POLLUTANTS, µg/m^3				
			SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x
	Tue/ Wed	10/11.05.11	246	61	24	9.5	16.6
IX	Mon/Tue	16/17.05.11	245	61	23	10.4	19.5
	Tue/ Wed	17/18.05.11	175	43	16	9.4	13.5
X	Mon/Tue	23/24.05.11	268	67	26	12.4	17.8
	Tue/ Wed	24/25.05.11	215	53	20	9.1	18.5
XI	Mon/Tue	30/31.05.11	166	41	15	10.1	19.6
	Tue/ Wed	31/01.05/06.11	106	36	12	7.5	14.1
XII	Mon/Tue	06/07.06.11	235	58	22	11.0	17.5
	Tue/ Wed	07/08.06.11	194	48	18	9.2	16.4

SUMMARY

Parameters	SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x
No. of observations	**24**	**24**	**24**	**24**	**24**
Minimum Concentration	106	36	12	7.5	13.4
Maximum Concentration	274	68	27	13.8	19.8
Average	219.0	55.7	21.2	10.6	17.1
98th percentile	271.7	67.5	26.5	13.3	19.7

Table 3.14

STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011
Unit : µg/m³

SL. No.	POLLUTANT	LOCATION CODE	MIN.	PERCENTILE VALUE											MAX.	ARITH. MEAN	GEO. MEAN	STD. DEVIA-TION	STD. *	% EXCEEDING STANDARD LIMITS
				10	20	30	40	50	60	70	80	90	95	98						
01.	SPM	SA - 1	106.0	127.2	171.4	212.9	235.2	243.0	245.8	254.1	256.8	266.8	268.9	271.7	274.0	219.0	211.2	52.9	700	0
		SA - 2	109.0	125.9	168.6	177.9	208.6	218.0	242.8	246.5	256.8	264.4	265.9	267.1	268.0	209.7	202.4	51.5	700	0
		SA - 3	106.0	126.1	211.8	256.0	270.6	278.5	288.8	312.5	339.2	345.7	350.3	351.5	352.0	264.6	250.3	77.4	700	0
		SA - 4	114.0	139.0	163.2	177.0	190.0	207.0	234.6	251.1	255.4	262.7	274.9	281.9	286.0	208.4	202.0	50.8	700	0
		SA - 5	110.0	140.5	236.0	253.2	269.0	281.5	310.6	316.3	338.0	345.2	347.9	352.3	356.0	270.3	257.3	74.0	700	0
		SA - 6	96.0	110.9	137.8	153.2	158.2	201.0	217.6	223.9	233.6	243.2	245.0	245.5	246.0	184.7	177.0	51.3	200	0
		SA – 7	109.0	127.1	187.8	214.6	227.4	245.0	254.2	263.3	271.6	313.8	331.6	340.5	346.0	233.4	222.9	65.5	200	0
		SA - 8	89.0	111.1	122.0	131.9	136.4	142.0	146.0	151.1	158.2	168.0	170.6	179.1	186.0	140.2	138.2	23.7	200	0
		SA - 9	88.0	98.3	120.0	130.8	139.0	139.5	143.8	155.1	156.8	168.1	176.7	178.0	178.0	138.5	136.1	25.5	200	0

* SPM has been compared with Jharia Coal Mines standard in Core Zone and in other than Core Zone as per NAAQS.

Table – 3.14 (Contd.)
STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011 Unit : µg/m³

SL. NO.	POLLUTANT	LOCATION CODE	MIN.	PERCENTILE VALUE											MAX.	ARITH. MEAN	GEO. MEAN	STD. DEVIATION	STD. *	% EXCEEDING STANDARD LIMITS
				10	20	30	40	50	60	70	80	90	95	98						
02.	PM_{10}	SA - 1	36.0	38.9	42.2	52.5	58.2	60.5	61.0	63.0	64.0	66.7	67.0	67.5	68.0	55.7	54.6	10.7	100	0
		SA - 2	35.0	41.1	48.0	50.9	59.2	62.0	69.2	70.1	71.0	71.7	72.0	72.5	73.0	59.5	58.1	12.5	100	0
		SA -3	36.0	42.3	52.8	64.0	67.4	69.0	72.0	78.1	81.4	83.7	84.9	85.5	86.0	67.0	65.1	15.2	100	0
		SA - 4	34.0	39.5	46.4	50.7	53.6	59.0	66.8	71.0	72.0	73.0	73.9	74.5	75.0	58.6	57.0	13.4	100	0
		SA - 5	29.0	36.5	61.0	65.8	70.0	73.5	81.0	82.1	83.0	84.0	84.0	84.5	85.0	68.9	65.9	17.8	100	0
		SA - 6	30.0	31.3	33.0	34.9	36.2	46.0	49.8	51.2	53.4	55.4	56.0	56.0	56.0	43.4	42.3	9.9	100	0
		SA - 7	40.0	44.6	48.4	59.3	64.4	69.5	73.0	75.1	77.2	81.1	82.9	83.0	83.0	65.2	63.6	14.2	100	0
		SA - 8	23.0	30.2	34.6	36.8	38.4	40.0	44.8	49.6	56.4	62.0	62.9	63.5	64.0	43.9	42.2	12.3	100	0
		SA - 9	28.0	31.3	33.6	35.9	36.4	40.5	44.2	47.0	50.8	58.8	60.9	62.6	64.0	42.5	41.4	10.5	100	0
03.	$PM_{2.5}$	SA - 1	12.0	14.3	15.6	19.8	22.0	23.0	23.8	24.1	25.0	26.0	26.0	26.5	27.0	21.2	20.6	4.7	60	0
		SA - 2	10.0	14.2	17.6	19.0	23.0	23.5	26.8	27.1	29.0	30.0	30.0	30.0	30.0	23.0	22.1	6.2	60	0
		SA -3	12.0	14.3	19.6	25.0	26.2	27.0	27.8	29.0	29.0	30.0	30.9	31.0	31.0	24.8	23.9	6.0	60	0
		SA - 4	11.0	13.9	16.6	18.8	20.0	21.5	25.4	27.1	29.0	29.7	30.9	32.1	33.0	22.3	21.3	6.4	60	0
		SA - 5	13.0	18.2	24.0	25.9	27.0	28.0	29.0	30.0	31.0	32.7	33.0	33.5	34.0	26.8	26.0	5.7	60	0
		SA - 6	12.0	13.0	13.6	14.0	14.2	18.5	20.0	21.1	22.0	22.7	23.0	23.0	23.0	17.6	17.1	4.2	60	0
		SA - 7	14.0	15.0	16.6	20.7	23.0	24.5	26.0	26.1	27.0	28.4	29.9	30.5	31.0	22.9	22.2	5.4	60	0
		SA - 8	11.0	12.0	12.6	13.0	14.2	15.0	17.0	19.3	22.4	25.0	25.0	25.5	26.0	17.1	16.4	5.1	60	0
		SA - 9	11.0	11.3	12.6	13.0	13.2	15.0	15.8	18.0	20.2	22.0	23.7	24.5	25.0	16.0	15.5	4.3	60	0

* PM10 & PM2.5 has been compared with NAAQS standard in Core Zone and Buffer Zone.

Table – 3.14 (Contd.)
STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011
Unit : µg/m³

SL. No.	POLLUTANT	LOCATION CODE	MIN.	PERCENTILE VALUE											MAX.	ARITH. MEAN	GEO. MEAN	STD. DEVIA-TION	STD. *	% EXCEEDING STANDARD LIMITS
				10	20	30	40	50	60	70	80	90	95	98						
04.	SO_2	SA - 1	7.5	8.7	9.2	9.4	10.0	10.4	11.2	11.7	12.1	12.5	12.8	13.3	13.8	10.6	10.4	1.7	120	0
		SA - 2	7.3	7.8	8.3	9.1	10.3	10.9	11.8	11.9	12.4	12.7	12.9	12.9	12.9	10.5	10.3	2.0	120	0
		SA -3	8.5	9.1	10.9	11.7	11.9	12.3	13.2	13.9	14.7	14.9	15.0	15.3	15.6	12.4	12.2	2.1	120	0
		SA - 4	7.3	7.4	7.6	8.2	9.1	9.8	11.1	11.9	12.4	12.8	13.4	13.7	13.9	10.1	9.9	2.2	120	0
		SA - 5	8.5	9.9	10.5	11.3	12.0	12.5	13.8	14.0	15.0	15.3	15.5	15.7	15.8	12.6	12.4	2.2	120	0
		SA - 6	8.2	8.9	9.5	9.8	10.0	10.3	10.5	10.6	11.0	11.4	11.6	12.0	12.3	10.2	10.2	1.0	80	0
		SA - 7	6.8	8.0	11.8	13.5	15.3	15.5	16.0	16.7	17.0	17.9	18.2	18.4	18.5	14.4	13.8	3.6	80	0
		SA - 8	7.3	8.1	8.6	9.4	9.6	10.0	10.6	10.7	10.8	11.4	11.8	11.9	11.9	9.9	9.8	1.3	80	0
		SA - 9	6.3	7.4	8.0	9.4	9.6	10.4	10.7	11.0	11.4	11.7	13.0	13.3	13.3	10.0	9.8	1.9	80	0
05.	NO_x	SA - 1	13.4	14.0	15.4	16.4	16.7	17.7	17.9	18.5	18.8	19.5	19.6	19.7	19.8	17.1	17.0	2.0	120	0
		SA - 2	10.1	11.3	13.3	15.0	16.6	17.3	17.6	18.2	19.2	19.6	19.9	20.2	20.4	16.3	15.9	3.2	120	0
		SA -3	13.4	14.0	17.0	19.3	20.1	21.8	23.4	24.6	24.8	26.6	26.8	27.0	27.1	21.1	20.6	4.5	120	0
		SA - 4	10.0	11.2	11.8	12.3	13.5	15.5	16.3	16.9	18.8	19.6	20.6	21.0	21.2	15.2	14.8	3.5	120	0
		SA - 5	13.9	15.4	16.0	18.1	19.1	19.8	20.0	21.5	22.6	23.1	23.5	23.5	23.5	19.4	19.2	3.0	120	0
		SA - 6	13.5	14.1	14.5	15.0	15.3	16.0	16.3	16.5	16.8	17.1	17.3	17.6	17.9	15.7	15.7	1.2	80	0
		SA - 7	10.2	12.1	15.9	18.2	19.3	20.7	21.2	21.7	23.0	27.0	28.0	28.5	28.7	19.9	19.1	5.3	80	0
		SA - 8	12.1	13.7	14.7	14.8	15.4	15.6	15.7	16.3	16.7	17.1	17.2	18.2	19.1	15.5	15.5	1.5	80	0
		SA - 9	11.2	12.4	13.4	14.2	15.0	15.4	15.9	16.1	17.1	17.9	18.4	18.4	18.4	15.2	15.1	2.1	80	0

* SO_2 & NO_x has been compared with Coal Mines standard in Core Zone and in other than Core Zone as per NAAQS.

3.3.2 Practice after the closure of the mine

a. As the sources of dust and fume generation would no longer be present, after the final mine closure the present practice of arresting the air pollution, as enumerated above will be discontinued. However, water sprinkling would be done on the roads, which remain in use after the final mine closure.

b. Quality of air would be monitored for a period of 3 years after cessation of mining activity. 3 samples at fortnight frequency for 3 years, one sample in core zone and one sample each in upwind and downwind direction will be collected and analysed.

3.4 Waste Disposal

This is an underground mine, therefore solid waste is not likely to be generated during the mining operation.

3.5 Details of Surface Structures proposed for dismantling

3.5.1 Infrastructure details

Details of Surface Structure proposed to be dismantled

As far as possible, industrial structures will be utilized by the adjacent mine. However, if these structures are not found fit at the end of mine life, the same will be dismantled and salvaged. The equipments will be removed and used somewhere else. Every effort will be made to restore the area to economic utilization value in line with mine closure plan.

A. **Service Buildings**: The service buildings/ structures, viz. workshop, stores, office building, cap-lamp room, Pit top office, winding rooms, etc. are to be demolished after collecting all re-useable items, or be used for some other projects and the land covered by them restored for productive use. However, it has to be ensured that as and when a service building is vacated/ abandoned, the same should be demolished to prevent any unauthorized occupation.

B. **Other Infrastructures**: All other infrastructures like sub-stations, transformers, community services, pump-houses, water-treatment/ filtration plants, waterlines, power lines, roads etc. will be utilized for the neighbouring projects.

However, possibility shall be explored for handing over the buildings and other infrastructures including the reclaimed land to the State Government for the benefit of local villagers and strengthening the area infrastructures. The end use of these facilities shall be decided by the State Government with the help of District Authorities and Village Panchayat. The peripheral village community facilities developed by the Mine Authorities will be left to the Local Body/ State Government for their management and public use.

Prior to surface demolition/ restoration, a surface audit will be undertaken on all surface structures, spoil heaps etc. to assess whether there is any hazardous material that could cause problem, i.e. explosive, asbestos, chemical, oil, etc.

A list of surface and UG assets (Plant & Machinery) will be prepared and made available to potential purchasers or transferred to other new/ working mines of the company. This will ensure that the assets perform during their economic life.

3.5.2 Post closure disposal/Re-use of the Buildings, Plants & Machineries

a. Disposal or reuse of existing HEMM, CHP, workshop and railway siding for OC

   Not Applicable

b. Disposal or reuse of haulage, ventilation, workshop and railway siding for UG

   At the time of closure of the mine, it is expected that most of the equipments would complete its rated life and would be surveyed off as per the Company’s guidelines. The surveyed off equipments would be auctioned as per prevalent norms.

However, if some of the equipments would not have covered their rated life, they would be diverted to the neighboring projects for gainful utilisation.

There is no railway siding in the leasehold.

c. Disposal or reuse of transmission lines and sub-station

As per the electricity demand of the existing neighboring Projects, an analysis would be made as to whether the existing sub-station and transmission lines could be gainfully used or not. If the scope of gainful utilization is not found, they will be dismantled and the usable items/spares/conductors etc. would be dispatched to needy Areas/Projects.

d. Disposal or reuse of residential and non-residential buildings

At the time of final closure, a list of surface buildings would be prepared in detail. Thereafter following steps would be taken in chorological order in respect of the available buildings:

- An assessment would be made to find that whether the available buildings can be used by the existing neighboring projects or any new project that might have come up in the vicinity.
- In case, the listed assets cannot be utilized by the nearby project, efforts would be made to sale these assets after making the list available to potential purchasers and asking the interested purchasers to submit sealed bids.
- Thereafter, the state agencies/local agencies may be asked to take possession of the buildings, if they required few of them.
- When there would be no takers, the buildings would be demolished and usable items would be recovered for future use.

Table 3.15 Infrastructure Details

Sl. No.	Particulars	Action Suggested
A	CHP	CHP doesn't exist in the leasehold area.
B	Workshop	-Do-
C	Railway Sidings	Railway siding doesn't exist in the leasehold area.
D	Colony	These will be handed over to the State Government if fit for use or will be dismantled.
E	Details of non-residential buildings	-Do-
F	Other facilities (ETP /STP)	-Do-

3.6 Safety and Security Arrangement

3.6.1 Mine entry:

After closure of the mining activities, all the entries to the mine will be effectively sealed off to avoid any accident and to prevent access to any unauthorized person. The area that is not reclaimed shall be properly fenced/ sealed to prevent any unauthorized entry into the area. Flags/Boards with warning signals shall be posted at vulnerable places to avoid chances of accidents. However, the guidelines / instructions from DGMS, if any, will be followed.

Sealing details and dimensions shall also be prepared for the purpose. The minimum thickness of mine sealing will be 100cm RCC (M20) with nominal reinforcement. For incline entry, the mine entry path of 5 m will be filled with debris and clay before sealing the mine.

3.6.2 Providing one time lighting arrangement

Sufficient lighting as per standard is provided at all the required places, i.e., pit office, haulage room, fan house, cap lamp room, mine entry, workshop, sub-station etc.

After closure of the mine, the lighting arrangements will be kept maintained at all locations which are not required to be demolished or dismantled like sub-stations, transformers, community services, pump-houses, water-

treatment/ filtration plants, waterlines, power lines, roads etc. to be utilised for the neighbouring projects and local communities.

3.6.3 Survey records of workings

All the mine workings including subsidence areas, roads, ponds, tanks etc. shall be resurveyed and records shall be updated. Copy of such records shall also be submitted to the appropriate competent authorities, such as DGMS and State Authorities.

Maintenance of records pertaining to Progressive Mine Closure

The Mine management shall maintain a Progressive mine closure plan for every 5 year period:

Progressive mine closure plan for UG activities

Similar to PMCP for surface activities, a progressive mine closure plan showing the UG activities shall be maintained. This plan shall also be updated on annual basis and signed by all the above mentioned officials.

Besides the above plan, a progressive mine closure register shall also be maintained by the mine management. This register shall carry details of the progressive mine closure activities carried out on yearly basis. The details to be maintained in the said register shall cover inter alia the name of activity, place, period of execution, executing agency, expenditure incurred, proof of expenditure incurred, final status of the area where activity was executed, plan on which such activity has been shown etc.

The entries into the said register shall be signed by the appropriate authorities from the Project and the Area. At the end of the year the said register (along with two plans) shall be placed before HOD (Env.) of the Company for scrutiny and approval.

3.6.4 Disposal management of hazardous material

At the time of closure, assessment would be made as to find whether there is any hazardous material that could cause problem. Such hazardous material e.g. explosives, chemicals, oil etc. shall be appropriately disposed off.

3.7 Entrepreneurship development Program

As the mine progresses, more and more local people gets indirectly dependent on the mine for their sustainable income. After closure of mine there would be no source of income for these people. In order to ensure that these people do not suffer in the post closure period, the Project authorities in consultation with BCCL (HQ) shall make efforts to develop entrepreneurial skills in the local people by imparting skill development/vocational training programs. It is expected that after developing adequate entrepreneurial skills, the local people would be able to run their own business in the post closure period and maintain a sustainable income for their livelihood.

3.8 Miscellaneous activities

In future, the prevalent geo-mining/environmental conditions in and around the project area may require execution of some other progressive mine closure activities not covered in the preceding paragraphs. Such activities may be carried out by the mine after observing the needful formalities and obtaining approval of HOD (Env.) of the Company.

3.9 Execution of progressive mine closure activities and 5 yearly monitoring

After observing the necessary administrative/financial formalities, the mine authorities shall execute the identified progressive mine closure activities, whenever and wherever required. The executed activities shall be shown on the above said plans and recorded in the said registers.

The executed progressive mine closure activities shall be monitored on 5-yearly basis by 3rd party (ISM, CMPDI, NEERI etc.).

The 5 yearly return from escrow fund would be equal to expenditure incurred on progressive mine closure activities during last 5 years or 80 % of total deposited amount in the escrow account (including interest) whichever is less. The said return would be subject to above said monitoring of progressive MCP by a third party (ISM/CMPDI/NEERI etc.).

As the 5 yearly return from escrow fund is linked with the expenditure incurred on progressive mine closure activities during last 5 years, it is very important that progressive mine closure records, plans, expenditure details along with proof are properly maintained.

At this juncture it is important to note that some of the progressive mine closure activities, enumerated in the preceding paragraphs, are legal obligations specified in Project reports, EMP, permissions obtained from statutory bodies such as CPCB, SPCB, DGMS etc. The Project authorities are bound to comply with these obligations.

3.10 Re-deployment of work force

The current manpower of the project is 526 and at present, it is very difficult to assess the manpower of the project, which will remain at the time of closure of mining activities in the presently worked seams. As some of the seams of the block is still virgin and is most likely to be mined in future, the remaining manpower will be gainfully utilized in continuing mining activity.

3.11 Emancipation from the community facilities and the facilities to the PAPs

3.11.1 The Project affected Persons (PAPs) and also the local communities are being provided many civic facilities, such as educational facilities, health facilities, and drinking water. As some of the seams of the block are still virgin and are most likely to be mined in future, these facilities, in all probability, will be kept maintained.

3.11.2 However, at the time of final closure after exhaustion of entire mineable reserve these facilities will be entrusted upon the local bodies/Trust of

PAPs/State bodies after consultation with local people and state authorities so that same could continue even after the mine closure. If needed, a lump sum reasonable amount would also be paid to the local bodies/Trust of PAPs/State bodies after proper approval for proper upkeep and maintenance of various community facilities.

3.11.3 To ensure that no financial loss due to the closure of mining activity in the presently worked seam occur to the local community engaged indirectly to the existing mine, following steps would be taken:

- It has been seen in past that in the event of closure of a mine, the local people indirectly dependent on the mine switch over their economic/professional activities in the existing/new or expansion mines located in the nearby area. Local management, if needed, extends some basic helps to them in such type of switching over. Hence, it is expected that in this project also the transition of the local people from one area to the other area for their sustenance would not be any problem.

- It is proposed that reclaimed and afforested land will be handed over to State Forest Dept. for the benefit of local ecosystem. The forest wealth can also be utilised by local people or tribal in the form of fruits and fodders.

- The proposed picnic spot would be handed over to a society of local people for commercial use of the picnic spot by them.

CHAPTER – IV

ECONOMIC REPURCUSSION

4.0 Economic Repercussions of closure of mine:

4.1 Manpower of the Project

The manpower of the Jogidih Colliery is 526.

Table 4.1 Present Manpower

Manpower	Strength (Nos.)
EXECUTIVE	7
NON EXECUTIVE	519
TOTAL	**526**

Post Closure Manpower

It has been proposed to monitor and implement the post-closure activities departmentally. Departmental manpower will be needed after closure of the mine for monitoring and implementation of the post closure activities. Manpower required for the same is given in Table- 4.2.

Table 4.2: Manpower required for monitoring and implementation of Mine Closure Activities

Sl. No.	Category of Manpower	Requisite heads
1	Officer-in-charge/ Manager (Mining)	1
2	Overman-in-charge	1
3	Foreman-in-charge	1
TOTAL		**3**

4.2 Assessment of Income Scenario of Local People

As Jogidih colliery is an underground mining project, no surface excavation is likely to be undertaken. Moreover, the basic mining infrastructures have been made on the company acquired land. So there will no displacement of local people for this project. Later, after closure of the mine the work force will be absorbed / re-employed / rehabilitated in operative collieries of BCCL.

After the closure of the mine, the manpower deployed in the mine will be further deployed in other mines of BCCL to make no loss of sustenance income to the eligible employee. The other secondary activities will not be affected by the closure of the mine and the mine discharge water after proper treatment will be provided to the local people for domestic and irrigational uses.

4.2.1 At present, it is very difficult to assess the manpower of the project, which will remain at the time of closure of mining activities in the existing project.

4.2.2 The local communities are being provided many civic facilities, such as educational facilities, health facilities, and drinking water. At the time of final closure after exhaustion of entire mineable reserve these facilities will be entrusted upon the local bodies/Trust of PAPs/State bodies after consultation with local people and state authorities so that same could continue even after the mine closure. If needed, a lump sum amount would also be paid to the local bodies/Trust of PAPs/State bodies for proper upkeep and maintenance of various community facilities.

4.2.3 To ensure that no financial loss due to the closure of mining activity in the presently worked seam occur to the local community engaged indirectly to the existing mine, following steps would be taken:

- It has been seen in past that in the event of closure of a mine, the local people indirectly dependent on the mine switch over their economic/professional activities in the existing/new or expansion mines located in the nearby area. Local Management, if needed, extends some basic helps to them in such type of switching over. Hence, it is expected that in the instant case also the transition of the local people from one area to the other area for their sustenance would not be any problem.

- It is proposed that reclaimed and afforested land, if any, will be handed over to State Forest Dept for the benefit of local ecosystem. The forest wealth can also be utilised by local people in the form of fruits and fodders.

CHAPTER – V

TIME SCHEDULE FOR POST-CLOSURE ACTIVITIES

5.1 It is very difficult to predict the various parameters which would be prevalent at the time of final mine closure (when the entire block reserve would get exhausted) and therefore a mine closure activity schedule cannot be rigidly prepared at this point of time.

5.2 The closure of mine involving technical aspects, environmental aspects, socio-political aspects and financial assurances as implementing post-closure activities will run for three years. The time schedule envisaged for completion of all closure activities is presented in the following table in the form of bar chart.

Table 5.1 Implementation Schedule for post-closure activities for Jogidih UG mine

Sl. No.	Major Activities	Time Period	Year-wise Phasing			
			Y1	**Y2**	**Y3**	**Y4**
1	Technical aspects	2 years				
2	Environmental aspects	2 years				
3	Post closure environment monitoring	3 years				
4	Socio-political aspects	3 years				

5.2.1 Technical Aspects:

i) **Safety & security**: In the mine closure plan, action will be taken to cover all the safety aspects including management of fire & subsidence and mine inundation.

ii) **Management of pit slopes and waste dump**: Jogidih being an underground mine, management of pit slope and waste dump will not be needed.

iii) **Management of hydrology and hydro-geology**: After closure of mining activities, the workings will be waterlogged which will help in maintaining the water table in the surrounding areas and may become a source of water supply to the neighbouring areas.

iv) **Closure of Mine Entries**: After closure of the mining activities, all the entries to the mine will be effectively sealed off to avoid any accident and to prevent access to any unauthorized person. The area that is not reclaimed shall be properly fenced/ sealed to prevent any unauthorized entry into the area. However, the guidelines / instructions from DGMS, if any, will be followed.

v) **Disposal of mining machinery**: All the underground machineries including SDLs, haulages etc. which will have residual life will be shifted to the other collieries of the area/company. The salvaging and shifting operation of mining machinery and other equipment will be done considering the ground realities during the period 1 (one) year advance of final mine closure.

vi) **Details of surface structure proposed to be dismantled**:
As far as possible, industrial structures will be utilised by the adjacent mines. However, if these structures are not found fit at the end of mine life, the same will be dismantled and salvaged. The equipments will be removed and used somewhere else. Every effort will be made to restore the area to economic utilization value in line with mine closure plan.

A. **Service Buildings**: The service buildings/ structures, viz. workshop, stores, office building, cap-lamp room, incline top office, haulage/winding rooms, etc. are to be demolished after collecting all re-useable items, or be used for some other projects and the land covered by them restored for productive use. However, it has to be ensured that as and when a service building is vacated/ abandoned, the same should be demolished to prevent any unauthorized occupation.

B. **Other Infrastructures**: All other infrastructures like sub-stations, transformers, community services, pump-houses, water-treatment/ filtration plants, waterlines, power lines, roads etc. will be utilized for the neighbouring projects.

However, possibility shall be explored for handing over the buildings and other infrastructures including the reclaimed land to the State Government for the benefit of local villagers and strengthening the area infrastructures. The end use of these facilities shall be decided by the State Government with the help of District Authorities and Village Panchayat. The peripheral village community facilities developed by the Mine Authorities will be left to the Local Body/ State Government for their management and public use.

Prior to surface demolition/ restoration, a surface audit will be undertaken on all surface structures, spoil heaps etc. to assess whether there is any hazardous material that could cause problem, i.e. explosive, asbestos, chemical, oil, etc.

A list of surface and UG assets (Plant & Machinery) will be prepared and made available to potential purchasers or transferred to other new/ working mines of the company. This will ensure that the assets perform during their economic life.

5.2.2 Environment Aspects

i) **Mined-out land and proposed final land use:** At Jogidih Colliery, it is proposed to extract coal by Bord & Pillar method. In the present stage development and depillaring with stowing has been envisaged. As such the surface land is not likely to be degraded. The existing infrastructures, if not usable, will be dismantled and the land will be graded & will be handed over to the local authorities for community use.

ii) **Air & Water quality management:** Appropriate air and water pollution control measures will be taken to contain the air and water pollution for maintaining the ambient air and water quality within the stipulated standards besides making the mining operation eco-friendly in the project. These

measures (both preventive and suppressive) are enumerated in Para 3.2.3 of the present report.

iii) **Management of waste:** The solid wastes generated by the mine during the coal production are non-hazardous and non-toxic in nature. The above solid wastes will be disposed off by backfilling the mined out area and then re-vegetating without causing any siltation problem on surface water bodies. However, scientific studies shall be undertaken regarding applicability of solid wastes for various uses. Toxic solid wastes like used oil, used batteries, oily sludge, besides filters and filter materials containing oil during maintenance of vehicles, will be generated by the mining project. Used oil will be stored in drums safely for disposal through auction to the authorized re-processors. Similarly, used batteries will be stored safely for auction to the authorized re-processors. The oily sludge, besides filter and filter materials, will be disposed off in impervious layer lined pits without causing environmental hazards.

iv) **Management of final voids**: The underground voids will be slowly get filled with water. However, safety of the neighbouring mines will be looked into before the entire underground void gets water filled.

v) **Land reclamation and rehabilitation:** If any cracks or void is created due to mining activities, it will be restored to original profile by filling up cracks/ voids. It is proposed that the site restoration should be kept progressive so that the restoration is more or less similar to the rate of mining.

vi) **Reclamation of forest/ vegetation and plantation:** No forest land is required for the project. However, regular plantation will be taken up during the life of the mine to create green barrier. The plant species will be selected in consultation with the state forest department.

The objective of restoration of post mining area will be determined through consultation with local community and the Government authority, so that the potential/ required end use of the mined out land is determined in advance.

Such usage may be agriculture, forestry, amenity development or nature reserve.

5.2.3 Post Closure Environment Monitoring

After cessation of mining and its related activities, there will be no effect on ambient air and water quality due to this mine as proper mitigation measures for air and water pollution control are to be taken by the authorities of the mine. However, the air and water quality parameters in the mined out area will be monitored by some external agency for next three years after closure of the mine.

Air and water samples will be taken from the specified sampling stations at regular frequency for 3 consecutive years after the closure of the mining project. 1 sample of mine water will be collected and analyzed with fortnightly frequency and 2 samples of ground water from core & buffer zones with monthly frequency. Similarly, 1 air sample will be taken at core zone, and 1 air sample each in upwind and downwind directions of the project at fortnightly frequency.

5.2.4 Socio-Political Aspects

i) **Re-deployment of work force**: Due to closure of mining operations, the persons directly employed in the mine will be surplus. Suitable manpower re-deployment plan may be formulated by the mining company sufficiently before closure of mine for re-deployment of the work force in other units of the company. Alternatively, they would be given option of voluntary retirement.

ii) **Civic facilities**: It is proposed that the civic facilities developed during the mining phase will be transferred to the local government/ municipality so that the region transforms smoothly into post mining phase. A one-time payment should be made by the mine for obtaining its release from providing these facilities, which will there from be taken care of by the local and state bodies.

iii) **Channelisation of available water**: If the mine has sufficient water, this can be used for domestic and agriculture purpose by the local community. The water from this area shall be discharged after treatment for domestic and agricultural usages.

iv) **Emancipation for project affected population**: The village/ basti which are to be rehabilitated as per Master Plan of JCF (March'08) is given in Table No. 5.2.

Table 5.2 Phasewise Rehabilitation as per Master Plan of JCF (March'08)

Village/Site	BCCL	Pvt.	Enchr	Oth	Total
PHASE-I					
Central Sinidih Bastee/12	3	0	0	0	3
East Sinidih Unit/11	29	15	15	0	59
HZL Factory Surroundings/13	0	40	0	2	42
Tundoo Khas Village/15	49	80	0	0	129
Tundoo Village/10	0	15	0	1	16
Total(Phase-I)	**81**	**150**	**15**	**3**	**249**
PHASE-II					
Baihardih Colony 'B'/ 1B	23	0	0	0	23
Baihardih Village/1A	44	0	0	0	44
Total(Phase-II)	**67**	**0**	**0**	**0**	**67**
Total(Phase I+II)	**148**	**150**	**15**	**3**	**316**

5.3 Although, it is very difficult to conclusively predict the likely impacts due to closure of the mining activities in the in the leasehold area of the Instant Project and the likely activities that would be taken up at that point of time, but a broad mine closure activity schedule may be prepared as per guidelines of Ministry of Coal. The post closure implementing activities will run for three years. The following activities are most likely to be implemented as per the given bar chart.

IMPLEMENTATION SCHEDULE FOR MINE CLOSURE OF JOGIDIH UG MINE

(LIFE OF THE MINE : 27 YEARS)

S. N	Activity	Time Frame	Year								
			1st Phase	2nd Phase	3rd Phase	4th Phase	5th Phase	Final Phase	Post Closure Phase		
			1st-5th year	2nd-10th year	11th-15th year	16th-20th year	21st-25th year	26th-27th year	PC1	PC2	PC3
A	**Dismantling of Structures**										
	Service Buildings	2 years									
	Residential Buildings	2 & ½ years									
	Industrial structures like CHP, Workshop, field sub-station, etc.	2 & ½ years									
B	**Permanent sealing of mine entries (incline mouth and air shaft)**										
	Sealing of incline mouths and air shafts	2 years									
C	***Subsidence Management**	Throughout the life of the mine, if required including 3 years after cessation of mining operation									
D	***Landscaping**										
	Landscaping of the cleared land for improving its esthetic	Throughout the life of the mine including 3 years after cessation of mining operation									
E	***Plantation**										

S. N	Activity	Time Frame	Year								
			1st Phase	2nd Phase	3rd Phase	4th Phase	5th Phase	Final Phase	Post Closure Phase		
			1st-5th year	2nd-10th year	11th-15th year	16th-20th year	21st-25th year	26th-27th year	PC1	PC2	PC3
	Plantation over leasehold area and on other open spaces	Throughout the life of the mine including 3 years after cessation of mining operation									
F	**Post Closure Env Monitoring / testing of parameters for three years**										
	Air Quality	3 years									
	Water Quality	3 years									
G	***Entrepreneurship Development (Vocational/skill development training for sustainable income of affected people**	Throughout the life of the mine									
H	***Miscellaneous and other mitigative measures**	Throughout the life of the mine including 3 years after cessation of mining operation									
I	**Post Closure Manpower cost for supervision**	3 years after mine closure									

NOTE: *: To be covered under Progressive Mine Closure activities also**.**

NOTE: The progressive mine closure will be done as per the provisions made out in the Project report and as per the situation/requirement that may arise in course of execution of the Project Report.

CHAPTER – VI

MINE CLOSURE COST

6.0 Mine Closure activities would be a constant exercise for the mine which would begin with the commencement of mining operations and continue till post closure. The mine closure activities would naturally entail certain expenditures, which will have to be borne by the mine operator. There would be two types of expenditures on account of mine closure activities in respect of Jogidih Colliery:

6.1 **Revenue expenditures**

This would cover the activities which are being executed along with normal mining operation and would continue to be executed in course of execution of the project. The cost of progressive mine closure activities is already part of the project cost.

6.2 **Expenditures to be incurred just prior to actual mine closure and in the post closure period**

6.2.1 As per MOC guidelines, a corpus escrow account @ ₹ 1.0 lakhs (August, 2009 Price Level) per Ha (for UG) and @ ₹ 6.0 lakhs(for OC) of the project area shall be opened with the coal controller organization to meet the expenses of final mine closure. The current Guidelines read as:

“It has been estimated that typically closure cost for an opencast mine will come around Rs. 6.00 lakh per Hectare of the project area and it would be Rs. 1.00 lakh per Hectare for underground mine project area at current price levels (August, 2009) and these rates will stand modified based on Wholesale Price Index as notified by Government of India from time to time”.

As per the data furnished by the mine/area, the Project Area in respect of Jogidih Colliery is same as the leasehold area. The closure cost has been worked out accordingly.

In Jogidih Colliery, the existing leasehold area is 167.0 Ha, out of which 3.90 Ha is abandoned quarry, not backfilled (Table No. 1.2). The remaining 163.10 Ha of leasehold area (Excluding Abandoned Quarry) has been considered for the calculation of closure cost of the area as per Underground norms and cost of closure of 3.90 Ha (Running and Abandoned Quarry) is calculated as per Open cast norms.

The money deposited in the Escrow Account has to deal with the following:

- Cost of closure activities.
- Cost towards organization for executing the closure activities.
- Cost of the post project monitoring.
- Creation of a corpus fund for the final mine closure

6.2.2 As per the above guidelines these rates will stand modified based on Whole Price Index as notified by Government of India from time to time. Thus the total expenditure on this front may be calculated in following manner:

- The total amount for mine closure activity in respect of **Jogidih Colliery (Excluding the abandoned quarry**) = 163.10 Ha X ₹1 Lakh X 1.35340*= ₹ 220.74 lakhs

- **The total amount for reclamation of the Running and Abandoned Quarry in the Leasehold Area of Jogidih Colliery**= 3.90 Ha X ₹ 6.00 lakhs X 1.35340* = ₹ 31.67 lakhs

*** The amount has been escalated based on WPI of July 2013, (175.4) vis-à-vis WPI of August '09(129.6).**

The WPI of July 2013 is provisional as per the Govt.'s notification (Office of the Economic Adviser).

6.2.3 It is difficult to conclusively predict the mining parameters on a long term basis owing to rapidly changing mining technology, developments in the field of clean coal technologies and R&D activities in development of alternative energy sources.

As per the latest Guidelines issued by the MoC, GoI(dt. 07.01.2013) the *"annual closure cost is to be computed considering the total project area at the above mentioned rates and dividing the same by the entire life of the mine in years for new projects and balance life of mine in years for operating/existing mines."*

Jharia Coalfield is characterized by occurrence of a number of working coal horizons, giving a leverage of extended working life of the mines. Some more seams can come in the lap of workable horizons due to improvement in mining technology in times to come. The underground mines in leasehold of JCF are generally small capacity mines, giving a false impression of very long lives due to small level of current production level. There may be a strategy in future to amalgamate the mines for higher production level to attain the economics of scale. In such a situation, the life of the mine arrived at with current level of production for the balance reserve may not be workable in the long run.

In view of the above, for the purpose of mine closure cost calculations, the life of the mine has been calculated based on the reserve available in the seams considered for production. At present, B&P (SDL), development is going on in I seam through Inclines. , which has balance extractable reserve of about 0.46 MT(development only). Further, the residual SOP reserves in X & I Seams which are amenable to extraction has been estimated as 2.8 MTe subject to DGMS permission. Thus, keeping in view the available reserves in the seams to be worked i.e., i(Dev) ,III &I(Dep-Caving) the remaining life of the mine will be 27 years. The production considered during development and depillaring are 200 TPD and 500 TPD respectively. Further, the mine has SOP reserves as well as virgin reserves in upper seams which may be mined in future subject to removal of surface/sub-surface constraints. If so happens , a fresh new Mine Closure Plan will be submitted incorporating all the changes.

To arrive, at the annual cost, to be deposited in each year in an escrow account, the mine closure cost **(Excluding the Cost of Abandoned Quarry)** has been divided by 27, as shown subsequently.

- Amount to deposited in 1st year will be (**Reclamation Cost of the Abandoned Quarry in the Leasehold Area (₹31.67 lakhs) + Amount to be deposited in 1st year for Mine Closure of Jogidih Colliery on UG norm (₹8.18 lakhs)**) -------- ₹ **39.85 lakhs.**
  - Amount to be deposited in 2nd year will be— ₹ 8.18 (1 + 5%)^1 lakhs
  - Amount to be deposited in 3rd year will be--- ₹ 8.18 (1 + 5%)^2 lakhs.

6.2.4 In the above fashion, an amount will be deposited every year up to the last year of mine life by applying the following formula:

- Amount to deposited in 1st year will be-------- ₹ 39.85 lakhs
- Amount to be deposited in nth year will be— ₹ 8.18 (1 + 5%) ^(n-1) lakhs

6.2.5 The amount calculated by the above formula shall be deposited every year by BCCL in the Escrow Account opened with the Coal Controller organisation in a scheduled Bank. An agreement, outlining detailed terms and conditions of operating the said Escrow Account shall be executed amongst BCCL, the Coal Controller and the commercial Bank.

6.2.6 Thus, total amount that shall be deposited for final mine closure activities **Jogidih Colliery** stands out to be **₹ 478.62 lakhs** as per the present status of the mine. The Break-Up cost of Mine Closure of Jogidih Colliery Yearwise is given in Table No. 6.1.

Table No. 6.1 Break-Up cost of Mine Closure of Jogidih Colliery Yearwise (WPI July 2013)

Year	Amount to be deposited per year in ₹ Lakhs
1.	39.85
2.	8.58
3.	9.01
4.	9.46
5.	9.94
6.	10.43
7.	10.96
8.	11.50
9.	12.08
10.	12.68
11.	13.32
12.	13.98
13.	14.68
14.	15.42
15.	16.19
16.	17.00
17.	17.85
18.	18.74
19.	19.68
20.	20.66
21.	21.69
22.	22.78
23.	23.92
24.	25.11
25.	26.37
26.	27.69
27.	29.07
Total	**478.62**

6.2.7 Based on the existing mine closure planning norms, the above calculated cost at current WPI on mine closure may be tentatively grouped under different heads as given in Table No. 6.2

Table No. 6.2 Break up Cost of Mine Closure of Jogidih Colliery Including Abandoned Quarry

Sl. No.	Activity	Mine Closure Cost (₹ in Lakhs)
	UG Part of the leasehold	
A	**Dismantling of Structures**	
	Service Buildings	15.64
	Residential Buildings	47.29
	Industrial Structures like CHP, Workshop, field sub-station, cap lamp room, haulage, fan installation etc.	28.29
B	**Permanent Sealing of mine entries(incline mouth and air shaft)**	
	Sealing of incline mouths and air shafts	23.78
C	***Subsidence Management**	21.23
D	**LANDSCAPING**	
	Landscaping of the cleared land for improving its aesthetic	39.33
E	***Plantation**	
	Plantation over the cleared area obtained after dismantling and on other barren spaces	58.10
F	**Monitoring/Testing of parameters for three years**	
	Air Quality	30.53
	Water Quality	28.34
G	***Entrepreneurship Development(Vocational/skill development training for sustainable income of affected people**	34.19
H	***Miscellaneous and other mitigative measures**	65.25
I	***Manpower Cost for Supervision**	54.97
	Sub-Total(UG Part)	**446.95**
	Abandoned Quarry Reclamation	
A	**Reclamation of the abandoned quarry**	39.85
	Sub-Total(OC Part)	**39.85**
	GRAND TOTAL	**478.62**

Note: * :To be covered under Progressive Mine Closure activities also.

6.2.8 However, the additional amount beyond the escrow account, if any estimated later on, will be provided by the mine operator after estimating the final mine closure cost five years prior to mine closure (as per the mine closure guideline)**.**

6.2.9 *Mining is to be carried out in a phased manner initiating afforestation/reclamation work in the mined out area of the first phase while commencing the mining in the second phase i.e. continuation of mining activities from one phase to other indicating the sequence of operations depending on the geo-mining conditions of the mine. Up to 80% of the total deposited amount including interest accrued in the ESCROW account may be released after every five years in line with the periodic examination of the Closure Plan as per Clause 3.1 of the Annexure of the Guidelines. The amount released should be equal to expenditure incurred on the Progressive mine closure in past five years or 80% whichever is less. The balance amount shall be released to mine owner/leaseholder at the end of the final Mine Closure on compliance of all provisions of Closure Plan. This compliance report should be duly signed by the lessee and certify that said closure of mine complied all statutory rules, regulations, orders made by the Central or State Government, statutory organisations, court etc. and certified by the Coal Controller.*

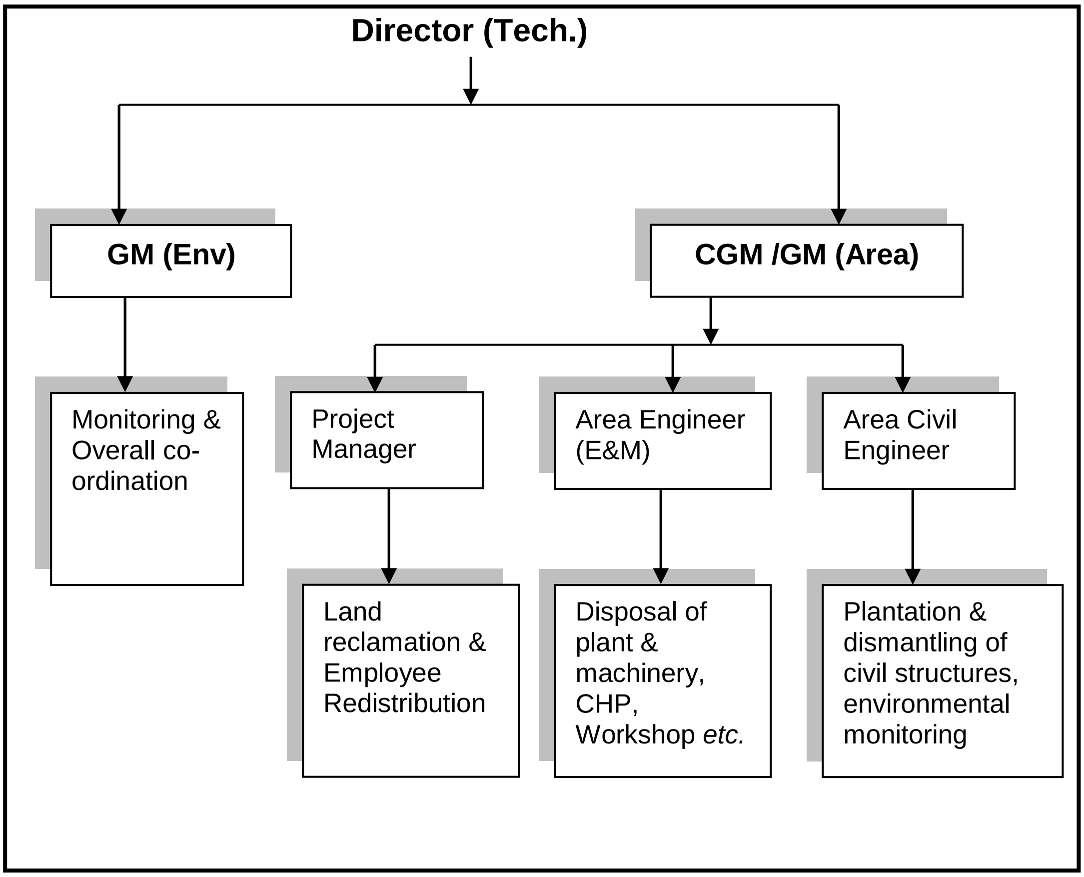
6.2.10 However, the additional amount beyond the escrow account, if any estimated later on, will be provided by the mine operator after estimating the final mine closure cost five years prior to mine closure (as per the mine closure guideline)**.**

CHAPTER-VII

IMPLEMENTATION PROTOCOL

7.1 As the mine closure activities would continue even after cessation of mining activities, an organization consisting of different discipline would be formed to undertake the implementation of mine closure activities as well as monitoring of the same**.** Such activity shall continue for a period of three years after the closure of mining activity in the mine. Once the closed mine becomes stabilized in respect of safety, environmental and social aspects, the monitoring team would be withdrawn.

7.2 For implementing the mine closure activities and monitoring thereof, the following organisational structure at corporate level has been proposed:



7.3 Environmental monitoring for three years after closure of mine will be carried out to evaluate the environmental quality of the area. If need be, proper

mitigation measures will be taken up after evaluating the environmental quality. Before closure of the mine, Area GM will prepare survey and disposal report and the same will be submitted to DGMS for acceptance.

7.4 When the mine closure activities would take final shape and the entire are under influence is brought to an acceptable shape, BCCL would obtain a mine closure certificate from Coal Controller to the effect that the protective, reclamation and rehabilitation works in accordance with the approved mine closure plan/final mine closure plan have been carried out for surrendering the reclaimed land to the State Government concerned.

CHAPTER – VIII

PLANS ENCLOSED

The following underground and surface plans have been enclosed along with this mine closure plan:

1. Location Plan of Cluster III
2. Surface plan of Cluster III showing surface features, roads, depot/siding, OB dumps, quarries (working/old/discontinued), subsidence, plantations, habitations, vacant land (whether under agriculture or waste land), surface water bodies, natural drainage and mine discharge water channels
3. Geological Plan of Cluster III
4. UG Working plan

CHAPTER – I

INTRODUCTION

1.0 Introduction

Akashkinaree Colliery had come into existence in 1945. After amalgamation with East Katras Colliery in 2006 it became New Akashkinaree Colliery. It is located in North - western part of the Jharia Coalfield. It covers a leasehold area of 367.58 Ha .It is about 26 Kms of Dhanbad. At present OC work is carried out with IV seam as base seam with Shovel & Dumper Combination (Departmental). I & II seams are being worked through Incline using Bord & Pillar method of underground mining with conveyor & SDLs in I seam (Development) and haulage & SDLs in II seam (Development).

Table No.1.1 Details of Working

Seam	Production Outlet	Method of work	Production (TPD)
I &II	I&II Seam Incline	B&P (Development)	500
IV seam (Base seam)		OC, Shovel-Dumper Combination	650

This Mine Closure Plan has been prepared on the basis of Approved Feasibility report & TOR/Form – I and data furnished by the officials of Govindpur Area/ BCCL.

1.1 Name of mine owner / company

Project: New Akashkinaree Colliery

Area: Govindpur Area

Company: BCCL

Mine Owner: Director (Technical) (Operation), BCCL (Nominated)

1.2 Address for Communication with PIN and Phone nos.

PO: Katrasgarh

District: Dhanbad

State:	Jharkhand
PIN:	828113
Mob. (Project Officer):	+91-9470596691

1.3 Location of mine:

Latitude:	23º47’30” N to 23º48’30” N
Longitude:	86º16’45” E to 86º17’30” E.
Area:	Govindpur Area
Coalfield:	Jharia Coalfield

1.4 Capacity of the mine

Date of start of development work: 1945

Date of start of production: 1945

The normative capacity for UG unit works out to 0.1825MT/Annum. The normative capacity for OC unit works out to be 0.237 MT/Annum.

1.5 Method of Mining including Equipment deployment

At present OC work is carried with IV seam as base seam with shovel-dumper combination (Departmental). I & II seams are being worked through Incline using Bord & Pillar method of underground mining with conveyor & SDLs in I seam (Development) and haulage & SDLs in II seam (Development).

1.6 Coal Processing/ Beneficiation Operation

Part of the coal is dispatched through NLG siding (in the leasehold of South Govindpur 4-5 km distance) to Power house. Rest of the coal is dispatched through e-auction.

No coal processing/beneficiation are envisaged for the current output of the mine.

1.7 Total Lease Area Involved : - 367.58 Ha

1.8 Type of Lease Area (Ha):-

Table 1.1 Type of Lease Area

Sl. No.	Particulars	Mining Area(Ha)	Outside mining area(Ha)	Total(Ha)
1	BCCL land	18.44	Nil	18.44
2	Vested land	60.44	Nil	60.44
3	Govt. land	Nil	Nil	Nil
4	Rly land	Nil	Nil	Nil
5	Private Land	288.70	Nil	288.70
	Total (Mine fed data)	367.58		367.58

1.9 Communication and Physiographic

The New Akashkinaree colliery is situated about 10 Kms southern side of NH-2 and 8 Kms northern side of NH-32 and is about 26 Kms west of Dhanbad railway station. D.C. Railway (E.C.R) runs from East to west through Southern side of the property. It is 2.5 Kms from Katras and falls in between Teturia halt .and Katrasgarh Rly station of EC railway.

The area has a rugged topography. The area is generally undulating in the mineable area of the mine with surface elevation ranging from 196 Mts to 212 mts. The area covered under this mining plan is mostly undulating with a significant drainage towards south, which is controlled by seasonal nallahs ultimately discharging in to Bagdigi Jore which falls in to Khudo river which finally falls in to Damodar River.

1.10 Type of Present and proposed land use of mining area (Ha)

Table 1.2 Land Use of Mining Area

Sl.No.	Type of land use	Present mining land use (in Ha)	Post-mining land use (in Ha)
1	Running Quarry		
	Backfilled	20.5	0
	Not back filled	7	0
2	Abandoned quarry		
	- Backfilled		0
	- Not Backfilled	11.81	0
3	External OB dump	28.75	0
4	Service building/ Mine Infrastructure	20	0

Sl.No.	Type of land use	Present mining land use (in Ha)	Post-mining land use (in Ha)
5	Coal dump,	6.4	0
6	Homestead Land	41.6	41.6
7	Agricultural Land	25	25
8	Forest Land		
9	Plantation / reclamation	15	234.54
10	Water Body	7.85	17.85
11	Barren Land	91.44	29.24
12	Others(Rail Road)	19.35	19.35
13	Fire area	72.88	0
	Total	367.58	367.58

1.11 Statutory Approvals

Table 1.3 Statutory Approval Status

Sl. No	Particulars	Status
A	Mine plan / F.R / P.R	Formulated
B	Forestry clearance	Not Required
C	Env clearance	Obtained
D	Consent to operate	Existing Mine
E	Any other approval from Central / State regulatory authorities for operating mine with special reference to mine closure.	Mine closure plan to be approved by BCCL Board of Directors.

1.12 Reasons for Closure

The present OC operations are being carried out with IV Seam as base on north of DB Road which has a balance life of 1 year. There is a proposal to work two OC patches between DB Road and the DC Railway line. The total extractable reserve in the three patches works out to 14.62 MTe(colliery estimates) With the present production capacity of 0.5 MTY, the life works out to 30 years.

The development with SDLs is being carried out in I & II Seams @ 500 TPD. Due to surface and sub-surface constraints, only development is possible under present scenario. The development reserve in the two seams works out to 2.0 MTe (as per colliery estimates). . With the present production of 500 TPD, the life for UG unit works out to 14 years.

A Project Report on Block-IV OCP (6.0 MTY) has been formulated with I seam as Base seam, which covers New Akashkinaree colliery upto the DC Rail line. If this PR is implemented, all the UG outlets of the mine will be excavated. In such a situation, it is envisaged that a New Closure Plan should be drawn up as per the revised scope of mining operations as per the relevant guidelines.

The mine may be closed in future on account of exhaustion of economically recoverable coal reserves in the lease hold area. The mine may also be closed on account of other unforeseen reasons i.e. Force Majeure or directives from statutory organizations or court etc. for which information and notices shall be served to concerned Government authorities and departments. As per guidelines of Ministry of Coal, Govt. of India, Mine Closure Plan has to be submitted along with the mine plan for getting competent approval within one or two years of date of approval of mine plan.

1.12.1 Need of Mine Closure Planning

Mining is a hazardous operation as it offsets the equilibrium of natural depositional environment viz. In-situ stress field, ground water, surface drainage system as well as the socio-economic condition. Although mining activities are usually short term phenomena, they are liable to leave long lasting impacts on landscape, ecology and on the mind set of local inhabitants. Thus, it is imperative that any mining venture should have adequate closure plan addressing issues viz. reclamation and environmental protection, rehabilitation of disturbed area which should be acceptable to local community as well as regulatory authority. Community acceptable implementation of mine closure plan will incur some extra cost, neglecting this aspect will lead to future problems of attending compensation or expensive socio-economic problems.

Mine closure encompasses restoration process designed to restore physical, chemical and biological quality, disturbed by the mining activities. Mine closure is not just something that happens at the end of a mine’s life rather mine closure is an ongoing series of decisions and activities beginning in the pre-mining stage of mine and ending with a creation of self sustainable site that can be returned to the community.

Thus, a mine closure plan needs to define the liabilities, responsibilities and authorities of the different agencies like the mine management, other regulatory bodies, Central and State Governments after mine closure.

Various objectives of the advance mine closure planning are as given below.

- To allow productive and sustainable after-use of the site, which is acceptable to the mine owner and the regulatory authority
- To protect public health and safety
- To eliminate environmental damage and thereby encourage environmental sustainability
- To minimize adverse socio-economic impacts of mining activities
- To protect the flora and fauna of the area affected by the mining
- Effective use of the assets created during the course of mining

Primarily, the mine closure activities are planned in two stages. The initial plan identifies the activities required to be executed in line with the mining activities in progress after the inception of the project i.e., progressive mine closure activities. These activities may undergo subtle changes depending upon the actual site condition during implementation. Finally, a detailed closure plan is to be prepared 4-5 years before the actual closure time of the mine depending upon the existing parameters at that point of time, i.e., final mine closure activities.

1.12.2 Mine closure planning strategy in respect of New Akashkinaree Colliery based on existing set of parameters

As the balance life of the mine is 14 years for UG (only development considered due to geo-mining constraints) and 30 years for OC operations for the considered area, , following activities are envisaged towards mine closure programme in respect of New Akashkinaree Colliery.

a. Progressive mine closure activities will continue as envisaged in the Feasibility report and as enumerated in the various approvals, permits, consents etc.

   The recent guidelines issued in this regard by MoC, GoI should also be followed.

b. Although, it is very difficult to foresee the likely impacts due to closure of the mining activities in the leasehold area of the project, but in the present report, the same has been estimated and some mitigating measures have been suggested based on the estimates. These suggested measures along with certain other measures, as deemed fit, at the time of closure of mining activity in the seams being worked at present shall be taken up.

c. The final closure plan carrying the finer details would be prepared at the time of preparing the mine plan for last mineable patch of coal seam in the leasehold area of the project.

1.13 Approval of Company Board of Directors or any other competent authority (Attach Copy)

The closure plan should be placed to Board of Directors of BCCL for approval.

CHAPTER – II

MINE DESCRIPTION

2.1 Geology of the Block

Geology of the mine has been established by surface and sub surface data from Geological reports of (i) Opencast Block-IV (Seams VIIIC to I/II) & (ii) Opencast Block-IV. Akashkinaree Colliery is located in the western part of Jharia Coalfield. The area is occupied by strata of Barakar formations containing Coking and Non-coking coal seams. The coal bearing rocks of Barakar formation of Lower Permian age occur in the Colliery area under a thin cover of soil and/alluvium (5 to 10m). A dyke trending E-W is present in this area. By and large the coal seams are free from pyrolitisation.

Altogether 10 boreholes have been drilled in Akashkinaree colliery area. All boreholes have been drilled by CMPDI in one series i.e. EKS, with total meterage of 1070.50m. The period of drilling of boreholes is from May’1978 to March’1985. The details of boreholes are given below in the table:-

Table No.2.1 Details of Boreholes

SERIES	DRILLING AGENCY	NO. OF BOREHOLES	METERAGE
EKS	CMPDI	10	1070.50

2.1.1 Geological Structure of the area

Strike & Dip

In general the strike of the formation is E-W and the dip varies from 7° to 16° due south.

Faults

No fault is encountered in this area. However, faults having throw less than 5m could not be ruled out in the area.

2.1.2 General Description of coal seams and its quality

In Akashkinaree colliery, detailed drilling has proved existence of number of coal seams from VIIIB to I/II seam.

2.1.3 Seam sequence

The generalized sequence of coal seams and the intervening partings in New Akashkinaree mine area is given in Table 2.2.

Table2.2: Generalised Seam Sequence and Parting/Quality

SEAM	THICKNESS (m)		AVERAGE THICKNESS (m)	DEPTH RANGE (m)	NO. OF FULL SEAM INTERSECTIONS	GRADE
	MINIMUM	MAXIMUM				
VIIIB	1.77 (EKS-8)	4.20(EKS-31)	3.00	0-65	3	W-II to W-IV/ B
P	3.00	-	-	-	-	-
VIIIA	3.60 (EKS-18)	4.60 (EKS-8)	4.10	0-70	2	W-II to UG
P (VIIIB with VIIIA U.S.	2	-	-	-	-	-
VIIIA U.S.	1.60 (EKS-31)	-	1.60	0-70	1	NA
P	3	-	-	-	-	-
VIIIA B.S.	0.99 (EKS-31)	1.25 (EKS-37)	1.12	0-80	2	NA
P (VIIIA L.S. with VII)	4	8	-	-	-	-
P (VIIIA with VII)	12	-	-	-	-	-
VII	7.16 (EKS-37)	-	7.16	0-90	1	W-III to UG
P (VIIIA with V/VI/VII)	16	-	-	-	-	-
V/VI/VII	26.88 (EKS-8)	-	26.88	0-120	1	NA
P (VII with V/VI)	2	6	-	-	-	-
V/VI	17.23 (EKS-31)	19.88 (EKS-18)	18.56	0-120	3	W-IV to UG/ F
P (V/VI/VII with IVT)	18	-	-	-	-	-
P(V/VI with IVT)	18	31	-	-	-	-
IV T	0.55 (EKS-8)	1.61 (EKS-7)	1.08	0-135	7	E-G
P	2	5	-	-	-	-
IVB	0.40 (EKS-37)	2.64 (EKS-18)	1.52	0-145	6	W-IV to UG/ D-G
P	15	22	-	-	-	-
III	1.90 (EKS-21)	4.80 (EKS-18)	3.35	0-165	9	D-F
P	16	19	-	-	-	-
I/II	0.50(EKS-22)	3.11 (EKS-31)	1.81	0-185	9	W-III to W-IV/ E

2.1.4 Reserves, types and quality

Balance mineable reserves for considered seams have been given in the Table 2.3:

Table-2.3 Seam Thickness, Grade & Reserve

Seam	Thickness (m)	Quality	Mineable Reserve (Mte)#	Remarks
UG				
II	4.26	W-IV	1.00	Only development reserve considered.
I	2.4	W-III	1.00	
Total			2.00	
OC				
Upto IV		W-III	14.62	Reserve spread in three isolated patches
Total			14.62	

Data as furnished by the mine officials

2.2 Mining Details

2.2.1 Mine boundary details

The boundary New Akashkinaree colliery is outlined by following collieries:

North: - Non Coal Bearing Area

West: - Govindpur Colliery & Teturia Colliery.

South: - Tata's Bhelatand Colliery

East: - Salanpur& Katras Coitudih Colliery

2.2.2 Working Seams

The details of the present working seams are given below in Table No 2.4:

Table 2.4 Present Workings

Seam	Production Outlet	Method of work	Production (TPD)
I &II	I&II Seam Incline	B&P (Development)	500
IV seam (Base seam)		OC, Shovel-Dumper Combination	650

2.3 Mining Methods

UG UNIT

Transport - i) Through combination of pony, gate & trunk conveyor belt in I/II Seam .

ii) Combination of Direct and Tugger haulages in III seam.

Ventilation - By Exhaust Fan at surface.

Stowing - Presently development is under progress. No stowing is being done.

The present ventilation system of the Mine is given in Table 2.5:

Table 2.5 Present Ventilation System

Seam	Intake Outlet	Return Outlet	Type	Quantity	Pressure(mm WG)
I Seam	I Seam Haulage Inc	Air Shaft	PV-160	2300 M3/Min.	25
	I Seam traveling Inc.				
II Seam	II Seam Haulage Inc	Air Shaft	PV-160	2300 M3/Min.	25
	II Seam traveling Inc.				

OC UNIT

At present OC work is carried with IV seam as base seam with shovel-dumper combination (Departmental). The details are as follows:

Present status

Present production 0.4 MT per annum

Stripping ratio 1:3.0

Present system of OB dumping - Partly in quarry for backfilling.

Present depth : 80 m

Thickness of top soil : Avg. 2.0 m.

Type of blasting being adopted : Deep hole blasting

Height & width of OB & Coal

	Height	Width
O.B	9.00 m	12.00 m
Coal	5.00 m	10.00 m

Seam wise status of Working.

Table 2.5 Seam wise status of working

Seam		Status
GEO	LOCAL	
XVIC/XVIB	XV	Exhausted
XVI/XVIA	XIV	Exhausted
XV	XIII	Caved out & quarried out, standing on pillar beneath Bagdigi Jore. There is no water, fire exists.
XIV	XII	Quarried out & Mostly caved out, rest standing on pillar beneath D.C Railway & Bagdigi Jore. There is no water, fire exists.
XIII TOP	XI	Quarried out & Mostly caved out, rest standing on pillar beneath D.C Railway & Bagdigi Jore. There is no water, fire exists.
XIII BOTT.	XA.	Developed & Mostly caved out, rest standing on pillar .There is no water, fire may exist.
XI/XII	X	Developed & Mostly caved out, rest standing on pillar. water in dip side , fire may exist
X	IX	Developed & partially caved out , rest standing on pillar. There is water in dip side, fire may exist
IX	VIIIB	Developed & partially caved out, rest standing on pillar. There is water in dip, fire may exist.
VIIIC	VIII A	Developed between DB Road & DC Railway lines, South side of DC Rly. Virgin. There is water in dip, no fire.
VIIIB	VIII	Developed& partially caved between DB Road & DC Railway lines, partially developed in South side of DC Rly. Rest Virgin. There is water in dip, no fire.
VIIIA	VII	Developed & partially caved between DB Road & DC Railway lines, in South side of DC Rly. Virgin. There is water in dip, no fire.
VII T&B	VI/V	Developed between DB Road & DC Railway lines, in South side of DC Rly. Virgin. There is water in dip, no fire.
V/VI T&B	IVT&B	Developed between DB Road & DC Railway lines, in South side of DC Rly. Virgin. There is water in dip, no fire.
IV T	IV	Exhausted in the north side of DB Road & South side of DB Road is Virgin. There is no water in dip, no fire.
III	II	Is being developed.
I/II	I	Is being developed

2.3.1 Depth of Workings

UG UNIT

The working seams occur at depth of about 160-170 m in the colliery.

OC UNIT

The working seams occur at depth of about 75-85 m in the colliery.

2.3.2 Mine Entries

Table 2.6 Details of Present Mine Entries

Seam	Outlet	Status
I Seam	I Seam Haulage Incline 12.6m2(x-section)	Direct Haulage 100 HP.Intake
	I Seam Travelling Incline 12.6m2(x-section)	Traveling roadway, intake
	Air shaft Dia 4.2m, depth 6.31 m	Return PV 160(Exhas.)60 HP – WG-25mm
II Seam	II Seam Haulage Incline 12.6m2(x-section)	Haulage 100 HP. Intake
	II Seam Travelling Incline 12.6m2(x-section)	Traveling roadway, intake
	Air shaft Dia 3.60 m, depth 14.20 m	Return. PV 160(Exhas.) 100 HP. WG-25mm

Development

Board and Pillar method of development has been proposed in the seam with SDLs loading onto tubs in III seam and Board and withSDLs loading onto conveyor belt in I seam. Exploitation of seam has been considered as long as the developmental reserve is available in the seam. The development district will consist of 5 level headings as far as possible leaving a panel barrier of one pillar width between the panels. The development shall be carried out by blasting off the solid. The width & height of the development galleries shall be restricted to 4.8 m & 3 m respectively. The depth of working as per the provision of Regulation 99 (4) of CMR 1957 shall govern the size of the pillar.

The panels shall be laid out in a manner, as far as possible, to be self-draining. The incubation period of coal seam shall be taken into account for sub-panelling, wherever required.

Coal loading at the face will be done by mean of SDL and loaded into tubs. Then the loaded tubs will be hauled by tugger haulage for onwards feeding to main level district haulage which will feed the tubs to the surface haulage line and from where tubs hauled up to the surface in III seam and Coal loading at the face will be done by mean of SDL and loaded onto pony belt. Pony belt feeding to gate belt and gate belt feeding to trunk belt in I/II SEAM.

The cycle of face operation in mechanized Board and Pillar mining would be as follows:

- Face preparation
- Drilling
- Charging, blasting and smoke clearing
- Dressing and supporting
- Machine fitting SDL
- Coal loading by SDL
- Face supporting,

2.3.3 Major Equipment

UG UNIT

Table 2.7A Details of Major Equipments (in UG unit)

Sl. No.	Equipment	Nos.
	SURFACE	
1	Haulage 100HP	2
2	MMV-AF65(60HP)	2
3	Transformer(1000KVA,6.6KV/440)	4
4	Lighting Transformer750KVA,6.6KV/440)	2
5	Submersibles pumps 160 HP	2
6	Submersibles pumps 120 HP	1
	UNDERGROUND	
1	Lower Height SDL	8
2	Tugger Haulage 37 KW	1
3	Coal Drill(1.5HP)	8
4	Pumps(150HP)	4
5	Roto Pump(12.5HP)	4
6	315KVA Transformer(TSU)	4

OC UNIT

Table 2.7B Details of Major Equipments (in OC unit)

Sl.No.	Machines	Capacity	Make	On Roll
2(Die)	EKG SHOVEL	3.2 cum	HEC	1
2(Die)	Hydraulic shovel CK – 300	2.7 cum.	L&T	4
4(Die)	D-155 –Dozer	320 HP	BEML	3
4(Die)	D-355 –Dozer	320 HP	BEML	1
5(Die)	HD Dumper	35 Te	BEML.	23
	Drill IDM 30	160 mm	IR	5
7(Die)	ICM – 260 Drill	100 mm	IR	1
9(Die)	Escort Crane	8 Te.	Escorts	1
10(Die)	Jeep(Diesel)		Mahindra	1
11(Die)	Truck		Tata	4
13(Die)	Water Tanker		BEML	1

2.4 Infrastructure Details

Workshop & Store:

- Auto workshop at Area Level-Light vehicle breakdown is attended here.
- Regional Store at Area Level.

Magazine – Location, capacity and area

There is a magazine available in the Mine leasehold within 0-1km. The requirement of explosives and detonators are met from the magazine .Its capacity is given below-

D-F=1500M

Explosive=900kg.

Detonators=20000 nos (class-VI, Division-III)

After 15 rotations/month the consumption is fulfilled

Infrastructure facilities available (Road, water supply etc.) –

Two nos. of DB road are available within the lease hold area of the mine, one is connected to Mahuda Rajganj and another is connected to Mahuda Katras. Pit water to the colonies is supplied through I seam, V/VI Submersible Pump.

Nos. of coal stock yard & location –

Heap No.2 (Near I Seam Incline)
Heap No.2A (Near II Seam Haulage)
Heap No. 6(Near II Seam Incline)
Heap No. 14(Near II Seam)
Heap No. 14A (Beside haul road)
Heap No. 15 (East of attn. room OCP)
Heap No. 13 (Near f attn. room OCP)
Heap No. 12 (Near OCP shed)
Heap No. 11 (Near weigh bridge E/ katras)
Heap No. 11 A (south of weigh bridge E/ katras)

Existing effluent treatment plant & sewage treatment plant (Mine & Colony) – At present there is no ETP & STP available in the mine. Mine water discharged through settling tank.

Present power supply:

- Source-DVC, installed capacity- From Bilbara substation 11 KV to I Seam Sub Station through 14No. Feeder.

Details of Transformer

- 1MVA, 11KV/550V - 1 No.
- 500 KVA ,11KV/ 440 V –1 No.(Lighting,)
- 5KVA ,11KV/ 440 V 1 No.(Lighting,)

2.5. Details of coal beneficiation plant and its use after closure of mine

No beneficiation plant is present in the leasehold area of the boundary.

CHAPTER – III

CLOSURE PLAN AND RELATED ACTIVITIES

3.1 Closure Planning details of mine

The progressive mine closure activities will continue as envisaged in the mining plan, if any, and as enumerated in the various approvals, permits, consents etc. It is very difficult to predict the various parameters which would be prevalent at the time of final mine closure and also to foresee the likely impacts due to closure of the mining activities (when the entire block reserve would get exhausted). However, broad mine closure activities need to be identified under the various heads.

New Akashkinaree Colliery falls in Cluster III for the purpose of EMP.

3.1.1 Mined out Land & proposed final land use

Management of mined out area

a) The present OC operations are being carried out with IV Seam as base on north of DB Road which has a balance life of 1 year. There is a proposal to work two OC patches between DB Road and the DC Railway line. The total extractable reserve in the three patches works out to 14.62 MTe. With the present production of 0.5 MTY, the life works out to 30 years.

The development with SDLs is being carried out in I & II Seams @ 500 TPD. Due to surface and sub-surface constraints, only development is possible under present scenario. The development reserve in the two seams works out to 2.0 MTe (as per colliery estimates). . With the present production of 500 TPD, the life works out to 14 years.

A Project Report on Block-IV OCP (6.0 MTY) has been formulated with I seam as Base seam, which covers New Akashkinaree colliery upto the DC Rail line. If this PR is implemented, all the UG outlets of the mine will be excavated. In such a situation, it is envisaged that a New Closure Plan should be drawn up as per the revised scope of mining operations as per the relevant guidelines.

The proposed post-mining land use plan vis-à-vis present land use is provided in Para 1.10.

a. Total Mined out area (Ha) – Present + Proposed----156.66Ha
b. Backfilled area (Ha) ----------146.66 Ha
c. Balance left mined out area (Ha) which will not be backfilled---10.00Ha
d. Land use of this balanced left mined out area: may be water filled in monsoon based on future mine plans.

The water filled area will be handed over to State Authorities for conversion into a picnic spot with proper fencing and security**.** If necessary the lagoon may also be used by the State authority for supplying water to local community after proper treatment of the same.

b) Mining is to be carried out in a phased manner initiating afforestation work in the mined out area of the first phase while commencing the mining in the second phase i.e. continuation of mining activities from one phase to other indicating the sequence operations depending upon the geo-mining conditions of the mine. Progressive mine closure plan shall be prepared for period of five years from the beginning of the mining operations. These plans would be examined periodically in every five years period and to be subjected to third party monitoring by the agencies approved by the Central Government for the purpose (NEERI, CMPDIL, ISM etc. as per current guidelines).

c) As regards, the underground void, if any, which will remain at the time of closure of the mine, the same will get gradually filled with water. The necessary precautions for the safety of the neighboring mine would be taken care of before deciding the voids to get water filled. Further, the water filled in UG voids will help in maintaining the water level in the nearby Area. The inclines will be covered with RCC structure with suitable opening for inspection by competent person.

d) The existing quarries shall act as water reservoir to help recharge the ground water table in the vicinity. All the available places amenable for plantation shall be planted with appropriate species in consultation with forest department.

3.2 Water quality management

3.2.1 Drainage pattern of the area (pre and post closure)

3.2.1.1Existing drainage pattern

The area has a rugged topography. The area is generally undulating in the mineable area of the mine with surface elevation ranging from 196 Mts to 212 mts. The area covered under this mining plan is mostly undulating with a significant drainage towards south, which is controlled by seasonal nallahs ultimately discharging in to Bagdigi Jore which falls in to Khudo river which finally falls in to Damodar River.

In course of mining, if any disturbance affecting the drainage pattern is caused, efforts shall be made to restore the normal drainage pattern as far as possible. If the restoration of original drainage profile is not feasible, efforts shall be made to achieve a drainage profile, which will ensure smooth drainage of the area with least possible surface erosion.

3.2.1.2 Post closure drainage pattern

Major area of the mine will be depillared with stowing. As mining of the property is associated with stowing, the general drainage pattern of the area would not get disturbed. Depression, if any, will be suitably filled with non - combustible rocks and cohesive soils, dozed and graded. If some minor alteration takes place, the natural drainage profile of the entire leasehold area would be kept maintained in a manner which will facilitate the normal run-off. Garland drain may be constructed to ensure the controlled drainage of the area.

3.2.2 Water Quality Status of Surface and Ground Water

3.2.2.1 Present Practice

Samples of mine water as well as drinking water are collected and were analysed for relevant physical, chemical and bacteriological parameters as per the norms stipulated by MOEF.

Water samples are collected as per standard procedure {IS: 3025 (part I) – 1987} and analyzed as per procedures outlined in relevant volume of BIS 3025 / NEERI / standard Methods (AAPHA).

If any deviation from the prescribed water quality standard is detected, the appropriate remedial actions shall immediately be enforced and frequency of sampling shall be increased till the water quality becomes normal. The source of contamination shall be identified and removed. The contaminated water bodies shall be suitably treated.

3.2.2.2 Present status of water quality

The monitoring of water quality under Baseline Environment Data Generation for Cluster III has been conducted M/S PDIL, Sindri by collecting water samples from ground water, surface water and mine water discharge / workshop discharge (if any) for the proposed project. The various purposes of the water environment monitoring are as follows:

- To assess the water quality characteristics for critical parameters;
- To evaluate the impacts on agricultural productivity, habitat conditions, creational resources and aesthetics in the vicinity ; and
- To facilitate predication of impact on water quality by project activities

The results as per PDIL Report are given subsequently.

Details of sampling location are given in Table 3.1 to 3.3 for Ground water, Surface water and effluent water.

To assess the quality of drinking water around the project area, the samples were collected from the following locations in and around the project area:

TABLE - 3.1
Sampling Location for Ground Water

Project Site: Cluster III **Period:** 19^{th} March-18^{th} June 2011

Sl. No.	Name of Sampling Locations	Frequency	Location Code
01.	Hand Pump – Katras Township	Once in a season	GW_1
02.	Hand Pump - Muraidih Village	Once in a season	GW_2
03.	Hand Pump - Sogiadih Village	Once in a season	GW_3

To assess the quality of lotic system (surface water), water samples were collected from the locations (Refer to PDIL Report) given in Table No. 3.2.

TABLE – 3.2
Sampling Location for Surface Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No	Name of Sampling Locations	Frequency	Location Code
01.	Khudia Nala U/S	Once in a season	SW_1
02.	Khudia Nala D/S	Once in a season	SW_2
03.	Pond Water – Near Harna Village	Once in a season	SW_3
04.	Bagdigi Jore U/S	Once in a season	SW_4
05.	Bagdigi Jore D/S	Once in a season	SW_5

To assess the quality of waste water discharge, water samples were collected from the locations given in Table 3.3.

TABLE – 3.3
Sampling Location for Industrial Effluent/Mine Water

Project Site: Cluster III **Period:** 19th March-18th June 2011

Sl. No.	Name of Sampling Locations	Frequency	Location Code
01.	Mine Water Discharge- Jogidih UGP	Once in a season	MW_1
02.	Mine Water Discharge- Maheshpur UGP	Once in a season	MW_2
03.	Workshop Discharge – Block IV/ Kooridih OCP (After Oil & Grease Trap)	Once in a season	WW_1
04.	Workshop Discharge – New Akashkinari OCP (After Oil & Grease Trap)	Once in a season	WW_2

The physico-chemical characteristics of three nos. of ground water samples collected from three different locations have been presented in Table 3.4.

TABLE – 3.4

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results			Detection Limit	IS:10500 Desirable/ Permissible Limits
		GW_1	GW_2	GW_3		
PHYSICAL						
1	pH	8.2	7.6	7.8	-	6.5-8.5
2	Temperature (^{O}C)	29.8	30.1	30.2	-	-
3	Colour, HU	<2	<2	<2	-	5/25
4	Odour	Unobj.	Unobj.	Unobj.	-	Unobj.
5	Taste	Agreeable	Agreeable	Agreeable	-	Agreeable
6	Turbidity (NTU)	<5	<5	<5	-	5/10
7	Total Suspended Solid	4	6	6	-	-
8	Total Dissolved Solids	500	552	330	-	500/2000
CHEMICAL						
1	P- Alkalinity as $CaCO_3$	NIL	NIL	NIL	-	-
2	Total Alkalinity as $CaCO_3$	212	184	66	-	200/600
3	Chloride as Cl	44	64	26	-	250/1000
4	Sulphate as SO_4	146	168	134	-	200/400
5	Nitrate as NO_3	1.5	1.4	1.2	-	45/100
7	Fluoride as F	0.6	0.5	0.5	-	1.0/1.5
8	Total Hardness as $CaCO_3$	384	386	164	-	300/600
9	Calcium Hardness as $CaCO_3$	200	262	112	-	75/200*
10	Magnesium Hardness as $CaCO_3$	184	124	52	-	30**
11	Sodium as Na	18	27	34	-	-
12	Potassium as K	2	3	4	-	-
13	Silica as SiO_2	16	22	22	-	-
HEAVY METALS						
1	Iron as Fe	0.08	0.8	0.3	0.04	0.3/1.0
2	Manganese as Mn	<0.05	<0.05	<0.05	0.05	0.1/0.3
3	Total Chromium as Cr	NT	NT	NT	0.01	0.05
4	Lead as Pb	NT	NT	NT	0.05	0.05
5	Zinc as Zn	0.14	0.16	0.14	-	5.0/15
6	Cadmium as Cd	NT	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	NT	0.02	0.05/1.5
8	Nickel as Ni	NT	NT	NT	-	0.01
9	Arsenic as As	NT	NT	NT	0.01	0.05
10	Selenium as Se	NT	NT	NT	0.01	0.01
OTHERS						
1	Mineral Oil	NT	NT	NT	-	0.01/0.03
2	Phenolic Compound as C_6H_5OH	NT	NT	NT	0.001	0.001/0.002
3	Coliform Organisms (MPN/100ml)	< 20	< 20	< 20	-	Absent

Note: 1) BDL – Below Detectable Level. 2) NT- Not Traceable
3) *-Calcium as Ca 4) **-Magnesium as Mg

Results & Discussion

The physico-chemical characteristics of the ground water samples showed great resemblance with respect to the characteristics like temperature, turbidity, pH, colour, odour, chloride, sulphate, total alkalinity, total hardness, TDS and heavy metals, etc. The range of concentrations of drinking water parameters were observed as given in Table No. 3.5.

TABLE – 3.5

Ground Water Quality at a Glance in Comparison to Drinking Water Standard

Parameters	Range of recorded Concentration (Results expressed in mg/l except pH)		
	Minimum	Maximum	Desirable/Permissible Limits as per IS: 10500
pH	7.6	8.2	6.5-8.5
Total Suspended Solid	4	6	-
Total Dissolved Solids	330	552	500 / 2000
Total Alkalinity as $CaCO_3$	66	212	200 / 600
Total Hardness, as $CaCO_3$	164	386	300 / 600
Chloride as Cl	26	64	250 / 1000
Sulphate as SO_4	134	168	200 / 400
Nitrate as NO_3	1.2	1.5	45/ 100
Iron as Fe	0.08	0.8	0.3 / 1.0

From the results presented in Table- 3.5, the Physico-chemical characteristics of the ground water samples were in good agreement with IS: 10500. All the parameters are within the limits specified under Drinking Water Standard (IS: 10500). As regards heavy metals, only Fe and Zn have been recorded with lower concentration & rest were not traceable. The ground water can be safely used for potable purposes.

The physico-chemical characteristics of five nos. of surface water samples collected from five different locations have been presented in Table nos. 3.6(A) and 3.6(B) respectively.

TABLE – 3.6 (A)

PHYSICO-CHEMICAL CHARACTERISTICS OF SURFACE WATER QUALITY

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	PARAMETERS	ANALYSIS RESULTS			DETECTION LIMIT	Limit as per IS: 2296 Class 'C'
		SW1	SW2	SW3		
PHYSICAL						
1	pH	7.9	7.5	7.8	-	6.5-8.5
2	Temperature (^{O}C)	29.2	29.3	30.1	-	*
3	Colour, HU	<2	<2	<2	-	300
4	Odour	Unobj.	Unobj.	Unobj.	-	*
5	Turbidity (NTU)	8	10	14	-	*
6	Total Suspended Solids	6	8	12	-	
7	Total Dissolved Solids	293	297	470	-	1500
CHEMICAL						
1	P- Alkalinity as $CaCO_3$	NIL	NIL	NIL	-	*
2	Total Alkalinity as $CaCO_3$	78	64	142	-	*
3	Chloride as Cl	36	38	90	-	600
4	Sulphate as SO_4	96	104	120	-	400
5	Nitrate as NO_3	2.6	2.6	4.6	-	50
6	Fluoride as F	<0.4	<0.4	<0.4	-	1.5
7	Total Hardness as $CaCO_3$	210	214	394	-	*
8	Calcium Hardness as $CaCO_3$	136	142	226	-	*
9	Magnesium Hardness as $CaCO_3$	74	72	168	-	*
10	Dissolve Oxygen	6.6	6.4	5.8	-	4.0
11	COD	06	06	04	-	*
12	BOD (3 days at 27^{o}C)	2.4	2.4	2.2	-	3.0
13	Total Kjeldahl Nitrogen as N	0.52	0.54	0.62	-	*
14	Sodium as Na	9	6	2	-	*
15	Potassium as K	1	1	1	-	*
16	Silica as SiO_2	12	14	12	-	*
HEAVY METALS						
1	Iron as Fe	0.08	0.09	0.06	0.04	5.0
2	Manganese as Mn	<0.05	<0.05	<0.05	0.05	*
3	Total Chromium as Cr	NT	NT	NT	0.006	0.05
4	Lead as Pb	NT	NT	NT	0.04	0.1
5	Zinc as Zn	0.12	0.14	0.14	-	15.0
6	Cadmium as Cd	NT	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	NT	0.02	1.5
8	Nickel as Ni	NT	NT	NT	-	*
9	Arsenic as As	NT	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	NT	0.01	0.05
11.	Cyanide as CN	NT	NT	NT	0.02	0.05
12.	Mercury as Hg	NT	NT	NT	0.001	
OTHERS						
1	Oil & Grease	BDL	BDL	BDL	0.1	0.1
2	Phenolic Compound as C_6H_5OH	NT	NT	NT	0.001	0.005
3	Coliform Organisms (MPN/100ml)	1.9 x 10^3	2.0 x 10^3	2.3 x 10^3	-	5000

Note: 1) BDL – Below Detectable Level; 2) * - Limit Not specified; 3) NT- Not Traceable

TABLE – 3.6 (B)

PHYSICO-CHEMICAL CHARACTERISTICS OF SURFACE WATER QUALITY

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	PARAMETERS	ANALYSIS RESULTS		DETECTION LIMIT	Limit as per IS: 2296 Class 'C'
		SW4	SW5		
PHYSICAL					
1	pH	7.2	7.3	-	6.5-8.5
2	Temperature (^{O}C)	29.2	29.4	-	*
3	Colour, HU	<2	<2	-	300
4	Odour	Unobj.	Unobj.	-	*
5	Turbidity (NTU)	6	8	-	*
6	Total Suspended Solids	14	16	-	
7	Total Dissolved Solids	486	510	-	1500
CHEMICAL					
1	P- Alkalinity as $CaCO_3$	NIL	NIL	-	*
2	Total Alkalinity as $CaCO_3$	160	164	-	*
3	Chloride as Cl	68	72	-	600
4	Sulphate as SO_4	140	146	-	400
5	Nitrate as NO_3	4.6	4.8	-	50
6	Fluoride as F	<0.4	<0.4	-	1.5
7	Total Hardness as $CaCO_3$	386	390	-	*
8	Calcium Hardness as $CaCO_3$	240	244	-	*
9	Magnesium Hardness as $CaCO_3$	146	146	-	*
10	Dissolve Oxygen	6.0	5.8	-	4.0
11	COD	3.8	04	-	*
12	BOD (3 days at 27^{o}C)	<2.0	<2.0	-	3.0
13	Total Kjeldahl Nitrogen as N	BDL	BDL	-	*
14	Sodium as Na	8	13	-	*
15	Potassium as K	1	2	-	*
16	Silica as SiO_2	10	12	-	*
HEAVY METALS					
1	Iron as Fe	0.16	0.16	0.04	5.0
2	Manganese as Mn	<0.05	<0.05	0.05	*
3	Total Chromium as Cr	NT	NT	0.006	0.05
4	Lead as Pb	NT	NT	0.04	0.1
5	Zinc as Zn	0.12	0.14	-	15.0
6	Cadmium as Cd	NT	NT	0.01	0.01
7	Copper as Cu	NT	NT	0.02	1.5
8	Nickel as Ni	NT	NT	-	*
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11.	Cyanide as CN	NT	NT	0.02	0.05
12.	Mercury as Hg	NT	NT	0.001	
OTHERS					
1	Oil & Grease	BDL	BDL	0.1	0.1
2	Phenolic Compound as C_6H_5OH	NT	NT	0.001	0.005
3	Coliform Organisms (MPN/100ml)	2.0 x 10^3	2.0 x 10^3	-	5000

Note: 1) BDL – Below Detectable Level; 2) * - Limit Not specified; 3) NT- Not Traceable

Results & Discussion

The physico-chemical characteristics of the surface water samples collected from the five locations have shown great resemblance with respect to the characteristics like temperature, turbidity, pH, colour, odour, chloride, sulphate, total alkalinity, total hardness, TDS and heavy metals, etc. The range of concentrations of important parameters of surface water characteristics have been presented in Table No. 3.7.

TABLE –3.7
Surface Water at a Glance

Parameters	**Range of recorded Concentration (Results expressed in mg/l except pH)**		
	Minimum	**Maximum**	**Limit as per IS: 2296 Class 'C'**
pH	7.2	7.9	6.5-8.5
Total Suspended Solids	6	16	-
Total Dissolved Solids	293	510	1500
Total Hardness, as $CaCO_3$	210	394	-
Calcium Hardness, as $CaCO_3$	136	244	-
Chloride as Cl	36	90	600
Sulphate as SO_4	96	146	400
Nitrate as NO_3	2.6	4.8	50
Iron as Fe	0.06	0.16	5.0

From the results presented in Table- 3.6(A) and Table- 3.6(B), it may safely be concluded that the physico-chemical characteristics of the surface water samples had a good resemblance with respect to almost all the parameters and were well within limits specified in Surface Water Standard IS: 2296. As regards heavy metals, except Iron and Zinc, all the other were not traceable. From the above, it may be concluded that all the parameters of the surface water samples were well within the specified limits of IS: 2296 Class ‘C’.

The physico-chemical characteristics of mine water & workshop effluent discharge samples collected from different locations have been presented hereunder in Table-3.8(A) & Table-3.8(B) respectively.

TABLE – 3.8 (A)

PHYSICO-CHEMICAL CHARACTERISTICS OF WASTE WATER DISCHARGE

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results			MOEF Standard Schedule-VI
		MW1	MW2	Detection Limit	
PHYSICAL					
1	pH	6.5	6.9	-	5.5-9.0
2	Temperature (^{O}C)	29.6	30.4	-	Te<Ts+5ºC
3	Colour,HU	<2.0	<2.0	-	*
4	Odour	Unobj.	Unobj.	-	Unobjectionable
5	Turbidity (NTU)	8	10	-	*
6	Total Suspended Solids	4	6	-	100
7	Total Dissolved Solids	870	814	-	*
CHEMICAL					
1	Total Alkalinity as $CaCO_3$	146	170	-	*
2	Chloride as Cl	60	74	-	*
3	Sulphate as SO_4	448	360	-	*
4	Nitrate as N	1.2	1.3	-	10
5	Dissolve Phosphate as PO_4	BDL	BDL	-	5.0
6	Fluoride as F	<0.4	<0.4	-	2.0
7	Total Hardness as $CaCO_3$	660	614	-	*
8	Calcium Hardness as $CaCO_3$	320	364	-	*
9	COD	6.2	6.4	-	250
10	BOD (3 days at 27^{O}C)	2.4	2.2	-	30
11	Total Kjeldahl Nitrogen as N	BDL	BDL	0.01	100
12	Sodium as Na	16	15	-	*
13	Potassium as K	3	2	-	*
14	Sulphide as S	BDL	BDL	0.01	2.0
15	Ammonical Nitrogen as N	0.46	0.32	0.02	50
HEAVY METALS					
1	Iron as Fe	0.1	0.1	0.04	3.0
2	Manganese as Mn	<0.05	<0.05	0.05	2.0
3	Lead as Pb	NT	NT	0.4	0.1
4	Zinc as Zn	0.24	0.26	-	5.0
5	Copper as Cu	NT	NT	0.5	3.0
6	Nickel as Ni	NT	NT	0.1	3.0
7	Mercury as Hg	NT	NT	0.01	0.01
8	Cyanide as CN	NT	NT	0.01	0.2
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11	Vanadium as V	NT	NT	0.01	0.2
12	Cadmium as Cd	NT	NT	0.002	2.0
13	Hexavalent Chromium as Cr^{+6}	NT	NT	0.1	0.1
14	Total Chromium as Cr	NT	NT	0.006	2.0
OTHERS					
1	Oil & Grease	<2.0	<2.0	-	10
2	Phenolic Compound C_6H_5OH	NT	NT	0.001	1.0

Note: 1) BDL – Below Detectable Level; **2)** NT – Not Traceable

TABLE – 3.8 (B)

PHYSICO-CHEMICAL CHARACTERISTICS OF WASTE WATER DISCHARGE

(Wherever not specified, characteristics are expressed in mg/l)

Period: 19th March-18th June 2011 **Date of Sampling:** 18.05.2011

Sl. No.	Parameters	Analysis Results			MOEF Standard Schedule-VI
		WW1	WW2	Detection Limit	
PHYSICAL					
1	pH	7.4	7.5	-	5.5-9.0
2	Temperature (^OC)	30.1	31.2	-	Te<Ts+5ºC
3	Colour,HU	<2.0	<2.0	-	*
4	Odour	Unobj.	Unobj.	-	Unobjectionable
5	Turbidity (NTU)	16	18	-	*
6	Total Suspended Solids	10	12	-	100
7	Total Dissolved Solids	782	840	-	*
CHEMICAL					
1	Total Alkalinity as $CaCO_3$	160	154	-	*
2	Chloride as Cl	30	36	-	*
3	Sulphate as SO_4	118	124	-	*
4	Nitrate as N	2.2	3.2	-	10
5	Dissolve Phosphate as PO_4	BDL	BDL	-	5.0
6	Fluoride as F	<0.4	<0.4	-	2.0
7	Total Hardness as $CaCO_3$	714	720	-	*
8	Calcium Hardness as $CaCO_3$	428	432	-	*
9	COD	7.6	6.4	-	250
10	BOD (3 days at 27^OC)	2.5	2.2	-	30
11	Total Kjeldahl Nitrogen as N	0.68	0.62	0.01	100
12	Sodium as Na	14	17	-	*
13	Potassium as K	2	3	-	*
14	Sulphide as S	BDL	BDL	0.01	2.0
15	Ammonical Nitrogen as N	1.24	1.26	0.02	50
HEAVY METALS					
1	Iron as Fe	0.08	0.09	0.04	3.0
2	Manganese as Mn	<0.05	<0.05	0.05	2.0
3	Lead as Pb	NT	NT	0.4	0.1
4	Zinc as Zn	0.14	0.16	-	5.0
5	Copper as Cu	NT	NT	0.5	3.0
6	Nickel as Ni	NT	NT	0.1	3.0
7	Mercury as Hg	NT	NT	0.01	0.01
8	Cyanide as CN	NT	NT	0.01	0.2
9	Arsenic as As	NT	NT	0.01	0.2
10	Selenium as Se	NT	NT	0.01	0.05
11	Vanadium as V	NT	NT	0.01	0.2
12	Cadmium as Cd	NT	NT	0.002	2.0
13	Hexavalent Chromium as Cr^{+6}	NT	NT	0.1	0.1
14	Total Chromium as Cr	NT	NT	0.006	2.0
OTHERS					
1	Oil & Grease	<2.0	<2.0	-	10
2	Phenolic Compound C_6H_5OH	NT	NT	0.001	1.0

Note: 1) BDL – Below Detectable Level; **2)** NT – Not Traceable

<u>Results & Discussion</u>

The range of concentrations of important parameters of waste water characteristics are given in Table No. 3.9.

TABLE – 3.9
Waste Water Discharge at a Glance

Parameters	Range of recorded Concentration (Results expressed in mg/l except pH)		
	Minimum	Maximum	Limits As per MoEF Notification (Sch.-VI)
pH	6.5	7.5	5.5-9.0
Total Suspended Solids	4	12	100
Total Dissolved Solids	782	870	-
Total Hardness as $CaCO_3$	614	720	-
Chemical Oxygen Demand	6.2	7.6	250
Chloride as Cl	30	74	-
Sulphate as SO_4	118	448	-
Nitrate as N	1.2	3.2	10
Iron as Fe	0.08	0.1	3

From the results shown above, it may be safely concluded that the Physico-chemical characteristics of the discharge water samples collected from the four locations for one season had variations with respect to almost all the parameters but were well within the limits of **General Standards for Discharge of Effluents (Table 3.10).** As regards heavy metals, like Iron was also within limits.

TABLE –3.10
GENERAL STANDARDS FOR DISCHARGE OF EFFLUENTS
[The Gazette of India – Extraordinary {Part II- Sec. 3(i)} Ministry of Environment and Forests Notification New Delhi, 19th May, 1993]

Sl. No.	Parameters	Standards			
		Inland Surface Water (a)	Public Sewers (b)	Land for irrigation (c)	Marine coastal areas (d)
1	Colour and odour	Note-1	Note-1	Note-1	Note-1
2	Suspended Solids, mg/l max.	100	600	200	Note-2
3	Particle size of Suspended Solids.	Note-3	-	-	Note-4
4	Dissolved solids (inorganic) mg/l max.	2100	-	2100	-
5	pH value	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
6	Temperature, ^{O}C	Note-5	-	-	Note-5
7	Oil & grease, mg/l max.	10	20	10	20

Sl. No.	Parameters		Standards			
			Inland Surface Water	**Public Sewers**	**Land for irrigation**	**Marine coastal areas**
			(a)	**(b)**	**(c)**	**(d)**
8	Total residual chlorine, mg/l max.		1.0	-	-	1.0
9	Ammonical Nitrogen (as N), mg/l. max.		50	50	-	50
10	Total Kjeldahl nitrogen (as NH_3), mg/l max.		100	-	-	100
11	Free ammonia (as N), mg/l max.		5	-	-	5
12	Biochemical Oxygen Demand (3 days at 27^oC), max.		30	350	100	100
13	Chemical Oxygen Demand, mg/l max.		250	-	-	250
14	Arsenic (as As), mg/l max.		0.2	0.2	0.2	0.2
15	Mercury (as Hg), mg/l max.		0.01	0.01	-	0.01
16	Lead (as Pb), mg/l max.		0.1	1.0	-	2.0
17	Cadmium (as Cd), mg/l max.		2.0	1.0	-	2.0
18	Hexavalent Chromium (as Cr^{+6}), mg/l. max.		0.1	2.0	-	1.0
19	Total Chromium (as Cr), mg/l max.		2.0	2.0	-	2.0
20	Copper (as Cu), mg/l max.		3.0	3.0	-	3.0
21	Zinc (as Zn), mg/l max.		5.0	15	-	15
22	Selenium (as Se), mg/l max.		0.05	0.05	-	0.05
23	Nickel (as Ni), mg/l max.		3.0	3.0	-	5.0
24	Boron (as B), mg/l max.		2.0	2.0	2.0	2.0
25	Percent Sodium, max.		-	-	60	-
26	Residual sodium carbonate, mg/l max.		-	-	5.0	-
27	Cyanide (as CN) mg/l max.		0.2	2.0	0.2	0.2
28	Chloride (as Cl) mg/l max.		1000	1000	600	-
29	Fluoride (as F) mg/l max.		2.0	15	-	15
30	Dissolved Phosphate (as P), mg/l max.		5.0	-	-	-
31	Sulphate (SO_4) mg/l max.		1000	1000	1000	-
32	Sulphide (as S), mg/l max.		2.0	-	-	5.0
33	Phenolic Compound (C_6H_5OH), mg/l max.		1.0	5.0	-	5.0
34	Radioactive materials:					
	(a) Alpha emitters, µc/ml max.		10^{-7}	10^{-7}	10^{-7}	10^{-7}
	(b) Beta emitters, µc/ml max.		10^{-6}	10^{-7}	10^{-6}	10^{-7}
35	Bio-assay test		Note-6	Note-6	Note-6	Note-6
36	Manganese (as Mn) mg/l max.		2.0	2.0	-	2.0
37	Iron (as Fe) mg/l max.		2	3	-	3
38	Vanadium (as V), mg/l max.		0.2	0.2	-	0.2
39	Nitrate Nitrogen, mg/l max.		10	-	-	20
40	Pesticides, µg/l max.					
	(i)	Benzene Hexachloride				
	(ii)	Carbaryl	10	-	10	10
	(iii)	DDT	10	-	10	10
	(iv)	Endosulfan	10	-	450	450
	(v)	Dimethoate	10	-	10	10

Sl. No.	Parameters		Standards			
			Inland Surface Water	Public Sewers	Land for irrigation	Marine coastal areas
			(a)	(b)	(c)	(d)
	(vi)	Fenitrothion	10	-	10	10
	(vii)	Malathion	10	-	10	10
	(viii)	Phorate	10	-	10	10
	(ix)	Methyl Parathion	10	-	10	10
	(x)	Phenthoate	10	-	10	10
	(xi)	Pyrethrums	10	-	10	10
	(xii)	Copper oxychloride	9600	-	9600	9600
	(xiii)	Copper sulphate	50	-	50	50
	(xiv)	Ziram	1000	-	1000	1000
	(xv)	Sulphur	30	-	30	30
	(III)	Paraquat	2300	-	2300	2300
	(IIIi)	Propanil	7300	-	7300	7300
	(IIIii)	Nitrofen	780	-	780	780

Note-1: All efforts should be made to remove colour and unpleasant odour as far as practicable.

Note-2: (a) For process water – 100,

(b) For cooling water effluent, 10% above total suspended matter in influent.

Note-3: Shall pass 850 micron IS sieve.

Note-4: (a) Floatable solids-max. 3 mm.

(b) Settleable solids-max. 850microns.

Note-5: Shall not exceed 5^{0}C above the receiving water temperature.

Note-6: 90% survivals of fish after 96 hours in 100% effluent.

3.2.2.3 Practice after the closure

The above practice of monitoring of quality of water would be continued for a period of 3 years after cessation of mining activity. If required, corrective action/steps would be taken to mitigate any adverse effect on local water regime. The responsibility of maintaining the quality of drinking water will be entrusted on the State Authorities after 3 years of mine closure.

3.2.3 MEASURES FOR CONTROL OF POLLUTION (DETAILS FOR POLLUTION CONTROL ARRANGEMENT)

3.2.3.1 IMPACT DUE TO WATER POLLUTION AND ITS MANAGEMENT

The mine discharge water may contain high-suspended solids and other pollutants. The treatment scheme thus needs to focus on the removal of suspended solids from the water. Pit water must be treated to meet the prescribed standards before being discharged into water bodies. When the water is used for agricultural or domestic work, it shall undergo further treatment, as established by Scientific Studies conducted in this regard. The important factors to be considered in selecting the appropriate method for treatment are as follows:

(a) Settling tank will be provided to collect the mine discharged water for settling the suspended solids.

(b) The flow and the quality of pit water vary seasonally. Therefore settling tank should be able to absorb these fluctuations.

(c) The mine water must be neutral in nature and therefore necessary neutraliser may be provided to maintain the pH of the settling pond water.

(d) In order to reduce the dependence on fresh water sources for meeting the demands of water in the mining related operations, the entire mining effluents water will be utilised. The entire effluent free mine water will be utilised in water spraying for dust suppression, hydraulic stowing, equipment washing and other industrial requirements.

(e) Mine water discharge and drainage in the core zone has been planned to be regulated in a manner so that impact on surface and other water bodies of the area is not affected. No diversion of any surface drainage channel is required as other than civil constructions, surface land will not be affected. Expected increase of solids due to surface handling of coal shall be controlled by:

  a. Construction of garland drain around the coal stock area
  b. Construction of settling tanks of adequate size for removal of particulate matters
  c. De-silting of settling ponds and drains at regular intervals
  d. Effluents from washing areas, garage and workshop will be collected in garlands and routed through a settling ponds and oil and grease trap. The solid wastes generated shall be treated as per the provisions of Hazardous Waste Management Act. The water shall be recirculated for washing.

3.2.4 WATER BALANCE OF THE AREA

HYDROGEOLOGY AND AQUIFER CHARACTERISTICS OF THE AREA

Groundwater occurrence and storage in study area are mainly controlled by the geological setup of the area. The ability of geological formation to store and transmit water is dependent on its formation parameters, such as porosity and hydraulic conductivity. Based on these two parameters, the rock formation of the area may be classified as hard and soft rocks. Hard rocks (mainly crystalline and consolidated sedimentary rocks) are characterized by very little porosity. Ground water in such rocks circulated to a limited extent through the secondary openings represented by joints, cracks, fissures and such other planes of discontinuity. Soft rocks represented by sandstone, pebbles and loose sand, posses higher degree of primary porosity and as such characterized by higher water storage capacity. As greater part of the study area is underlain by Precambrian crystalline rocks, the weathered residual of the hard rocks as well as the fractures, joints, fissures, faults and other zones of discontinuity are the principle repositories of ground water in the area. The weathered zone is usually of limited thickness, fractures and joints generally close up with depth. The thickness of weathered mantle in the hard rock zone of area is about 10-20 meter in the topographic lows. Ground water in the weathered and fracture zones of hard rocks occur under unconfined condition. Ground water circulating through fracture zone is sometimes held under pressure. Depth of the water table in the hard rock of the area generally ranges from 3.0 m to 15.0 m below ground level.

The Gondwana sediments form the semi-consolidated formations and are better water potential zone. The splintery shales of Talchir and basal pebbles bed, the variegated Barren Measure shales and the sandstones are the major litho units of the Gondwana Formations. Gondwana sandstones in general, are known to constitute good aquifers at many places. Ground water occurs under unconfined condition in the weathered mantles varying depths from 4.23 – 12.34 m as observed in the dugwells and semi-confined condition in the deeper aquifers. Depth of water level for pre-monsoon period varies from 5–12m below ground level and it stretches to a deeper depth of 7-12m in some places. The pre-monsoon water level rises due to recharge and becomes 2 - 8 m below ground level around the area during post-monsoon period.

Rainfall is the principal recharge source to groundwater. The area experiences an average annual rainfall of about 1200-1400 mm. Besides rainfall, the mine water discharge from the local mining areas and existing water bodies including water logged in abundant mine quarries are also contributed to the ground water recharge as return flow. In the study area, ground water is withdrawn usually by means of open dug wells and small diameter hand operated tube wells for domestic and irrigation purposes. The tube wells are most often deeper (25m – 58m) than the dug wells and tap the aquifer below the weathered mantle. As the area is being located in the hot-tropical belt, the temperature regime is very high, the daily maximum reaches to over 45^0C. Due to excessive heat, the loss of moisture through evaporation is considerably high (60-65%). During the wet monsoon seasons, the net evaporation is less than the precipitation, resulting in surplus water which loss through either surface runoff or being part of the subsurface storage. The surface run-off and sub-surface storage of water depends upon various factors including the amount of rainfall, topography of the area, land use pattern, soil type, slope, physiographic, drainage pattern and hydro-geomorphology of the catchment/ sub-catchment. The study area is having gentle slope towards south and south east. Water received on the slopes, gets collected in low-lying area and is thus ultimately absorbed in the top soil cover and become part of the ground water flow according to the slope to form seasonal streams/nallas.

In the mining area, the water levels are bound to be affected and disturbed. The mining area of JCF area is highly disturbed and the permeability of individual geological units is spatially variable and depends on lithology, fracturing and attenuation with depth. The porous and more open-jointed sandstone members tend to form aquifers, the shaly members are aquitards, which may be leaky but are poorly permeable & form poor permeable barriers to the vertical groundwater movement

Water quality monitoring will be done for three years after closure. The sampling stations shall be one no. mine water with quarterly frequency and two numbers ground water samples in core and buffer zone with quarterly frequency.

3.2.5 Acid Mine Drainage Source

Not Applicable

3.2.6 Water Management

3.2.6.1 Existing mine water discharge details

a. Mine water is pumped out in a settling tank. Clean water coming out from the settling tank is used for dust suppression, stowing and other Industrial uses.

b. Excess pumped out mine water is allowed to flow into the surface water bodies.

c. Drains are provided around the coal stock to collect run-off for diverting into settling pond before discharge into the natural water courses.

New Akashkinaree (UG)

Present pumping arrangement :

- Make of water
  Monsoon Period – Approx. 1600 GPM
  Lean period - Approx. 1200 GPM

- Installed capacity of main pumps discharging water of surface.- 1600 GPM.

- Quantity of water being discharged to surface.

Seam-wise pumping details of the mine are given below in Table No-3.11A

TABLE –3.11A Seam Wise Pumping Details

Seam	Pump No.	Details of pump			Location Dip/ level	Delivery through pit / inc. / BH	Discharge at settling Tank/ Nala/ River	Present use (domestic/ stowing/ industrial etc.)
		GPM	Head	KW				
I	**1**	**600**	150	125	38WL	Sump	Surface	Stage pump
I	**1**	**600**	180	125	Main dip	Gallery	Surface	Surface
II	**1**	**600**	180	125	39WL/1Dip junction.	Sump	Surface	
II	**1**	**600**	150	125	Between 2&3dip/34 L	Gallery	Surface	
S/pump	**2**	**600**	160	125	Hadhadia	V/VI Seam	Surface	Domestic
S/pump	**1**	**600**	120	125	Near office	I seam.	Surface	Domestic
Sub total	**7**	**3600**						

- Point of discharge of water. –Through Incline no.3, 14 and bore hole – 3 Nos.
- Use of discharge of water (Quantity wise) at surface is given below in Table no 3.11B :

TABLE –3.11B Details of Use of Discharged Water

Period	Total Discharge in (KLD)	Quantity wise use (KLD)				
		Domestic	Industrial	WTP	Bagdigi jore	Total
Monsoon	1400	355	200	216	170	941
Lean	850	355	200	200	50	805

New Akashkinaree (OC)

Installed capacity of main pumps discharging water to surface – 160HP/600 GPM, 2 nos of pump is installed in II seam incline for pumping of UG water for domestic supply.

Points of discharge of water –

(a) II seams UG Reservoir

(b) Pond near Sub-Station.

Use of discharged water (quantity-wise) –

(a) For East Bassuria Colony – 0.6 Million Gallon/day

(b) For Bhuli – 1.28 Million gallons/day.

There is no dewatering arrangement in the OC.

3.2.7. Post closure Mine water discharge

Once the reserve is exhausted, the entries into the mine would be securely sealed for safety purposes. However, if for the safety of the future mine or any neighboring mine, pumping is required from the worked seams, then the arrangements for pumping will be kept intact and the water shall be discharged into the surface water bodies after passing the same through settling tank on the surface. The accumulated water in underground workings may be utilized to meet water shortage in nearby areas.

3.3 Air quality management

3.3.1 Present practice

a. At present air borne dust is suppressed by:

- Sprinkling water on the various roads of the mine where vehicles ply.
- Water sprinkling at the various points where coal is handled.
- Proper loading of trucks to avoid any spillage of coal.
- Proper maintenance of I.C. engines.

The quality of air is monitored on regular basis by drawing samples from the various residential and non-residential areas of the project. The test results are compared with the standards prescribed by the MOEF and if any deviation is detected, remedial actions are immediately taken to bring the AAQ standard within the prescribed limits. The practice of air quality management would be continued throughout the project life as per the norms stipulated by MOEF.

The monitoring of air quality under Baseline Environment Data Generation for Cluster III has been conducted M/S PDIL, Sindri and test results of air samples are furnished subsequently.

Table No. 3.12

SAMPLING LOCATION FOR AIR QUALITY MONITORING

Project: Cluster III **Period:** 19th March -18th June 2011

Sl. No.	Location Name/Location Code	Direction & distance w.r.t Project Site	Height of Sampling Point (m)	Description
01.	Jogidih UGP - Core zone - SA_1	-	3.0	Industrial Area
02.	Maheshpur UGP - Core zone - SA_2	-	3.0	Industrial Area
03.	Block IV Kooridih OCP-Core Zone - SA_3	-	3.0	Industrial Area
04.	Govindpur UGP Colliery-Core Zone - SA_4	-	3.0	Industrial Area
05.	New Akashkinari OCP-Core Zone - SA_5	-	3.0	Industrial Area
06.	Katras Choitudih Village - SA_6	SE, 1.0 Km	3.0	Residential Area
07.	Muraidih Village – SA_7	NW, 0.8 Km	3.0	Residential Area
08.	Harna Village – SA_8	NW, 2.6 Km	3.0	Residential Area
09.	Sogiadih Village – SA_9	NW, 2.5 Km	3.0	Residential Area

Table No. 3.13

AIR QUALITY DATA

Period: 19th March -18th June 2011 **Location:** New Akashkinari OCP- SA_5

WEEK	DAY	DATE	CONCENTRATION OF AIR POLLUTANTS, µg/m³				
			SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x
I	Mon/Tue	21/22.03.11	297	77	31	13.2	19.8
	Tue/ Wed	22/23.03.11	246	64	25	10.9	16.8
II	Mon/Tue	28/29.03.11	314	82	33	14.0	20.8
	Tue/ Wed	29/30.03.11	288	75	30	12.8	19.3
III	Mon/Tue	04/05.04.11	347	83	34	15.4	21.8
	Tue/ Wed	05/06.04.11	236	61	24	10.5	18.2
IV	Mon/Tue	11/12.04.11	341	84	29	15.2	23.5
	Tue/ Wed	12/13 .04.11	256	67	26	11.4	15.4
V	Mon/Tue	18/19.04.11	115	30	13	9.1	13.9
	Tue/ Wed	19/20.04.11	179	47	17	10.0	19.7
VI	Mon/Tue	25/26.04.11	356	85	33	15.8	22.4
	Tue/ Wed	26/27.04.11	254	66	26	11.3	15.2
VII	Mon/Tue	02/03.05.11	316	82	31	14.0	23.0
	Tue/ Wed	03/04.05.11	124	32	14	8.5	15.4
VIII	Mon/Tue	09/10.05.11	236	61	24	10.5	16.2
	Tue/ Wed	10/11.05.11	319	83	32	14.2	20.1
IX	Mon/Tue	16/17.05.11	348	84	29	15.5	22.9
	Tue/ Wed	17/18.05.11	275	72	28	12.2	23.5
X	Mon/Tue	23/24.05.11	341	83	28	15.2	21.5
	Tue/ Wed	24/25.05.11	269	70	27	12.0	19.1
XI	Mon/Tue	30/31.05.11	314	82	30	14.0	19.8
	Tue/ Wed	31/01.05/06.11	110	29	21	9.9	15.6
XII	Mon/Tue	06/07.06.11	336	84	30	14.9	23.2
	Tue/ Wed	07/08.06.11	269	70	27	12.0	19.1

SUMMARY

Parameters	SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x
No. of observations	**24**	**24**	**24**	**24**	**24**
Minimum Concentration	110	29	13	8.5	13.9
Maximum Concentration	356	85	34	15.8	23.5
Average	270.3	68.9	26.8	12.6	19.4
98th percentile	352.3	84.5	33.5	15.7	23.5

Table 3.14

STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011
Unit : µg/m³

SL. No.	POLLUTANT	LOCATION CODE	MIN.	PERCENTILE VALUE											MAX.	ARITH. MEAN	GEO. MEAN	STD. DEVIA-TION	STD. *	% EXCEEDING STANDARD LIMITS
				10	20	30	40	50	60	70	80	90	95	98						
01.	**SPM**	SA – 1	106.0	127.2	171.4	212.9	235.2	243.0	245.8	254.1	256.8	266.8	268.9	271.7	274.0	219.0	211.2	52.9	700	0
		SA – 2	109.0	125.9	168.6	177.9	208.6	218.0	242.8	246.5	256.8	264.4	265.9	267.1	268.0	209.7	202.4	51.5	700	0
		SA – 3	106.0	126.1	211.8	256.0	270.6	278.5	288.8	312.5	339.2	345.7	350.3	351.5	352.0	264.6	250.3	77.4	700	0
		SA – 4	114.0	139.0	163.2	177.0	190.0	207.0	234.6	251.1	255.4	262.7	274.9	281.9	286.0	208.4	202.0	50.8	700	0
		SA – 5	110.0	140.5	236.0	253.2	269.0	281.5	310.6	316.3	338.0	345.2	347.9	352.3	356.0	270.3	257.3	74.0	700	0
		SA – 6	96.0	110.9	137.8	153.2	158.2	201.0	217.6	223.9	233.6	243.2	245.0	245.5	246.0	184.7	177.0	51.3	200	0
		SA – 7	109.0	127.1	187.8	214.6	227.4	245.0	254.2	263.3	271.6	313.8	331.6	340.5	346.0	233.4	222.9	65.5	200	0
		SA – 8	89.0	111.1	122.0	131.9	136.4	142.0	146.0	151.1	158.2	168.0	170.6	179.1	186.0	140.2	138.2	23.7	200	0
		SA – 9	88.0	98.3	120.0	130.8	139.0	139.5	143.8	155.1	156.8	168.1	176.7	178.0	178.0	138.5	136.1	25.5	200	0

* SPM has been compared with Jharia Coal Mines standard in Core Zone and in other than Core Zone as per NAAQS.

Table – 3.14 (Contd.)

STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011 Unit : µg/m³

SL. NO.	POLLUTANT	LOCATION CODE	MIN.	PERCENTILE VALUE											MAX.	ARITH. MEAN	GEO. MEAN	STD. DEVIATION	STD. *	% EXCEEDING STANDARD LIMITS
				10	20	30	40	50	60	70	80	90	95	98						
02.	PM_{10}	SA – 1	36.0	38.9	42.2	52.5	58.2	60.5	61.0	63.0	64.0	66.7	67.0	67.5	68.0	55.7	54.6	10.7	100	0
		SA – 2	35.0	41.1	48.0	50.9	59.2	62.0	69.2	70.1	71.0	71.7	72.0	72.5	73.0	59.5	58.1	12.5	100	0
		SA -3	36.0	42.3	52.8	64.0	67.4	69.0	72.0	78.1	81.4	83.7	84.9	85.5	86.0	67.0	65.1	15.2	100	0
		SA – 4	34.0	39.5	46.4	50.7	53.6	59.0	66.8	71.0	72.0	73.0	73.9	74.5	75.0	58.6	57.0	13.4	100	0
		SA – 5	29.0	36.5	61.0	65.8	70.0	73.5	81.0	82.1	83.0	84.0	84.0	84.5	85.0	68.9	65.9	17.8	100	0
		SA – 6	30.0	31.3	33.0	34.9	36.2	46.0	49.8	51.2	53.4	55.4	56.0	56.0	56.0	43.4	42.3	9.9	100	0
		SA – 7	40.0	44.6	48.4	59.3	64.4	69.5	73.0	75.1	77.2	81.1	82.9	83.0	83.0	65.2	63.6	14.2	100	0
		SA – 8	23.0	30.2	34.6	36.8	38.4	40.0	44.8	49.6	56.4	62.0	62.9	63.5	64.0	43.9	42.2	12.3	100	0
		SA – 9	28.0	31.3	33.6	35.9	36.4	40.5	44.2	47.0	50.8	58.8	60.9	62.6	64.0	42.5	41.4	10.5	100	0
03.	$PM_{2.5}$	SA – 1	12.0	14.3	15.6	19.8	22.0	23.0	23.8	24.1	25.0	26.0	26.0	26.5	27.0	21.2	20.6	4.7	60	0
		SA – 2	10.0	14.2	17.6	19.0	23.0	23.5	26.8	27.1	29.0	30.0	30.0	30.0	30.0	23.0	22.1	6.2	60	0
		SA -3	12.0	14.3	19.6	25.0	26.2	27.0	27.8	29.0	29.0	30.0	30.9	31.0	31.0	24.8	23.9	6.0	60	0
		SA – 4	11.0	13.9	16.6	18.8	20.0	21.5	25.4	27.1	29.0	29.7	30.9	32.1	33.0	22.3	21.3	6.4	60	0
		SA – 5	13.0	18.2	24.0	25.9	27.0	28.0	29.0	30.0	31.0	32.7	33.0	33.5	34.0	26.8	26.0	5.7	60	0
		SA – 6	12.0	13.0	13.6	14.0	14.2	18.5	20.0	21.1	22.0	22.7	23.0	23.0	23.0	17.6	17.1	4.2	60	0
		SA – 7	14.0	15.0	16.6	20.7	23.0	24.5	26.0	26.1	27.0	28.4	29.9	30.5	31.0	22.9	22.2	5.4	60	0
		SA – 8	11.0	12.0	12.6	13.0	14.2	15.0	17.0	19.3	22.4	25.0	25.0	25.5	26.0	17.1	16.4	5.1	60	0
		SA – 9	11.0	11.3	12.6	13.0	13.2	15.0	15.8	18.0	20.2	22.0	23.7	24.5	25.0	16.0	15.5	4.3	60	0

* PM10 & PM2.5 has been compared with NAAQS standard in Core Zone and Buffer Zone.

Table – 3.14 (Contd.)

STATUS OF AIR POLLUTANTS IN THE STUDY AREA

Period : 19th March -18th June 2011
Unit : µg/m³

SL. NO.	POLLUTANT	LOCATION CODE	MIN.	PERCENTILE VALUE											MAX.	ARITH. MEAN	GEO. MEAN	STD. DEVIATION	STD. *	% EXCEEDING STANDARD LIMITS
				10	20	30	40	50	60	70	80	90	95	98						
04.	SO_2	SA – 1	7.5	8.7	9.2	9.4	10.0	10.4	11.2	11.7	12.1	12.5	12.8	13.3	13.8	10.6	10.4	1.7	120	0
		SA – 2	7.3	7.8	8.3	9.1	10.3	10.9	11.8	11.9	12.4	12.7	12.9	12.9	12.9	10.5	10.3	2.0	120	0
		SA -3	8.5	9.1	10.9	11.7	11.9	12.3	13.2	13.9	14.7	14.9	15.0	15.3	15.6	12.4	12.2	2.1	120	0
		SA – 4	7.3	7.4	7.6	8.2	9.1	9.8	11.1	11.9	12.4	12.8	13.4	13.7	13.9	10.1	9.9	2.2	120	0
		SA – 5	8.5	9.9	10.5	11.3	12.0	12.5	13.8	14.0	15.0	15.3	15.5	15.7	15.8	12.6	12.4	2.2	120	0
		SA – 6	8.2	8.9	9.5	9.8	10.0	10.3	10.5	10.6	11.0	11.4	11.6	12.0	12.3	10.2	10.2	1.0	80	0
		SA – 7	6.8	8.0	11.8	13.5	15.3	15.5	16.0	16.7	17.0	17.9	18.2	18.4	18.5	14.4	13.8	3.6	80	0
		SA – 8	7.3	8.1	8.6	9.4	9.6	10.0	10.6	10.7	10.8	11.4	11.8	11.9	11.9	9.9	9.8	1.3	80	0
		SA – 9	6.3	7.4	8.0	9.4	9.6	10.4	10.7	11.0	11.4	11.7	13.0	13.3	13.3	10.0	9.8	1.9	80	0
05.	NO_x	SA – 1	13.4	14.0	15.4	16.4	16.7	17.7	17.9	18.5	18.8	19.5	19.6	19.7	19.8	17.1	17.0	2.0	120	0
		SA – 2	10.1	11.3	13.3	15.0	16.6	17.3	17.6	18.2	19.2	19.6	19.9	20.2	20.4	16.3	15.9	3.2	120	0
		SA -3	13.4	14.0	17.0	19.3	20.1	21.8	23.4	24.6	24.8	26.6	26.8	27.0	27.1	21.1	20.6	4.5	120	0
		SA – 4	10.0	11.2	11.8	12.3	13.5	15.5	16.3	16.9	18.8	19.6	20.6	21.0	21.2	15.2	14.8	3.5	120	0
		SA – 5	13.9	15.4	16.0	18.1	19.1	19.8	20.0	21.5	22.6	23.1	23.5	23.5	23.5	19.4	19.2	3.0	120	0
		SA – 6	13.5	14.1	14.5	15.0	15.3	16.0	16.3	16.5	16.8	17.1	17.3	17.6	17.9	15.7	15.7	1.2	80	0
		SA – 7	10.2	12.1	15.9	18.2	19.3	20.7	21.2	21.7	23.0	27.0	28.0	28.5	28.7	19.9	19.1	5.3	80	0
		SA – 8	12.1	13.7	14.7	14.8	15.4	15.6	15.7	16.3	16.7	17.1	17.2	18.2	19.1	15.5	15.5	1.5	80	0
		SA – 9	11.2	12.4	13.4	14.2	15.0	15.4	15.9	16.1	17.1	17.9	18.4	18.4	18.4	15.2	15.1	2.1	80	0

* SO_2 & NO_x has been compared with Coal Mines standard in Core Zone and in other than Core Zone as per NAAQS.

New Akashkinari OCP- Core Zone (SA - 5)

At this location, SPM, PM_{10} and $PM_{2.5}$ concentration were observed in the range of 110 to 356µg/m^3, 29 to 85µg/m^3 and 13 to 34µg/m^3 respectively. SO_2 and NO_x concentration were in the range of 8.5 to 15.8µg/m^3 and 13.9 to 23.5µg/m^3

3.3.2 Practice after the closure of the mine

a. As the sources of dust and fume generation would no longer be present, the present practice of arresting the air pollution, as enumerated above at However, water sprinkling would be done on the roads, which remain in use after the mine closure.

b. Quality of air would be monitored for a period of 3 years after cessation of mining activity. 3 samples at fortnight frequency for 3 years, one sample in core zone and one sample each in upwind and downwind direction will be collected and analysed.

3.4 Dump Reclamation

External dump

The external OB dumps shall be formed in suitable lifts of appropriate height keeping an overall slope not exceeding 36^0 from the horizontal. In course of mining and after the completion of the final lift, the external OB dump shall be biologically reclaimed. The dumps shall be afforested by selecting proper plant species in consultation with State Forest Department.

As per new Guidelines for Preparation of Mine Closure Plan GOI (Ministry for Coal) Dated 7th January, 2013 all efforts should be made and reflected (in the Project Report/Mining Plan) to keep land requirement bare minimum for external OB dumping to minimise land degradation. This may necessitate increase of dump height to the maximum extent keeping in view the safety requirement with special emphasis on stability analysis. After back filling of quarry voids, the left out void may be allowed to be filled with water. This will help to recharge and stabilize the water table in the neighbourhood and the local populace will benefit from it.

Internal Dumps

The residual voids, if any, will serve as a lagoon and may be utilised as water reservoir for the locality. The entire area shall be suitably fenced. Most of the back filled area shall be afforested by selecting proper plant species in consultation with State Forest Department. A part of the back filled area would also be developed for agricultural purpose with the help of the concerned State Authority.

The underground unit is not likely to generate any solid waste during the mining operation.

3.5 Details of Surface Structures proposed for dismantling

3.5.1 Infrastructure details

As far as possible, industrial structures will be utilized by the adjacent mine. However, if these structures are not found fit at the end of mine life, the same will be dismantled and salvaged. The equipments will be removed and used somewhere else. Every effort will be made to restore the area to economic utilization value in line with mine closure plan.

A. SERVICE BUILDINGS: The service buildings/ structures, viz. workshop, stores, office building, cap-lamp room, Pit top office, winding rooms, etc. are to be demolished after collecting all re-useable items, or be used for some other projects and the land covered by them restored for productive use. However, it has to be ensured that as and when a service building is vacated/ abandoned, the same should be demolished to prevent any unauthorized occupation.

B.OTHER INFRASTRUCTURES: All other infrastructures like sub-stations, transformers, community services, pump-houses, water-treatment/ filtration plants, waterlines, power lines, roads etc. will be utilized for the neighbouring projects.

However, possibility shall be explored for handing over the buildings and other infrastructures including the reclaimed land to the State Government for the benefit of local villagers and strengthening the area infrastructures. The end use of these facilities shall be decided by the State Government with the help of District Authorities and Village Panchayat. The peripheral village community facilities developed by the Mine Authorities will be left to the Local Body/ State Government for their management and public use.

Prior to surface demolition/ restoration, a surface audit will be undertaken on all surface structures, spoil heaps etc. to assess whether there is any hazardous material that could cause problem, i.e. explosive, asbestos, chemical, oil, etc.

A list of surface and UG assets (Plant & Machinery) will be prepared and made available to potential purchasers or transferred to other new/ working mines of the company. This will ensure that the assets perform during their economic life.

3.5.2 Post closure disposal/Re-use of the Buildings, Plants & Machineries

a. Disposal or reuse of existing HEMM, CHP, workshop and railway siding for OC

   Since the opencast is being operated through departmental/outsourced HEMM, after closing of the mine the departmental HEMM may be transferred to other running projects of BCCL.

b. Disposal or reuse of haulage, ventilation, workshop and railway siding for UG

   At the time of closure of the mine, it is expected that most of the equipments would complete its rated life and would be surveyed off as per the Company's guidelines. The surveyed off equipments would be auctioned as per prevalent norms.

   However, if some of the equipments would not have covered their rated life, they would be diverted to the neighbouring projects for gainful utilisation.

   There is no railway siding in the leasehold.

c. Disposal or reuse of transmission lines and sub-station

   As per the electricity demand of the existing neighbouring projects, an analysis would be made as to whether the existing sub-station and transmission lines could be gainfully used or not. If the scope of gainful utilization is not found, they will be dismantled and the usable items/spares/conductors etc. would be dispatched to needy Areas/Projects.

d. Disposal or reuse of residential and non-residential buildings

At the time of final closure, a list of surface buildings would be prepared in detail. Thereafter following steps would be taken in chorological order in respect of the available buildings:

- An assessment would be made to find that whether the available buildings can be used by the existing neighboring projects or any new project that might have come up in the vicinity.
- In case, the listed assets cannot be utilized by the nearby project, efforts would be made to sale these assets after making the list available to potential purchasers and asking the interested purchasers to submit sealed bids.
- Thereafter, the state agencies/local agencies may be asked to take possession of the buildings, if they required few of them.
- When there would be no takers, the buildings would be demolished and usable items would be recovered for future use.

Table 3.15 Proposals for Infrastructures

Sl. No.	Particulars	Action Suggested
A	CHP	This will be dismantled and land covered with plantation
B	Workshop	-Do-
C	Railway Sidings	There is no railway siding.
D	Colony	These will be handed over to the State Government if fit for use or will be dismantled.
E	Details of non-residential buildings	-Do-
F	Other facilities (ETP /STP)	-Do-

3.6 Safety and Security Arrangement

3.6.1 Mine entry

After closure of the mining activities, all the entries to the mine will be effectively sealed off to avoid any accident and to prevent access to any unauthorized person. The area that is not reclaimed shall be properly fenced/ sealed to prevent any unauthorized entry into the area. Flags/Boards with warning signals shall be posted at vulnerable places to avoid chances of accidents. However, the guidelines / instructions from DGMS, if any, will be followed.

Sealing details and dimensions shall also be prepared for the purpose. The minimum thickness of mine sealing will be 100cm RCC (M20) with nominal reinforcement. For incline entry, the mine entry path of 5 m will be filled with debris and clay before sealing the mine.

Details of fencing around abandoned quarry, indicating the length of the fencing

As explained earlier the proposed OCP patches will not be backfilled and the void will act as water reservoir. It is proposed to develop a water lagoon in the area. The water lagoon may be handed over to State Authorities for conversion into a picnic spot.

The void of the quarry would be properly fenced to avoid any inadvertent entry of animals or human beings. Sufficient Boards and danger signs shall be placed all around.

Later on, the responsibility of keeping the fencing secured would be entrusted on the State Authorities.

The entry into the mine is the haul road. This haul road will remain for entry into the picnic spot. Both side of this haul road will be afforested.

3.6.2 Slope stability arrangement for high wall and back filled dumps

During operation of the mine, overall slope will be maintained at an angle not exceeding 22^0- 28^0. Vegetation cover will also be provided along the slopes to arrest any failure.

As regards stability of back-filled dumps, the final level of reclaimed backfill will be matched with the levels of surrounding areas leaving a final residual void which will serve as a lagoon which may be utilised as water reservoir for the locality.

During operation, the external and internal OB dump will be developed with 40 m berm width and maximum height of 60m in case of external OB dump and the overall dump slope shall not exceed **22^0- 28^0.** The waste dumps will be provided with toe wall and garland drains. The dump will be technically reclaimed and vegetation will be grown after spreading the top soil. The above measures will prevent slope failure and improve the aesthetic value.

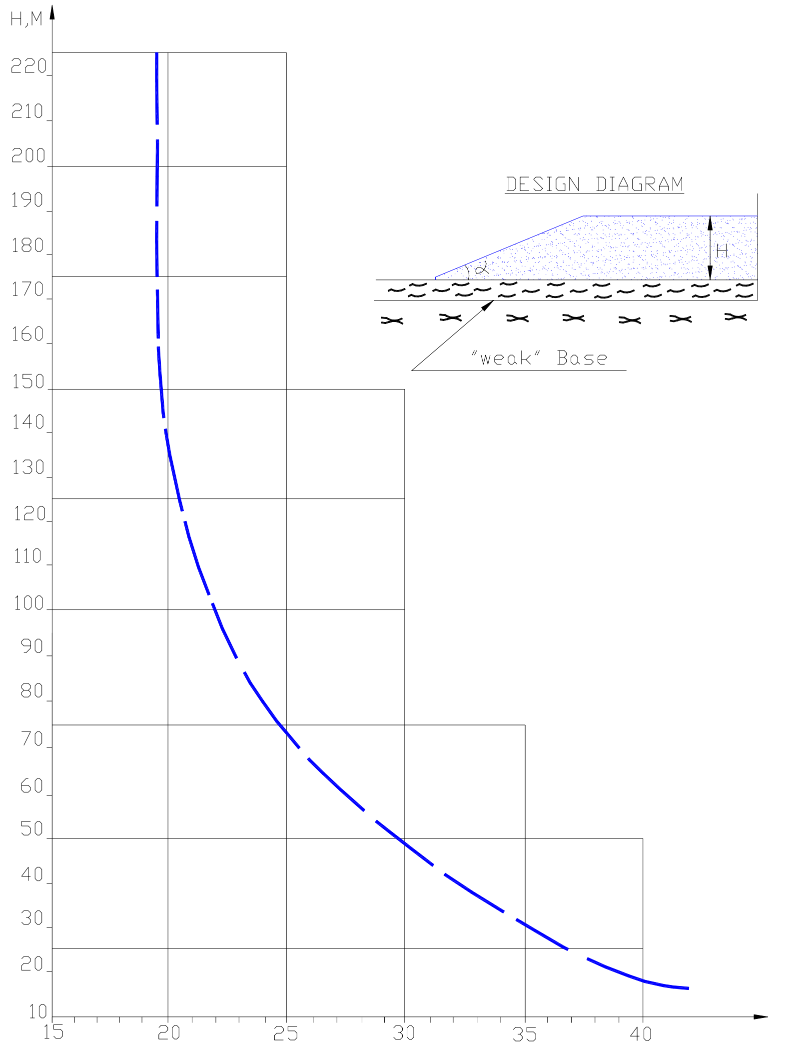


Fig. 5.5.4. Graph illustrating dependence of stable slope angle (α) on height (H) of ex-site dumps formed on "weak" Base

3.6.3 Providing one time lighting arrangement

Sufficient lighting as per standard is provided at all the required places, i.e., pit office, haulage room, fan house, cap lamp room, mine entry, workshop, sub-station haul road in quarry etc.

After closure of the mine, the lighting arrangements will be kept maintained at all locations which are not required to be demolished or dismantled like sub-stations, transformers, community services, pump-houses, water-

treatment/ filtration plants, waterlines, power lines, roads etc. to be utilised for the neighbouring projects and local communities.

3.6.4 Survey records of workings

All the mine workings including subsidence areas, roads, ponds, tanks etc. shall be resurveyed and records shall be updated. Copy of such records shall also be submitted to the appropriate competent authorities, such as DGMS and State Authorities.

Maintenance of records pertaining to Progressive Mine Closure

The Mine management shall maintain following 2 Nos. of Progressive mine closure plans for every 5 year period:

A. **A Progressive mine closure plan for surface activities**

This plan shall be maintained at a scale of 1: 4000 showing the entire progressive mine closure activities (surface) carried out on yearly basis. The plan shall be updated on annual basis and shall be signed by appropriate authorities from the Project and the Area. After every annual renewal, the plan shall be placed before HOD (Env.) of the Company for scrutiny and approval.

B. **A Progressive mine closure plan for UG activities**

Similar to PMCP for surface activities, a progressive mine closure plan showing the UG activities shall be maintained. This plan shall also be updated on annual basis and signed by all the above mentioned officials.

Besides the above plan, a progressive mine closure register shall also be maintained by the mine management. This register shall carry details of the progressive mine closure activities carried out on yearly basis. The details to be maintained in the said register shall cover inter alia the name of activity, place, period of execution, executing agency, expenditure incurred, proof of expenditure incurred, final status of the area where activity was executed, plan on which such activity has been shown etc.

The entries into the said register shall be signed by the appropriate authorities from the Project and the Area. At the end of the year the said register (along with two plans) shall be placed before HOD (Env.) of the Company for scrutiny and approval.

3.6.5 Disposal management of hazardous material

At the time of closure, assessment would be made as to find whether there is any hazardous material that could cause problem. Such hazardous material e.g. explosives, chemicals, oil etc. shall be appropriately disposed off.

3.7 Entrepreneurship development Program

As the mine progresses, more and more local people gets indirectly dependent on the mine for their sustainable income. After closure of mine there would be no source of income for these people. In order to ensure that these people do not suffer in the post closure period, the Project authorities in consultation with ECL (HQ) shall make efforts to develop entrepreneurial skills in the local people by imparting skill development/vocational training programs. It is expected that after developing adequate entrepreneurial skills, the local people would be able to run their own business in the post closure period and maintain a sustainable income for their livelihood.

3.8 Miscellaneous activities

In future, the prevalent geo-mining/environmental conditions in and around the project area may require execution of some other progressive mine closure activities not covered in the preceding paragraphs. Such activities may be carried out by the mine after observing the needful formalities and obtaining approval of HOD (Env.) of the Company.

3.9 Execution of progressive mine closure activities and 5 yearly monitoring

After observing the necessary administrative/financial formalities, the mine authorities shall execute the identified progressive mine closure activities, whenever and wherever required. The executed activities shall be shown on the above said plans and recorded in the said registers.

The executed progressive mine closure activities shall be monitored on 5-yearly basis by 3rd party (ISM, CMPDI, NEERI etc.).

The 5 yearly return from escrow fund would be equal to expenditure incurred on progressive mine closure activities during last 5 years or 80 % of total deposited amount in the escrow account (including interest) whichever is less. The said return would be subject to above said monitoring of progressive MCP by a third party (ISM/CMPDI/NEERI etc.).

As the 5 yearly return from escrow fund is linked with the expenditure incurred on progressive mine closure activities during last 5 years, it is very important that progressive mine closure records, plans, expenditure details along with proof are properly maintained.

At this juncture it is important to note that some of the progressive mine closure activities, enumerated in the preceding paragraphs, are legal obligations specified in Project reports, EMP, permissions obtained from statutory bodies such as CPCB, SPCB, DGMS etc. The Project authorities are bound to comply with these obligations.

3.10 Re-deployment of work force

The current manpower of the project is 1210. And at present, it is very difficult to assess the manpower of the project, which will remain at the time of closure of mining activities in the presently worked seams. As some of the seams of the block is still virgin and is most likely to be mined in future, the remaining manpower will be gainfully utilized in continuing mining activity.

3.11 Emancipation from the community facilities and the facilities to the PAPs

3.11.1 The Project affected Persons (PAPs) and also the local communities are being provided many civic facilities, such as educational facilities, health facilities, and drinking water. As some of the seams of the block are still virgin and are most likely to be mined in future, these facilities, in all probability, will be kept maintained.

3.11.2 However, at the time of final closure after exhaustion of entire mineable reserve these facilities will be entrusted upon the local bodies/Trust of PAPs/State bodies after consultation with local people and state authorities so that same could continue even after the mine closure. If needed, a lump sum reasonable amount would also be paid to the local bodies/Trust of PAPs/State bodies after proper approval for proper upkeep and maintenance of various community facilities.

3.11.3 To ensure that no financial loss due to the closure of mining activity in the presently worked seam occur to the local community engaged indirectly to the existing mine, following steps would be taken:

- It has been seen in past that in the event of closure of a mine, the local people indirectly dependent on the mine switch over their economic/professional activities in the existing/new or expansion mines located in the nearby area. Local management, if needed, extends some basic helps to them in such type of switching over. Hence, it is expected that in this project also the transition of the local people from one area to the other area for their sustenance would not be any problem.

- It is proposed that reclaimed and afforested land will be handed over to State Forest Dept. for the benefit of local ecosystem. The forest wealth can also be utilised by local people or tribal in the form of fruits and fodders.

- The proposed picnic spot would be handed over to a society of local people for commercial use of the picnic spot by them.

CHAPTER – IV

ECONOMIC REPURCUSSION

4.0 Economic Repercussions of closure of mine:

4.1 Manpower of the Project

The total manpower strength of New Akashkinaree is 1210. Details of the manpower are given in Table No- 4.1

Table 4.1: Details of manpower

Manpower	No.
Executive	44
Supervisory and Clerical Staff TR/PR Worker	1166
TOTAL	1210

POST CLOSURE MANPOWER

It has been proposed to monitor and implement the post-closure activities departmentally. Departmental manpower will be needed after closure of the mine for monitoring and implementation of the post closure activities. Manpower required for the same is given in Table- 4.2.

Table 4.2: Manpower required for monitoring and implementation of Mine Closure Activities

Sl. No.	Category of Manpower	Requisite heads
1	Officer-in-charge/ Manager (Mining)	1
2	Overman-in-charge	2
3	Foreman-in-charge	2
TOTAL		**5**

4.2 ASSESSMENT OF INCOME SCENARIO OF LOCAL PEOPLE

As New Akashkinaree colliery is a mixed mine, there will be surface excavation which shall be undertaken on company acquired land only. Moreover, the basic mining infrastructures have been made on the company acquired land. So there will no displacement of local people for this project. Later, after closure of the mine the work force will be absorbed / re-employed / rehabilitated in operative collieries of BCCL.

After the closure of the mine, the manpower deployed in the mine will be further deployed in other mines of BCCL to make no loss of sustenance income to the eligible employee. The other secondary activities will not be affected by the closure of the mine and the mine discharge water after proper treatment will be provided to the local people for domestic and irrigational uses.

4.2.1 At present, it is very difficult to assess the manpower of the project, which will remain at the time of closure of mining activities in the instant project.

4.2.2 The local communities are being provided many civic facilities, such as educational facilities, health facilities, and drinking water. At the time of final closure after exhaustion of entire mineable reserve these facilities will be entrusted upon the local bodies/Trust of PAPs/State bodies after consultation with local people and state authorities so that same could continue even after the mine closure. If needed, a lump sum amount would also be paid to the local bodies/Trust of PAPs/State bodies for proper upkeep and maintenance of various community facilities.

4.2.3 To ensure that no financial loss due to the closure of mining activity in the presently worked seam occur to the local community engaged indirectly to the existing mine, following steps would be taken:

- It has been seen in past that in the event of closure of a mine, the local people indirectly dependent on the mine switch over their economic/professional activities in the existing/new or expansion mines located in the nearby area. Local Management, if needed, extends some basic helps to them in such type of switching over. Hence, it is expected that in the instant case also the transition of the local people from one area to the other area for their sustenance would not be any problem.

- It is proposed that reclaimed and afforested land, if any, will be handed over to State Forest Dept for the benefit of local ecosystem. The forest wealth can also be utilised by local people in the form of fruits and fodders.

CHAPTER – V

TIME SCHEDULE FOR POST-CLOSURE ACTIVITIES

5.1 It is very difficult to predict the various parameters which would be prevalent at the time of final mine closure (when the entire block reserve would get exhausted) and therefore a mine closure activity schedule cannot be rigidly prepared at this point of time.

5.2 The closure of mine involving technical aspects, environmental aspects, socio-political aspects and financial assurances as implementing post-closure activities will run for three years. The time schedule envisaged for completion of all closure activities is presented in the following table in the form of bar chart.

Table 5.2: Implementation Schedule for post-closure activities for New Akashkinaree Colliery

Sl. No.	**Major Activities**	**Time Period**	**Year-wise Phasing**			
			Y1	**Y2**	**Y3**	**Y4**
1	Technical aspects	2 years				
2	Environmental aspects	2 years				
3	Post closure environment monitoring	3 years				
4	Socio-political aspects	3 years				

5.2.1 TECHNICAL ASPECTS:

i) **Safety & security**: In the mine closure plan, action will be taken to cover all the safety aspects including management of fire & subsidence and mine inundation.

i) **Management of pit slopes and waste dump**: New Akashkinaree Colliery being a mixed mine, management of pit slope and waste dump will be needed.

ii) **Management of hydrology and hydro-geology**: After closure of mining activities, the workings will be waterlogged which will help in maintaining the water table in the surrounding areas and may become a source of water supply to the neighbouring areas.

iii) **Closure of Mine Entries**: After closure of the mining activities, all the entries to the mine will be effectively sealed off/fenced to avoid any accident and to prevent access to any unauthorized person. The area that is not reclaimed shall be properly fenced/ sealed to prevent any unauthorized entry into the area. However, the guidelines / instructions from DGMS, if any, will be followed.

iv) **Disposal of mining machinery**: All the opencast/underground machineries including HEMMs, SDLs, haulages etc. which will have residual life will be shifted to the other collieries of the area/company. The salvaging and shifting operation of mining machinery and other equipment will be done considering the ground realities during the period 1 (one) year advance of final mine closure.

v) **Details of surface structure proposed to be dismantled**:

As far as possible, industrial structures will be utilised by the adjacent mine. However, if these structures are not found fit at the end of mine life, the same will be dismantled and salvaged. The equipments will be removed and used somewhere else. Every effort will be made to restore the area to economic utilization value in line with mine closure plan.

A. **Service Buildings**: The service buildings/ structures, viz. workshop, stores, office building, cap-lamp room, incline top office, haulage/winding rooms, etc. are to be demolished after collecting all re-useable items, or be used for some other projects and the land covered by them restored for productive use. However, it has to be ensured that as and when a service building is vacated/ abandoned, the same should be demolished to prevent any unauthorized occupation.

B. **Other Infrastructures**: All other infrastructures like sub-stations, transformers, community services, pump-houses, water-treatment/ filtration plants, waterlines, power lines, roads etc. will be utilized for the neighbouring projects.

However, possibility shall be explored for handing over the buildings and other infrastructures including the reclaimed land to the State Government for the benefit of local villagers and strengthening the area infrastructures. The end use of these facilities shall be decided by the State Government with the help of District Authorities and Village Panchayat. The peripheral village community facilities developed by the Mine Authorities will be left to the Local Body/ State Government for their management and public use.

Prior to surface demolition/ restoration, a surface audit will be undertaken on all surface structures, spoil heaps etc. to assess whether there is any hazardous material that could cause problem, i.e. explosive, asbestos, chemical, oil, etc.

A list of surface and UG assets (Plant & Machinery) will be prepared and made available to potential purchasers or transferred to other new/ working mines of the company. This will ensure that the assets perform during their economic life.

5.2.2 ENVIRONMENT ASPECTS

i) **Mined-out land and proposed final land use:** As New Akashkinaree is a mixed mine, the mined out land will properly be reclaimed as per the existing guideline of environment management plan. The existing infrastructures, if not usable, will be dismantled and the land will be graded & will be handed over to the local authorities for community use.

ii) **Air & Water quality management:** Appropriate air and water pollution control measures will be taken to contain the air and water pollution for maintaining the ambient air and water quality within the stipulated standards besides making the mining operation eco-friendly in the project. These measures (both preventive and suppressive) are enumerated in Para 3.2.3 of the present report.

iii) **Management of waste:** The solid wastes generated by the mine during the coal production are non-hazardous and non-toxic in nature. The above solid wastes will be disposed off by backfilling the mined out area and then re-vegetating without causing any siltation problem on surface water bodies. However, scientific studies shall be undertaken regarding applicability of solid wastes for various uses. Toxic solid wastes like used oil, used batteries, oily sludge, besides filters and filter materials containing oil during maintenance of vehicles, will be generated by the mining project. Used oil will be stored in drums safely for disposal through auction to the authorized re-processors. Similarly, used batteries will be stored safely for auction to the authorized re-processors. The oily sludge, besides filter and filter materials, will be disposed off in impervious layer lined pits without causing environmental hazards.

iv) **Management of final voids**: The underground voids will be slowly get filled with water. However, safety of the neighbouring mines will be looked into before the entire underground void gets water filled.

v) **Land reclamation and rehabilitation:** If any cracks or void is created due to underground mining activities, it will be restored to original profile by filling up cracks/ voids. In case of opencast working it should be properly reclaimed. It is proposed that the site restoration should be kept progressive so that the restoration is more or less similar to the rate of mining.

vi) **Reclamation of forest/ vegetation and plantation:** No forest land is required for the project. However, regular plantation will be taken up during the life of the mine to create green barrier. The plant species will be selected in consultation with the state forest department.

The objective of restoration of post mining area will be determined through consultation with local community and the Government authority, so that the potential/ required end use of the mined out land is determined in advance. Such usage may be agriculture, forestry, amenity development or nature reserve.

5.2.3 POST CLOSURE ENVIRONMENT MONITORING

After cessation of mining and its related activities, there will be no effect on ambient air and water quality due to this mine as proper mitigation measures for air and water pollution control are to be taken by the authorities of the mine. However, the air and water quality parameters in the mined out area will be monitored by some external agency for next three years after closure of the mine.

Air and water samples will be taken from the specified sampling stations at regular frequency for 3 consecutive years after the closure of the mining project. 1 sample of mine water will be collected and analyzed with fortnightly frequency and 2 samples of ground water from core & buffer zones with monthly frequency. Similarly, 1 air sample will be taken at core zone, and 1 air sample each in upwind and downwind directions of the project at fortnightly frequency.

5.2.4 SOCIO-POLITICAL ASPECTS

i) **Re-deployment of work force**: Due to closure of mining operations, the persons directly employed in the mine will be surplus. Suitable manpower re-deployment plan may be formulated by the mining company sufficiently before closure of mine for re-deployment of the work force in other units of the company. Alternatively, they would be given option of voluntary retirement.

ii) **Civic facilities**: It is proposed that the civic facilities developed during the mining phase will be transferred to the local government/ municipality so that the region transforms smoothly into post mining phase. A one-time payment should be made by the mine for obtaining its release from providing these facilities, which will there from be taken care of by the local and state bodies.

iii) **Channelisation of available water**: If the mine has sufficient water, this can be used for domestic and agriculture purpose by the local community. The water from this area shall be discharged after treatment for domestic and agricultural usages.

iv) **Emancipation for project affected population**: The village/ basti which are to be rehabilitated as per Master Plan of JCF (March'08) is given in Table No. 5.2(includes those covered in erstwhile East Katras and Katras Project).

TABLE 5.2

Village/Site	BCCL	Pvt.	Enchr	Oth	Total
PHASE-I					
Choitudih/19	2	0	64	0	66
Koiludih 6/17	62	43	0	0	105
Total(Phase-I)	**64**	**43**	**64**	**0**	**171**
PHASE-II					
Akashkinaree 04/06	21	0	21	0	42
Akashkinaree -2/O2	2	0	0	0	2
Akashkinaree 3/O4	0	0	10	0	10
Akashkinaree 5/O7	7	0	21	0	28
Akashkinaree-6/O8	22	0	14	0	36
Bhandardih 2 /11	17	13	4	0	34
Koiludih 01/03	0	21	0	0	21
Koiludih 3/10	51	279	29	3	362
Koiludih 4/15	111	0	66	1	178
Koiludih-2/O9	15	0	14	0	29
Koiludih-5/16	1	0	0	0	1
Malkera/18	6	14	0	0	20
Bhandardih 3/12	0	4	0	0	4
Akashkinare Colony/ O6	46	0	15	1	62
Labour Qtrs. Along PWD Road/ O2	35	0	25	0	60
Part of Bhatmurna Bastee/O3	0	32	30	0	62
Qtrs. Along office compound/O4	139	0	84	0	223
Qtrs.on South side of Akashkinaree/O5	140	4	27	0	171
Total(Phase-II)	**613**	**367**	**360**	**5**	**1345**
Total(Phase I+II)	**677**	**410**	**424**	**5**	**1516**

5.3 Although, it is very difficult to conclusively predict the likely impacts due to closure of the mining activities in the in the leasehold area of the Instant Project and the likely activities that would be taken up at that point of time, but a broad mine closure activity schedule may be prepared as per guidelines of Ministry of Coal. The post closure implementing activities will run for three years. The following activities are most likely to be implemented as per the given bar chart.

IMPLEMENTATION SCHEDULE FOR MINE CLOSURE IN NEW AKASHKINAREE OC MINE

(LIFE OF THE MINE : 30 YEARS)

S. N	Activity	Time Frame	Year								
			1st Phase	2nd Phase	3rd Phase	4th Phase	5th Phase	Final Phase	Post Closure Phase		
			1-5	6-10	11-15	16-20	21-25	26-30	PC1	PC2	PC3
A	**Dismantling of Structures**										
	Service Buildings	2 years									
	Residential Buildings	2 & ½ years									
	Industrial structures like CHP, Workshop, field sub-station, etc.	2 & ½ years									
B	**Permanent Fencing of mine void and other dangerous area**										
	Random rubble masonry of height 1.2 metre including leveling up in cement concrete 1:6:12 in mud mortar	2 years									
C	**Grading of highwall slopes**										
	Levelling and grading of highwall slopes	2 years									
D	**OB Dump Reclamation**										
	*Handling/Dozing of OB Dump and backfilling	Throughout the life of the mine including 3 years after cessation of mining operation									
	*Technical and Bio-reclamation including plantation and post care	Throughout the life of the mine including 3 years after cessation of mining operation									
E	**Landscaping**										
	*Landscaping of the open space in the leasehold area for improving its esthetics and eco value	Throughout the life of the mine including 3 years after cessation of mining operation									
F	**Plantation**										
	Plantation over cleared area obtained after dismantling	2 years									

S. N	Activity	Time Frame	Year								
			1st Phase	2nd Phase	3rd Phase	4th Phase	5th Phase	Final Phase	Post Closure Phase		
			1-5	6-10	11-15	16-20	21-25	26-30	PC1	PC2	PC3
	*Plantation around the quarry area and in safety zone	Throughout the life of the mine including 3 years after cessation of mining operation									
	*Plantation over the external OB Dump	Throughout the life of the mine									
G	**Post Closure Env Monitoring / testing of parameters for three years**										
	Air Quality	3 years									
	Water Quality	3 years									
H	*** Entrepreneurship Development (Vocational/skill development training for sustainable income of affected people**	Throughout the life of the mine									
I	***Miscellaneous and other mitigative measures**	Throughout the life of the mine including 3 years after cessation of mining operation									
J	**Post Closure Manpower cost for supervision**	3 years									

NOTE: *: To be covered under Progressive Mine Closure activities also**.**

NOTE: The progressive mine closure will be done as per the provisions made out in the Project report and as per the situation/requirement that may arise in course of execution of the Project Report.

IMPLEMENTATION SCHEDULE FOR MINE CLOSURE IN NEW AKASHKINAREE UGMINE

(LIFE OF THE MINE : 14 YEARS)

S.N	Activity	Time Frame	Year					
			1st Phase	2nd Phase	Final Phase	Post Closure Phase		
			1st - 5th	6th - 10th	11th - 14th	PC1	PC2	PC3
A	**Dismantling of Structures**							
	Service Buildings	2 years						
	Residential Buildings	2 & ½ years						
	Industrial structures like CHP, Workshop, field sub-station, etc.	2 & ½ years						
B	**Permanent sealing of mine entries (incline mouth and air shaft)**							
	Sealing of incline mouths and air shafts	2 years						
C	***Subsidence Management**	Throughout the life of the mine, if required including 3 years after cessation of mining operation						
D	**Landscaping**							
	Landscaping of the cleared land for improving its esthetic	Throughout the life of the mine including 3 years after cessation of mining operation						
E	***Plantation**							
	Plantation over leasehold area and on other open spaces	Throughout the life of the mine including 3 years after cessation of mining operation						
F	**Post Closure Env Monitoring / testing of parameters for three years**							
	Air Quality	3 years						

S.N	Activity	Time Frame	Year					
			1st Phase	2nd Phase	Final Phase	Post Closure Phase		
			1st - 5th	6th - 10th	11th - 14th	PC1	PC2	PC3
	Water Quality	3 years						
G	***Entrepreneurship Development (Vocational/skill development training for sustainable income of affected people**	Throughout the life of the mine						
H	***Miscellaneous and other mitigative measures**	Throughout the life of the mine including 3 years after cessation of mining operation						
I	**Post Closure Manpower cost for supervision**	3 years after mine closure						

NOTE: *: To be covered under Progressive Mine Closure activities also**.**

NOTE: The progressive mine closure will be done as per the provisions made out in the Project report and as per the situation/requirement that may arise in course of execution of the Project Report.

CHAPTER – VI

MINE CLOSURE COST

6.0 Mine Closure activities would be a constant exercise for the mine which would begin with the commencement of mining operations and continue till post closure. The mine closure activities would naturally entail certain expenditures, which will have to be borne by the mine operator. There would be two types of expenditures on account of mine closure activities in respect of New Akashkinaree Colliery.

6.1 **Revenue expenditures**

This would cover the activities which are being executed along with normal mining operation and would continue to be executed in course of execution of the project. The cost of progressive mine closure activities is already part of the project cost.

6.2 **Expenditures to be incurred just prior to actual mine closure and in the post closure period**

6.2.1 As As per MOC guidelines, a corpus escrow account @ ₹ 1.0 lakhs (August, 2009 Price Level) per Ha (for UG) and @ ₹ 6.0 lakhs(for OC) of the project area shall be opened with the coal controller organization to meet the expenses of final mine closure. The current Guidelines read as:

"It has been estimated that typically closure cost for an opencast mine will come around Rs. 6.00 lakh per Hectare of the project area and it would be Rs. 1.00 lakh per Hectare for underground mine project area at current price levels (August, 2009) and these rates will stand modified based on Wholesale Price Index as notified by Government of India from time to time".

As per the data furnished by the mine/area, the project area and leasehold area in respect of New Aakashkinaree Colliery is the same and the closure cost is calculated accordingly.

In New Akashkinaree Colliery, the present project area is 367.58 Ha, out of which 144 Ha is for opencast project (Table No. 1.2). The remaining 223.58 Ha of project area (Excluding Opencast Project) has been considered for the calculation of closure cost of the area as per Underground norms and cost of closure of 144 Ha (Opencast Project) is calculated as per Open cast norms.

The overlapping area (where UG & OC operations have been done in different vertical levels) has been considered for calculation of closure cost as per opencast norms.

The money deposited in the Escrow Account has to deal with the following:

- Cost of closure activities.
- Cost towards organization for executing the closure activities.
- Cost of the post project monitoring.
- Creation of a corpus fund for the final mine closure

6.2.2 As per the above guidelines these rates will stand modified based on Whole Price Index as notified by Government of India from time to time. Thus the total expenditure on this front may be calculated in the manner described overleaf.

- ➢ The total amount for mine closure activity in respect of **New Akashkinaree UG (Excluding Opencast Project**) = 223.58 Ha X ₹ 1 Lakh X 1.35340* = ₹ 302.59 lakhs

- ➢ The total amount for mine closure activity in respect of **New Akashkinaree (OC**) = 144 Ha X ₹ 6 Lakh X 1.35340* = ₹1169.33 lakhs

*** The amount has been escalated based on WPI of July 2013 (175.4) vis-à-vis WPI of August '09(129.6).**

The WPI of July 2013 is provisional as per the Govt.'s notification (Office of the Economic Adviser).

6.2.3 It is difficult to conclusively predict the mining parameters on a long term basis owing to rapidly changing mining technology, developments in the field of clean coal technologies and R&D activities in development of alternative energy sources.

As per the latest Guidelines issued by the MoC, GoI(dt. 07.01.2013) the *"annual closure cost is to be computed considering the total project area at the above mentioned rates and dividing the same by the entire life of the mine in years for new projects and balance life of mine in years for operating/existing mines."*

Jharia Coalfield is characterized by occurrence of a number of working coal horizons, giving a leverage of extended working life of the mines. Some more seams can come in the lap of workable horizons due to improvement in mining technology in times to come. The underground mines in leasehold of JCF are generally small capacity mines, giving a false impression of very long lives due to small level of current production level. There may be a strategy in future to amalgamate the mines for higher production level to attain the economics of scale. In such a situation, the life of the mine arrived at with current level of production for the balance reserve may not be workable in the long run.

In view of the above and as discussed in para 1.12, for the purpose of mine closure cost calculations, the life of the mine has been calculated based on the development reserve available in the currently producing seams, proposed OCP patches, surface and sub-surface constraints.

The present OC operations are being carried out with IV Seam as base on north of DB Road which has a balance life of 1 year. There is a proposal to work two OC patches between DB Road and the DC Railway line. The total extractable reserve in the three patches works out to 14.62 MTe. With the present production of 0.5 MTY, the life works out to 30 years.

The development with SDLs is being carried out in I & II Seams @ 500 TPD. Due to surface and sub-surface constraints, only development is possible under present scenario. The development reserve in the two seams works out to 2.0 MTe (as per colliery estimates). With the present production of 500 TPD, the life works out to 14 years.

A Project Report on Block-IV OCP (6.0 MTY) has been formulated with I seam as Base seam, which covers New Akashkinaree colliery upto the DC Rail line. If this PR is implemented, all the UG outlets of the mine will be excavated. In such a situation, it is envisaged that a New Closure Plan should be drawn up as per the revised scope of mining operations as per the relevant guidelines.

The life of **New Akashkinaree UG** mine will be 14 years. To arrive, at the annual cost, to be deposited in each year in an escrow account, the mine closure cost has been divided by 14, as shown below:

- Amount to deposited in 1st year will be-----₹ 21.61 lakhs
- Amount to be deposited in 2nd year will be—₹. 21.61 (1 + 5%)^1 lakhs
- Amount to be deposited in 3rd year will be—₹. 21.61 (1 + 5%)^2 lakhs

6.2.4 In the above fashion, an amount will be deposited every year up to the last year of mine life by applying the following formula:

- Amount to be deposited in N_{th} year = ₹ 21.61 (1 + 5%) ^(n-1) lakhs

Thus, total amount that shall be deposited for final mine closure activities **New Akashkinaree UG** stands out to be ₹ **423.60** lakhs as per the present status of the mine.

6.2.5 The life of **New Akashkinaree OC** mine will be 30 years. To arrive, at the annual cost, to be deposited in each year in an escrow account, the mine closure cost has been divided by 30, as shown below:

- Amount to deposited in 1st year will be-----₹ 38.98 lakhs
- Amount to be deposited in 2nd year will be—₹. 38.98 (1 + 5%)^1 lakhs
- Amount to be deposited in 3rd year will be—₹. 38.98 (1 + 5%)^2 lakhs

6.2.6 In the above fashion, an amount will be deposited every year up to the last year of mine life by applying the following formula:

- Amount to be deposited in N_{th} year = ₹ 38.98 (1 + 5%) ^(n-1) lakhs

6.2.7 Thus, total amount that shall be deposited for final mine closure activities **New Akashkinaree OC** stands out to be ₹ **2589.64** lakhs as per the present status of the mine.

Table No. 6.1 Break-Up cost of Mine Closure of New Akashkinaree Colliery

Year	Amount (₹ in Lakhs)		
	New Akashkinaree OC	New Akashkinaree UG	Total
1	38.98	21.61	**60.59**
2	40.93	22.69	**63.62**
3	42.97	23.83	**66.80**
4	45.12	25.02	**70.14**
5	47.38	26.27	**73.65**
6	49.75	27.59	**77.34**
7	52.23	28.96	**81.19**
8	54.85	30.41	**85.26**
9	57.59	31.93	**89.52**
10	60.47	33.53	**94.00**
11	63.49	35.21	**98.70**
12	66.67	36.97	**103.64**
13	70.00	38.82	**108.82**
14	73.50	40.76	**114.26**
15	77.17		**77.17**
16	81.03		**81.03**
17	85.08		**85.08**
18	89.34		**89.34**
19	93.80		**93.80**
20	98.49		**98.49**
21	103.42		**103.42**
22	108.59		**108.59**
23	114.02		**114.02**
24	119.72		**119.72**
25	125.71		**125.71**
26	131.99		**131.99**
27	138.59		**138.59**
28	145.52		**145.52**
29	152.80		**152.80**
30	160.44		**160.44**
Total	**2589.64**	**423.60**	**3013.24**

6.2.8 Based on the existing mine closure planning norms, the above calculated cost at current WPI on mine closure may be tentatively grouped under following heads:

Table No. 6.2A Break up Cost of Mine Closure of New Akashkinaree UG Colliery

Sl. No.	Activity	Mine Closure Cost (₹ in Lakhs)
A	**Dismantling of Structures**	
	Service Buildings	14.83
	Residential Buildings	44.82
	Industrial Structures like CHP, Workshop, field sub-station, cap lamp room, haulage, fan installation etc.	26.81
B	**Permanent Sealing of mine entries(incline mouth and air shaft)**	
	Sealing of incline mouths and air shafts	22.54
C	***Subsidence Management**	20.12
D	***LANDSCAPING**	
	Landscaping of the cleared land for improving its esthetic	37.28
E	***Plantation**	
	Plantation over the cleared area obtained after dismantling and on other barren spaces	55.07
F	**Monitoring/Testing of parameters for three years**	
	Air Quality	28.93
	Water Quality	26.86
G	***Enterpreneuship Development(Vocational/skill development training for sustainable income of affected people**	32.41
H	***Miscellaneous and other mitigative measures**	61.85
I	**Manpower Cost for Supervision**	52.10
	TOTAL	**423.60**

Note: * :To be covered under Progressive Mine Closure activities also.

Table No. 6.2B Break up Cost of Mine Closure of New Akashkinaree OC Colliery

Sl. No.	Activity	Mine Closure Cost (₹ in Lakhs)
A	**Dismantling of Structures**	
	Service Buildings	5.18
	Residential Buildings	69.14
	Industrial Structures like CHP, Workshop, field sub-station, etc.	7.77
B	**Permanent Fencing of Mine Void and other dangerous area**	
	Random Ruble masonry of height 1.2 metre including levelling up in cement concrete 1:6:12 in mud mortar	38.84
C	**Grading of Highwall slopes**	
	Levelling and grading of highwall slopes	45.84
D	**OB Dump Reclamation**	
	*Handling/Dozing of external OB Dump into mine void	2295.97
	*Bio-Reclamation including soil spreading, plantation and maintenance	10.36
E	**LANDSCAPING**	
	Landscaping of the cleared land for improving its esthetic	7.77
F	**Plantation**	
	Plantation over area obtained after dismantling	12.95
	*Plantation around fencing	5.18
	*Plantation over the cleared external OB Dump	0.52
G	**Monitoring/Testing of parameters for three years**	
	Air Quality	5.70
	Water Quality	5.18
H	***Enterpreneuship Development(Vocational/skill development training for sustainable income of affected people**	6.73
I	***Miscellaneous and other mitigative measures**	51.79
J	***Manpower Cost for Supervision**	20.72
	TOTAL	**2589.64**

Note: * :To be covered under Progressive Mine Closure activities also.

6.2.9 Thus, total amount that shall be deposited for final mine closure activities (**New Akashkinaree OC**) during the period of 30 years has been estimated as ₹ 2589.64 lakhs and total amount that shall be deposited for mine closure activities (**New Akashkinaree UG**) during the period of 14 years has been estimated as ₹ 423.60 lakhs.

6.2.9 Mining is to be carried out in a phased manner initiating afforestation/reclamation work in the mined out area of the first phase while commencing the mining in the second phase i.e. continuation of mining activities from one phase to other indicating the sequence of operations depending on the geo-mining conditions of the mine. Up to 80% of the total deposited amount including interest accrued in the ESCROW account may be released after every five years in line with the periodic examination of the Closure Plan as per Clause 3.1 of the Annexure of the Guidelines. The amount released should be equal to expenditure incurred on the Progressive mine closure in past five years or 80% whichever is less. The balance amount shall be released to mine owner/leaseholder at the end of the final Mine Closure on compliance of all provisions of Closure Plan. This compliance report should be duly signed by the lessee and certify that said closure of mine complied all statutory rules, regulations, orders made by the Central or State Government, statutory organisations, court etc. and certified by the Coal Controller.

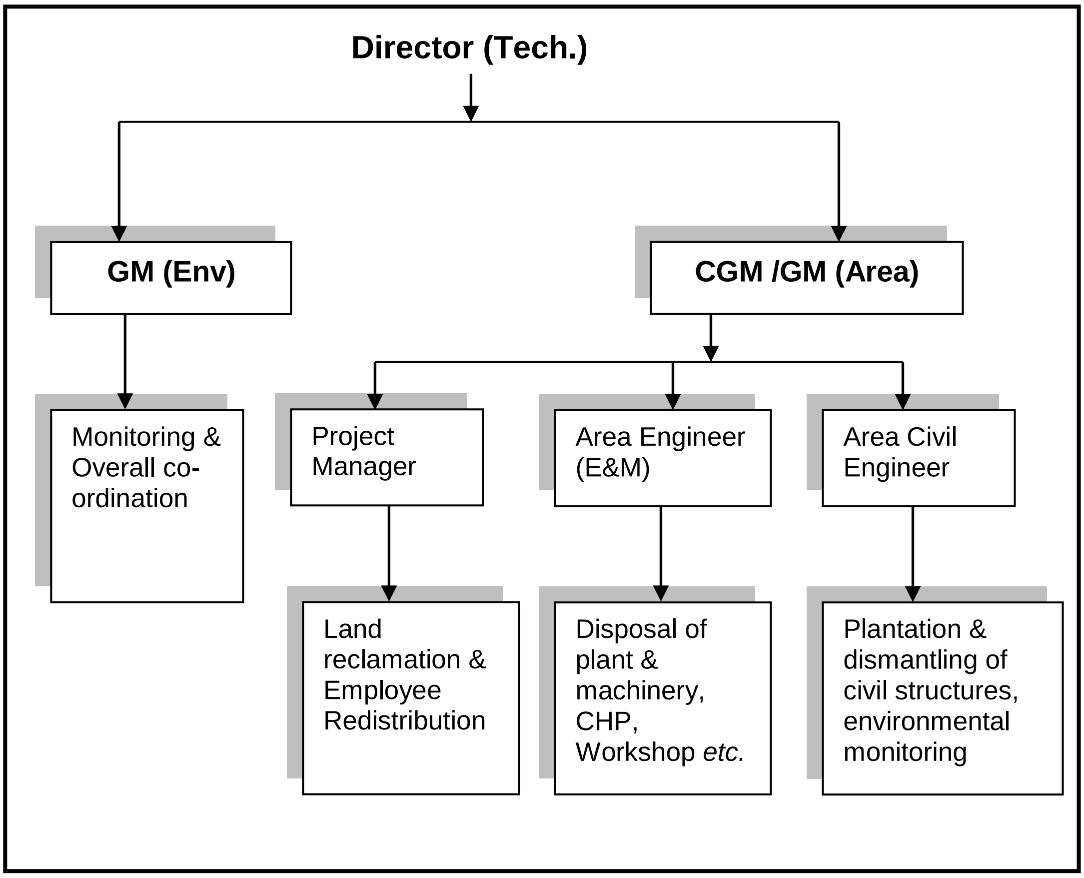
6.2.10 However, the additional amount beyond the escrow account, if any estimated later on, will be provided by the mine operator after estimating the final mine closure cost five years prior to mine closure (as per the mine closure guideline)**.**

CHAPTER-VII

IMPLEMENTATION PROTOCOL

7.1 As the mine closure activities would continue even after cessation of mining activities, an organization consisting of different discipline would be formed to undertake the implementation of mine closure activities as well as monitoring of the same**.** Such activity shall continue for a period of three years after the closure of mining activity in the mine. Once the closed mine becomes stabilized in respect of safety, environmental and social aspects, the monitoring team would be withdrawn.

7.2 For implementing the mine closure activities and monitoring thereof, the following organisational structure at corporate level has been proposed:



7.3 Environmental monitoring for three years after closure of mine will be carried out to evaluate the environmental quality of the area. If need be, proper

mitigation measures will be taken up after evaluating the environmental quality. Before closure of the mine, Area GM will prepare survey and disposal report and the same will be submitted to DGMS for acceptance.

7.4 When the mine closure activities would take final shape and the entire are under influence is brought to an acceptable shape, BCCL would obtain a mine closure certificate from Coal Controller to the effect that the protective, reclamation and rehabilitation works in accordance with the approved mine closure plan/final mine closure plan have been carried out for surrendering the reclaimed land to the State Government concerned.

CHAPTER – VIII

PLANS ENCLOSED

The following underground and surface plans have been enclosed along with this mine closure report plan:

a. Location Plan of Cluster III
b. Surface plan showing surface features, contours,roads, depot/siding, OB dumps, quarries (working/old/discontinued), subsidence, plantations, habitations, vacant land , surface water bodies, natural drainage and mine discharge water channels of Cluster III
c. Geological Plan of Cluster III
d. Seam-wise working plans (for UG)

Annexure-III

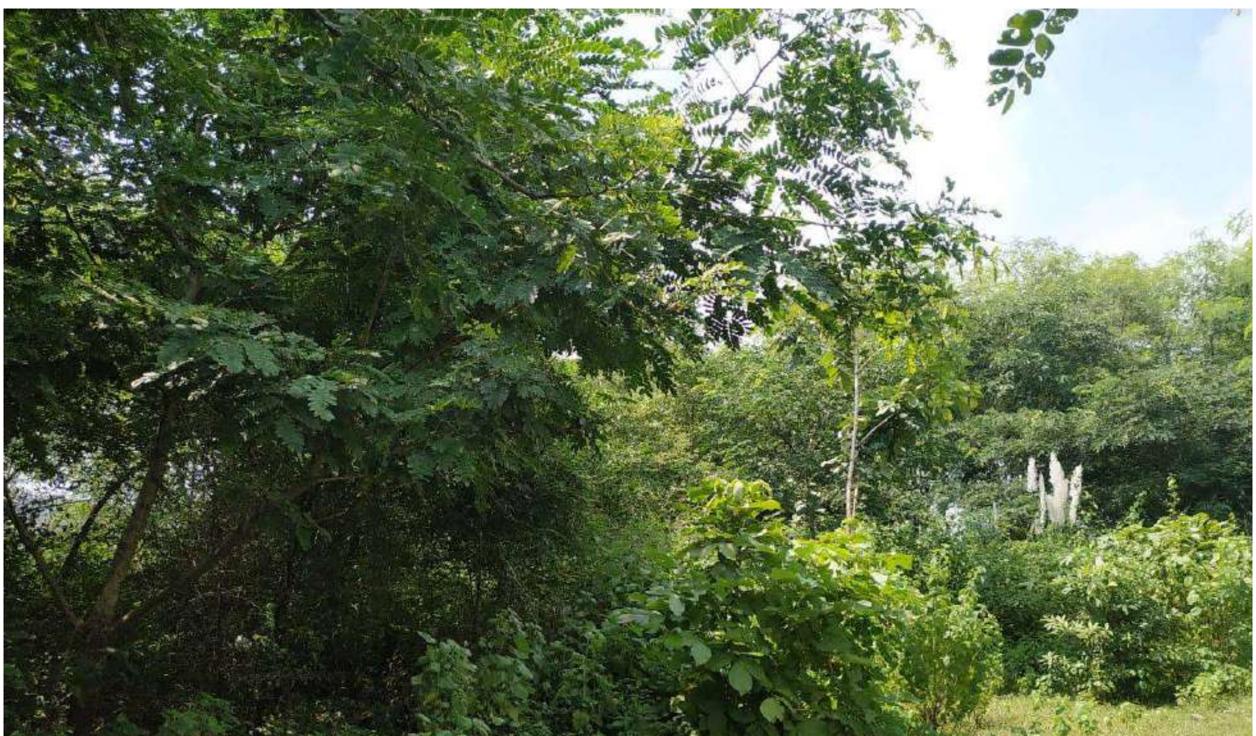
Stone Pitching along the water body

Annexure-IV

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

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

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



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

Annexure-V

Details of OB generated

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

Details of Backfilling

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

Annexure-VI

Proposed Coal Production, OB generation, and plantation for FY 2022-23

FY 2021-22	New Akashkinaree Colliery (Mixed)	Block-IV Colliery (Mixed)	Maheshpur Colliery (UG)	Jogidih Colliery (UG)
Coal Production (Te)	0.6 MTe (OCP); 0.05 MTe(UG)	0.45 MTe	50000 Te	40000 Te
OB (cum)	15,00,000	8,50,000	NA	NA

Details of plantation done for FY 2021-22

FY 2021-22	New Akashkinaree Colliery (Mixed)	Block-IV Colliery (Mixed)	Maheshpur Colliery (UG)	Jogidih Colliery (UG)
Biological reclamation (Ha)	23	Nil	388 Bamboo gabion	Nil

Proposed Plantation for FY 2022-23

Type of Plantation	Nos.	Executing Agency
Bamboo Gabion Plantation	1978 Nos.	DFO, Dhanbad

Annexure-VII

Details of Block Plantation/Biological Reclamation done up to 31.03.2022

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

Details of Block Plantation/Biological Reclamation done up to 31.03.2022

Year of Plantation	Type of Plantation	Nos.	Executing Agency
FY 2020-21	Bamboo Gabion Plantation	388 Nos.	DFO, Dhanbad

Annexure-VIII

Sedimentation ponds and settling tanks for mine water utilization

Roads constructed within colliery premises


Network:28-Aug-2021 at 12:27:05 PM IST
Local:28-Aug-2021 at 12:27:05 PM IST
N 23° 47' 12.896", E 86° 15' 43.413"
Sahnidih Main Road
Sahnidih 828125
JH
India


Network:28-Aug-2021 at 12:28:57 PM IST
Local:28-Aug-2021 at 12:28:58 PM IST
N 23° 47' 12.896", E 86° 15' 43.413"
Sahnidih Main Road
Sahnidih 828125
JH
India

388 nos. bamboo gabion plantation in Maheshpur Colliery (Plantation year FY 2021-22)

Water Sprinkling on Haul roads through Mist type water tanker

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

Sponsor

Bharat Coking Coal Limited (BCCL)

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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.

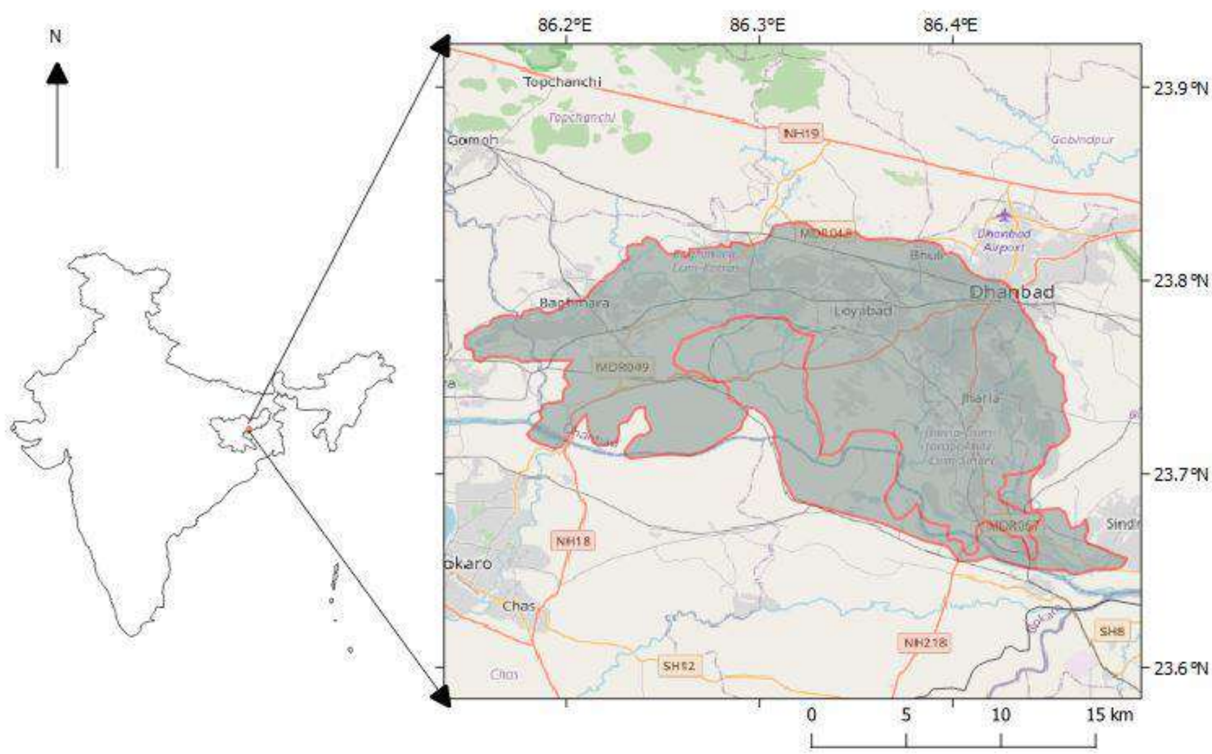


Figure 1.1: Geographical location of Jharia Coalfield in India

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).

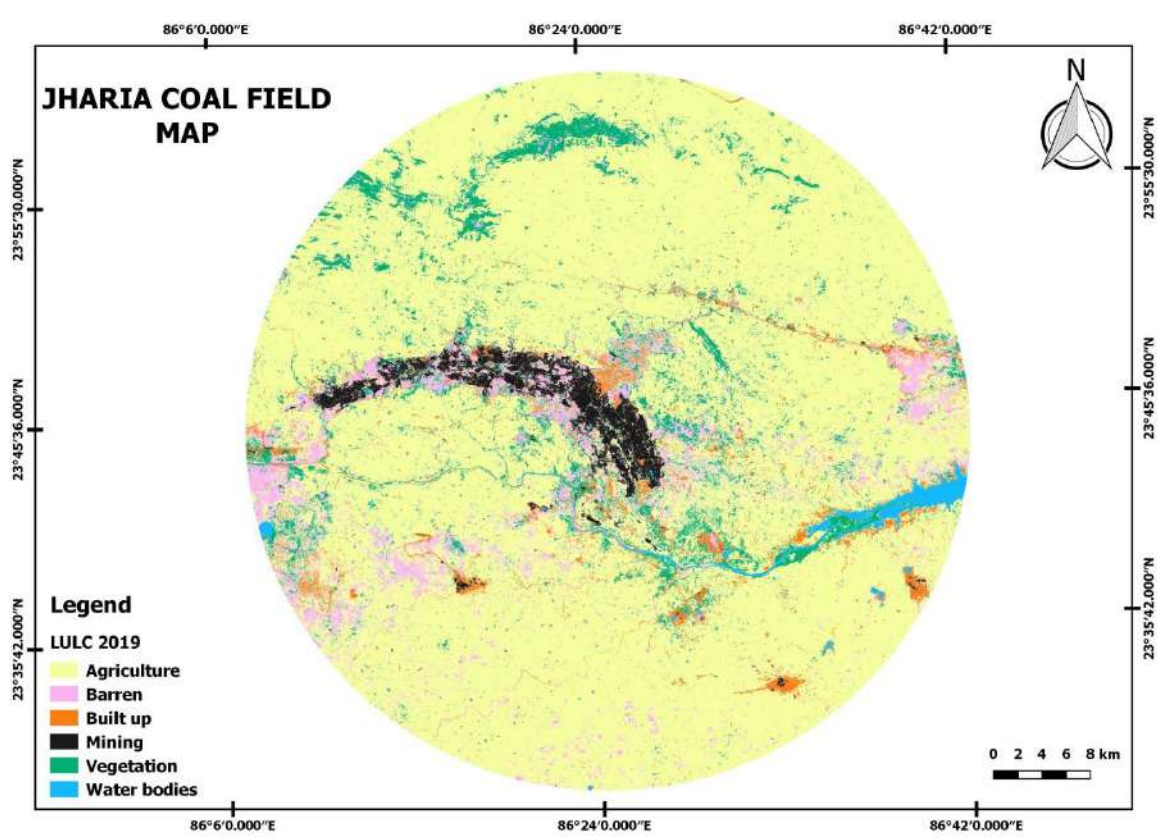


Figure 1.2: Land Use land cover map of Jharia coal field area

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.

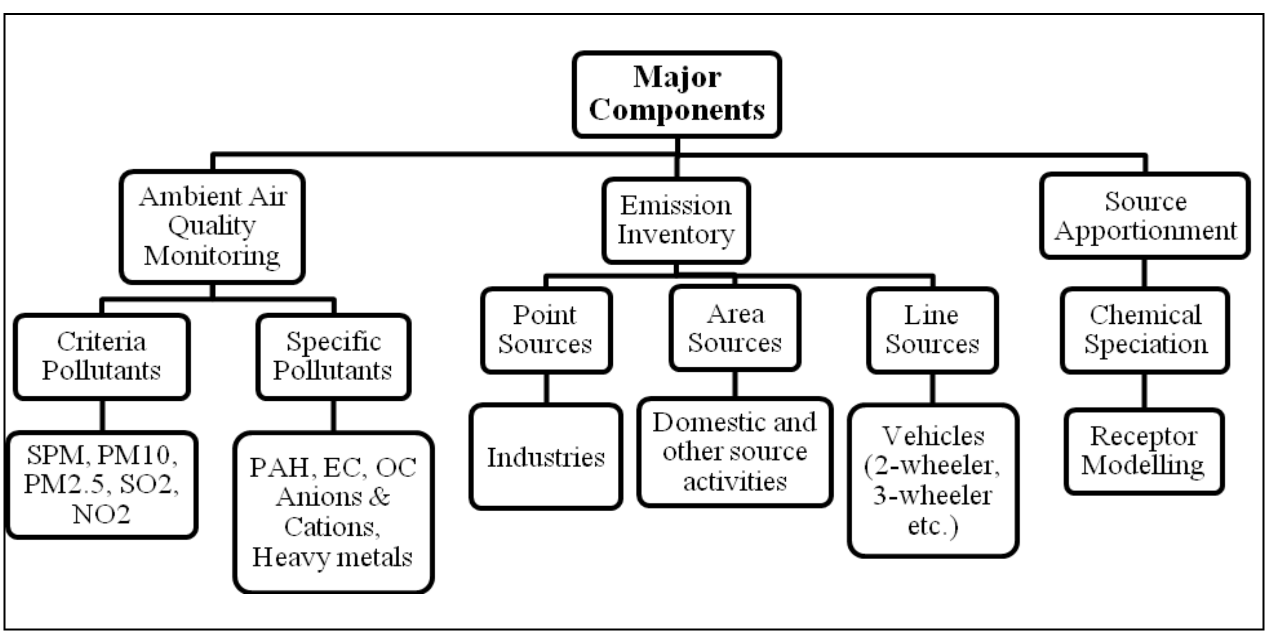


Figure 1.3: Air quality Monitoring & emission source apportionment studies

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

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

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

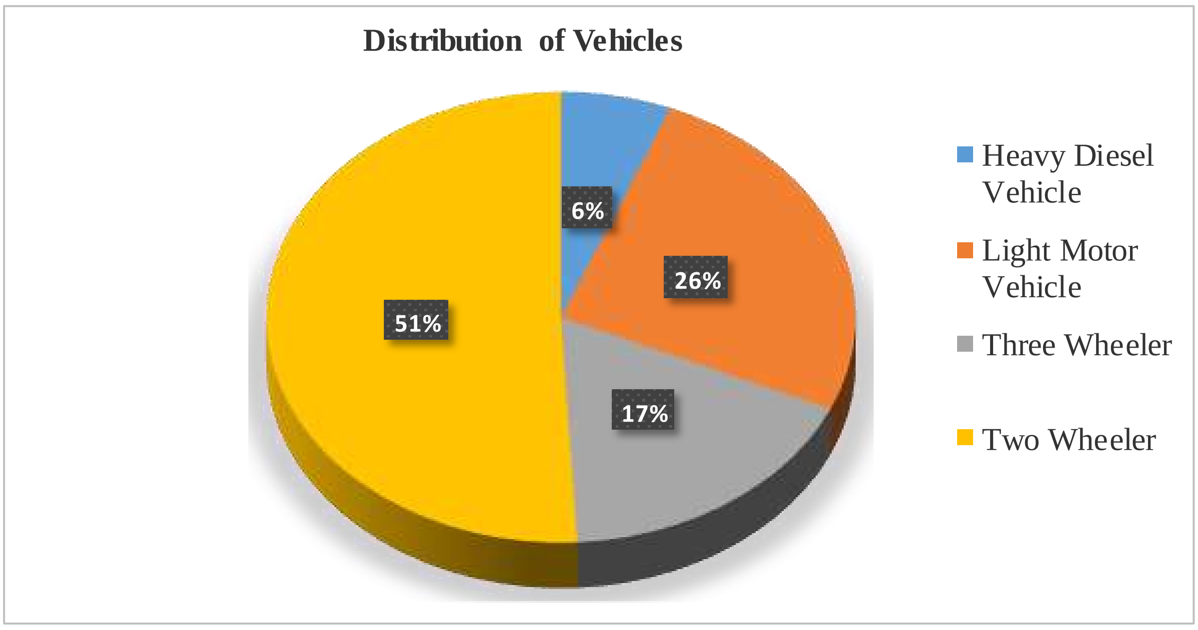


Figure 2.1 Percentage of different types of vehicle surveyed on the road network during the field survey

Table 2.2: Utilization Factors for different types of vehicle

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

2.4. Methodology

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

$$E_i = N_v \times VKT \times E_f \tag{2.1}$$

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

N_v is the number of vehicles of a particular type

VKT is the vehicle km travelled

E_i, km is the emission factor for a specific vehicle

Table 2.3: Emission estimate for road transport

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

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

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

E = k. (SL/2)^0.65 . (W/3)^1.5 (2.2)

Where, 'E' = emission rate of PMs (Table 2.3);
SL is silt load (g/m2);
W is the average weight of the vehicle (Tons);
k is constant (the function of particle size) in g VKT^{-1} (Vehicle Kilometer Travel)

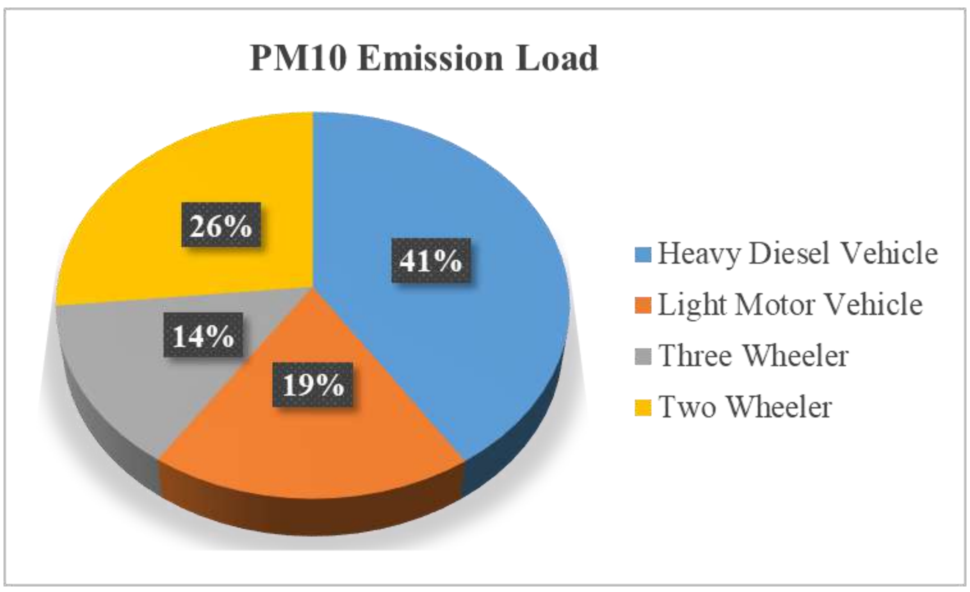


Figure 2.2 PM_{10} emission load for different categories of vehicle

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

Table 2.4: Emission rate for the paved and unpaved road

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

2.5. Results

2.5.1. Industrial Emission

Emission inventory estimates are determined based on considering available industrial activity information, emission factors (Table 2.5) and observations. For the current study, industrial and mining information was collected for emission inventory development. Emission inventory information for industries was collected from the regional office of JSPCB. In Dhanbad, the major industries are the power plant and the coking industry. Other than those are coal mines, thus coal as a fuel is majorly used in industries and households. Emission loads by point source are depicted in Table 2.6 as per emission inventory.

Table 2.5: Emission factor for coal mining activities

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

Table 2.6: Emission load from Industrial sector in Dhanbad

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

2.5.2. Area/Distributed source

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

Area sources considered for emission inventory for Dhanbad city are:

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

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

- **Emission load from mining activities**

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

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

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

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

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

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

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

- **Cooking operations in slum households**

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

Table 2.9: Emission from coal as fuel

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

- **Emissions from crematorium**

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

Table 2.10: Emission from Crematoria using Wood as fuel

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

- **Emissions from bakeries**

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

Table 2.11: Emission from Bakeries using Coal as fuel

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

- **Emissions from hotels and restaurants**

Data were collected from 35 hotels in Dhanbad city. It has been found that most hotels/restaurants were using a combination of coal and LPG as cooking fuel. Emission from coal and LPG were calculated and depicted in Table 2.12 and 2.13.

Table 2.12: Emission from Hotel & Restaurants using Coal

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

Table 2.13: Emission from Hotel & Restaurants using LPG

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

- **Emission from open eat-outs**

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

Table 2.14: Emission loads from open eat-outs

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

2.5.3. Grid wise emission inventory

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

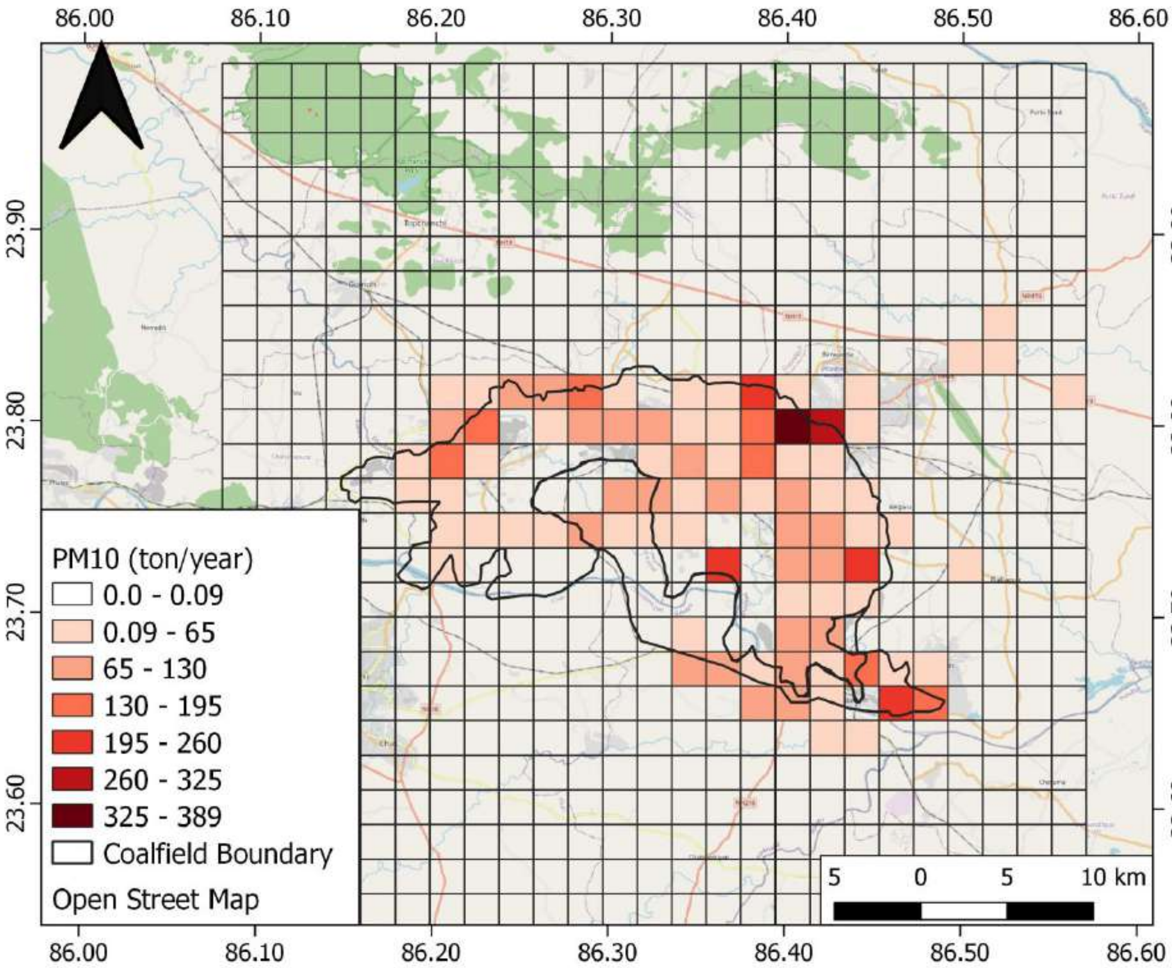


Figure 2.3 Grid-wise emission inventory of PM_{10} in tons/year over the study area

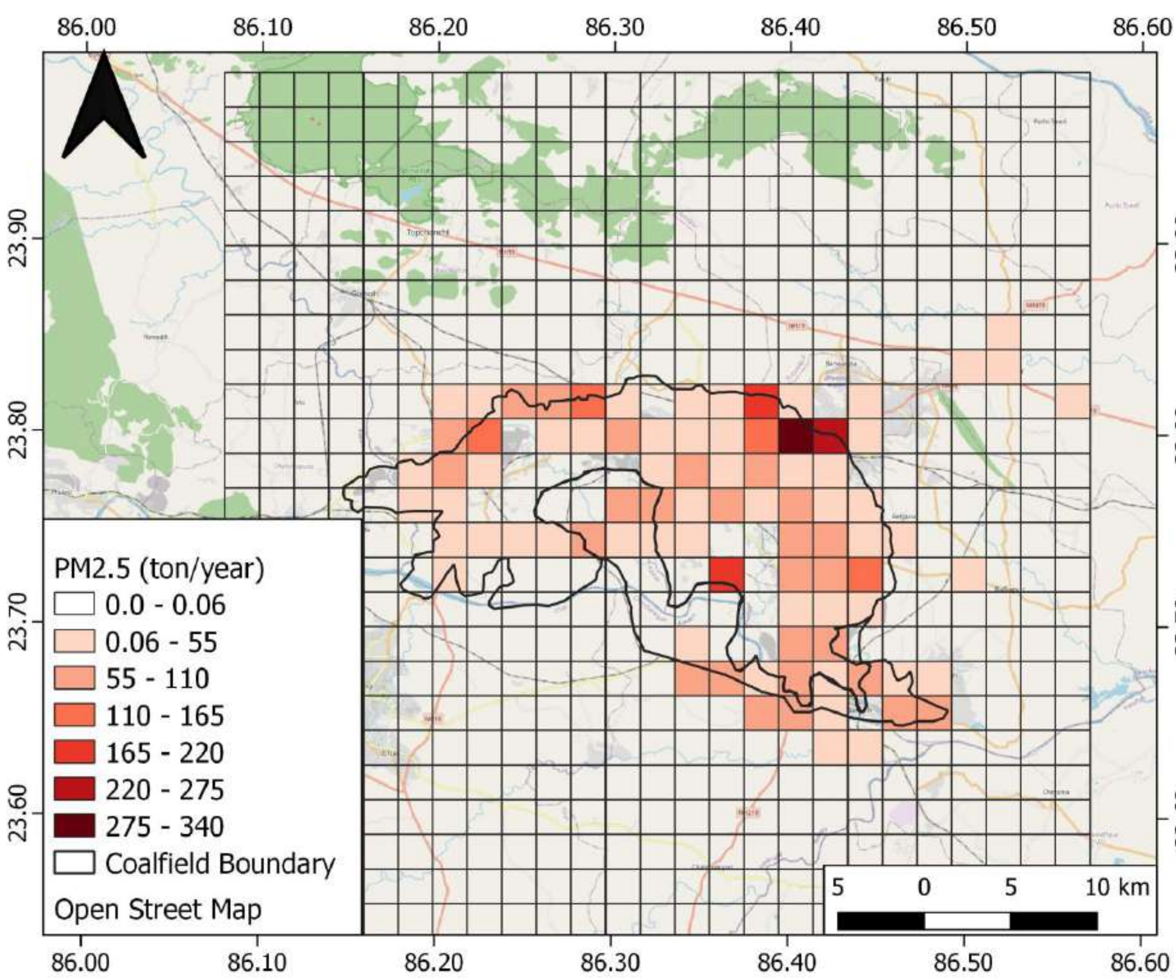
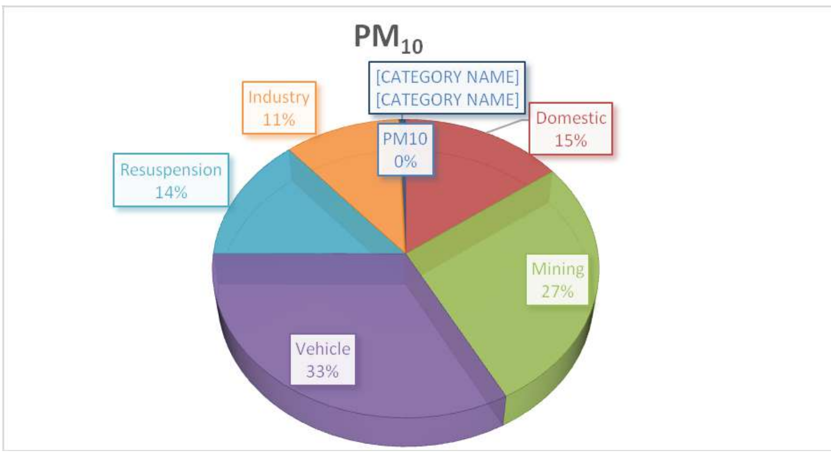
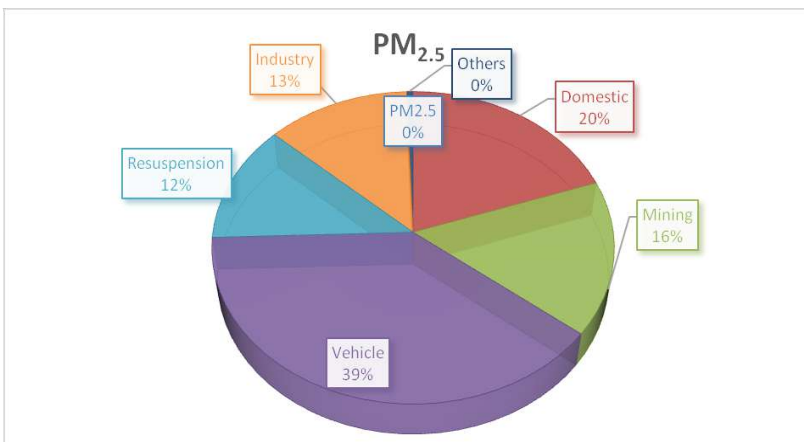


Figure 2.4 Grid-wise emission inventory of PM2.5 in tons/year over the study area

The respective share of various emission sources is represented through pie diagrams shown in Figure 2.5. Data shows that PM_{10} emissions are contributed mostly from vehicular emissions followed by emissions from the mines whereas, $PM_{2.5}$ emissions are contributed mostly from vehicular emissions, domestic burning and mine activities. The grid-wise emission inventory maps and the information on the pollution sources provide the basis for the policymakers to target the hotspots of pollution generation in order to take effective mitigation actions.



(a)



(b)

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

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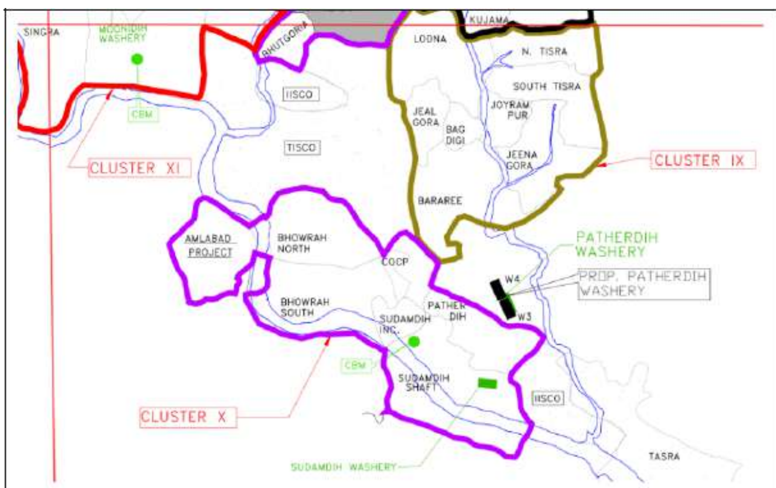
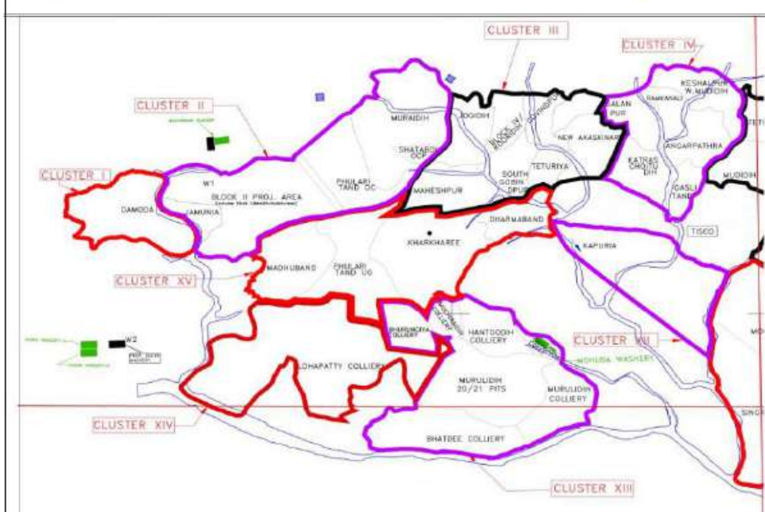
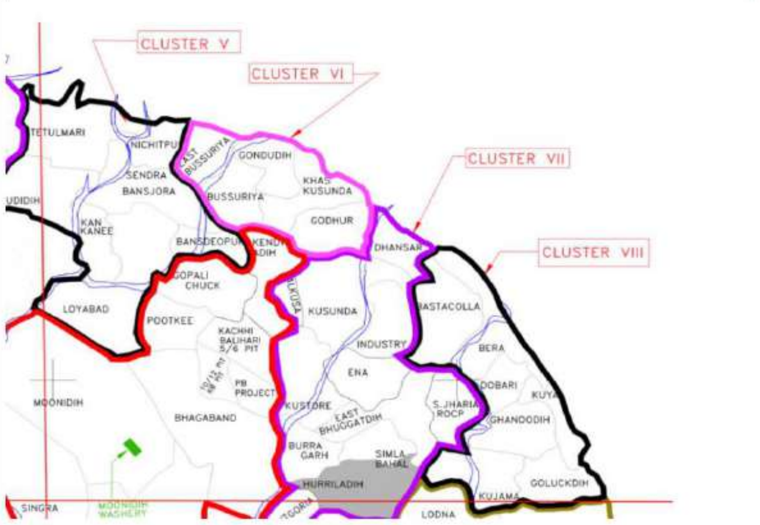
Chapter 3 Air Quality Monitoring and Receptor modelling

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

Table 3.3.1: The details of mine cluster in Jharia Coalfield

<table>
<tr><td>
</td><td>Day 1: Cluster I, II, III, IV, XII, XIII, XV and XIV</td></tr>
<tr><td>
</td><td>Day 2: Cluster V, VI, VII, and VIII</td></tr>
<tr><td>
</td><td>Day 3: Cluster IX, X and XI</td></tr>
</table>

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

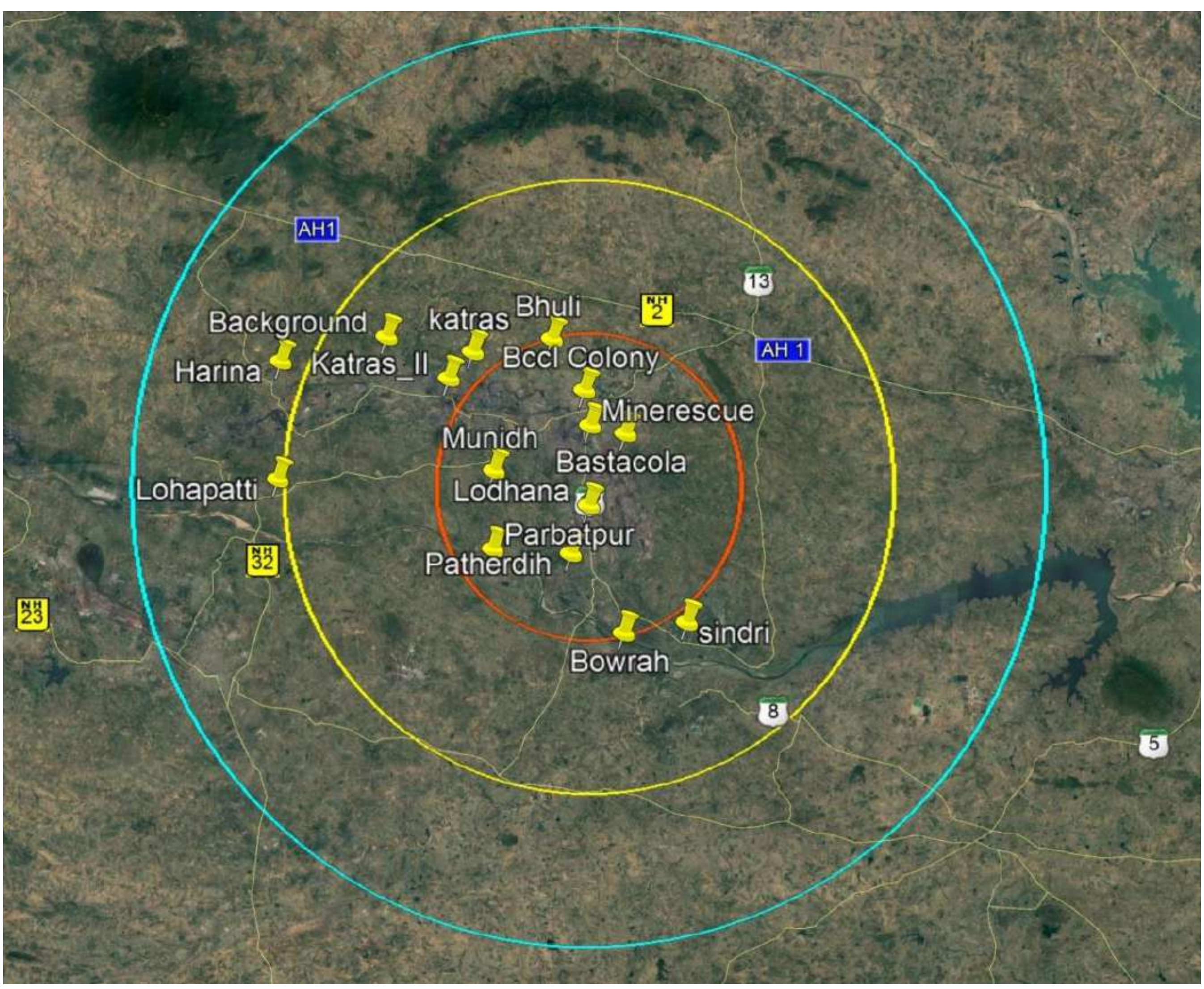


Figure 3.1: Air monitoring sites under 30 km buffer area

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 300̊C and FID temperature 320̊C.

3.2.6. EC & OC analysis

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

3.3. Results

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

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

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

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

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

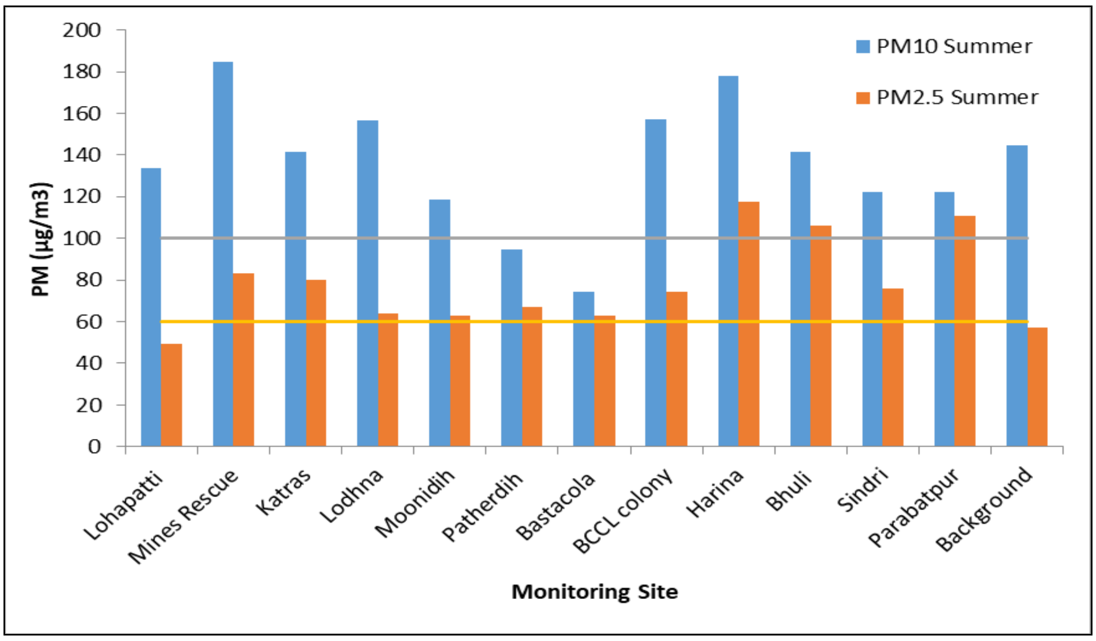


Figure 3.2: Average concentration of PM_{10} and $PM_{2.5}$ in JCF region in summer compared to NAAQS (2009)

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

Monitoring Sites	Site Description	Average Concentration (µg/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).

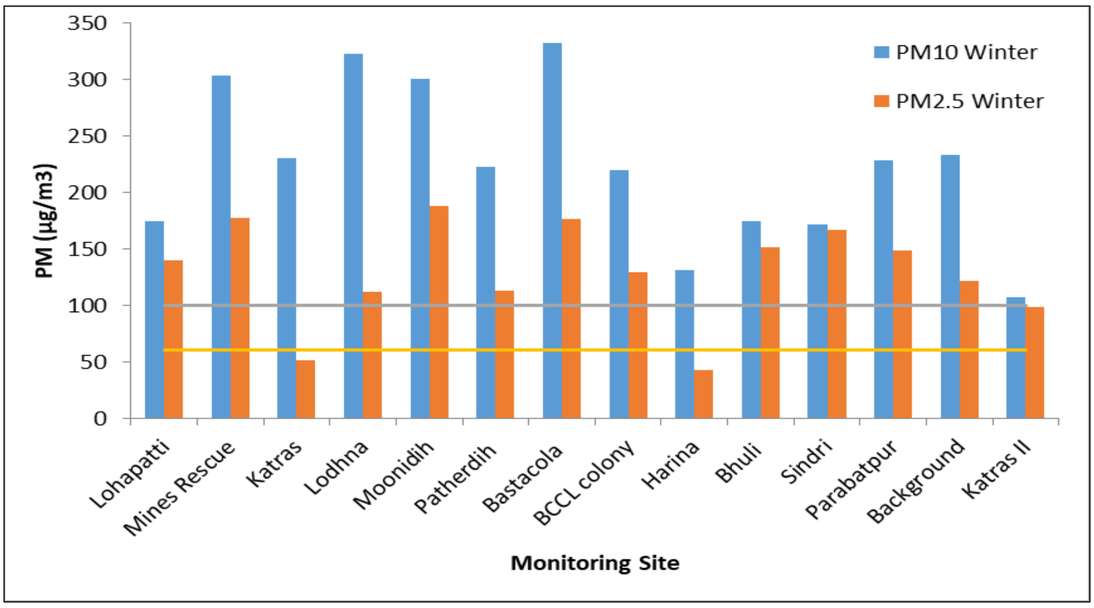


Figure 3.3: Average concentration of PM_{10} and $PM_{2.5}$ in JCF region during Winter compared to NAAQS (2009)

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.

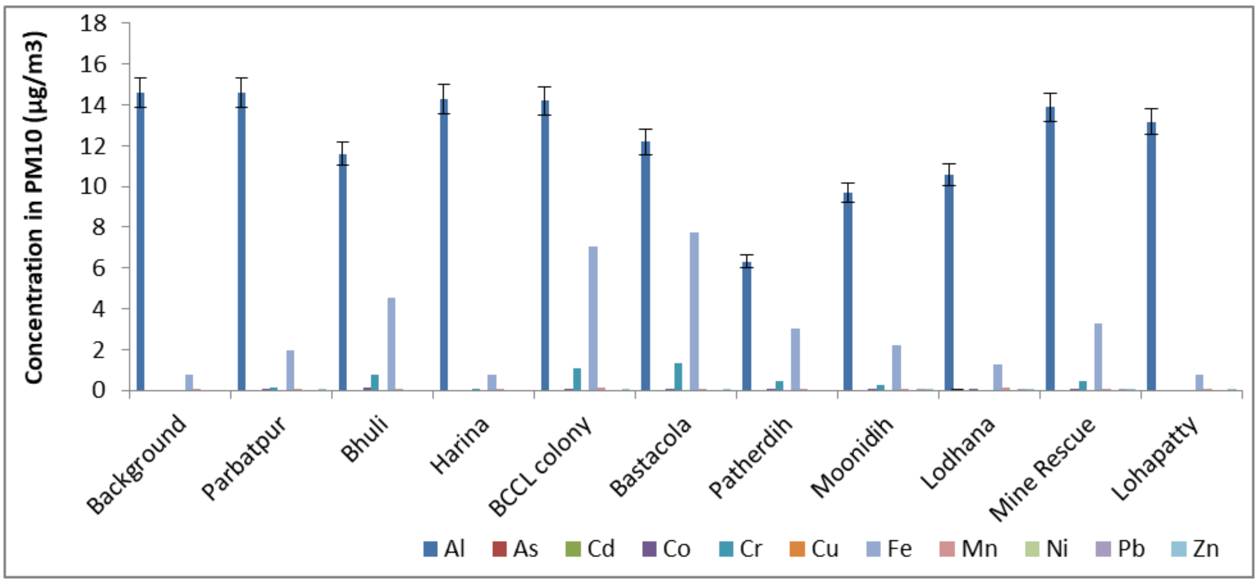


Figure 3.4: Metal concentration of PM_{10} in the summer season

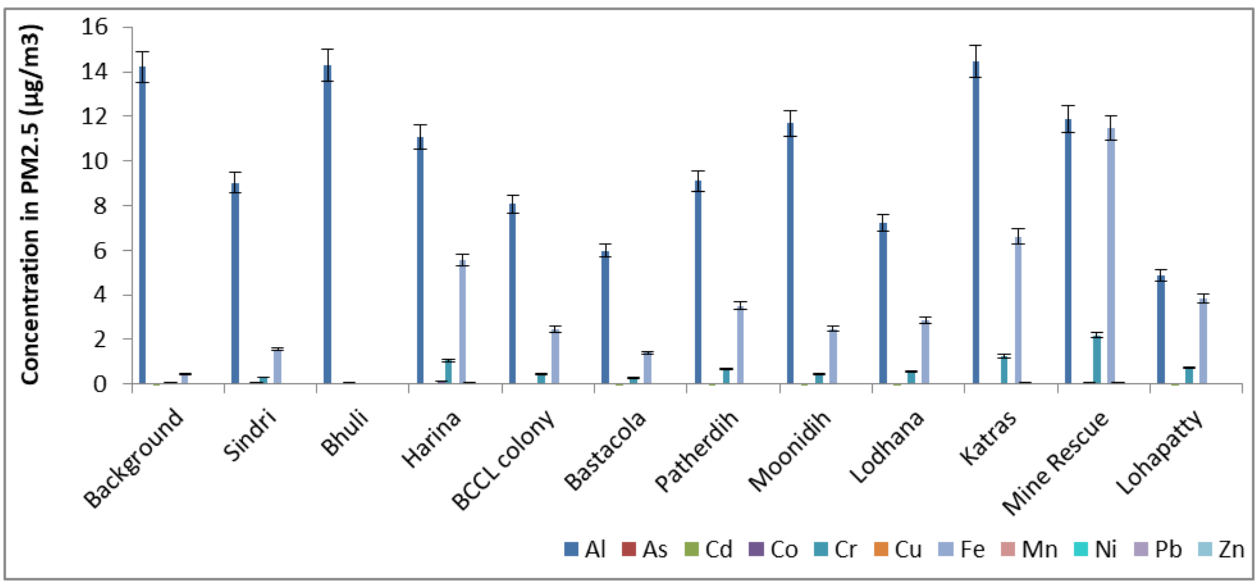


Figure 3.5: Metal concentration of $PM_{2.5}$ in the summer season

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.

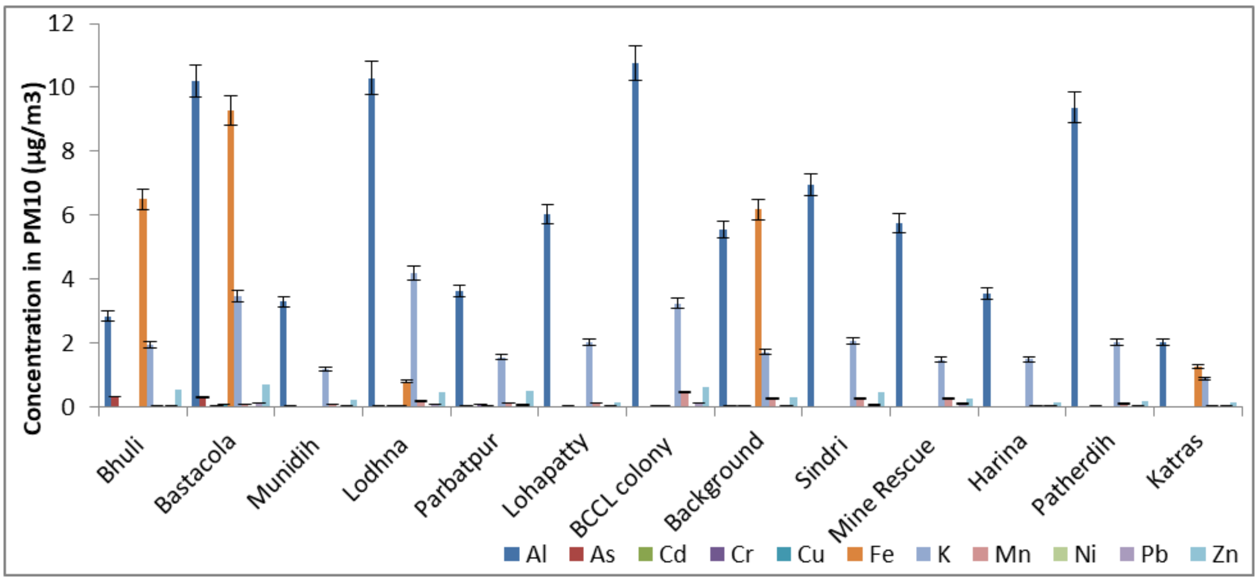


Figure 3.6: Metal concentration of PM_{10} in winter season

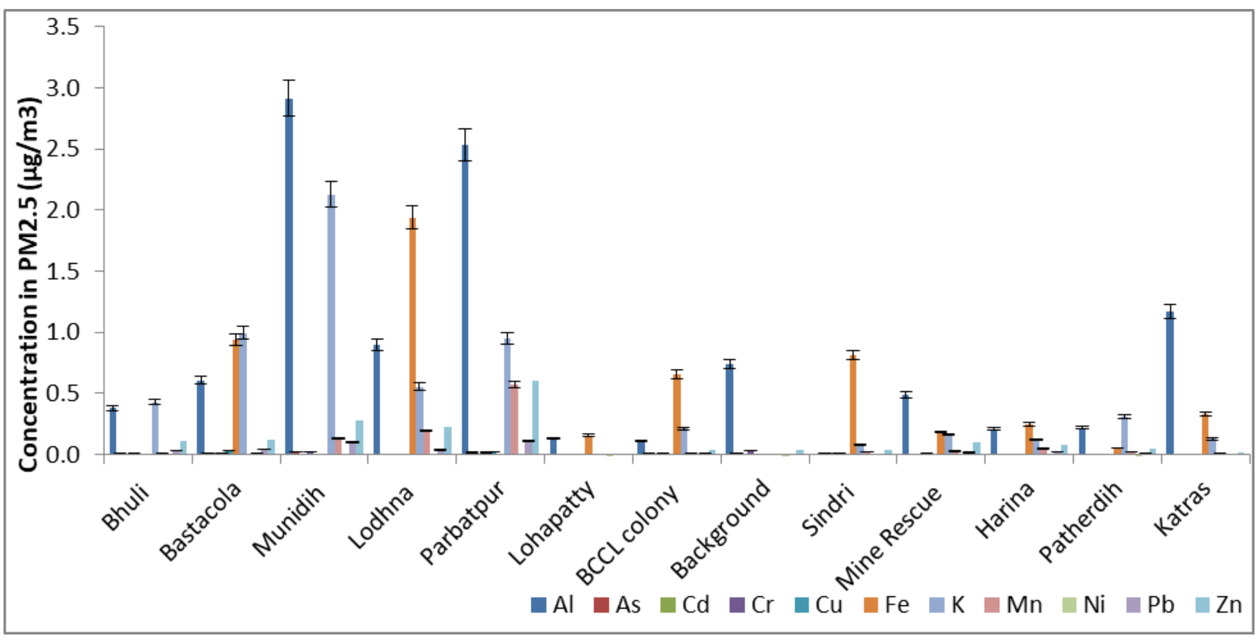


Figure 3.7: Metal concentration of PM 2.5 in winter season

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.

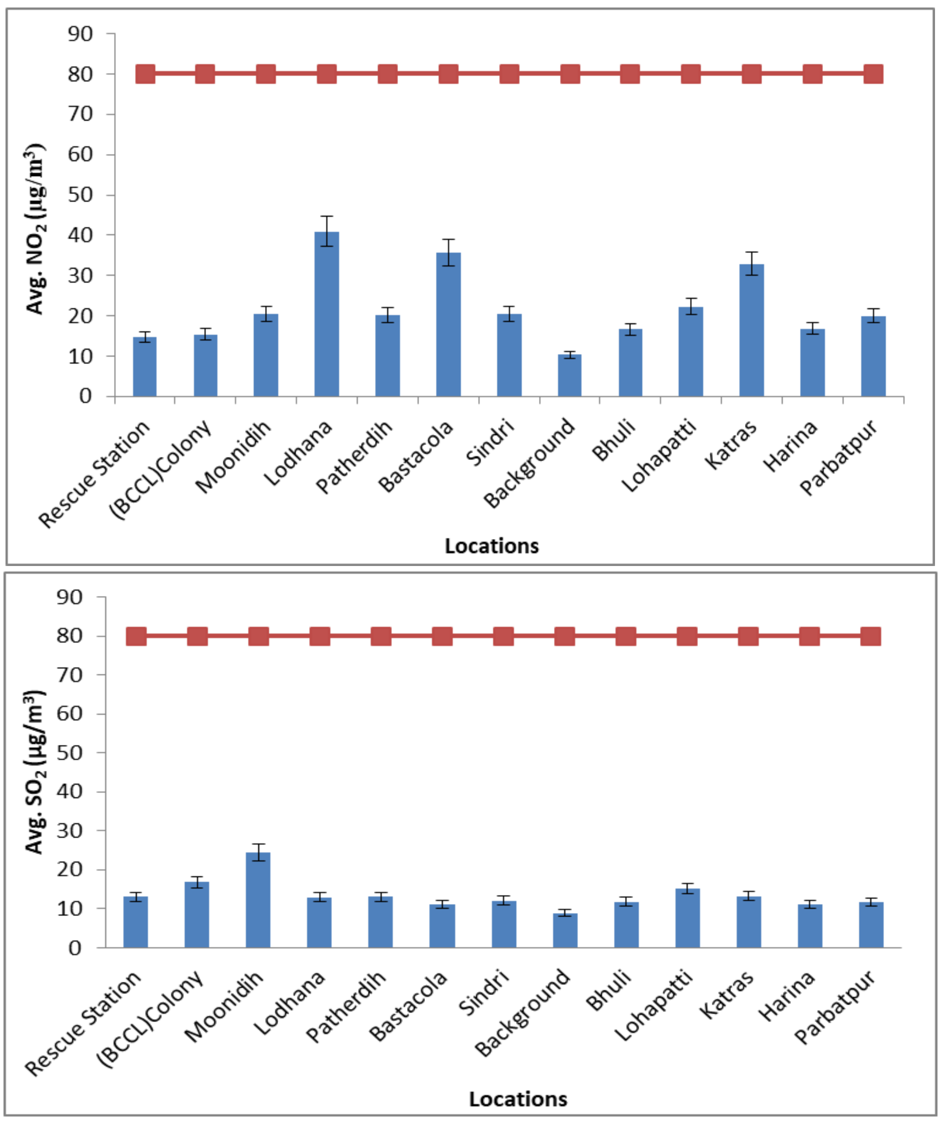


Figure 3.8: NO_2 and SO_2 Concentration of all monitoring sites in summer season

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.

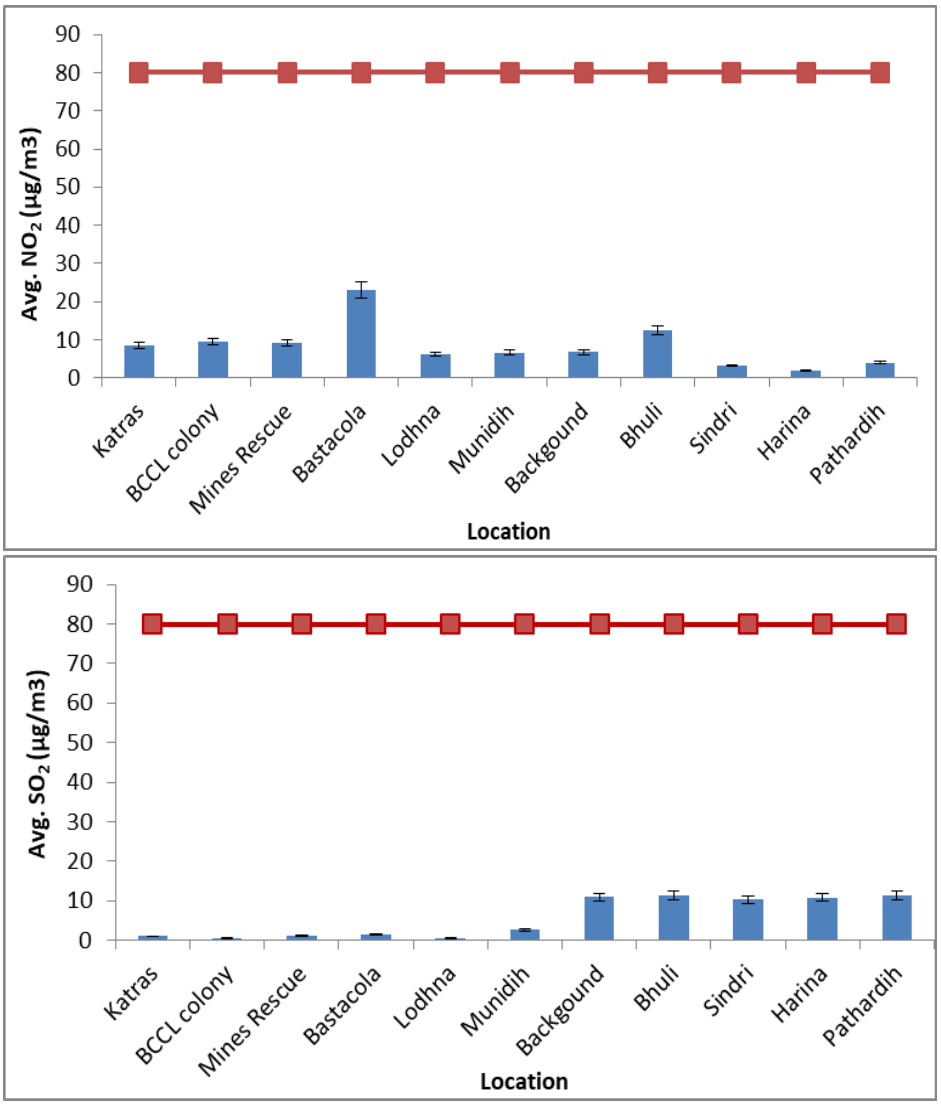


Figure 3.9: NO_2 and SO_2 Concentration of all monitoring sites in Winter season

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).

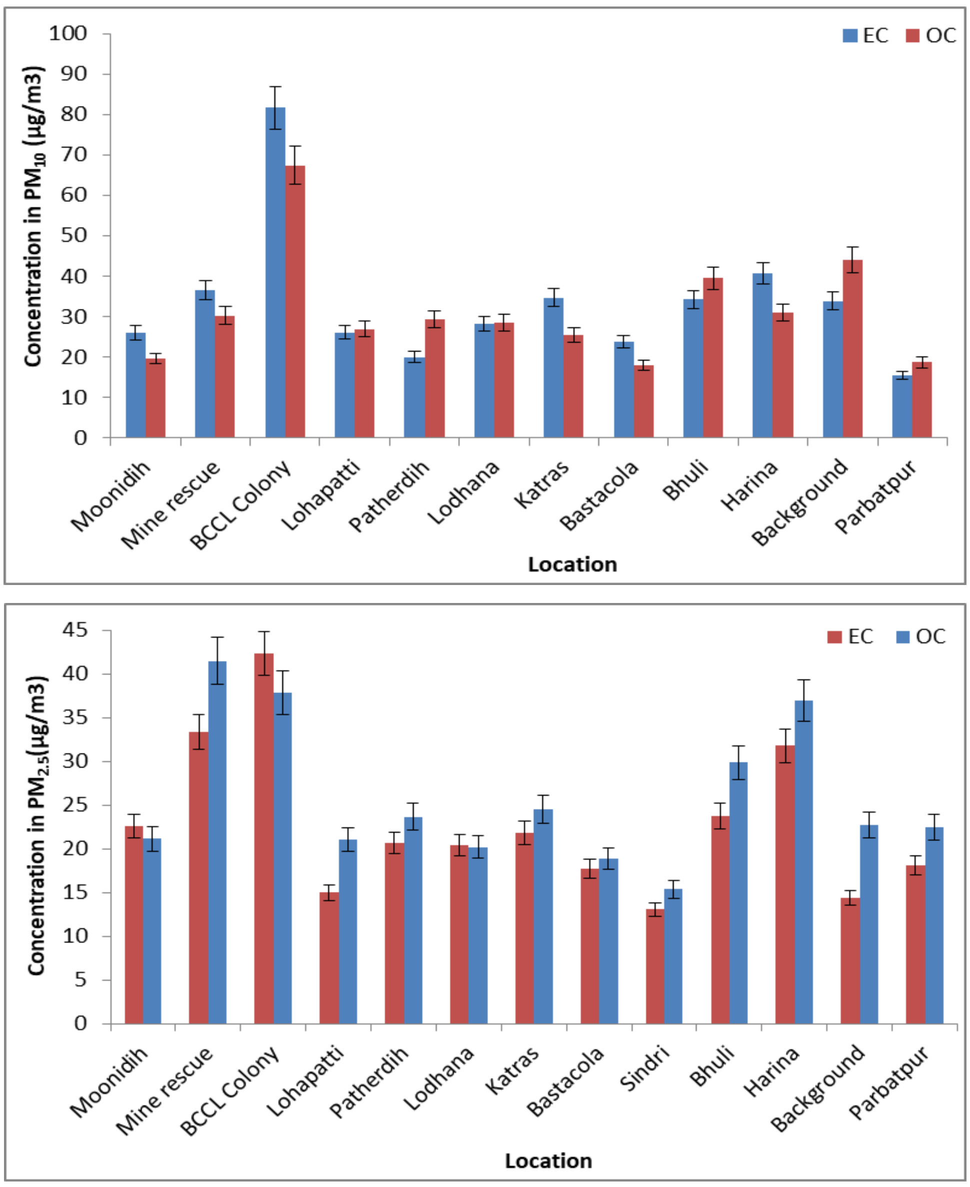


Figure 3.10: EC & OC concentration in PM_{10} and $PM_{2.5}$ in Summer season

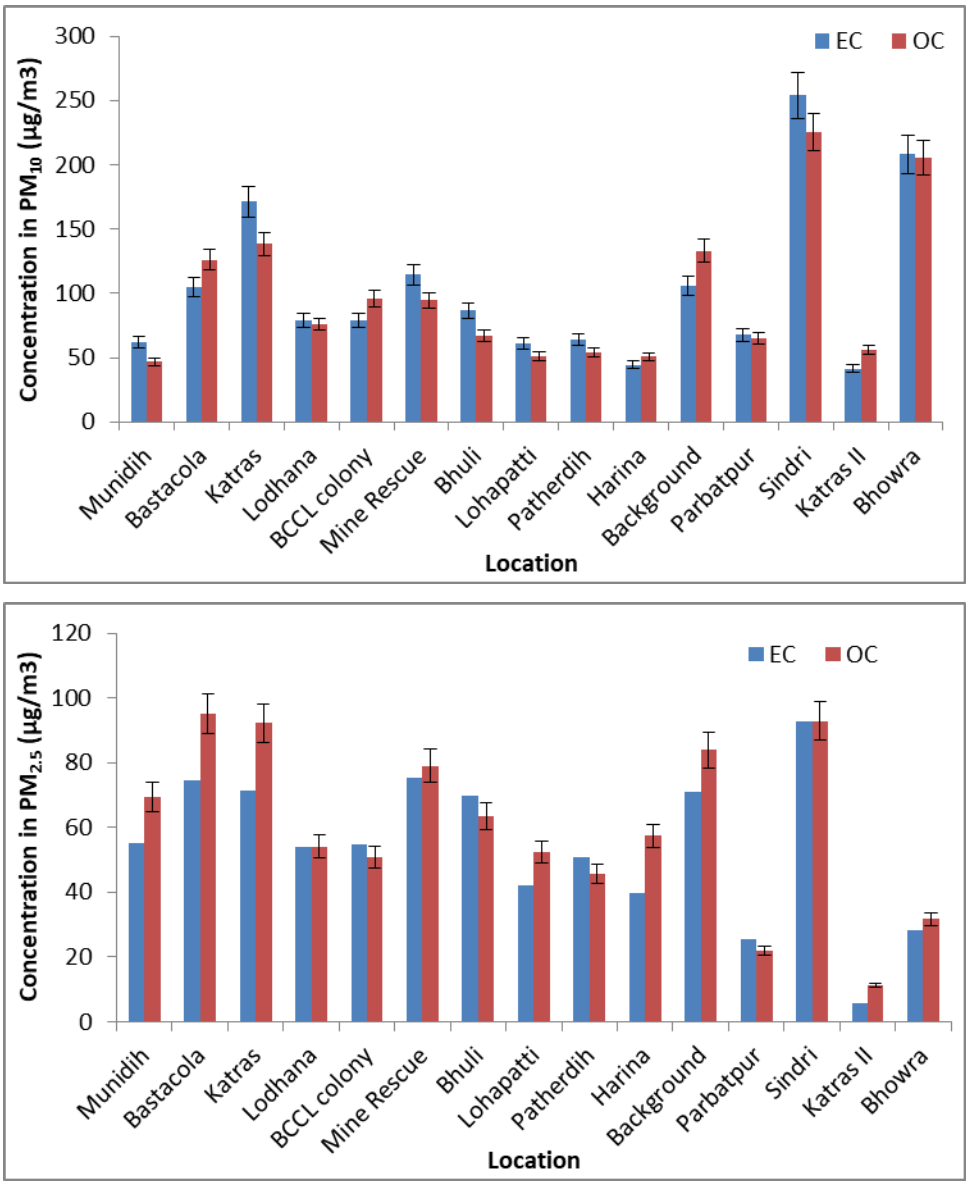


Figure 3.11: EC & OC concentration in PM_{10} and $PM_{2.5}$ in Winter Season

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.

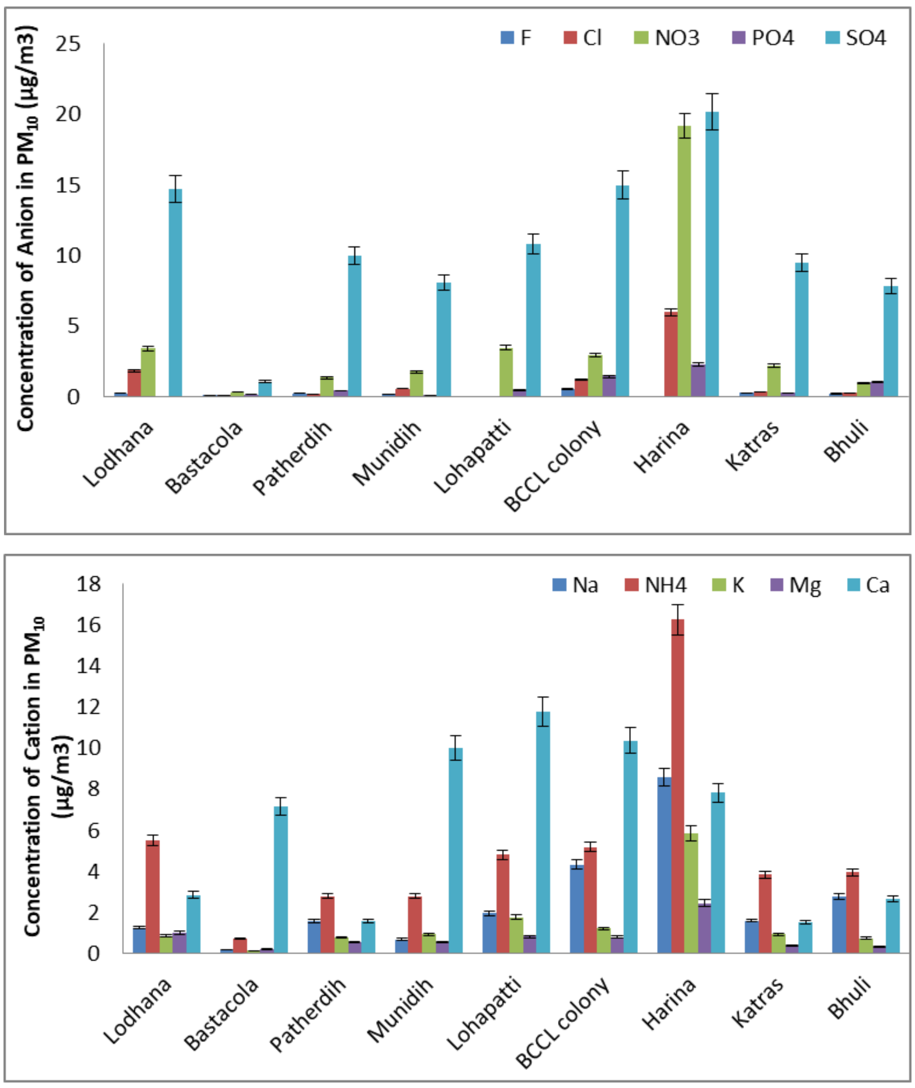


Figure 3.12: Anion and Cation concentration in PM_{10} in summer

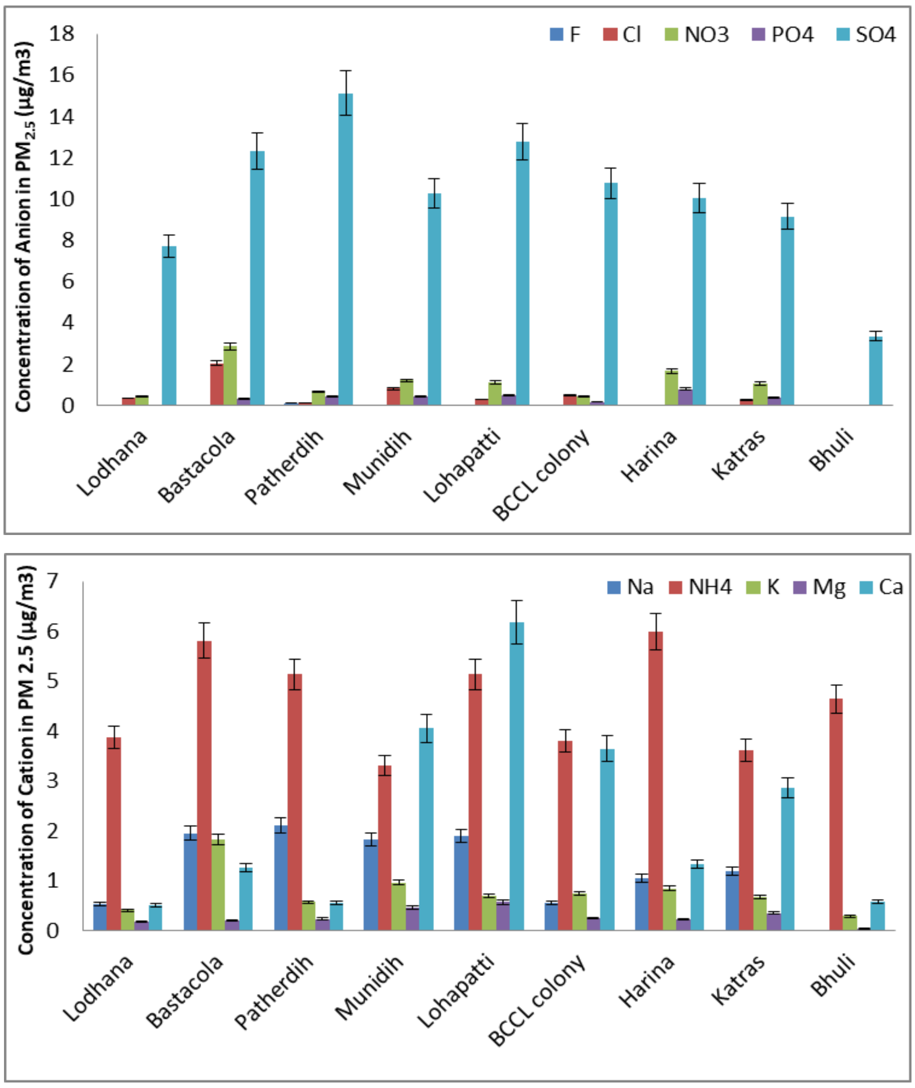


Figure 3.13: Anion and Cation concentration in $PM_{2.5}$ in summer

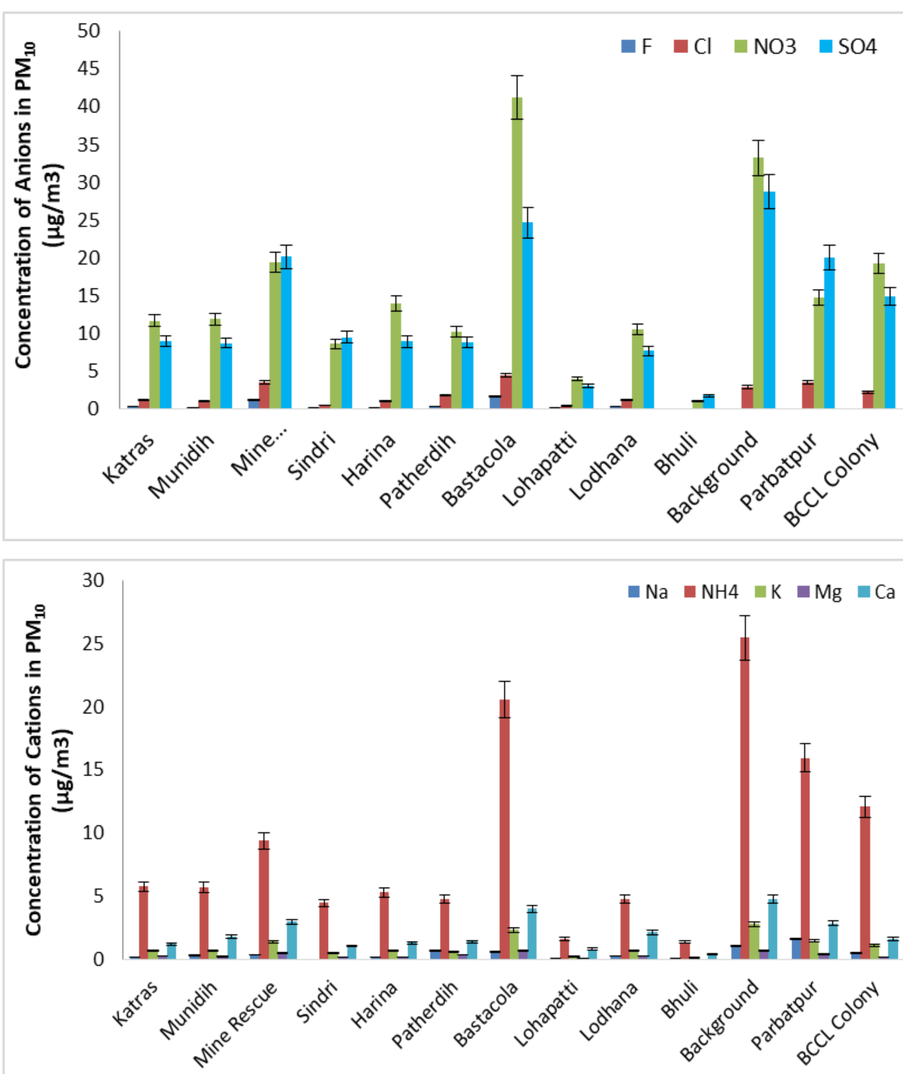


Figure 3.14: Anion and Cation concentration in PM_{10} in winter

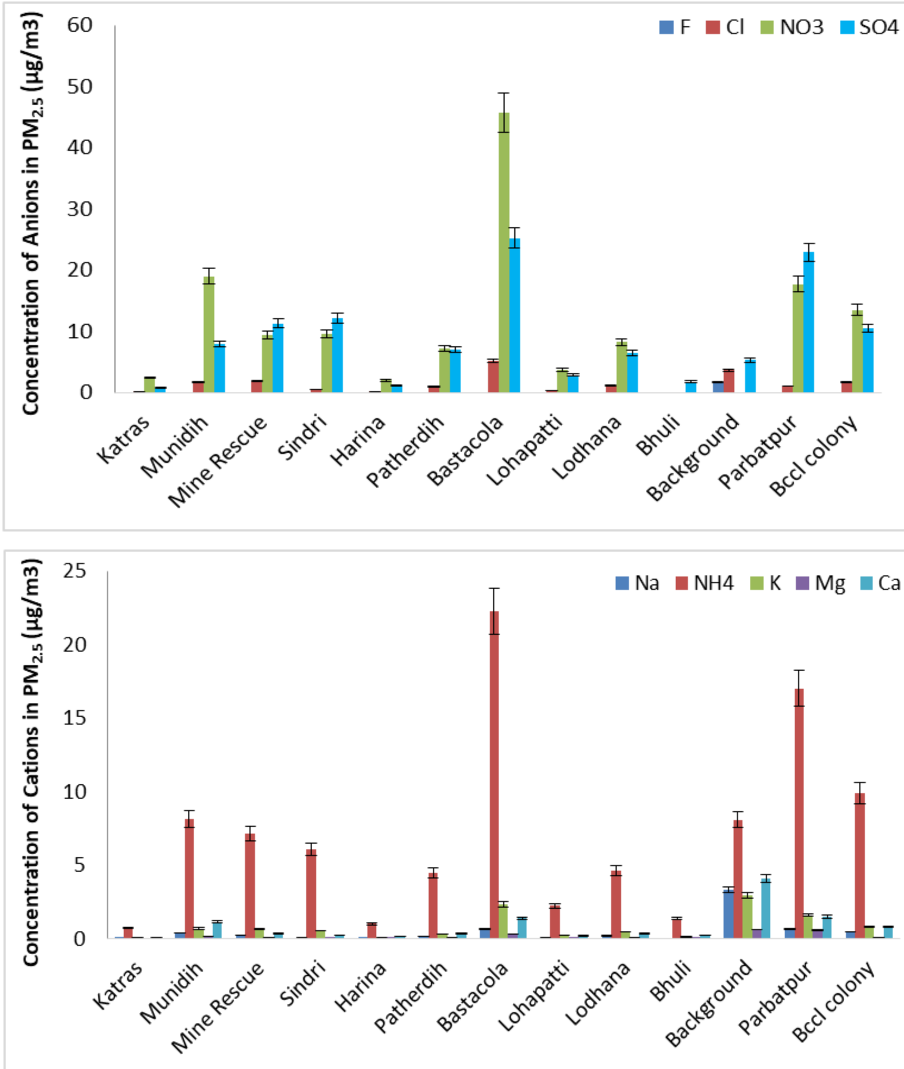


Figure 3.15: Anion and Cation concentration in $PM_{2.5}$ in winter

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:

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

C_i is the concentration of species i measured at a receptor site (derived from the chemical analysis), X_{ij} is the ith elemental concentration measured in the jth sample, and m_j is the airborne mass concentration of material from the jth source contributing to the jth sample. The term a_{ij} is included as an adjustment for any gain or loss of species i between the source and receptor. The term is assumed to be unity for most of the chemical species.

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

The CMB model assumptions are:

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

The following steps are followed for running the CMB model:

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

For source apportionment of PM_{10}, CMB 8.2 software (USEPA 1997) provides many goodness's of fit tests to verify the accuracy of the model. The normal checks, as specified in the manual by USEPA (1997) to accept the model are; t-statistics i.e., source contribution divided by the error of source contribution should be greater than 2, χ^2 (chi-square) is the weighted sum of squares of the differences between calculated and measured fitting species concentrations divided by the effective variance and the degrees of freedom, it should be less than 4. The weighting is inversely proportional to the squares of the precision in the source profiles and ambient data for each species. Ideally, χ^2 would be zero, there would be no difference between calculated and measured species concentrations. The χ^2 less than one indicate a very good fit for the data. Values greater than 4 indicate that one or more of the fitting species concentrations are not well-explained by the source contribution estimates (SCE). The source contribution estimate approximates the total mass concentration which is a convenient check on the %mass explained value. When the SCE is less than its standard error, the source contribution is undetectable. Two or three times the standard error may be taken as the upper limit of the SCE in this case. Assuming that the errors are normally distributed, there is about a 66% probability that the true source contribution is within one standard error and about a 95% probability that the true concentration is within two standard errors of the SCE.

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

4.1.2. Source profiling

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

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

4.1.3. Ambient profiling

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

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

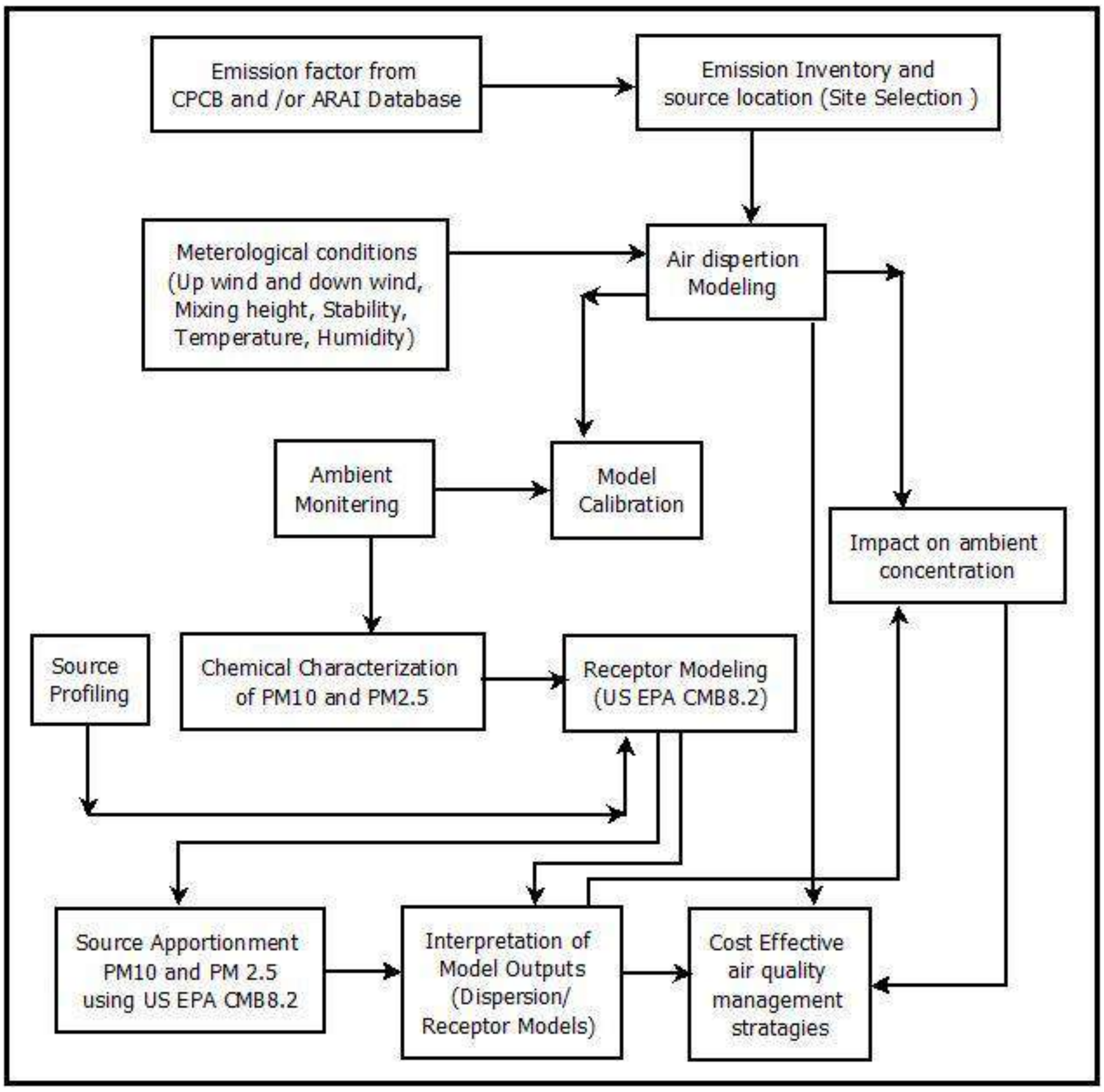


Figure 4.1: General methodology followed in the source apportionment studies

4.2. Results of the Chemical Mass Balance

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

4.2.1. Domestic combustion

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

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

4.2.2. Industrial Emission

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

4.2.3. Coal Mining

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

4.2.4. Transportation

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

4.2.5. Secondary Inorganic Aerosol

During summer, the secondary inorganic aerosol contribution to PM_{10} and $PM_{2.5}$ is about 8% and 16%, respectively. Secondary inorganic aerosols contribution found in winter is about 14% and 17%, respectively for PM_{10} and $PM_{2.5}$. The secondary inorganic aerosol source is a high concentration of nitrate (NO_3^-), sulphate (SO_4^{2-}), and ammonium ((NH_4^-). These secondary products are formed in the atmosphere, being emitted either by natural or anthropogenic sources. The oxidation of NO_x forms the secondary nitrate. It is favoured by low temperature (Li et al.2004), while high temperature and strong solar radiations favour the formation of secondary sulfates through photochemical reactions (Seinfieldand Pandis, 2016). Secondary inorganic aerosol formation from precursors (SO_2 and NO_2) enhances the pollution burden over the vicinity. Biomass burning, the presence of metal traces (Fe, Al, Mn, Zn, Cr etc.) from vehicular or industrial emission play a key role to neutralise the oxides of nitrogen and sulphur and thus raises the amount of secondary inorganic aerosols in the atmosphere.

4.2.6. Agriculture

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

4.2.7. Open burning

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

4.2.8. Road Resuspension dust

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

4.2.9. Other emission Contribution

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

4.3 Inferences

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

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

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

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

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

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

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

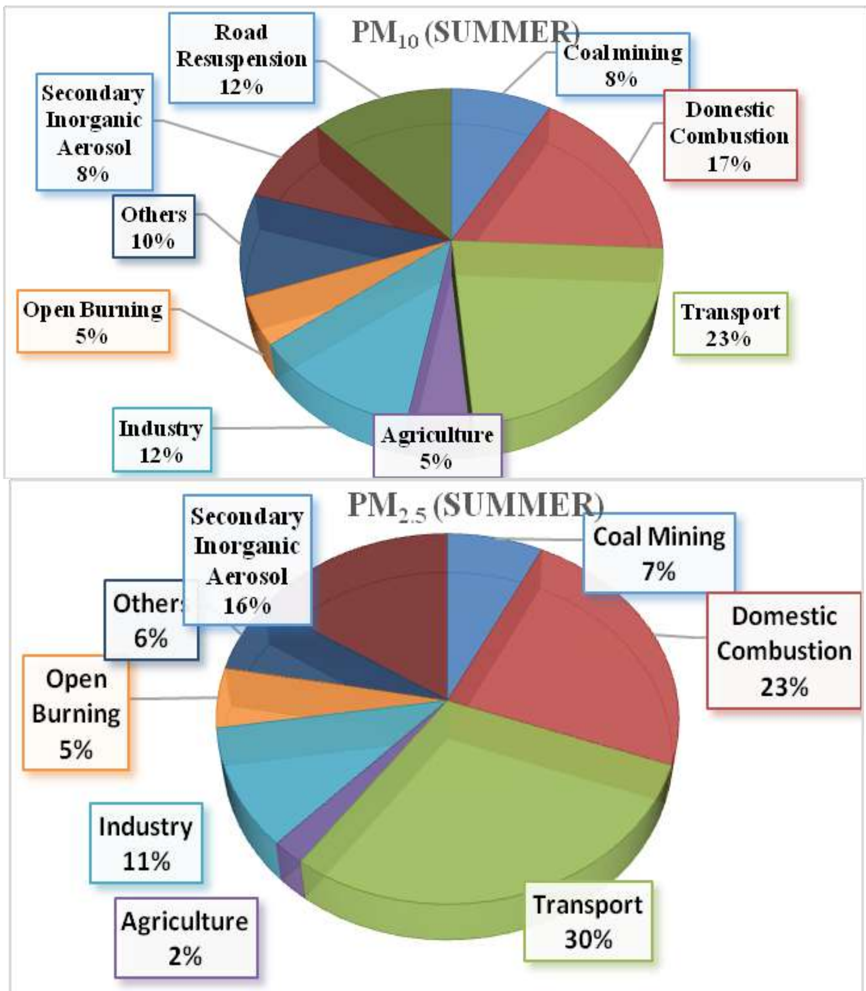


Figure 4.2: Source contribution at receptor locations of PM_{10} and $PM_{2.5}$ in summer

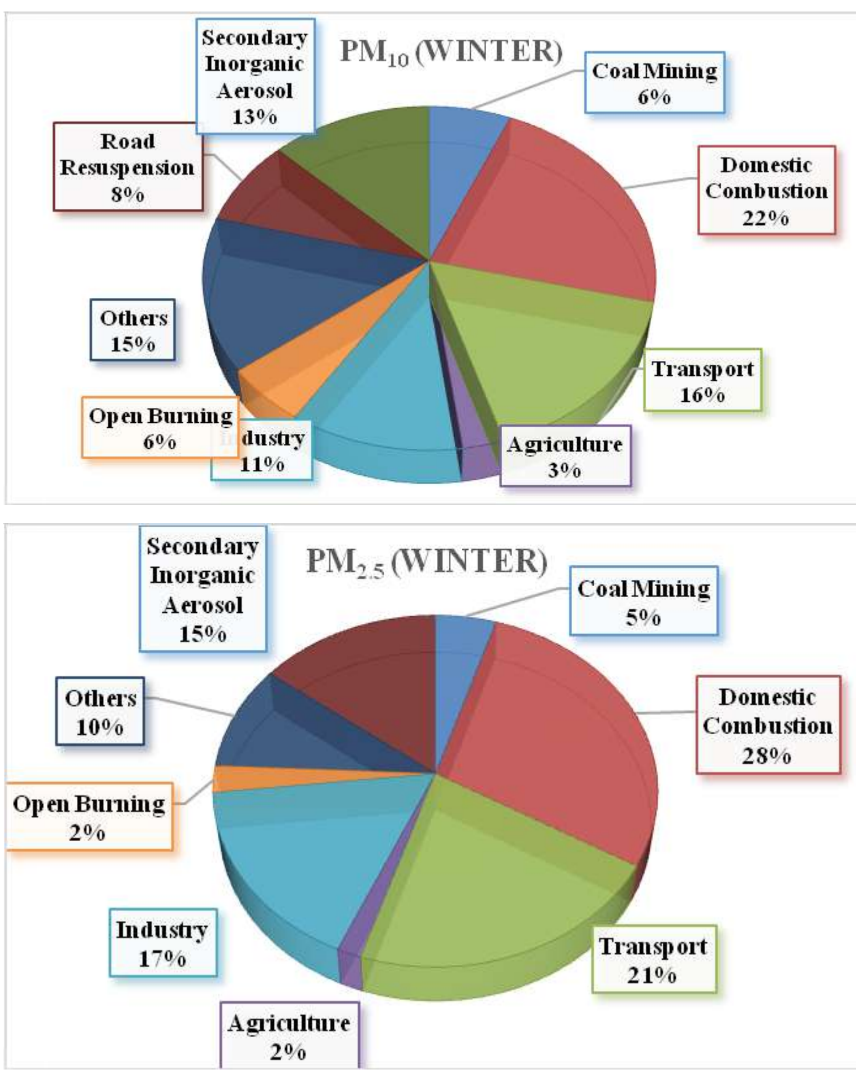


Figure 4.3: Source contribution at receptor locations of PM_{10} and $PM_{2.5}$ in winter

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

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

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

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

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Chapter 5 Dispersion Modelling

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

5.1. Wind data analysis

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

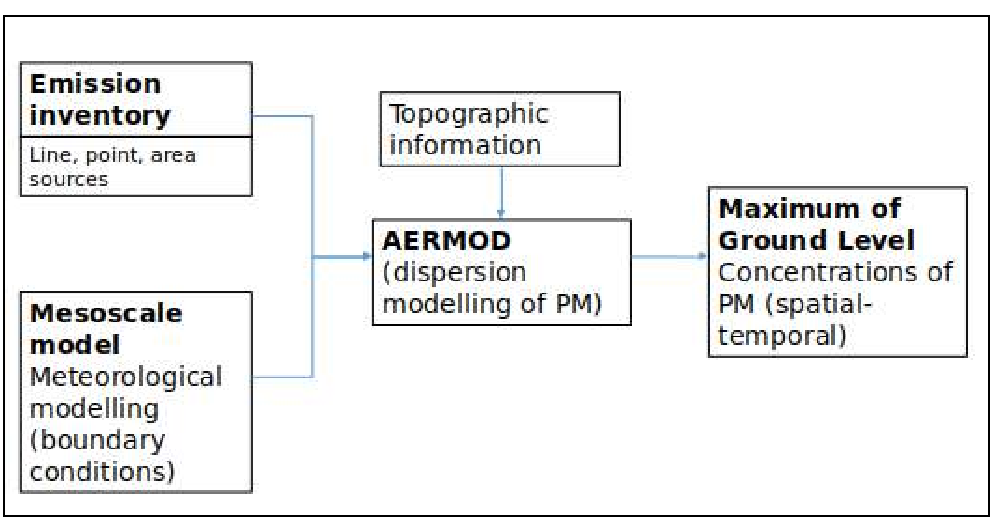


Figure 5.1: Methodology followed in the study.

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

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

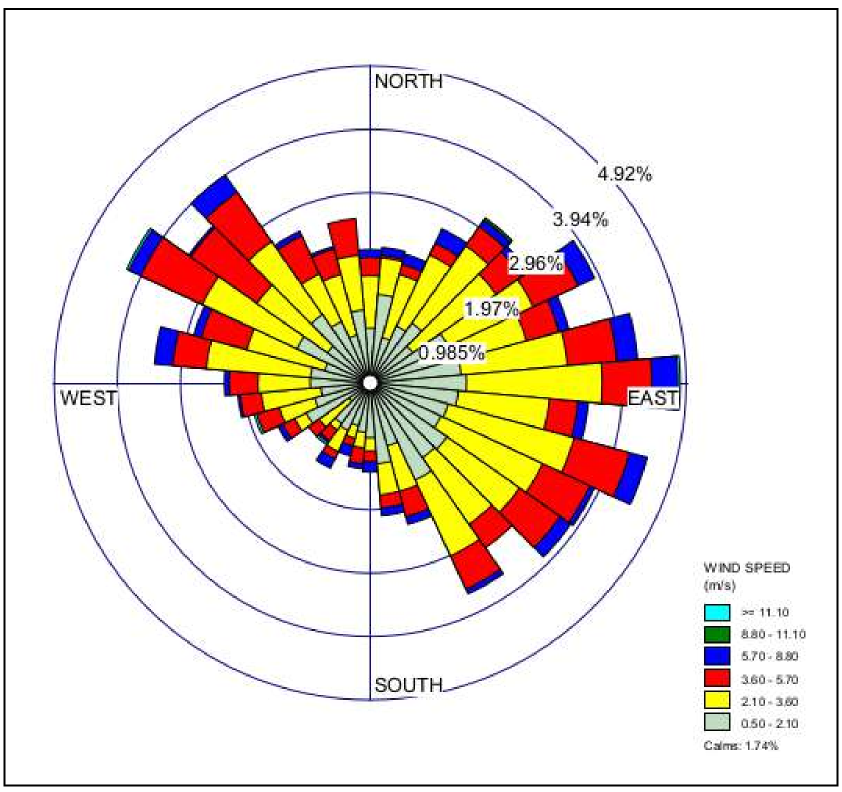


Figure 5.2: Windrose of the study area during March-June, 2019 (wind direction blowing towards the center)

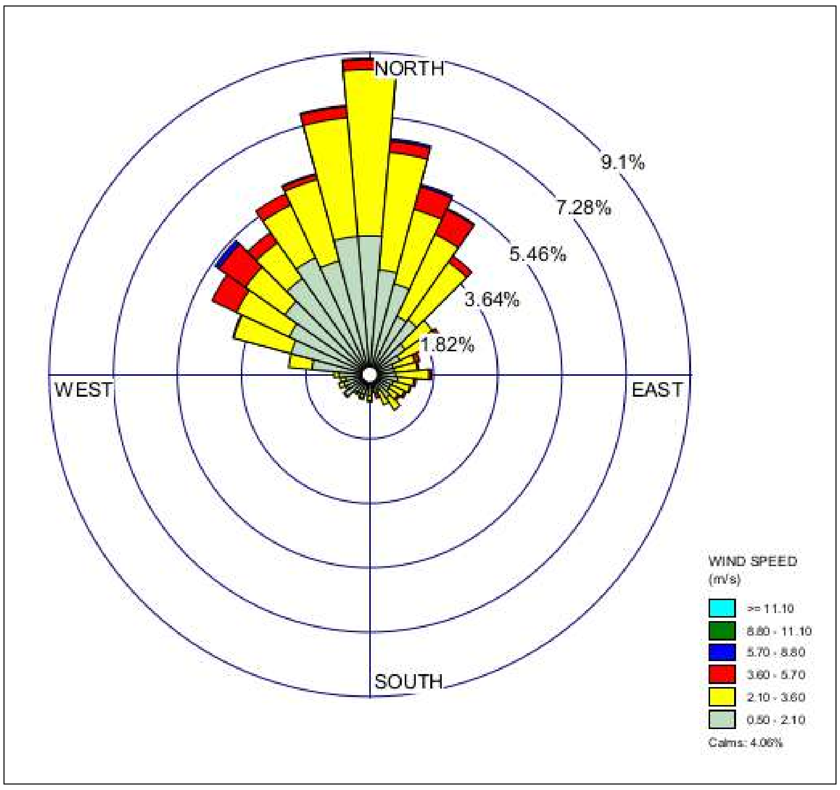


Figure 5.3: Windrose of the study area during November-December 2019 (wind direction blowing towards the centre)

5.2. Dispersion of Particulate matter

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

The emissions in grams per second were calculated from the emission inventory survey, for the line and point sources. Whereas, the emission rates in g/s/m^2 were calculated for the area sources including mining. These emission rates from each source type have been computed in the study area and fed into the AERMOD model domain for the simulation of spatial average concentrations of PM_{10} and $PM_{2.5}$. In the present study, the maximum GLC (ground level concentrations, in µg/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.

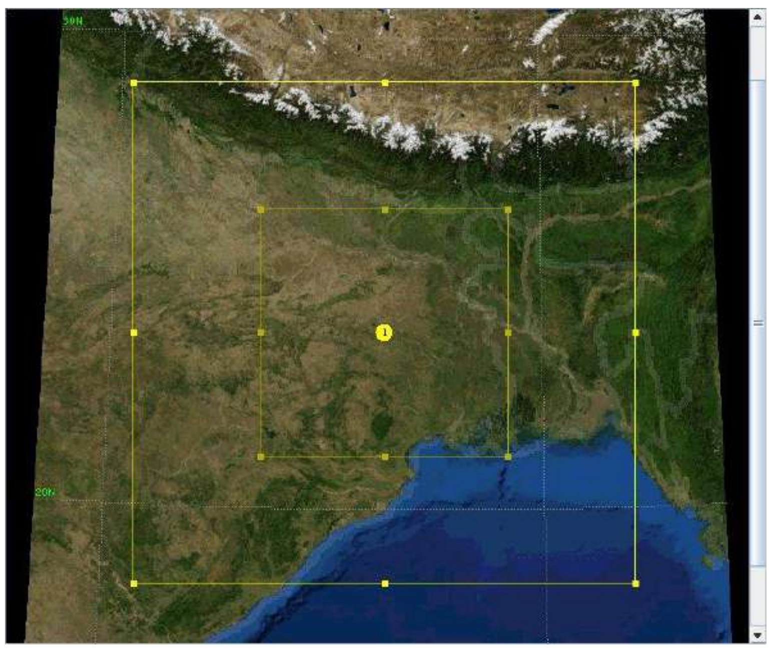


Figure 5.4: AERMOD grid covering the Jharia Coal Fields (JCF). The line, area, and point sources covered in the study are indicated in red color. The UTM coordinates of the left bottom point are x=406111 and y=2603492, and the coordinates of the right top point are x=456248 and y=2653417.

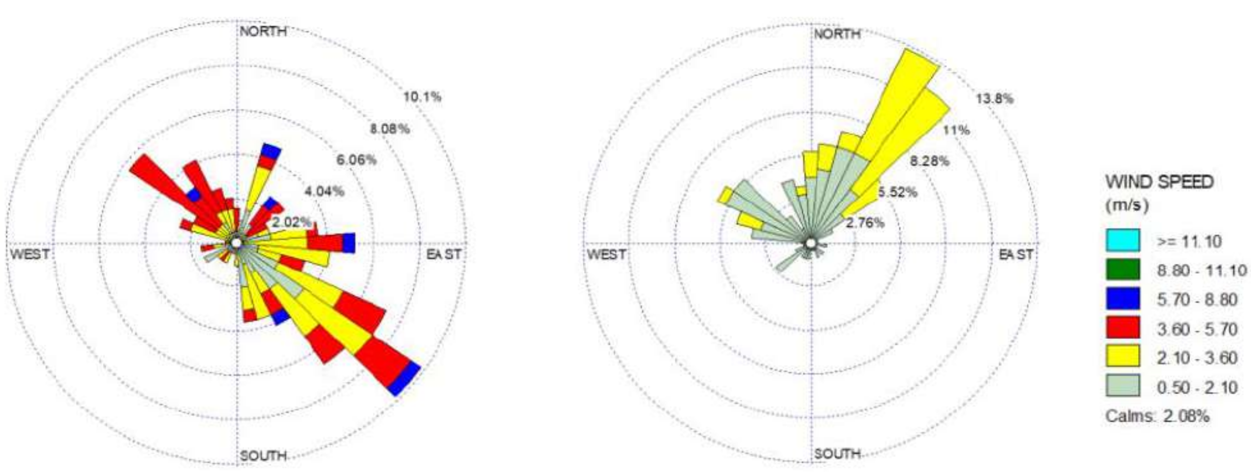
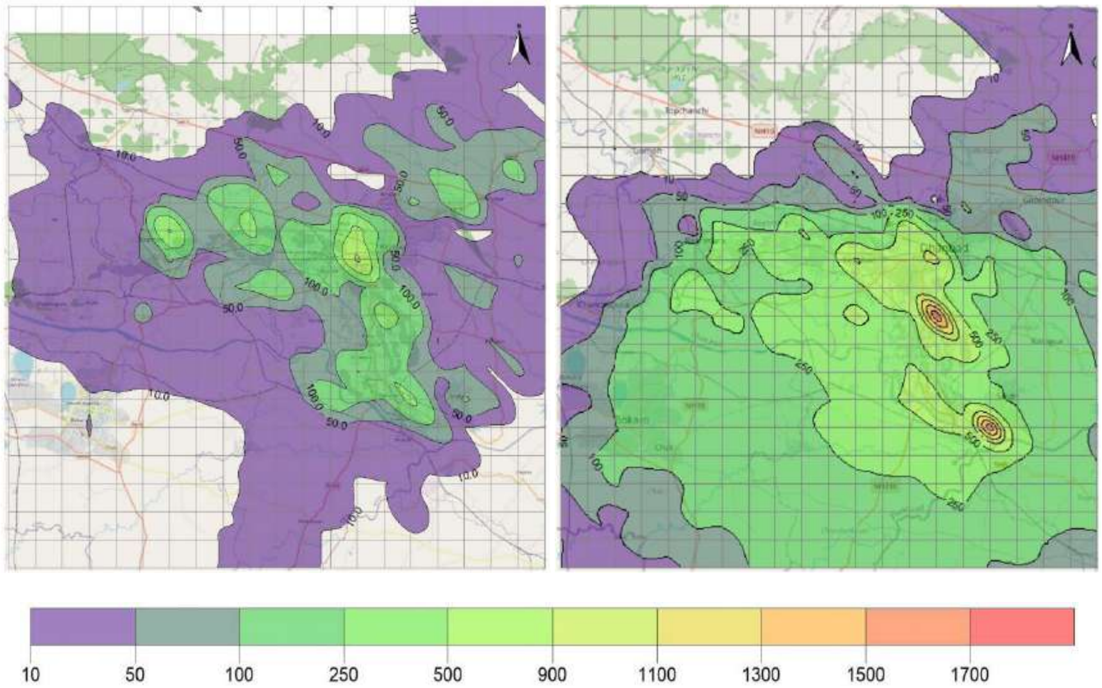
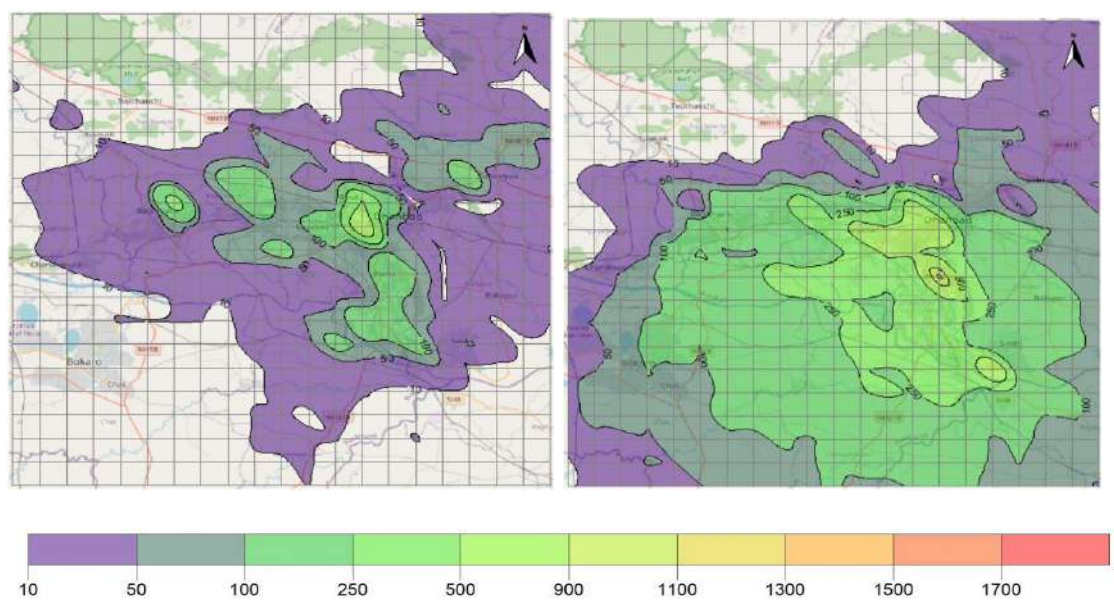


Figure 5.5: Windrose diagram for the summer (left) and winter seasons (right) at Jharia Coal Fields during the sampling period. Wind direction is flowing towards the centre.



(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} (µg/m^3) and (b) $PM_{2.5}$ (µg/m^3)

5.3 Validation of the model

Comparison between the model simulated period average PM and the measured PM concentrations was made to determine the overall efficiency of the dispersion model. In the present study, the model validation metrics viz. mean bias (MB), normalized mean bias (NMB), mean gross error (MGE), normalized mean gross error (NMGE), and Pearson’s correlation (r) were calculated for PM_{10} and $PM_{2.5}$ separately including data of both seasons. At some of the monitoring locations like Mines Rescue, Katras, Patherdih, Harina, Lodhna, and Lohapatti the discrepancies between the modeled and observed data were found to be high, for both summer and winter seasons. At remaining locations for both seasons, the results indicate an acceptable/fair degree of model performance in simulating the particulate dispersion. Results show that the correlation coefficient between the measured and modeled PM_{10} is 0.6, which is fair enough in environmental open systems, similarly, for $PM_{2.5}$ the correlation value is around 0.7 (Table 5.1).

Table 5.1 Performance Stimulation Metric

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

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

Chapter 6 Recommendation

6.1. Mine industries

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

6.2. Area Sources

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

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

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

6.3. Line Source

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

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

6.4. Others

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

Annexure -1

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

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

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

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

Annexure-X

GROUNDWATER LEVEL & QUALITY REPORT

FOR CLUSTER OF MINES, BCCL

(Assessment year – 2021-22)

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

JHARIA COALFIELD AND RANIGANJ COALFIELD (PART)

For

(BHARAT COKING COAL LIMITED)

(A Subsidiary of Coal India Limited)

KOYLA BHAWAN (DHANBAD)

Prepared by

Hydrogeology Department

Exploration Division

CMPDI (HQ), Ranchi

MARCH – 2022

Job no - 200421008

GROUNDWATER LEVEL & QUALITY REPORT

FOR CLUSTER OF MINES, BCCL

(Assessment year – 2021-22)

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

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CENTRAL MINE PLANING & DESIGN INSTITUTE

HYDROGEOLOGY SECTION, EXPLORATION DEPARTMENT

GONDWANA PLACE, KANKE ROAD, RANCHI, JHARKHAND– 834031

(Accredited Groundwater Professional Institutions by CGWA)

(Accredited as a GWCO by QCI-NABET)

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

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Annexure – I

DETAILS OF THE REPORT

Sl No.	ITEMS	INFORMATIONS
1	Geographical Area	Jharia Coalfield (JCF): 453 sq. km. Raniganj Coalfield (RCF part): 19.64 sq. km. (Cluster-XVI area only)
2	Major Physiographic Units	Dissected Pediplain with surface Reduced Level (RL) varies from 160 m to 220 m above mean sea level (AMSL) in JCF and 100 m to 140 m AMSL in RCF.
3	Drainage System	Damodar River is the master drainage flowing along western boundary of the JCF. Jamunia River, Khudia River, Katri River, Jarian Nala, Ekra Jore, Kari Jore, Kashi Jore, Chatkari Jore and their tributaries are flowing through the JCF area. Damodar River, Barakar River is the master drainage of the part of RCF area (CV Area).
4	Annual Rainfall (IMD-report)	Jharkhand State: 1264.10 mm Rainfall data given in **Annexure-IV**.
5	Geological Formations	Gondwana Formation (Talchir Formation, Barakar Formation, Barren Measure Formation & Raniganj Formation)
6	Aquifer System	Unconfined/Phreatic Aquifer – thickness 25 m (Avg.) Semi-confined to confined Aquifer – thickness from 25 m upto 650 m
7	Hydrogeological properties (Aquifer Pump Test)	Unconfined Aquifer (Damoda BJ Section & Block-II): Hydraulic Conductivity – upto 0.50 m/day Transmissivity – 10 - 42 m^2/day
		Semi-confined to confined Aquifer (Sitanala & Kumari Block): Hydraulic Conductivity – 0.0006-1.44 & 0.05-0.0027 m/day Transmissivity – 0.06 – 0.573 m^2/day
8	Groundwater Level Monitoring Network	Out of total 252 nos. of monitoring stations 64 nos located within core mining area and rest comes within Buffers zone. 60 Nos. of Groundwater monitoring well (Dug Wells) network established by CMPDI to record groundwater level data in and around the Core Zone of JCF and 4 Nos. of Groundwater monitoring well (Dug Wells) in RCF (CV Area).
9	Groundwater Levels Below Ground Level (bgl)	JCF area: Pre-monsoon – 0.62 to 11.26 m (Avg. 5.23 m bgl) in '2021-22 Post-monsoon – 0.05 to 7.62 m (Avg. 2.28 m bgl) in '2021-22 RCF area (part): Pre-monsoon – 2.0 to 6.20 m (Avg. 3.34 m bgl) in '2021-22 Post-monsoon – 1.10 to 5.25 m (Avg. 2.44 m bgl) in '2021-22
10	Groundwater Quality	Potable as per GEC-2015 Norms (**Annexure- VIII**)
11	Proposed Piezometers	Proposed piezometers (23 nos.) to monitor impact of coal mining on groundwater regime within the coalfield area (JCF & part of RCF) for maximum depth upto 290 m.
12	Stage of Groundwater Development (CGWB)	Dhanbad District-76.30% (GWRE-2017)

GROUNDWATER LEVEL & QUALITY REPORT FOR CLUSTER OF MINES OF BCCL

1.0 INTRODUCTION

1.1 LOCATION DETAILS AND BRIEF ABOUT THE PROJECT

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

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

1.2 OBJECTIVE OF THE STUDY:

The objective of the report is to conducting hydrogeological study by quarterly monitoring of groundwater level and quality of the Jharia coalfield and Raniganj coalfield (part) within BCCL command area for 15 nos. Cluster of mines of BCCL. The data collected shall submitted to the MoEF&CC, CPCB & SPCB within stipulated timeframe. The work being done yearly and require d 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 taken into account for hydro-geological investigation of the study area.

i) The monitoring of the groundwater levels done four times/year during (May, August, Nov and Jan).
ii) The monitoring of the groundwater quality done 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.

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 AMSL in Barora area (Cluster-I) to 160 m above mean sea level (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) areas 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 southeast course and ultimately joins Damodar River, the master drainage. The drainage of the JCF is mainly controlled by Jamuniya River (5^{th} order), Khudia nala (3^{rd} order), Katri River (4^{th}) and Chatkari nala (3^{rd} 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 in Barakar River and Panchet dam in 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 flooded by water, either permanently or seasonally. The primary factor that distinguishes **wetlands** from other landform or water bodies is the characteristic vegetation of 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 given 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 upto 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 stations computed and then monthly district rainfall series has constructed by considering arithmetic average of all the station rainfall values within the district. The monthly rainfall series of the state has 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 utilized for identification of the mean spatial patterns and rainfall intensity trends. From mean and standard deviation (SD), the coefficient of variation (CV) calculated as follows: 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 see 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, September and southwest monsoon season, annual respectively. The trend lines 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. In the monthly rainfall June, July, August, September and seasonal rainfall shows decreasing trend. During the last 30 years highest rainfall of 390.3 mm received in June in the year 1994, 492.1 mm received in June in the year 2017, 431.5 mm received in August in the year 1997, while highest rainfall of 395.2 in September received in the year 1995. Highest annual rainfall of 1587.9 mm received in the year 1999 and highest southwest monsoon rainfall of 1364.6 mm received in the year 1994 (Climate Research and Services, IMD, Ministry of Earth Sciences, Pune, Jan'2020).

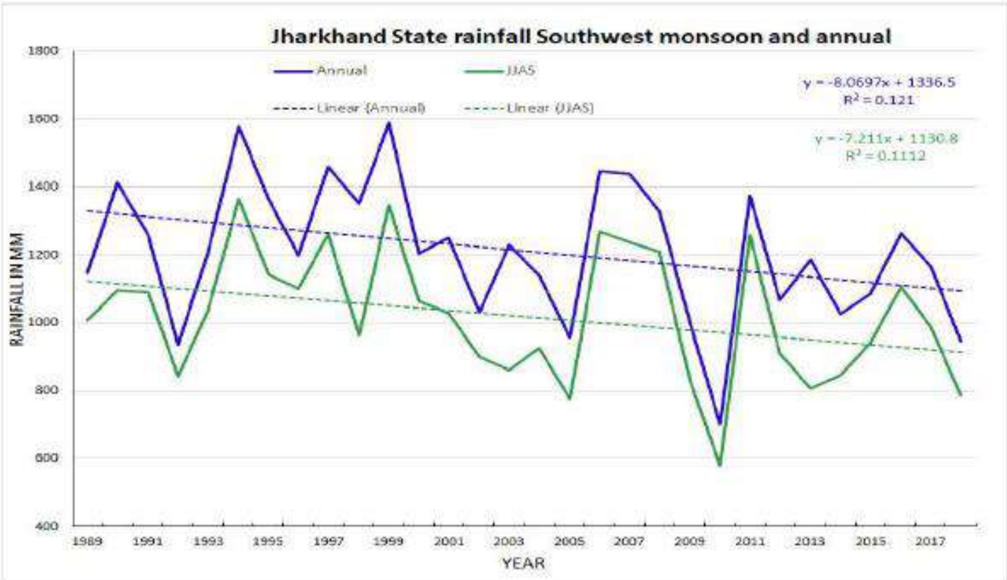


Fig-1.

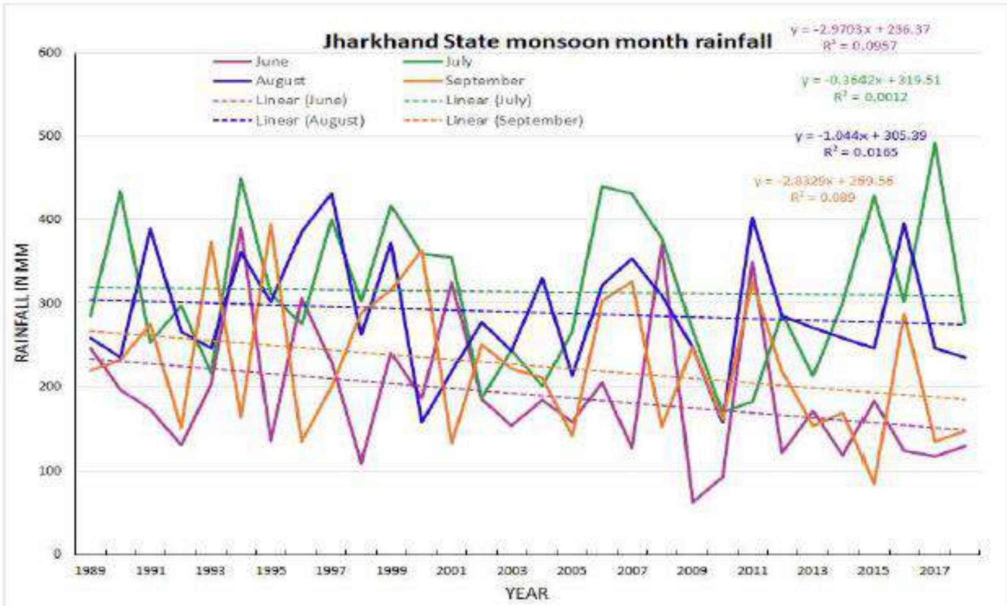


Fig-2.

2.0 GEOLOGY AND HYDROGEOLOGICAL SETUP OF THE AREA

2.1 REGIONAL GEOLOGY

The Jharia Coalfield covers an area of 453 sq. km. located in Dhanbad District, Jharkhand. The non-coal bearing Talchir Formation exposed in patches along the northern fringe of the Coalfield. The Barakar FormatioN overlies the Talchir is covering the most part of the Jharia Coalfield and having an area of 218 sq. km. This successively overlain by the non-coal bearing Barren Formation mainly exposed in the central part of the Coalfield. This, in turn, 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 in 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 which only 35 sq. km. comes under leasehold area of BCCL out of 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 in the area

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 constituted of fine to coarse grain sandstone having primary porosity of intergranular void space. The secondary porosity formed due to presence of faults, fracture, joints, etc. Sandstone of Gondwana formations in JCF and RCF are very hard, compact and cemented sandstone and forming less potential aquifer, particularly the 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 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 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 potential than semi-confined to confined aquifer.

SEMI-CONFINED TO CONFINED AQUIFER

The semi-confined to confined aquifer consisting of sandstone bed is sandwiched with coal seams/shale beds and multiple aquifer system developed due to presence of multiple numbers 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 potential.

Table –2 Generalized Hydrogeological Units developed in the study Area

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

2.4 GENERAL AQUIFER PARAMETERS

PHREATIC/UN-CONFINED AQUIFER

The wells tested by CMPDI for determination of aquifer parameters in Damuda (BJ Section) and Block-III area of JCF. The hydraulic conductivity of the un-confined aquifer is 0.50 m/day as computed from pumping tests on the wells. The transmissivity of the unconfined aquifer ranges from 10.68 m^2 /day to 41.48 m^2 /day.

SEMI-CONFINED TO CONFINED AQUIFER

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

Table – 3: Aquifer parameters considered for the study Area

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

3.0 GROUND WATER LEVEL MONITORING

To collect the representative groundwater levels in the study area, CMPDI has established a monitoring network of total 252 monitoring stations out of which 64 located within core zone and rest comes within Buffer zone. Total 60 nos. dug well within JCF and 04 nos. dug well within RCF (part) area (Details of the Hydrograph stations & water level given in **Annexure-V, VA** & **VB**) spread over the entire BCCL leasehold area, **Plate-I**. Water level monitoring in all hydrograph stations has been done in pre-monsoon as well as in post monsoon whereas in 64 stations monitoring done in quarterly (May'21, Aug'21, Nov'21 and Jan'22) basis.

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 in 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 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 given from 2005 to 2021 of CMPDI monitoring stations (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
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

3.2 GROUNDWATER LEVEL SCENARIO IN NON-MINING/MINING AREA

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

Table – 5: Depth to water table

Formation	*Area*		*DTW (bgl, m) [Year-2021-22]*		*Average GWL (m)*	
			Pre-monsoon (Apr/May)	*Post-monsoon (Nov/Dec)*	*Pre-monsoon*	*Post-monsoon*
Sedimentary (Gondwana)	Non-mining		1.45-8.20	0.35-3.70	5.10	2.00
	Mining	OC	1.40-10.35	0.84-5.65	4.66	2.15
		UG	1.09-10.13	0.55-7.62	5.75	2.80
Metamorphics (Hard rock)	Peripheral part of the Coalfield		0.62-11.75	0.50-7.45	6.80	3.60

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 the JCF and RCF (part) area. The average hydraulic gradient of the water table within mining and non-mining areas given in Table-6. There is no significant change in hydraulic gradient observed. Relatively steep gradient near active opencast mining areas w.r.t., Non-Mining, Underground mines and Metamorphics areas observed.

Table – 6: Average hydraulic gradient

Sl. No	*Formation*	*Area*		*Average hydraulic gradient*
1	Sedimentary (Gondwana)	Non-Mining		1.0×10^{-3} to 3.25×10^{-3}
		Mining	OC	1.0×10^{-2} to 4.0×10^{-3}
			UG	1.0×10^{-2} to 3.0×10^{-3}
2	Metamorphics (Hard rock)	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 (Cluster-I consisting of Damoda 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 works out upto 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 Damoda block area marked by more or less flat and gently undulating topography. The RL varies from 179 m to 208 m AMSL and the general slope of topography is towards east. Jamuniya River, Kari Jore, Podo Jore and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Jamuniya River.

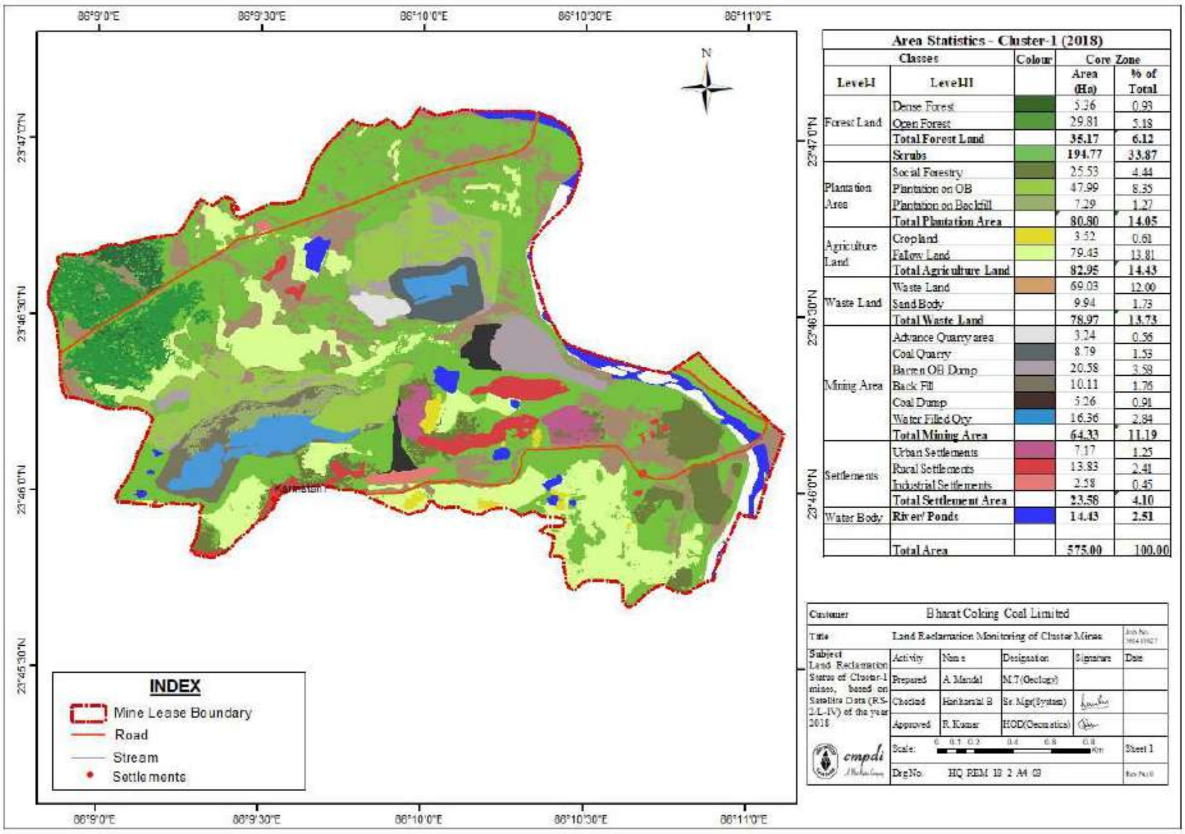
Monitoring stations (**B-15, B-21A, B51 and B-53**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'21, August'21, and Nov'21 and January'21, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	B-15	Bera Basti	1.46	0.25	0.35	1.01	3.70	0.15	1.47	1.70	1.90	0.45	1.65	2.65
2	B21A	Dugdha	8.38	2.5			10.00	4.15	5.80	6.70	9.45	1.90	-	-
3	B-51	Taranga	5.70	0.90	1.00	4.88	5.00	0.88	2.10	3.00	5.10	1.10	2.70	2.90
4	B-53	Karmatanr	4.85	1.52	1.87	2.87	3.12	1.07	1.40	1.92	3.22	0.97	1.42	2.12
Average WL (bgl)			5.10	1.29	1.07	2.92	3.70	0.15	1.47	1.70	4.92	1.11	1.92	2.56

LAST THREE-YEAR ASSESSMENT:

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

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



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

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 works out upto 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 Damoda block area marked by more or less flat and gently undulating topography. The RL varies from 176 m to 235 m AMSL. Jamuniya River, Khudia River and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Jamuniya River and Khudia River.

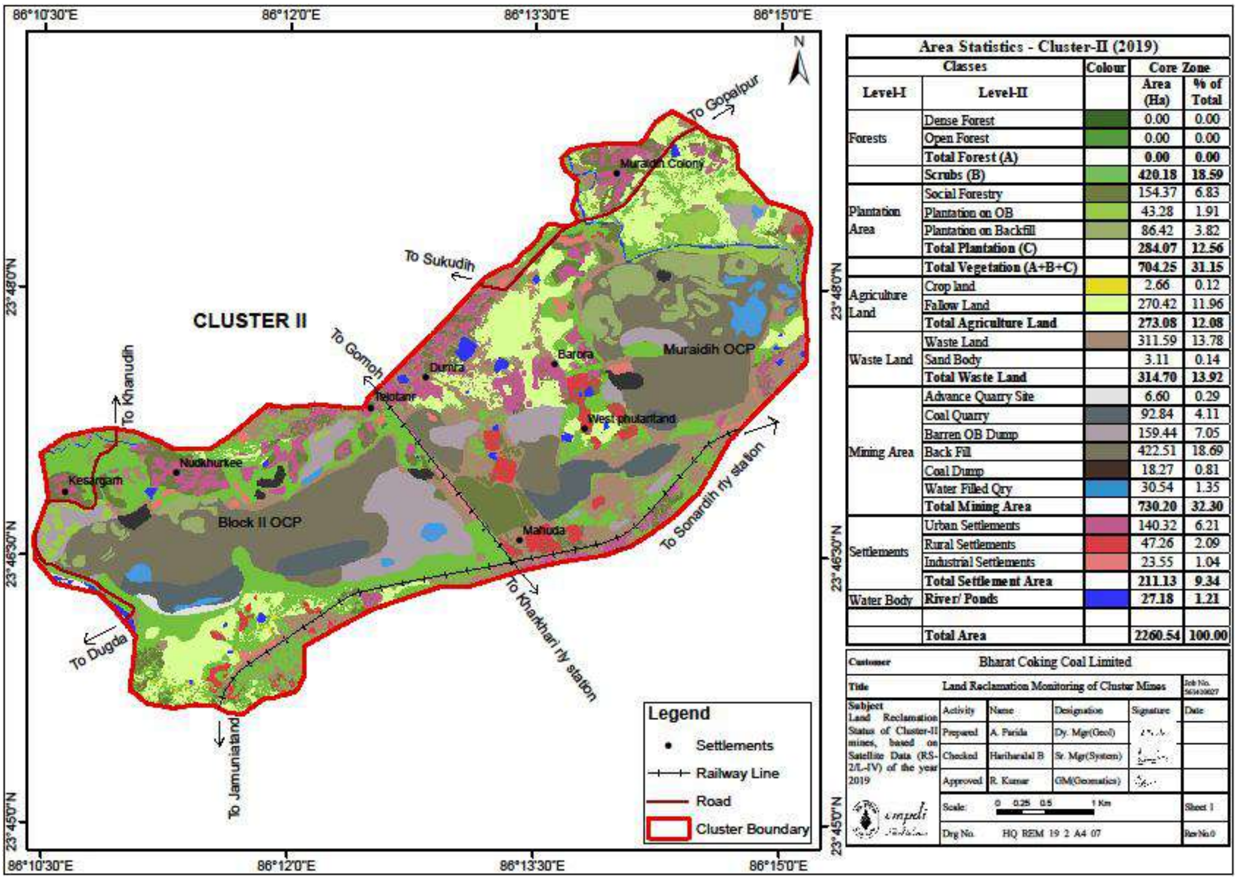
Monitoring stations (**B-1, B-59, B-60, B-61A and B-62A**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'21, August'21, and Nov'21 and January'22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	B-1	Muraidih	2.58	0.58	1.91	2.03	3.28	0.73	1.63	1.73	3.18	1.33	1.73	1.98
2	B-59	Khodovaly	5.49	0.30	0.90	0.95	5.25	0.67	1.40	2.10	6.20	0.80	0.90	1.20
3	B-60	Bahiyardih	11.26	1.33	2.23	6.53	10.33	0.91	3.21	6.13	8.13	1.23	3.23	4.93
4	B61A	Kesargora	4.42	0.47	0.97	0.97	3.32	0.85	1.60	2.07	3.32	1.39	0.52	1.12
5	B62A	Sadiyardih	6.87	1.35	4.50	4.60	6.95	2.77	3.00	4.95	7.55	2.80	3.25	4.95
Average WL (bgl)			6.12	0.81	2.10	3.02	5.83	1.19	2.17	3.40	5.68	1.51	1.93	2.84

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.57 m   Max – 11.26 m
Post-monsoon GW Level (m): Min – 0.52 m   Max – 4.50 m

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



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	977.33×10^4	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. It is located in the western most part of Jharia coalfield in Dhanbad district of Jharkhand. The life of the project works out upto 60 years considering annual target production 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 varies from 160 m to 208.80 m AMSL. The general slope of the area is towards south. Khudia River, Baghdihi Jore, Katri River and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Khudia River.

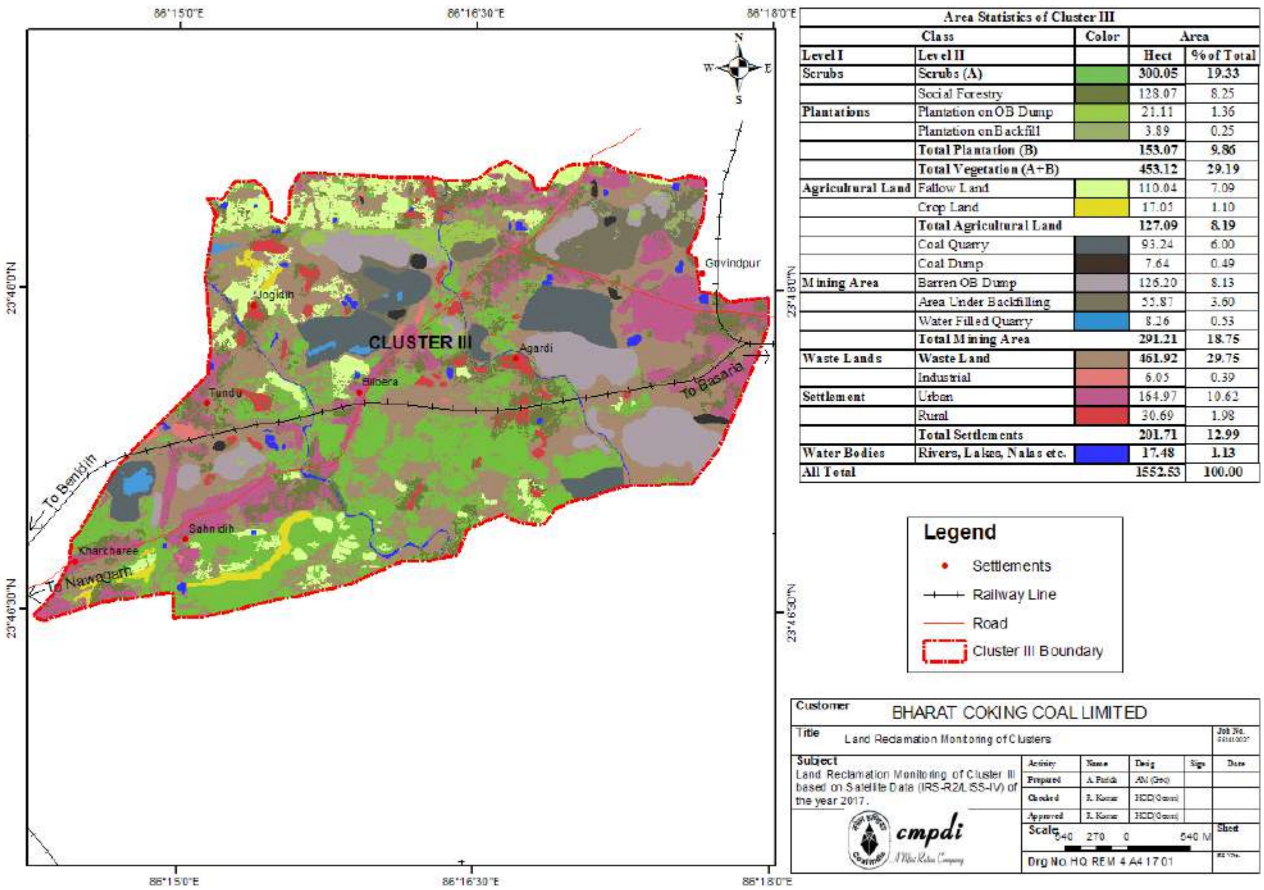
Monitoring stations (**A-12, A-25, A-29, B-14 and B-60**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'21, August'21, and Nov'21 and January'22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A12	Jamua	1.92	0.50	1.10	1.72	2.60	0.32	0.50	1.20	2.10	0.29	0.45	0.75
2	A25	Sinidih	5.78	1.73	2.43	2.53	2.98	1.30	1.83	2.53	6.08	1.43	1.93	2.48
3	A29	Dharmaband	6.49	2.90	5.90	6.65	6.20	1.21	3.20	3.25	4.85	1.20	3.40	3.65
4	B14	Mathadih	2.84	0.24	2.04	2.10	2.44	0.32	1.04	1.69	2.24	0.54	0.94	2.04
5	B60	Sonardih	11.26	1.33	2.23	6.53	10.33	0.91	3.21	6.13	8.13	1.23	3.23	4.93
Average WL (bgl)			5.66	1.34	2.74	3.91	4.91	0.81	1.96	2.96	4.68	0.94	1.99	2.77

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.92 m Max – 11.26 m
Post-monsoon GW Level (m): Min – 0.45 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**

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

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 works out 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 its tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Katri River.

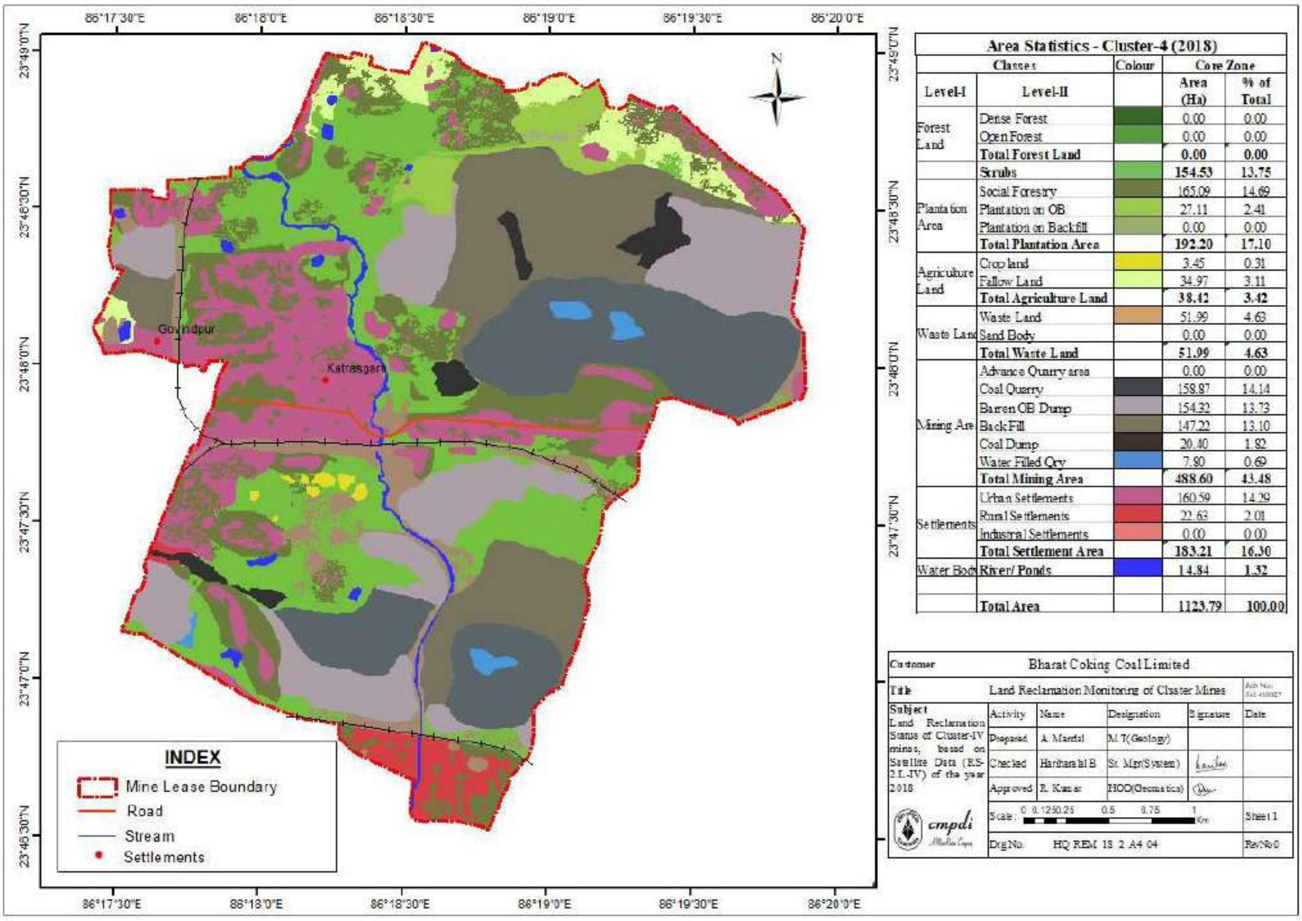
Monitoring stations (**A-26, A28A, B-64 and B-65A**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May’21, August’21, and Nov’21 and January’22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A-26	Malkhera	6.70	2.10	2.73	3.63	6.98	2.69	3.18	4.78	6.58	2.23	3.33	3.83
2	A28A	Lakarka	6.23	0.53	3.75	4.47	4.00	1.33	3.03	3.35	2.45	1.25	3.15	3.60
3	B-64	Keshalpur	2.35	0.30	0.95	1.00	1.85	0.93	0.50	1.37	0.95	0.30	0.45	1.20
4	B65A	Jhinjipahari	9.03	0.45	1.42	2.80	9.25	0.03	2.30	4.10	11.05	1.85	0.95	2.95
Average WL (bgl)			6.08	0.85	2.21	2.98	5.52	1.25	2.25	3.40	5.26	1.41	1.97	2.90

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 0.95 m Max – 11.05 m
Post-monsoon GW Level (m): Min – 0.45 m Max – 3.75 m

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



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

E. GROUND WATER LEVEL OF CLUSTER-V

Cluster-V consists of twelve mines namely; Tetulmari OC & UG mines, Mudidih OC & UG mines, Nichitpur OC mine, Sendra Bansjore 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 works out more than 30 years considering annual target production 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 its tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Jarian Nala and Ekra Jore.

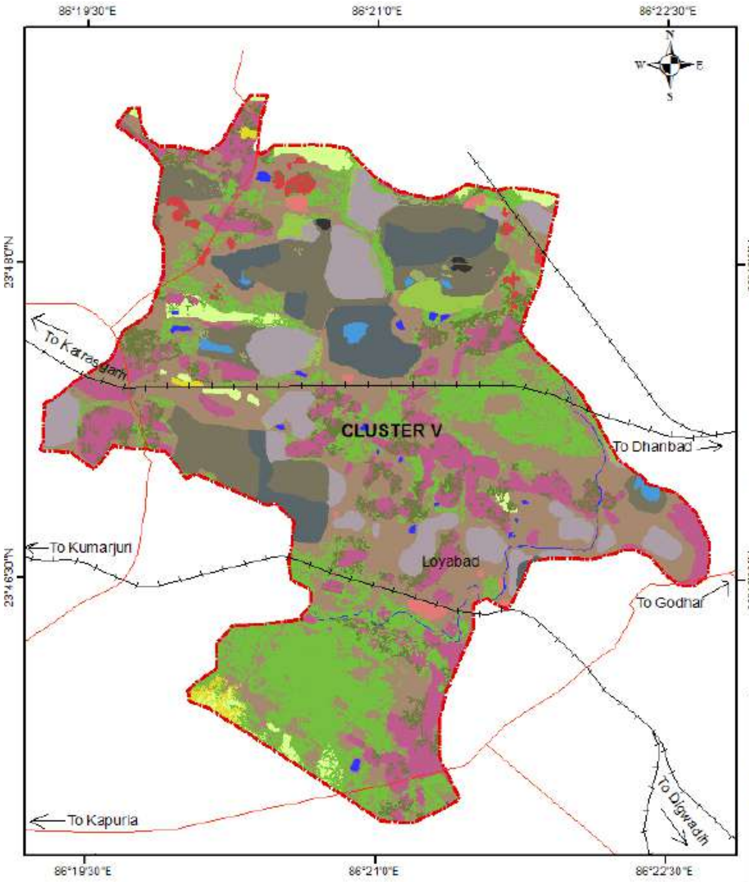
Monitoring stations (**A-3, A-16, A-27 and D-23**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'21, August'21, and Nov'21 and January'22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A-3	Sijua	0.62	0.07	0.05	0.07	1.57	0.02	0.47	0.77	3.47	0.32	0.47	0.62
2	A-16	Ekra	3.45	1.90	2.00	3.00	7.15	1.34	1.75	3.20	5.45	1.65	1.95	4.55
3	A-27	Tetulmari	1.67	0.80	0.90	1.13	2.40	0.03	1.10	1.90	2.40	0.15	0.92	1.30
4	D-23	Jogta	5.43	1.87	1.60	1.65	5.60	1.69	3.35	3.70	4.70	1.65	1.40	1.50
Average WL (bgl)			2.79	1.16	1.14	1.46	4.18	0.77	1.67	2.39	4.01	0.94	1.19	1.99

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 0.62 m Max – 5.60 m
Post-monsoon GW Level (m): Min – 0.05 m Max – 3.35 m

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



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

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

Drg No. HQ REM 4A4 17 01

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 coalmines; 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 works out more than 30 years considering annual target production of 7.631 MTPA (Toposheet no – 73 I/6).

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

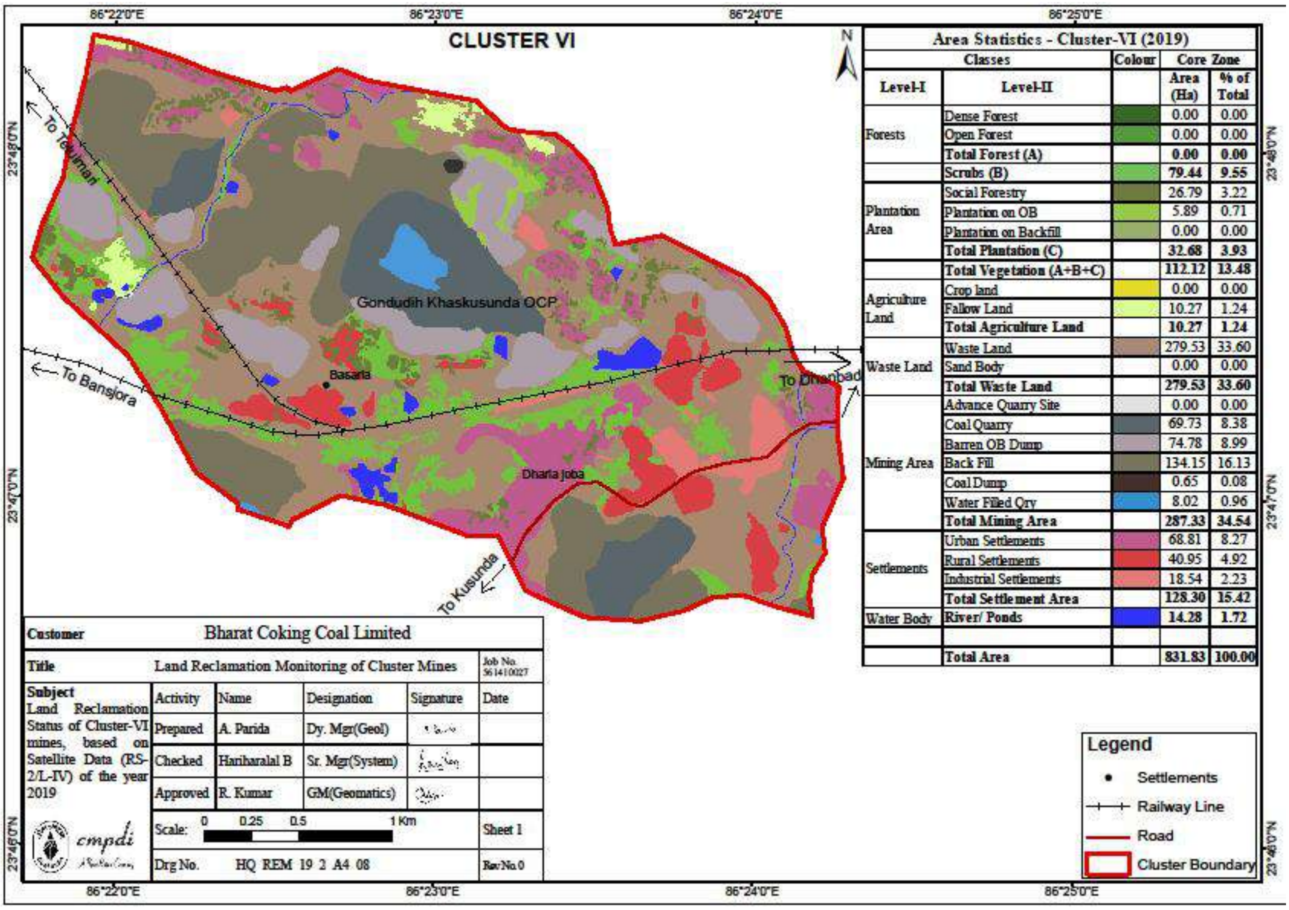
Monitoring stations (**D-25 and D-30**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'21, August'21, and Nov'21 and January'22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D25	Godhur	10.50	2.90	3.80	4.40	10.50	2.28	5.62	6.40	9.90	4.35	5.38	5.50
2	D30	Borkiboa	4.23	0.60	0.84	1.80	4.50	1.65	1.35	2.40	4.60	0.38	0.75	1.95
Average WL (bgl)			7.37	1.75	2.32	3.10	7.50	1.97	3.49	4.40	**7.25**	**2.37**	**3.07**	**3.73**

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 4.23 m Max – 10.50 m
Post-monsoon GW Level (m): Min – 0.75 m Max – 5.62 m

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



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

G. GROUND WATER LEVEL OF CLUSTER-VII

Cluster-VII consists of fourteen mines namely; Kusunda Area, Bastacolla Area and PB Area B.C.C.L (Jharia Coalfield) is located in Dhanbad district of Jharkhand. Cluster–VII consists of coal mines; 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 of BCCL. This Cluster of mines is located in east central part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project works out more than 30 years considering annual target production 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 its tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Kari Jore and Chatkari Jore.

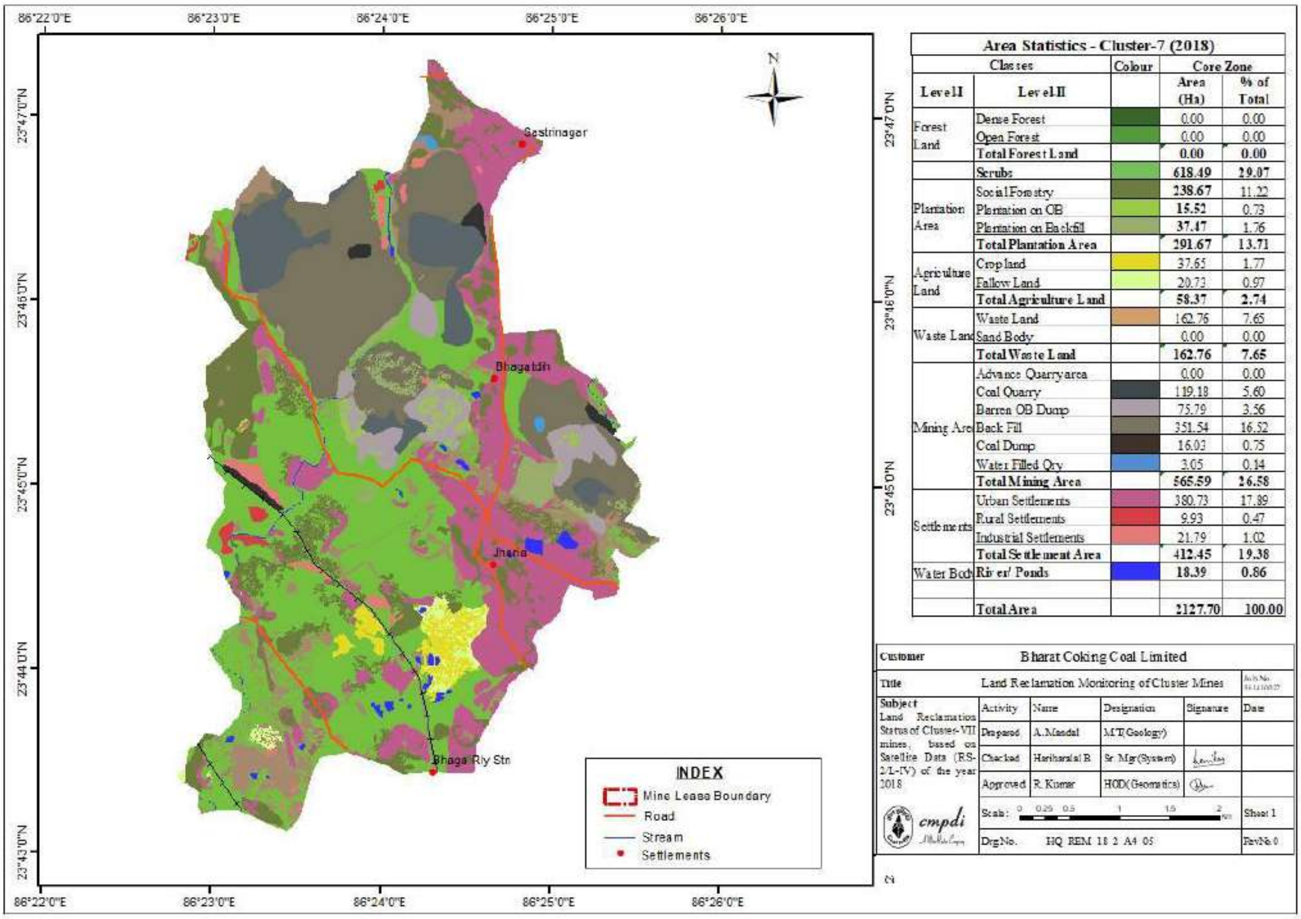
Monitoring stations (**D-3, D-4, D-33, D-34, D-47, D-55 and D-80**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'21, August'21, and Nov'21 and January'22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D-3	Dhansar	3.41	0.80	0.85	1.30	5.40	0.56	1.38	1.90	1.75	1.05	1.30	1.45
2	D-4	Jharia	3.01	1.41	1.16	1.61	3.41	0.51	1.41	2.26	2.81	1.16	1.71	2.16
3	D33	Kustore	1.75	0.62	0.85	1.60	3.65	0.48	1.45	1.80	2.35	0.25	1.65	2.35
4	D34	Kusunda	3.78	2.05	2.90	2.95	3.30	2.00	2.80	2.95	4.75	2.10	2.40	2.55
5	D47	Parastanr	4.05	3.22	2.45	4.88	9.45	3.41	5.45	5.83	4.55	1.90	4.35	4.20
6	D55	Hariladih	9.52	5.62	7.62	9.02	9.42	3.88	8.60	8.62	8.42	2.97	5.47	8.62
7	D80	Bastacolla	7.10	2.17	2.55	3.10	4.30	2.08	4.90	5.00	5.00	2.30	3.05	3.80
Average WL (bgl)			4.66	2.27	2.63	3.49	5.56	1.85	3.71	4.05	4.23	1.68	2.85	3.59

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.75 m   Max – 9.52 m
Post-monsoon GW Level (m): Min – 0.85 m   Max – 8.60 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 under administrative control of Bastacolla Area of B.C.C.L (Jharia Coalfield) is located in Dhanbad district of Jharkhand. 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 are under Bastacolla Area of BCCL is located in the west part of Jharia Coalfield. All above the mines are contiguous in nature and the environmental impact is overlapping in ambient environment due to cumulative effect of the mining activities. The life of the project works out upto 25 years considering annual target production 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 its tributaries controlling the drainage pattern of the area. The area comes under the watershed of Chatkari Jore.

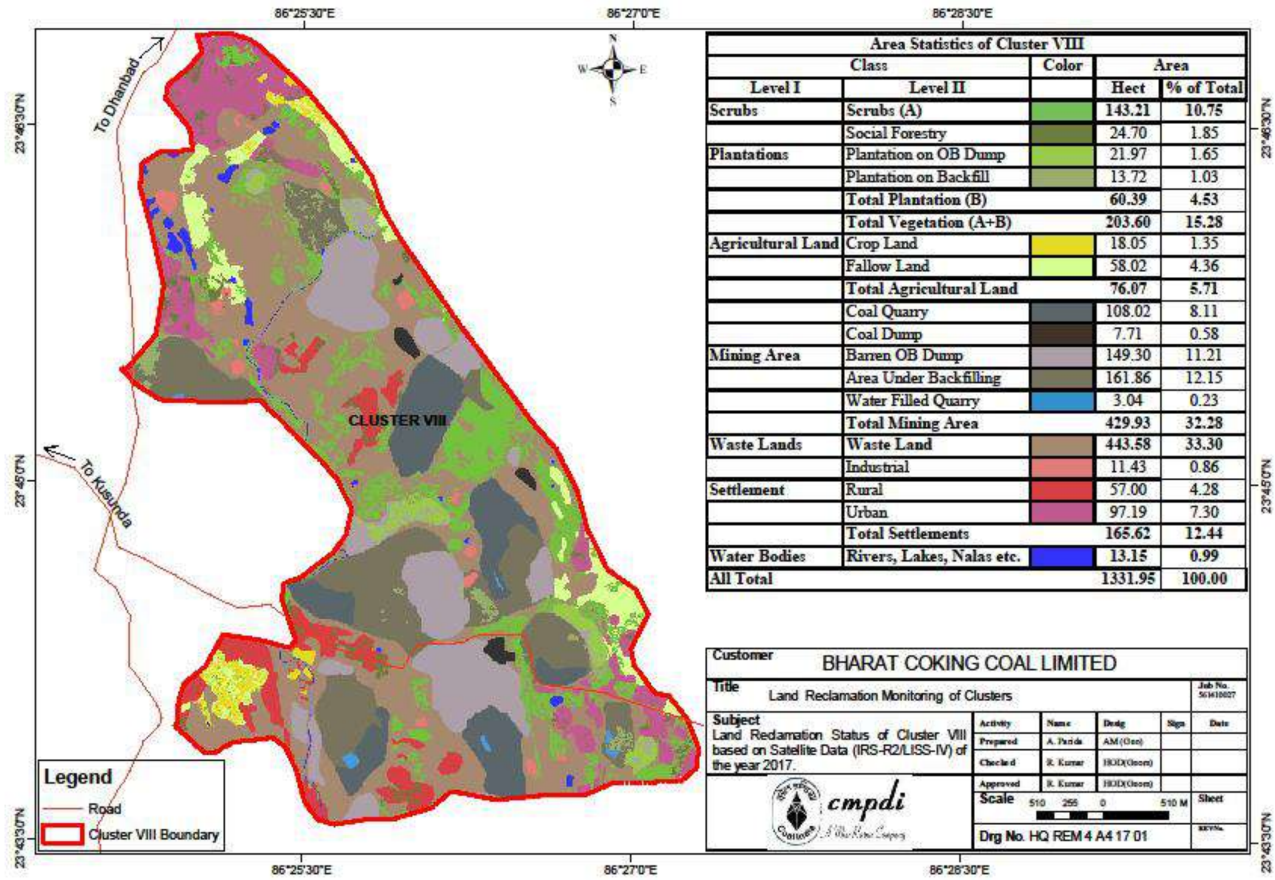
Monitoring stations (**D-8, D-43, D-49 and D-51**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May’21, August’21, and Nov’21 and January’22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D-8	Alokdiha	4.55	1.85	2.27	3.20	5.83	1.70	2.75	3.20	4.80	1.95	2.85	4.25
2	D43	Alagdih	4.65	2.40	2.60	3.35	6.60	2.31	2.55	3.05	7.35	3.55	2.70	4.25
3	D49	Galucdih	1.40	0.73	0.85	1.00	3.25	1.41	1.65	1.98	1.75	0.60	1.50	1.25
4	D51	Chankuiya	9.43	5.65	5.65	7.50	8.45	6.03	5.70	7.35	9.95	8.05	5.75	7.75
Average WL (bgl)			5.01	2.66	2.84	3.76	6.03	2.86	3.16	3.90	5.96	3.54	3.20	4.38

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.40 m Max – 9.95 m
Post-monsoon GW Level (m): Min – 0.85 m Max – 5.75 m

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



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

I. GROUND WATER LEVEL OF CLUSTER-IX

Cluster - IX of B.C.C.L mines under administrative control of Lodna Area of B.C.C.L (Jharia Coalfield) 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) are under the administrative control of Lodna Area of Bharat Coking Coal Limited (B.C.C.L - A Subsidiary of Coal India Limited). Among them N. Tisra/S. Tisra OCP, Jeenagora OCP and N. Tisra UG mine will be amalgamated and will formed North Tisra/South Tisra Expansion OCP. North Tisra/South Tisra Expansion OCP, Lodna UG, Bagdigi UG, Bararee UG and Joyrampur UG are under Lodna Area of BCCL is located in the west part of Jharia Coalfield. All above the mines are contiguous in nature and the environmental impact is overlapping in ambient environment due to cumulative effect of the mining activities. The life of the project works out upto 30 years considering annual target production 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 its tributaries controlling the drainage pattern of the area. The area comes under the watershed of Chatkari Jore.

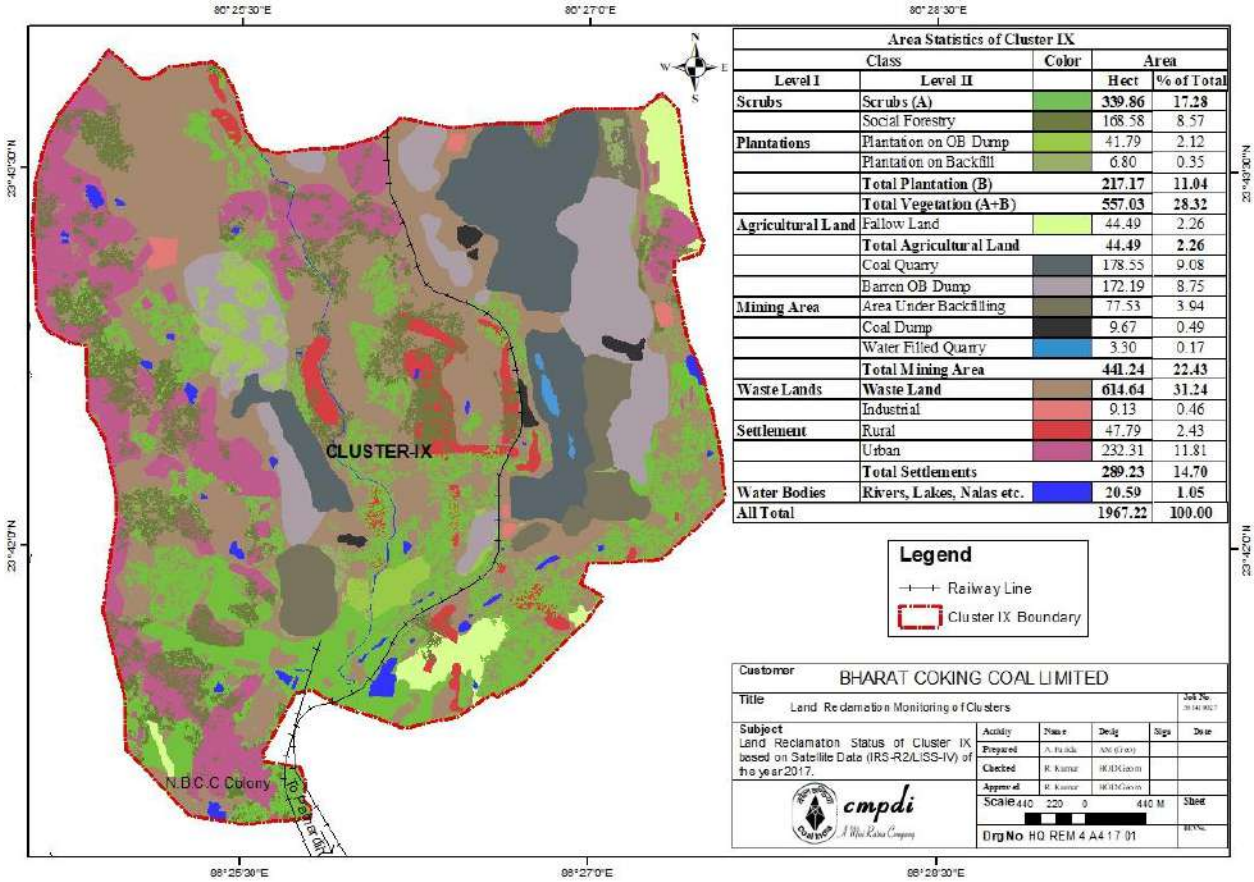
Monitoring stations (**D-5, D-7, D-39, D-40A, D-41 and D-74**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May’21, August’21, and Nov’21 and January’22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D-5	Jiyalgora	7.28	3.35	4.00	6.40	8.60	3.20	7.70	7.90	8.25	2.90	4.85	8.20
2	D-7	Golden Pahari	6.08	2.38	2.63	3.88	7.33	2.56	5.13	5.35	8.23	1.88	3.28	4.86
3	D-39	Tilaboni	10.70	4.60	5.10	8.15	9.40	3.35	6.05	6.78	12.60	4.00	5.95	12.45
4	D40A	Khapa Dhawra	1.95	1.35	1.80	2.35	1.95	0.30	1.43	6.78	1.85	1.50	1.45	1.95
5	D-41	Joyrampur	1.95	1.34	1.38	1.45	3.30	1.43	1.45	1.60	2.30	0.70	1.25	1.40
6	D-74	BhulanBararee	6.93	3.20	2.90	3.70	4.30	2.58	3.93	4.00	5.80	2.35	3.57	4.95
Average WL (bgl)			5.82	2.70	2.97	4.32	5.81	2.24	4.28	4.54	6.51	2.22	3.39	5.64

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.85 m Max – 12.60 m
Post-monsoon GW Level (m): Min – 1.25 m Max – 7.70 m

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



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	601.52×10^4	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 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 works out is more than 30 years considering annual target production of 2.289 MTY.

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

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

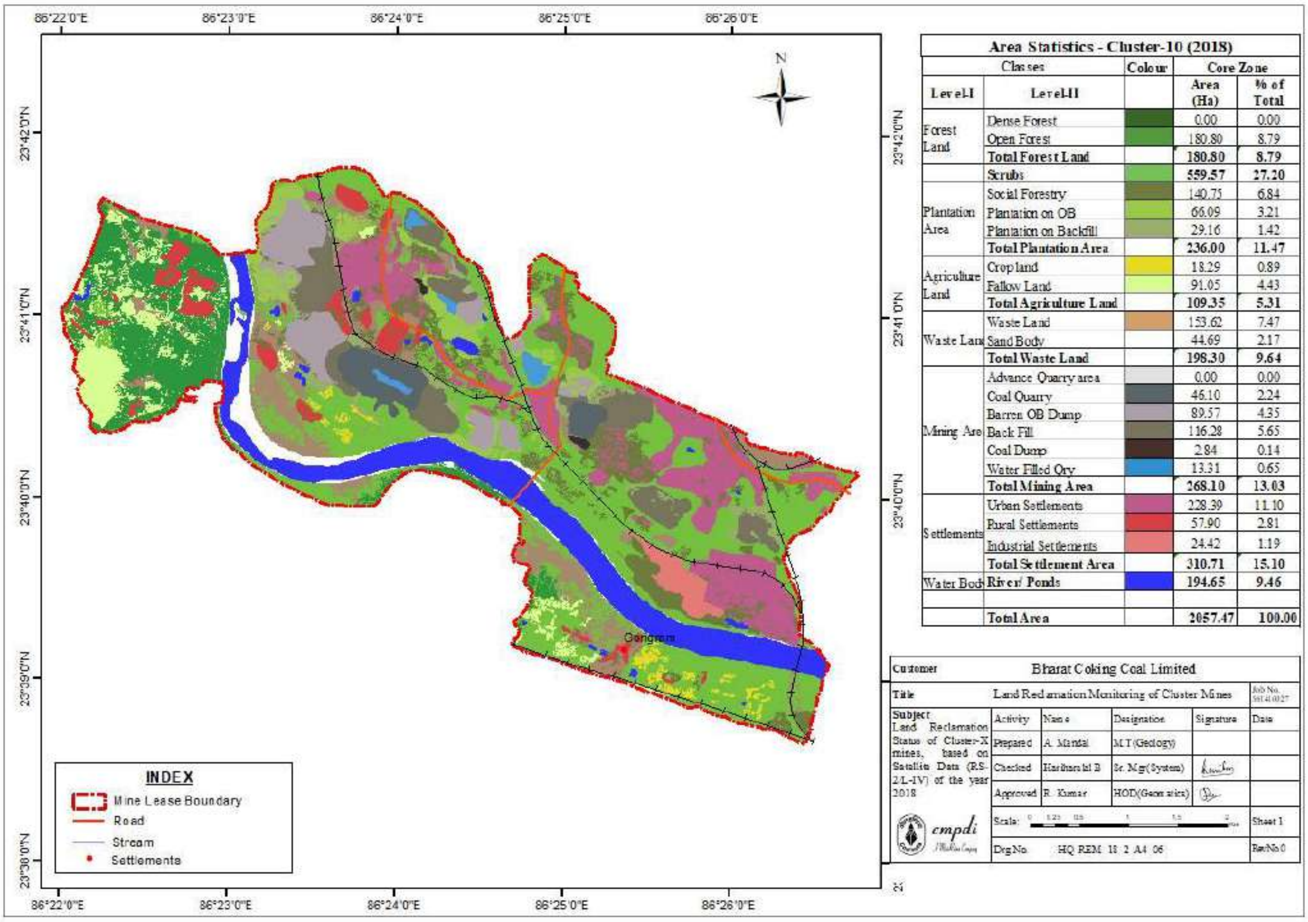
Monitoring stations (**A-19, D-35, D-36 and D-77**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'21, August'21, and Nov'21 and January'22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A-19	Bhowrah	3.30	1.95	1.90	2.20	6.05	2.30	3.25	3.70	4.85	0.95	3.43	4.95
2	D-35	Patherdih	6.60	2.70	2.90	4.30	8.20	2.98	5.40	5.62	8.00	3.15	3.80	5.90
3	D-36	Sudamdih	2.02	0.45	0.55	0.55	2.10	0.06	1.00	1.15	1.20	0.10	0.55	0.65
4	D-77	Amlabad	5.98	2.60	4.69	5.60	6.40	5.90	3.50	4.25	6.40	2.80	3.20	4.50
Average WL (bgl)			4.48	1.93	2.51	3.16	5.69	2.81	3.29	3.68	5.11	1.75	2.75	4.00

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.20 m Max – 8.20 m
Post-monsoon GW Level (m): Min – 0.55 m Max – 4.69 m

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



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

K. GROUND WATER LEVEL OF CLUSTER-XI

Cluster–XI consists of eight coal mines; Moonidih UG, Gopalichak UG Project, Kachi Balihari 10/12 Pit UG, Pootkee Balihari Project UG, Bhagaband UG, Kendwadih UG (closed), Pootkee UG (closed), Kachi Balihari 5/6 Pit UG (closed) 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 works out about upto 50 years considering annual target production of 6.604 MTPA (toposheet no. no. 73 I/5 7 73 I/6).

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

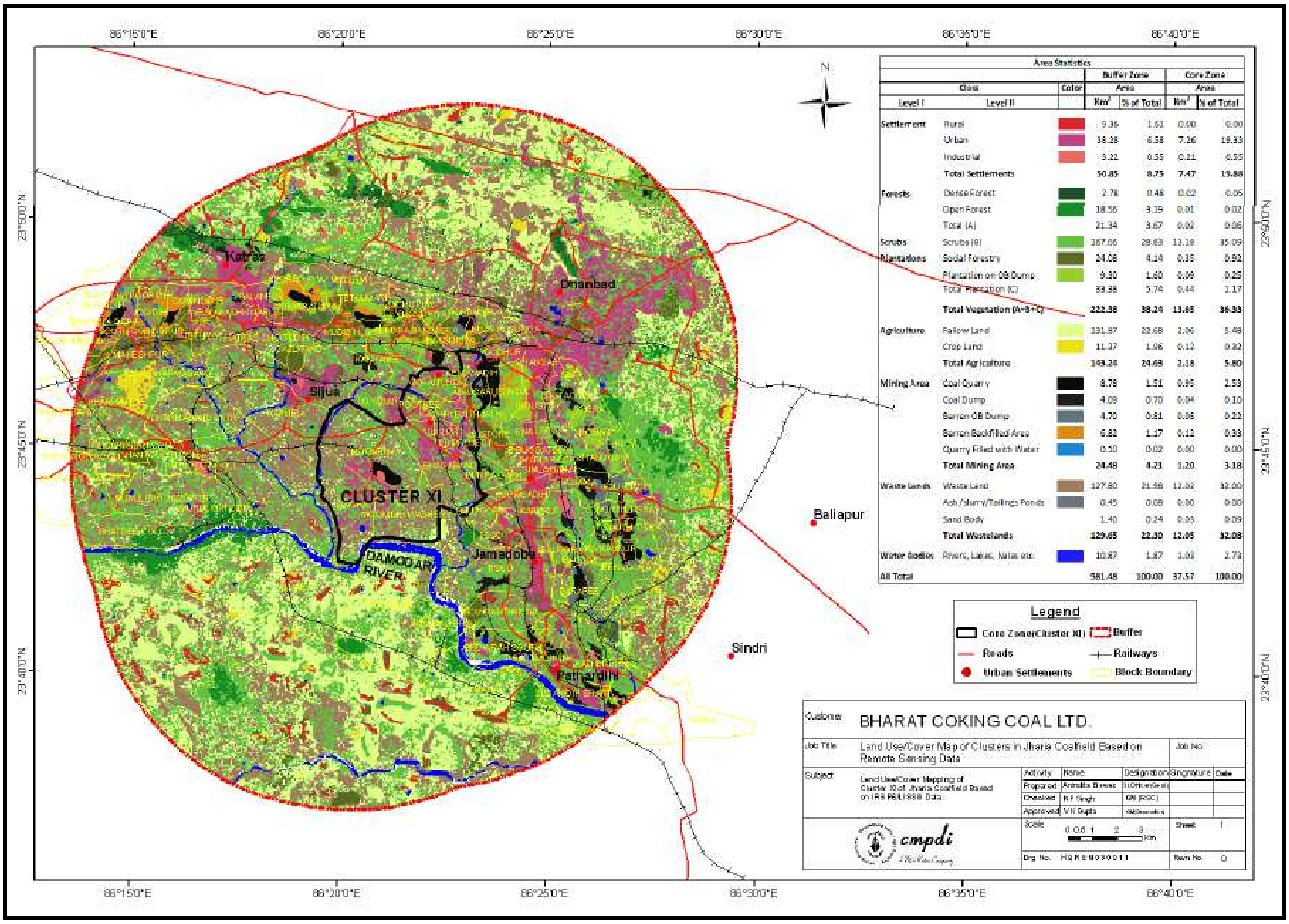
Monitoring stations (**A-17, A-18, A-20 and A-32**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'21, August'21, and Nov'21 and January'22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A-17	Kachi Balihari	3.36	1.62	2.37	2.54	2.14	0.64	1.69	1.79	2.94	0.34	2.24	2.42
2	A-18	Baghaband	1.09	0.54	0.57	0.74	1.09	0.39	0.34	0.89	2.29	1.09	0.69	1.09
3	A-20	Gorbudih	5.47	1.47	2.02	3.07	8.47	1.44	3.87	4.42	4.57	3.32	1.82	4.02
4	A-32	Baludih	2.35	0.73	0.96	1.50	1.90	0.36	1.75	1.80	2.75	0.62	0.95	1.65
Average WL (bgl)			3.07	1.09	1.48	1.96	3.40	0.71	1.91	2.23	3.14	1.34	1.43	2.30

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.09 m Max – 8.47 m
Post-monsoon GW Level (m): Min – 0.34 m Max – 3.87 m

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



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

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 is located in the south-western part of Jharia coal field in Dhanbad district of Jharkhand. The area is covered by Survey of India toposheet no. 73 I/6. The life of the project works out about 15 years considering annual target production of 0.234 MTPA.

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

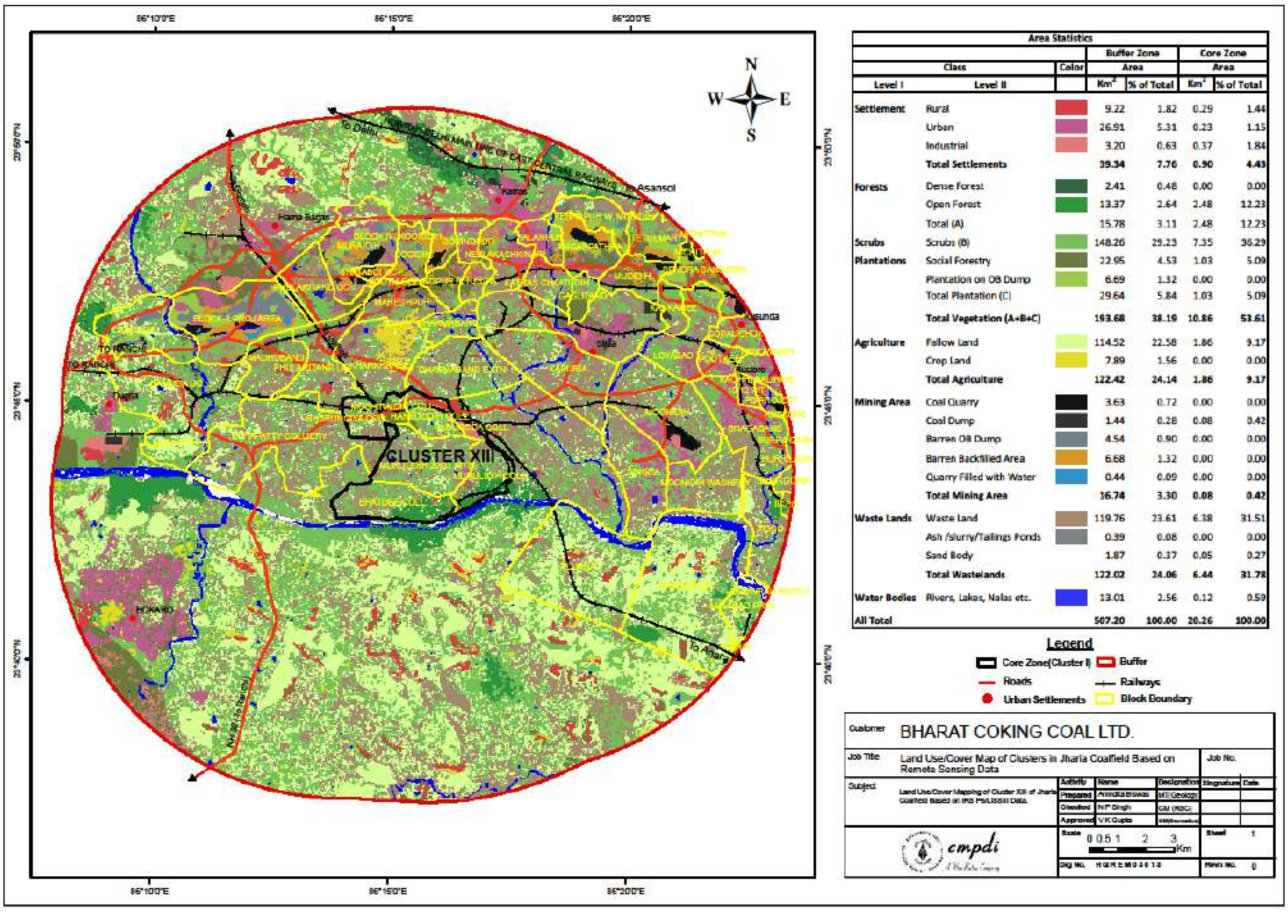
Monitoring stations (**A-22, A-23, A-33, A-34, B-25 and B-48**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'21, August'21, Nov'21 and January'22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A22A	Nagdah	2.90	0.40	1.10	1.50	2.90	0.20	1.98	2.00	2.60	1.75	2.00	2.85
2	A-23	Machhayara	9.52	1.87	2.82	4.82	8.92	1.12	5.62	7.12	11.97	5.37	3.77	6.57
3	A-33	Mahuda Wa	2.85	0.80	0.85	1.33	4.55	0.38	1.85	2.85	3.65	0.55	1.25	1.55
4	A-34	Mahuda vil.	5.20	1.83	3.55		8.35	3.43	3.45	5.35	6.35	3.45	3.95	5.45
5	B-25	Mahuda more	5.10	1.98	2.58	3.30	7.90	3.02	2.55	3.45	4.80	1.38	1.40	3.50
6	B-48	Mahuda	7.23	2.28	6.05	6.60	8.20	3.37	3.85	4.51	7.05	2.85	4.35	5.45
Average WL (bgl)			5.47	1.53	2.83	3.51	6.80	1.92	3.22	4.21	6.07	2.56	2.79	4.23

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.85 m Max – 11.97 m
Post-monsoon GW Level (m): Min – 0.85 m Max – 6.05 m

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



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

M. GROUND WATER LEVEL OF CLUSTER-XIV

Cluster-XIV of B.C.C.L mines under administrative control of Western Jharia Area of B.C.C.L (Jharia Coalfield) is located in Dhanbad district of Jharkhand. Lohapatty UG and Lohapatty OC patch (proposed) 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- XIV is located in western part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project works out upto 08 years considering annual target production of 0.526 MTPA. Cluster-XIV mine involves leasehold area of about 1418.25 Ha of land. It covered in Survey of India toposheet no. 73 I/2.

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

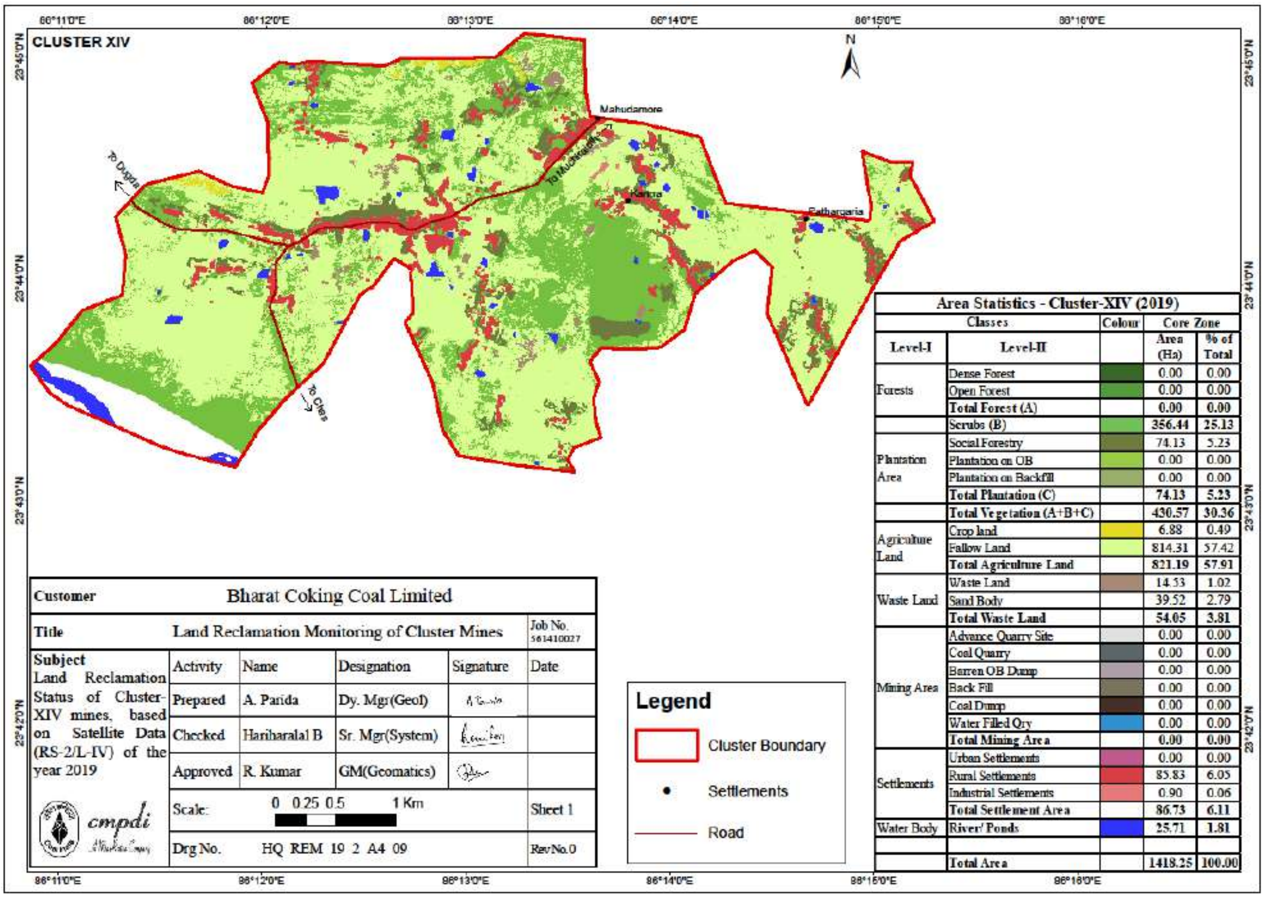
Monitoring stations (**B-23, B-24 and B-67**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'21, August'21, and Nov'21 and January'22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	B-23	Lohapatti	4.12	1.24	1.44	1.81	3.24	0.77	1.76	2.69	2.84	1.12	1.34	2.24
2	B-24	Telmuchu	5.68	1.55	2.08	3.07	5.48	1.13	3.53	4.38	4.58	1.23	2.33	3.63
3	B-67	Simatanr	8.95	2.45	2.95	3.65	7.55	1.83	3.95	5.90	8.57	3.37	4.35	4.65
Average WL (bgl)			6.25	1.75	2.16	2.84	5.42	1.24	3.08	4.32	5.33	1.91	2.67	3.51

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.84 m Max – 8.95 m
Post-monsoon GW Level (m): Min – 1.34 m Max – 4.35 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	1251.76×10^4	0.0	1251.76×10^4
2	Open Land	79.76×10^4	0.0	79.76×10^4
3	Road/ Paved Area	85.83×10^4	0.0	85.83×10^4
4	Rooftop area of building/ sheds	0.90×10^4	0.0	0.90×10^4
5	Total	1418.25×10^4	0.0	1418.25×10^4

N. GROUND WATER LEVEL OF CLUSTER-XV

Cluster - XV of B.C.C.L mines under administrative control of Govindpur Area and barora Area of B.C.C.L (Jharia Coalfield) is located in Dhanbad district of Jharkhand. Cluster–XV consists of four coal mines; Kharkharee UG (underground mine) and Dharmaband UG are under the administrative control of Govindpur Area and Madhuband UG & Phularitand UG are under the administrative control of Barora Area of Bharat Coking Coal Limited (B.C.C.L - A Subsidiary of Coal India Limited). The Cluster-XV is located in western part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project works out upto 30 years considering annual target production of 0.423 MTPA. Cluster-XV mine involves leasehold area of about 1696.55 Ha of land. It covered in Survey of India toposheet no. 73 I/1 and 73 I/5.

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

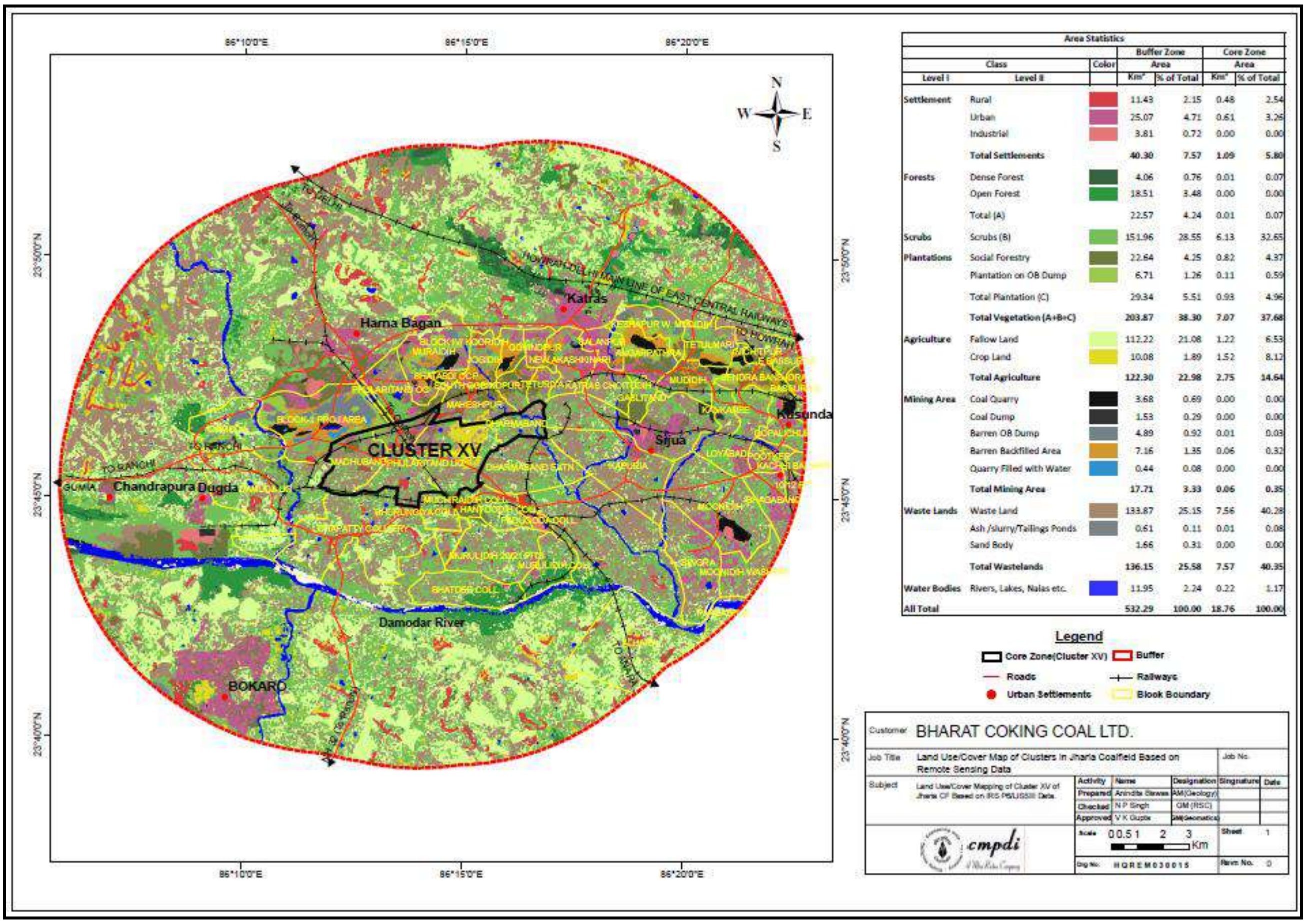
Monitoring stations (**A-24, B-32A and B-61A**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'21, August'21, and Nov'21 and January'22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A24	Pipratanr	10.13		2.78	4.55	4.88	-	4.28	4.68	15.88	1.73	2.48	4.08
2	B32A	Madhuband	5.60	1.34	1.70	2.30	3.30	1.18	2.00	2.21	5.55	1.25	1.70	2.35
3	B61A	Kesargora	4.42	0.47	0.97	0.97	3.32	0.85	1.60	2.07	3.35	1.39	0.52	1.12
Average WL (bgl)			6.72	0.91	1.82	2.61	3.83	1.02	2.63	2.99	5.39	7.97	3.63	4.27

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.32 m Max – 15.88 m
Post-monsoon GW Level (m): Min – 0.52 m Max – 4.28 m

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



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	365.18×10^4	0.0	957.34×10^4
2	Open Land	1130.53×10^4	0.0	538.37×10^4
3	Road/ Paved Area	101.67×10^4	0.0	101.67×10^4
4	Rooftop area of building/ sheds	99.17×10^4	0.0	99.17×10^4
5	Total	1696.55×10^4	0.0	1696.55×10^4

O. GROUN D WATER LEVEL OF CLUSTER-XVI

Cluster - XVI of B.C.C.L mines under administrative control of Chanch Victoria Area of B.C.C.L (Raniganj Coalfield) is located in Dhanbad district of Jharkhand. The Cluster-XVI (Dahibari-Basantimata Group of mines) is located on the western part of the Raniganj Coalfield and falls within Dhanbad district of Jharkhand. There are total five collieries within this Clusture- XVI (Dahibari-Basantimata OC, Basantimata UG, New Laikdih OC, Laikdih Deep UG and Chanch UG Colliery). All above the mines are contiguous in nature and the environmental impact is overlapping in ambient environment due to cumulative effect of the mining activities. The life of the project works out upto 24 years considering annual target production of 1.963 MTPA. Cluster-XVI mine involves leasehold area of about 2008.40 Ha of land. It covered in Survey of India toposheet no. 73 I/14.

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

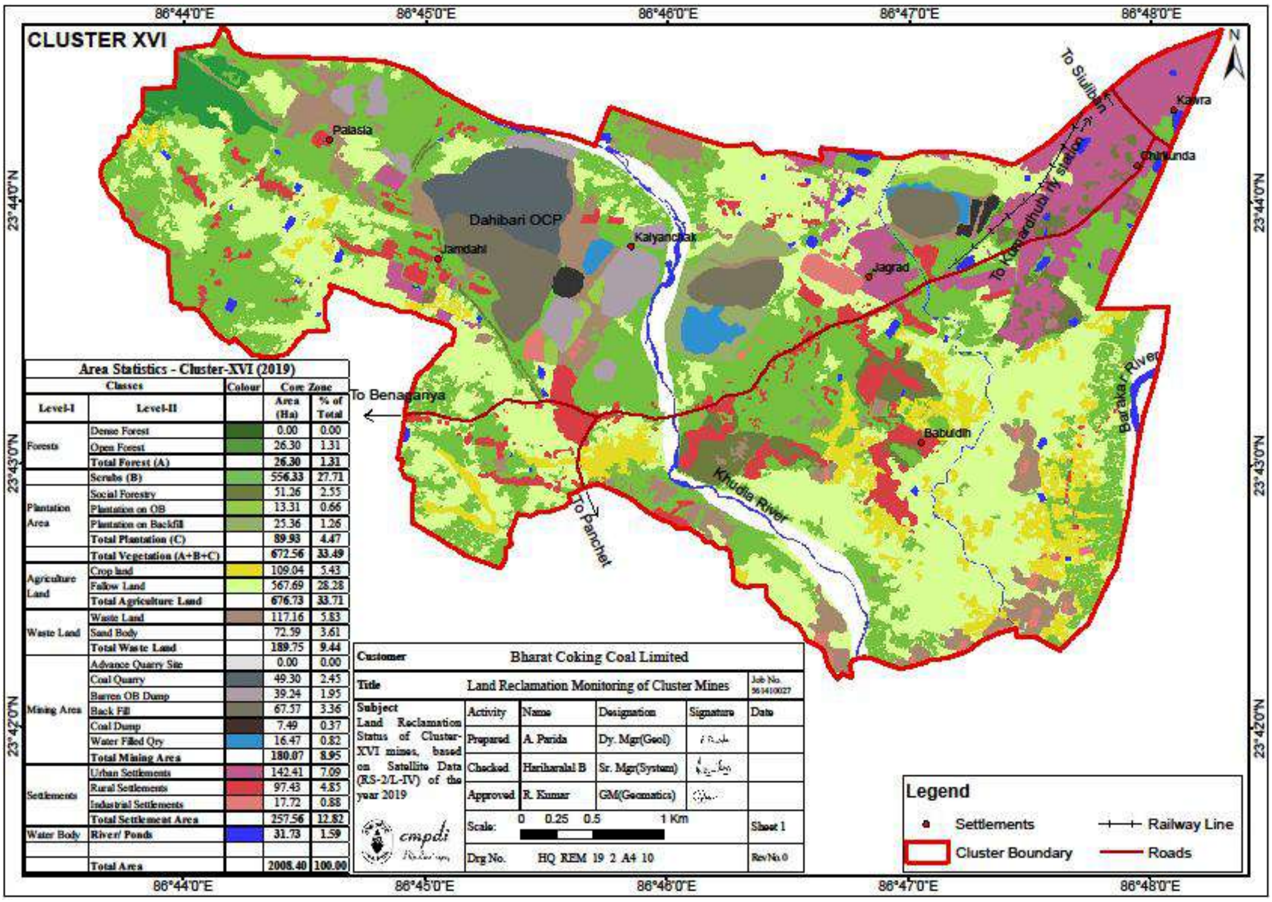
Monitoring stations (**DB-22, DB-23, DB-24 & DB-25**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'21, August'21, and Nov'21 and January'22, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2021-22				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	DB22	Dahibari, Basti	2.31	1.55	1.38	1.57	2.63	1.30	2.25	2.38	4.93	1.38	1.63	1.73
2	DB23	Dahibari OC	2.00	1.05	1.10	1.70	2.50	0.70	1.95	2.17	1.60	0.88	0.80	1.00
3	DB24	Dahibari	6.20	4.20	5.25	5.80	3.60	1.57	5.70	5.90	9.35	3.20	3.88	4.80
4	DB25	Basantimata UG	2.83	1.01	2.03	2.63	3.98	1.19	2.63	2.68	-	-	-	-
Average WL (bgl)			3.34	1.95	2.44	2.93	3.18	1.19	3.13	3.28	4.53	1.82	2.10	2.51

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.60 m Max – 9.35 m
Post-monsoon GW Level (m): Min – 0.80 m Max – 5.70 m

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



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

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 fluctuation Below ground level (May, Aug, Nov'21 & Jan'22)	Avg. Fluctuation (in meters) during 2021-22	Geological Formation
1	I	4 nos.	0.25 to 8.38 m	2.93 m	Barakar
2	II	5 nos.	0.30 to 11.26 m	4.02 m	Barakar
3	III	5 nos.	0.24 to 11.26 m	2.92 m	Barakar
4	IV	4 nos.	0.30 to 9.03 m	3.87 m	Barakar
5	V	4 nos.	0.07 to 5.43 m	1.66 m	Barakar
6	VI	2 nos.	0.60 to 10.50 m	5.05 m	Barakar
7	VII	7 nos.	0.62 to 9.52 m	2.03 m	Barakar
8	VIII	4 nos.	0.73 to 9.43 m	2.17 m	Barakar
9	IX	6 nos.	1.34 to 10.70 m	2.85 m	Barakar
10	X	4 nos.	0.45 to 6.60 m	1.97 m	Barakar
11	XI	4 nos.	0.54 to 5.47 m	1.80 m	Barakar & Barren Measure
12	XIII	6 nos.	0.40 to 9.52 m	2.64 m	Raniganj
13	XIV	3 nos.	1.24 to 8.95 m	4.09 m	Raniganj
14	XV	3 nos.	0.47 to 10.13 m	4.90 m	Barakar & Barren Measure
15	XVI	3 nos.	1.01 to 6.20 m	0.90 m	Barakar

Depth to water level (in bgl) values described that water level goes down to maximum 11.26 m during pre-monsoon'2021 and maximum upto 7.62 m during post-monsoon'2021. Un-confined aquifer affected around 20 m to 30 m maximum 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 shown in **Annexure–VI**. Water Table contour map and Depth to water level map shown in **Plate-IV & V**.

Monitoring groundwater (quantity & quality) to assess the present condition and resource has done regularly in the coalfield areas. Well hydrographs (**Annexure–VI**) are prepared and studied to identify long-term trends. Hydrograph trend analysis of CGWB monitoring wells and observation well reveals increasing groundwater level trends in most of the Cluster of mines. However, decline trends in both Pre and Post-monsoon GW level in Cluster-I, Cluster-V, Cluster-VI and Cluster-VII is recorded but no significant decline 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) given in **Annexure–V** and Quality is given in **Annexure–VII**.

5.0 GROUND WATER QUALITY

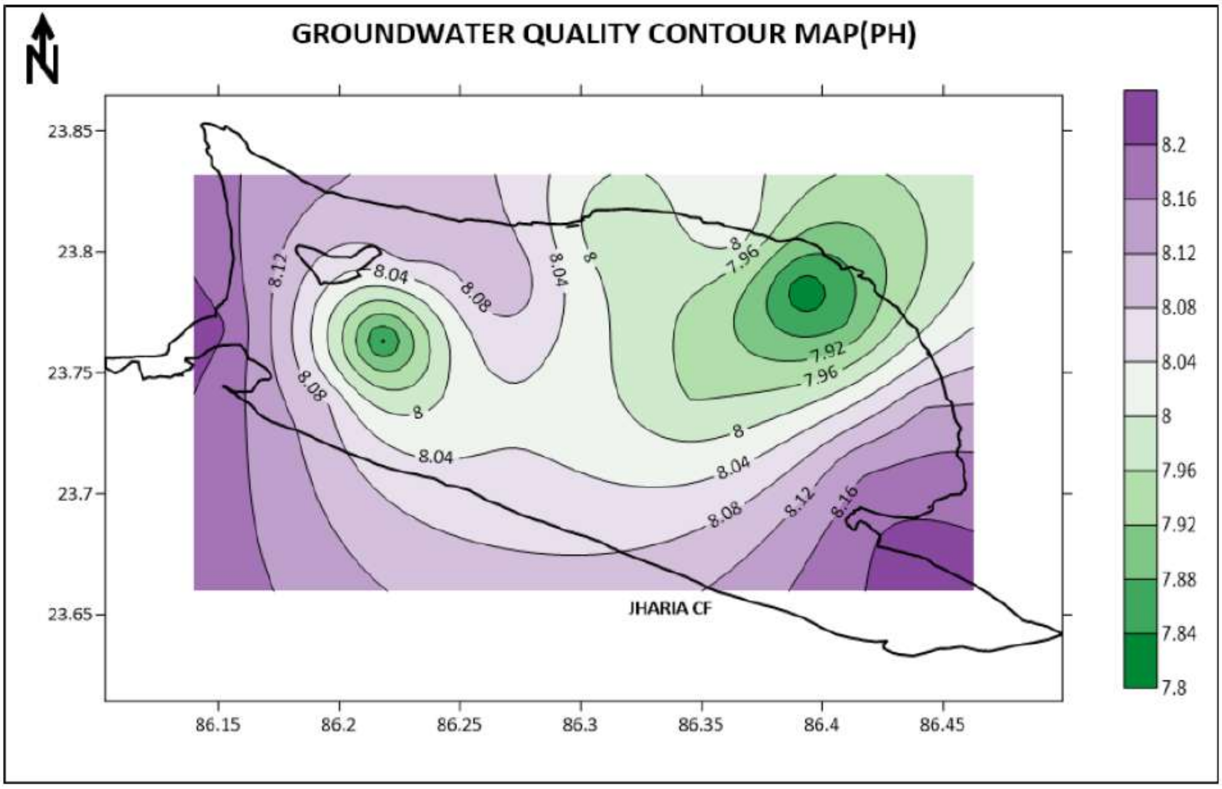
The ground water sample of the study area (15 nos. of Cluster of mines, BCCL) collected from dug wells and analyzed. Fifteen ground water samples (GW-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15 & 16) analyzed during the month of June'2021 at CMPDI, RI-II, Dhanbad. The water sampling details given in **Annexure–V** and Water sample locations shown in **Plate-II**. The water quality data enclosed in **Annexure–VII.**

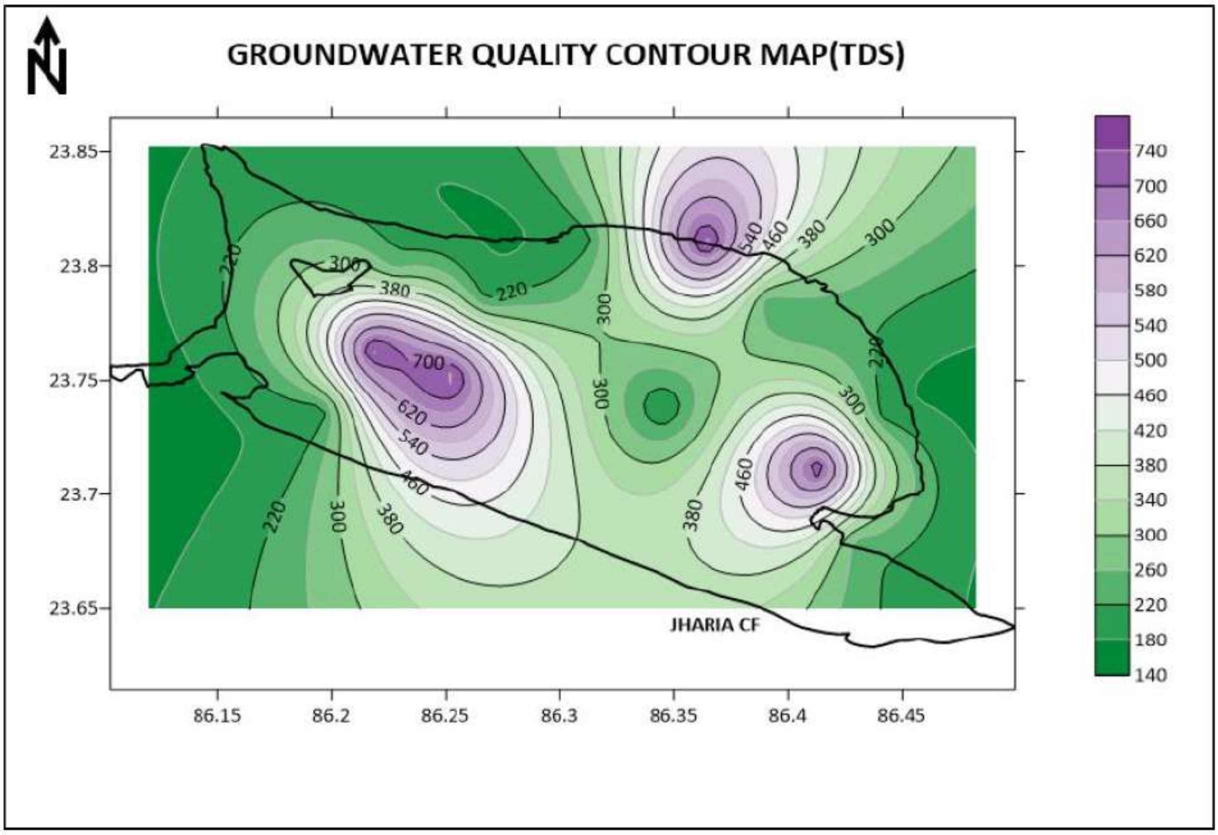
The study of the variations in water quality parameters described below:

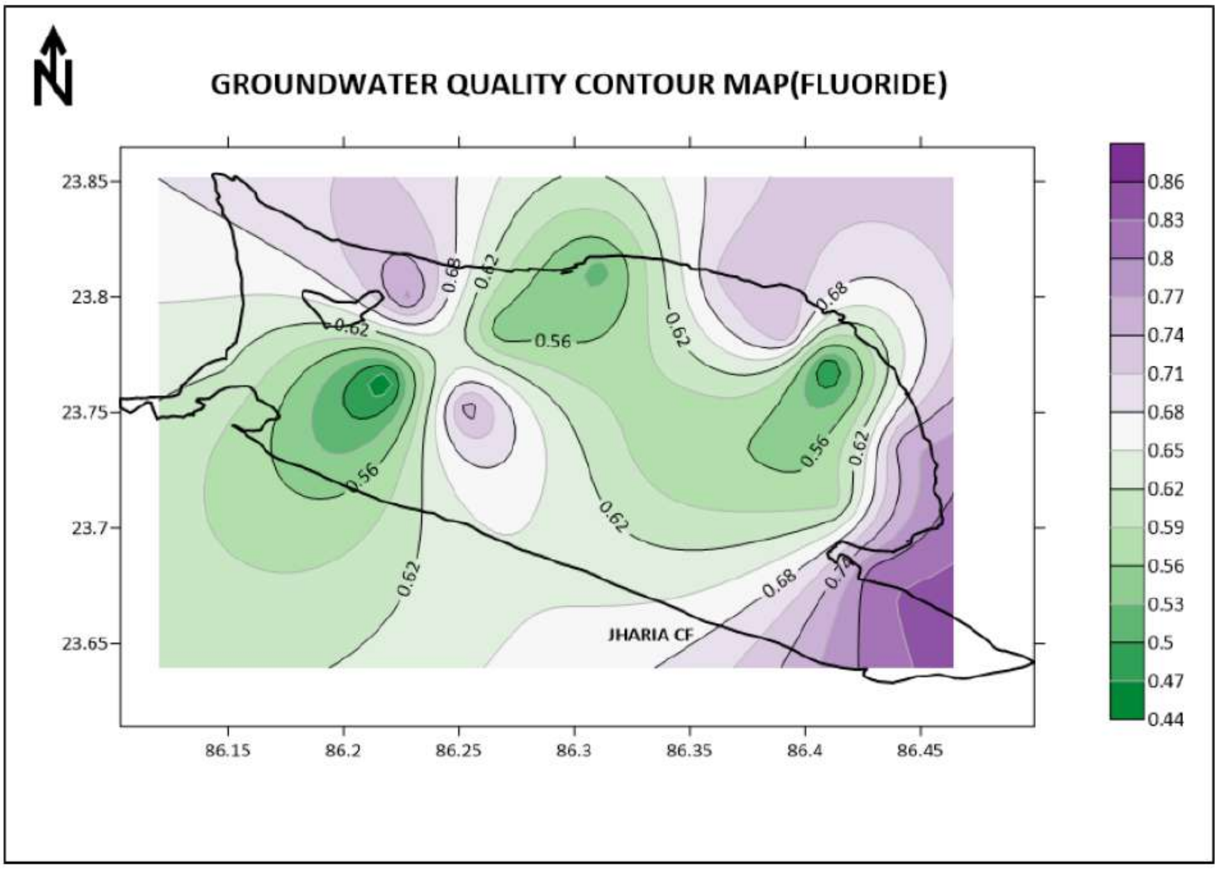
The pH of the groundwater samples varies between 7.65 (GW-5) to 8.15 (GW-11), the pH is within the IS 10500 limit of drinking water standard.

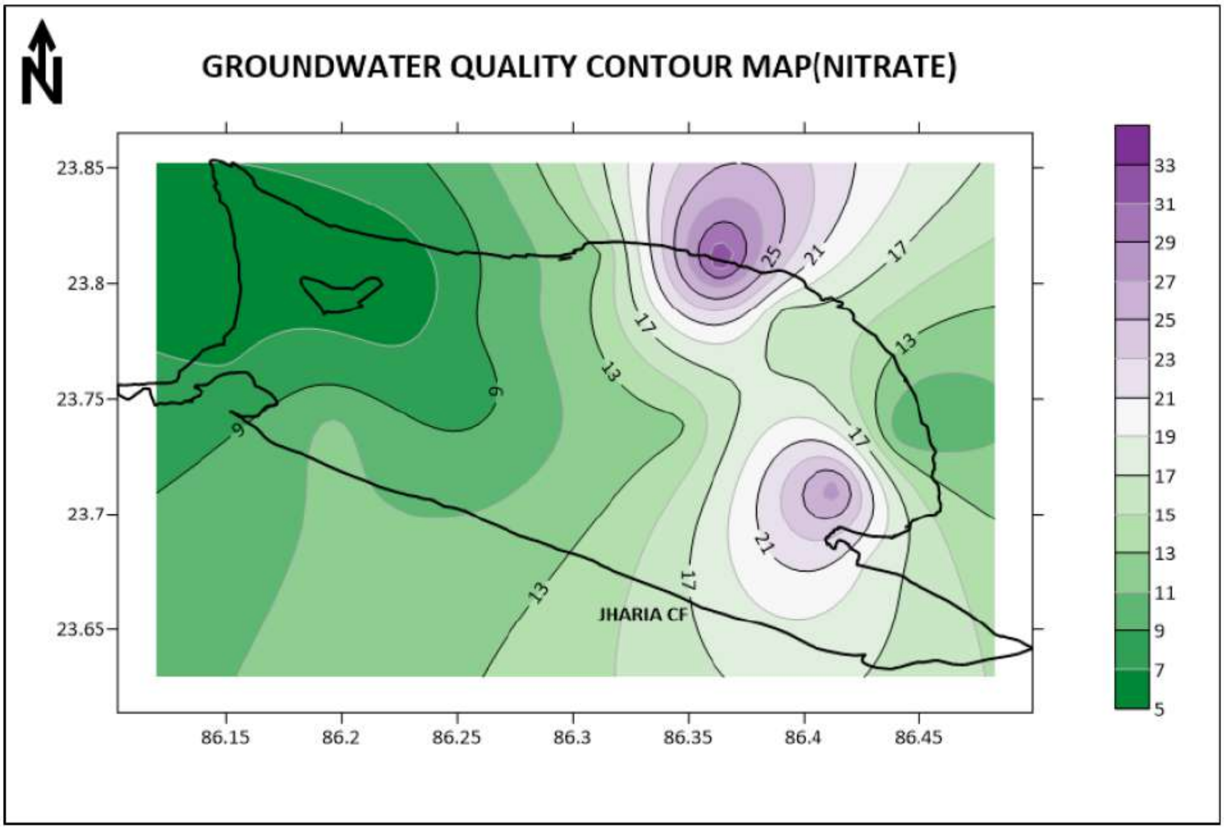
The mineral constituents dissolved in water constitute the dissolved solids. The total dissolve solids vary from 425 (GW-1) to 889 mg/l (GW-9), the TDS values ranges slightly above the IS 10500:2012 standards limits of drinking water.

The alkalinity of the water samples varies from 101 (GW-14) to 182 mg/l (GW-7) and are within the stipulated standard of (200 mg/l) drinking water. The concentrations of calcium in the water samples vary from 41 (GW-1) to 158 mg/l (GW-13) and are ***slightly above*** the permissible limit (75 mg/l) of drinking water standards. The total hardness ranges between 226 (GW-8) to 638 mg/l (GW-5) and the value of total hardness in water samples are ***above*** the permissible limit (200 mg/l). The sulphate ranges between 31 (GW-1) to 187 mg/l (GW-16) and the value of sulphate in water sample are within the permissible limit (200 mg/l). The Iron, Copper, Manganese, Lead, Zinc and Chromium concentration in the water samples found to be below the upper ISI limits for drinking water.


GROUNDWATER QUALITY CONTOUR MAP(PH)
N
JHARIA CF
8.2
8.16
8.12
8.08
8.04
8
7.96
7.92
7.88
7.84
7.8
23.85
23.8
23.75
23.7
23.65
86.15
86.2
86.25
86.3
86.35
86.4
86.45


GROUNDWATER QUALITY CONTOUR MAP(TDS)
N
JHARIA CF
740
700
660
620
580
540
500
460
420
380
340
300
260
220
180
140
23.85
23.8
23.75
23.7
23.65
86.15
86.2
86.25
86.3
86.35
86.4
86.45


GROUNDWATER QUALITY CONTOUR MAP(FLUORIDE)
N
23.85
23.8
23.75
23.7
23.65
86.15
86.2
86.25
86.3
86.35
86.4
86.45
0.86
0.83
0.8
0.77
0.74
0.71
0.68
0.65
0.62
0.59
0.56
0.53
0.5
0.47
0.44
0.68
0.62
0.56
0.74
JHARIA CF


GROUNDWATER QUALITY CONTOUR MAP(NITRATE)
N
23.85
23.8
23.75
23.7
23.65
86.15
86.2
86.25
86.3
86.35
86.4
86.45
33
31
29
27
25
23
21
19
17
15
13
11
9
7
5
JHARIA CF

6.0 STAGE OF GROUNDWATER EXTRACTION

The groundwater mainly utilized for domestic needs and for 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 GWRE). The highest stage of development is in Jharia Block (127.0%) & Dhanbad Block (107.50%) and lowest stage of development is in Baliapur Block (78.24%) as per GWRE-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 2017, Block wise data of Dhanbad District given below:

Table–8A: Block wise Stage of Groundwater development

Sl No.	Administrative Unit		Stage of GW Development	Category (GWRE-2013)	Category (GWRE-2017)
	District	Block			
1	Bokaro	Bermo	156.30%	**Over- exploited**	**Over- exploited**
2	Dhanbad	Baghmara	91.74%	Critical	Critical
3	Dhanbad	Baliapur	78.24%	Semi- Critical	Semi- Critical
4	Dhanbad	Dhanbad	107.50%	**Over- exploited**	**Over- exploited**
5	Dhanbad	Jharia	127.0%	**Over- exploited**	**Over- exploited**
6	Dhanbad	Topchachi	98.45%	Critical	Critical

- **Dynamic Groundwater Resource Assessment, CGWB as per 2013 & 2017.**

Table–8B: Cluster wise Groundwater development scenario

Cluster/ Area	Adminis-trative Blocks/Stage Of GW Extraction	Total Water demand (cum/day)				Avg. GW level (bgl in m) 2021-22		GW level declining trend 2005-2021		Remarks
		Mine Discharge + BH pumping	Surface Water Source	Total Use (Domestic + Industrial)	Excess Or other use	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
Cluster-I	Bermo (SOD: Over-exploited)	2173 (2065+108)	NIL	2112 (1698+414)	61	5.10	1.07	YES	YES	Recharge structure needed
Cluster-II	Baghmara (SOD: Critical)	8350	Jamunia river	6737 (2755+3982)	1613	6.12	2.10	NO	NO	Excess mine water needed to be utilized
Cluster-III		12760 (10960+1800)	NIL	8946 (7849+1097)	3814	5.66	2.74	NO	NO	
Cluster-IV		5900	MADA	5100 (3605+1495)	800	6.08	2.21	NO	NO	
Cluster-V		12690 (11025+1665)	MADA	11063 (5710+5353)	1897	2.80	1.15	YES	YES	
Cluster-VI	Dhanbad (SOD: Over-exploited)	4150	MADA	4150 (1664+2486)	0.0	7.37	2.32	YES	NO	--
Cluster-VII		21565	MADA	20826 (17596+3230)	739	4.66	2.63	YES	YES	Excess mine water needed to be utilized water
Cluster-VIII	Jharia (SOD: Over-exploited)	9320	MADA	5294 (3730+1564)	4026	5.01	2.84	NO	NO	
Cluster-IX		12980	MADA	9358 (4549+4809)	3622	5.82	2.97	NO	NO	
Cluster-X		11825	Damodar river	6201 (4255+1946)	5624	4.48	2.51	YES	NO	
Cluster-XI	Dhanbad (SOD: Over-exploited)	24960	MADA & DVC	19425 (14015+5410)	5535	2.82	1.48	NO	NO	
Cluster-XIII	Baghmara (SOD: Critical)	750	Damodar river	692	58.0	5.47	2.83	NO	NO	--
Cluster-XIV		943	NA	668	275	6.25	2.16	NO	NO	--
Cluster-XV		6200	NA	5941 (4600+1341)	259	6.72	1.82	NO	NO	--
Cluster-XVI	Nirsa (SOD:Safe)	1910	DVC (Barakar river)	1730 (1380+350)	180	3.34	2.44	NO	NO	--

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

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

7.0 IMPACT OF MINING ON GROUND WATER REGIME

7.1 GENERAL CONSEQUENCES OF COAL MINES ON AMBIENT HYDROGEOLOGICAL REGIME

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

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

The general need in mine planning from the hydrogeological point of view is the estimation of make of water (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 the groundwater regime be determined in advance. However, the mine pumping in most of the cases are passive dewatering for the safety of the mine pit, active mine dewatering is done in few cases for very high potential aquifers.

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

Generally, in the opencast and underground mines of Jharia Coalfield, alluvium and overlying weathered mantle are the first to excavate 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, the depression in the water table created. The initial discharges due to this depression is large in amount due to concentration of flow to that region. In the top zones, water table condition prevails and away from the opening in the stratified section, semi-confined conditions exist. With progress of mine operations, there is an increase in the depth of incision as a result; the semi-confined aquifers are also punctured.

During mining the hydraulic gradients generally, steeps down near mine i.e. within the mine influence area. In the up-dip region, only un-confined aquifer punctured through the mining process and thus only it 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 not punctured as it lies below the working coal seams and hence normally there is no noticeable effect in the aquifer related to this formation.

7.3 ESTIMATION OF RADIUS OF MINE INFLUENCE ZONE

Radius of Influence can 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 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 has used for Barakar Formations i.e. 0.05 m/d or 5.7×10^{-7} m/sec.

It may be appropriate to mention here that the presence of prominent boundaries/water bodies, faults or interfringing of sandstone and shale beds may restrict propagation of the 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 not directly affected. During the working of board and pillar method, subsidence takes place during the extraction of total coal (depillaring), both the phreatic and semi-confined aquifers get affected. Surface vigilance and filling up subsided zone, if any, has to constantly in view. 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 upto 500 m and becomes milder/ negligible thereafter.

8.0 CONSERVATION MEASURES & FUTURE STRATEGY

- BCCL has installed 25 Pressure Filter Plant of total capacity of 4.16 MGD to meet drinking water requirement nearby the 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 with the capacity of 5.84 MGD are in progress.

- BCCL 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 plant has proposed at other sites of BCCL.
- A scheme entitled '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 through pipe line by mine discharge at mines of Barora, Block-II and Govindpur Area.
- Rooftop rainwater harvesting (RWH) will took up in the project area using the administrative buildings. 138 no. of quarters having roof-top area of about 14950 sq. m. is already prepared to harvest rainwater and around 13150 cum/annum of water is going to be recharged the nearby groundwater system through RWH structures. Proposal already 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 rainfall and abundant ground water recharge, the water levels will recoup and attain normalcy. Thus, the impact of mining on groundwater system may 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 through connecting pipeline to abandoned dug wells. Utilization of mine water for irrigation use 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.
- Creation of awareness among workers and local peoples about Rainwater harvesting and artificial recharge will have priority. This aspect usually covered during the Environmental Week celebrated every year (5 to 12 June).
- 23 nos. of Piezometer proposed to install within JCF and RCF to monitor GW level (**Plate-III**).

Monitoring of water quality of mine water discharge, local River/nala and domestic water source (dug well/hand pump wells) will continued under routine monitoring (May, August, November & Jan).

9.0 EXISTING/PROPOSED RAINWATER HARVESTING STRUCTURES IN BCCL COAL MINES

Fig-3 to 4.

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

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

Fig-5 to 6.

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

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

Fig-7 to 8.

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

RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

Fig-9 to 10.

RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

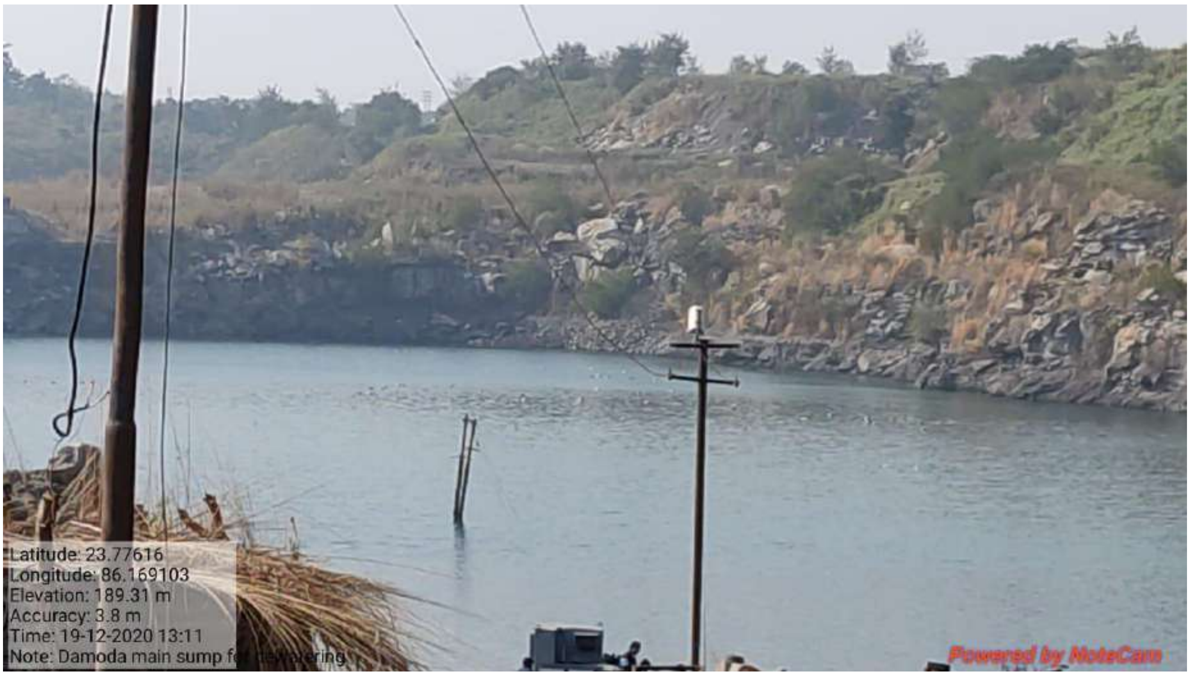
RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

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

FILTER PLANT IN THE MINE AREA

Fig-15.

Annexure-III

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

Annexure – V

Location of Hydrograph Stations (Dug Wells)

Well No	Latitude	Longitude	Well No	Latitude	Longitude
A-3	23^{0}47'53.35" N	86^{0}19'55.14" E	**B-64**	23^{0}48'43.14" N	86^{0}18'44.25" E
A-12	23^{0}48'20.31" N	86^{0}16'51.64" E	**B-65A**	23^{0}48'53.65" N	86^{0}18'11.82" E
A-16	23^{0}46'57.00" N	86^{0}21'38.57" E	**B-67**	23^{0}43'30.70" N	86^{0}14'01.45" E
A-17	23^{0}45'09.44" N	86^{0}22'16.35" E	**D-3**	23^{0}46'46.31" N	86^{0}24'49.30" E
A-18	23^{0}44'37.65" N	86^{0}22'58.90" E	**D-4**	23^{0}44'29.37" N	86^{0}24'42.88" E
A-19	23^{0}41'12.86" N	86^{0}23'55.27" E	**D-5**	23^{0}42'20.05" N	86^{0}24'86.06" E
A-20	23^{0}44'56.64" N	86^{0}19'55.35" E	**D-7**	23^{0}43'12.08" N	86^{0}27'11.89" E
A-22	23^{0}43'06.65" N	86^{0}14'48.53" E	**D-8**	23^{0}44'06.13" N	86^{0}27'20.72" E
A-23	23^{0}45'06.38" N	86^{0}15'12.69" E	**D-23**	23^{0}47'20.89" N	86^{0}20'09.96" E
A-24	23^{0}45'20.44" N	86^{0}13'45.12" E	**D-25**	23^{0}47'03.28" N	86^{0}23'29.56" E
A-25	23^{0}47'06.20" N	86^{0}15'27.79" E	**D-30**	23^{0}48'36.10" N	86^{0}21'50.07" E
A-26	23^{0}46'49.24" N	86^{0}18'12.12" E	**D-33**	23^{0}45'34.62" N	86^{0}23'18.50" E
A-27	23^{0}48'42.55" N	86^{0}20'21.80" E	**D-34**	23^{0}45'36.50" N	86^{0}23'02.45" E
A-28A	23^{0}47'34.74" N	86^{0}18'04.18" E	**D-35**	23^{0}40'46.54" N	86^{0}25'46.33" E
A-29	23^{0}47'08.02" N	86^{0}16'02.72" E	**D-36**	23^{0}40'19.26" N	86^{0}25'18.98" E
A-32	23^{0}44'15.56" N	86^{0}20'43.80" E	**D-39**	23^{0}43'28.50" N	86^{0}26'0.10" E
A-33	23^{0}44'32.58" N	86^{0}16'58.28" E	**D-40A**	23^{0}43'20.18" N	86^{0}25'45.70" E
A-34	23^{0}42'58.63" N	86^{0}15'19.31" E	**D-41**	23^{0}42'40.00" N	86^{0}26'17.20" E
B-1	23^{0}48'48.06" N	86^{0}14'16.87" E	**D-43***	NA	NA
B-14	23^{0}48'00.81" N	86^{0}16'25.88" E	**D-47**	23^{0}45'20.59" N	86^{0}24'34.86" E
B-15	23^{0}46'06.92" N	86^{0}08'59.30" E	**D-49**	23^{0}44'08.96" N	86^{0}26'32.71" E
B-21A	23^{0}45'10.50" N	86^{0}09'36.38" E	**D-51**	23^{0}44'20.86" N	86^{0}27'11.37" E
B-23	23^{0}44'13.05" N	86^{0}11'46.56" E	**D-55**	23^{0}43'58.37" N	86^{0}24'07.45" E
B-24	23^{0}44'26.80" N	86^{0}13'09.38" E	**D-74**	23^{0}41'33.66" N	86^{0}25'06.10" E
B-25	23^{0}44'44.98" N	86^{0}13'57.80" E	**D-77**	23^{0}41'00.74" N	86^{0}22'25.55" E
B-32A	23^{0}45'49.18" N	86^{0}13'03.64" E	**D-80**	23^{0}46'09.46" N	86^{0}24'33.08" E
B-48	23^{03}4'35.09" N	86^{0}16'38.30" E	**DB-22**	23^{0}43'38.81" N	86^{0}45'09.00" E
B-51	23^{0}47'40.20" N	86^{0}09'11.90" E	**DB-23**	23^{0}43'44.24" N	86^{0}45'06.39" E
B-53	23^{0}45'55.25" N	86^{0}09'35.44" E	**DB-24**	23^{0}43'53.00" N	86^{0}45'03.88" E
B-59	23^{0}47'59.87" N	86^{0}13'37.97" E	**DB-25**	23^{0}44'10.75" N	86^{0}44'35.84" E
B-60	23^{0}48'7.87" N	86^{0}15'37.12" E			
B-61A	23^{0}45'59.85" N	86^{0}11'40.80" E			
B-62A	23^{0}45'44.15" N	86^{0}11'27.80" E			

Annexure – VA

Details of Hydrograph Stations (Dug Wells)

Well No	Location	M.P. (agl) in m	Well Dia in m	Well Depth (m bmp)	R.L. (G.L) (m)	Formation	Owner	Utility
A-3	Sijua	0.53	3.00	5.20	203	Barakar	Govt.	Domestic
A-12	Jamua	0.80	1.90	3.30	202	Barakar	Govt.	Domestic
A-16	Ekra, Kalali	0.45	3.10	6.50	205	Barakar	Govt.	Domestic
A-17	Kachi Balihari	0.56	1.60	5.30	182	Barakar	Govt.	Domestic
A-18	Bhagabandh	0.61	1.45	3.37	182	Barakar	Govt.	Domestic
A-19	Bhaura	0.54	3.15	11.65	162	Barakar	Govt.	Domestic
A-20	Gorbhudih	0.43	3.30	8.30	181	BM	Govt.	Domestic
A-22	Nagdah, Niche	0.00	1.40	9.50	171	Raniganj	Govt	Irrigation
A-23	Machhyara	0.43	1.85	12.40	203	Raniganj	Govt	Domestic
A-24	Pipra Tanr	0.22	1.80	19.55	208	Raniganj	Govt	Domestic
A-25	Sinidih	0.22	2.00	11.30	203	Barakar	Govt	Domestic
A-26	Pasitanr	0.32	1.80	9.65	198	Barakar	Govt	Domestic
A-27	Chandor	0.60	2.50	5.50	221	Barakar	Govt	Domestic
A-28A	Lakarka 6 no.	0.65	1.30	5.25	199	Barakar	BCCL	Domestic
A-29	Aambagan	0.10	2.60	9.15	186	Barakar	Govt	Domestic
A-32	Baludih	0.55	2.30	6.85	182	BM	Govt	Domestic
A-33	Mahuda	0.75	2.00	10.80	195	BM	BCCL	Domestic
A-34	Bhatdih	0.55	3.50	24.50	162	Raniganj	BCCL	Domestic
B-1	Muraidih	0.47	1.80	5.35	212	Talchir	Govt	Domestic
B-14	Mathadih	0.76	2.15	3.75	201	Barakar	Govt	Domestic
B-15	Bera Basti	0.55	1.60	2.50	221	Talchir	Dhanu Roy	Domestic
B-21A	Dugdha	0.55	2.10	10.35	220	Metamorphics	Govt	Domestic
B-23	Lohapati	0.26	3.60	10.85	204	Raniganj	Govt	Domestic
B-24	Telmuchu	0.67	4.35	10.83	207	Raniganj	Govt	Domestic
B-25	Mahuda More	0.10	2.45	8.45	205	Raniganj	Govt	Domestic
B-32A	Madhuband	0.80	4.30	8.60	205	Barakar	BCCL	Domestic
B-48	Mahuda	0.65	2.10	11.50	181	Raniganj	Mosque	Domestic
B-51	Taranga	0.00	2.50	5.75	215	Metamorphics	Bisun	Irrigation
B-53	Karmatanr	0.58	2.70	13.25	195	Barakar	Govt	Domestic
B-59	Khodovaly	0.60	2.40	9.30	202	Barakar	BCCL	Domestic
B-60	Bahiyardih	0.77	3.00	15.60	196	Barakar	BCCL	Domestic
B-61A	Kesargora	0.48	2.00	11.20	201	Barakar	BCCL	Domestic
B-62A	Sadariyadih	0.15	3.10	9.50	188	Barakar	Govt	Domestic

Annexure – VA

Details of Hydrograph Stations (Dug Wells)

Well No	Location	M.P. (agl) in m	Well Dia in m	Well Depth (m bmp)	R.L. (G.L) (m)	Formation	Owner	Utility
B-64	Keshalpur	0.65	1.10	3.40	195	Barakar	BCCL	Domestic
B-65A	Jhinjipahari	0.95	2.20	12.40	196	Barakar	Shiv Temple	Domestic
B-67	Simatanr	0.55	2.20	11.80	198	Raniganj	Govt	Domestic
D-3	Dhansar	0.60	1.70	8.70	217	Barakar	Govt	Domestic
D-4	Jharia	0.59	1.90	5.73	218	Barakar	Govt	Domestic
D-5	Jiyalgora	0.70	2.80	10.55	183	Barakar	Govt	Domestic
D-7	Golden Pahari	0.67	2.85	10.05	201	Barakar	BCCL	Domestic
D-8	Alokdiha	0.35	1.75	7.57	201	Metamorphics	BCCL	Domestic
D-23	Jogta (Sindra)	0.40	3.10	7.25	205	Barakar	BCCL	Domestic
D-25	Godhar More	0.60	2.75	5.60	219	Barakar	Govt	Domestic
D-30	Borkiboa	0.70	2.00	5.60	221	Talchir	H.Kumbhakar	Domestic
D-33	Kustore-4	0.55	1.85	3.45	196	Barakar	BCCL	Domestic
D-34	Kusunda-7	0.60	1.50	3.45	201	Barakar	BCCL	Domestic
D-35	Patherdih	0.40	2.00	11.20	160	Barakar	BCCL	Domestic
D-36	Sudamdih	0.90	2.00	6.20	141	Barakar	BCCL	Domestic
D-39	Tilabani	0.85	2.00	5.90	178	Barakar	BCCL	Domestic
D-40A	Khapra Dhaora	0.55	1.95	3.70	180	Barakar	Panchayat	Domestic
D-41	Joyrampur	0.50	1.80	4.00	180	Barakar	BCCL	Domestic
D-43	Alagdih	0.45	2.20	8.90	200	Metamorphics	Govt	Domestic
D-47	Parastanr	0.45	3.20	23.80	206	Barakar	BCCL	Domestic
D-49	Goluckdih	0.55	1.80	6.15	192	Barakar	BCCL	Domestic
D-51	Chankuiya	0.55	3.70	11.90	197	Barakar	BCCL	Domestic
D-55	Hariladih	0.48	2.80	11.80	184	Barakar	Govt	Domestic
D-74	Bhulan Barari	0.10	1.60	12.80	173	Barakar	Govt	Domestic
D-77	Rohoniatanr	0.40	3.15	6.70	156	Barakar	Govt	Domestic
D-80	Bastacolla	0.70	2.50	24.95	219	Barakar	Govt	Domestic
DB-22	Nichebasti	0.67	2.40	10.65	121	Barakar	Govt	Domestic
DB-23	Dahibari OC	0.70	2.30	8.00	-	Barakar	BCCL	Domestic
DB-24	Dahibari	0.60	3.60	13.70	125	Barakar	BCCL	Domestic
DB-25	Palasya	0.37	1.55	5.25	127	Barakar	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 14	***Nov 14***	***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***
A-3	4.67	2.37	3.70	3.42	4.87	0.47	0.67	0.77	1.27	0.47	3.47	0.47	1.57	0.47	0.62	0.05
A-12	2.45	1.4	3.00	2.68	2.50	0.70	2.55	0.85	2.80	1.0	2.10	0.45	2.60	0.50	1.92	1.10
A-16	5.5	2.9	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
A-17	2.19	1.91	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
A-18	1.76	1.19	2.84	1.29	1.14	0.89	1.29	0.99	1.24	0.99	2.29	0.69	1.09	0.34	1.09	0.57
A-19	3.00	2.75	3.05	2.75	7.81	4.11	6.37	2.45	5.55	2.45	4.85	3.43	6.05	3.25	3.30	1.90
A-20	3.97	2.55	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
A22A	1.50	2.0	3.20	1.96	3.25	1.75	4.27	1.77	3.35	1.30	2.60	2.00	2.90	1.98	2.90	1.10
A-23	8.76	6.82	11.3	9.37	11.87	8.13	6.40	1.50	11.15	7.17	11.97	3.77	8.92	5.62	9.52	2.82
A-24	16.28	14.98	17.2	14.5	16.62	12.43	11.87	6.97	14.58	6.88	15.88	2.48	*4.88	4.28	10.13	2.78
A-25	7.03	5.28	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
A-26	7.71	4.58	7.73	3.18	8.93	4.48	5.28	2.53	6.23	3.88	6.58	3.33	6.98	3.18	6.70	2.73
A-27	1.63	1.55	4.40	3.95	4.85	1.80	2.90	1.25	2.90	1.0	2.40	0.92	2.40	1.10	1.67	0.90
A28A	3.29	1.91	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
A-29	3.3	2.35	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
A-32	3.15	2.45	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
A-33	4.08	1.57	4.91	1.97	5.75	2.60	6.45	1.55	4.07	2.35	3.65	1.25	4.55	1.85	2.85	0.85
A-34	4.45	4.45	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
B-1	2.43	1.81	3.28	2.75	3.58	1.93	2.33	0.85	2.88	2.08	3.18	1.73	3.28	1.63	2.58	1.91
B-14	3.24	4.44	2.94	2.29	2.44	0.47	2.94	1.84	3.64	2.84	2.24	0.94	2.44	1.04	2.84	2.04
B-15	0.95	1.45	1.50	0.45	1.85	0.55	4.85	0.15	1.85	0.85	1.90	1.65	3.70	1.47	1.46	0.35
B21A	9.54	3.7	7.37	4.65	5.55	4.50	8.85	5.65	9.65	2.65	9.45	-	10.00	5.80	8.38	-
B-23	6.57	2.74	7.86	4.29	6.81	2.41	7.74	2.14	6.64	2.14	2.84	1.34	3.24	1.76	4.12	1.44
B-24	9.40	2.21	10.0	5.78	10.63	4.28	10.03	4.03	9.28	4.33	4.58	2.33	5.48	3.53	5.68	2.08
B-25	5.82	5.15	6.88	-	7.05	1.70	6.70	1.40	5.90	3.70	4.80	1.40	7.90	2.55	5.10	2.58
B32A	8.33	2.05	7.55	3.32	6.95	3.07	6.95	2.80	6.75	3.90	5.55	1.70	3.30	2.00	7.23	6.05
B-48	6.38	4.35	7.90	5.42	9.35	4.60	7.70	4.15	7.33	3.97	7.05	4.35	8.20	3.85	7.23	6.05
B-51	2.09	1.98	4.65	3.40	4.90	3.18	4.98	2.55	5.02	2.42	5.10	2.70	5.00	2.10	5.70	1.0
B-53	3.39	-	5.58	2.82	4.70	1.45	4.02	1.92	3.92	1.42	3.22	1.42	3.12	1.40	4.85	1.87
B-59	2.65	1.0	4.12	1.60	4.40	0.50	5.40	0.60	5.47	1.10	6.20	0.90	5.25	1.40	5.49	0.90
B-60	9.82	4.59	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
B61A	6.93	3.57	6.15	4.52	6.58	3.87	2.57	0.82	2.57	2.02	3.32	0.52	3.32	1.60	4.42	0.97
B62A	8.83	5.85	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

Annexure – VB

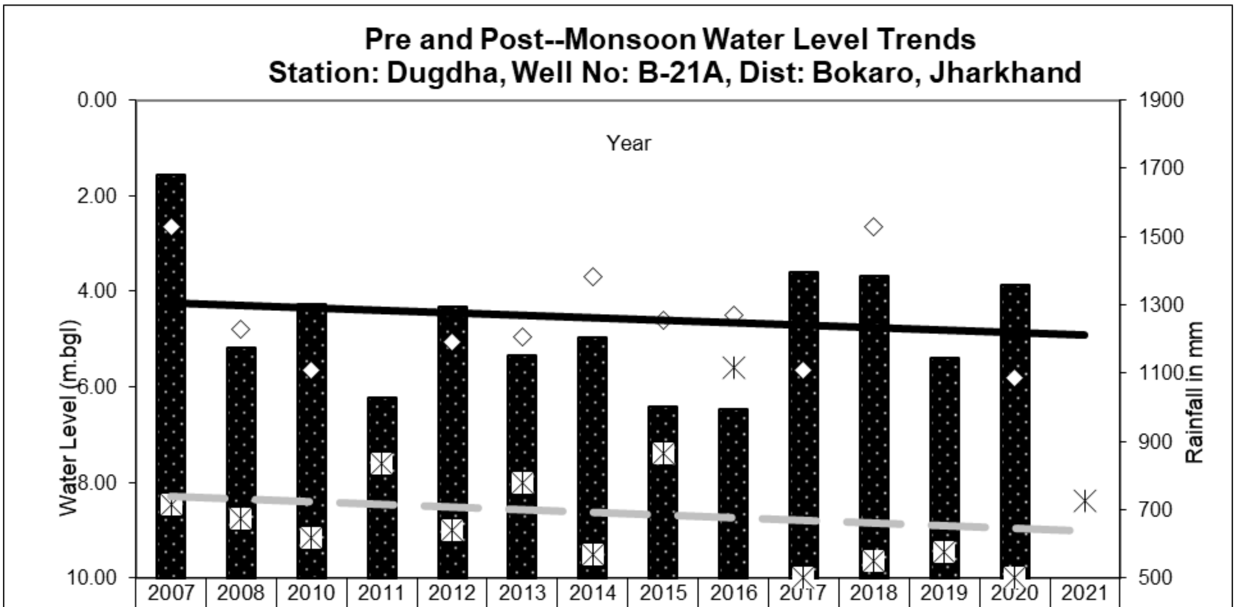
Historical Water Level data of Hydrograph Stations

Well No	Water level below ground level (bgl) in meters															
	May 14	*Nov 14*	*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*
B-64	0.7	1.15	1.38	0.95	2.35	0.55	1.25	0.85	2.15	1.85	0.95	0.45	1.85	0.50	2.35	0.95
B65A	10.45	2.4	7.82	5.87	7.15	2.68	9.05	1.25	10.03	2.40	11.05	0.95	9.25	2.30	9.03	1.42
B-67	9.80	3.72	9.23	5.53	9.53	4.30	10.00	2.15	9.55	4.0	8.57	4.35	7.55	3.95	8.95	2.95
D-3	2.54	2.11	4.25	2.25	2.35	1.90	2.15	2.30	3.43	2.45	1.75	1.30	5.40	1.38	3.41	0.85
D-4	1.23	0.91	2.41	1.27	1.21	1.36	1.21	1.46	1.91	1.56	2.81	1.71	3.41	1.41	3.01	1.16
D-5	9.0	7.8	9.37	8.33	9.40	6.40	7.90	5.20	7.80	5.30	8.25	4.85	8.60	7.70	7.28	4.00
D-7	5.28	5.53	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
D-8	7.73	-	6.24	4.38	8.00	3.43	5.15	1.85	5.65	1.85	4.80	2.85	5.83	2.75	4.55	2.27
D-23	6.38	2.4	6.55	3.48	5.70	1.63	2.80	2.98	4.40	3.40	4.70	1.40	5.60	3.35	5.43	1.60
D-25	4.42	2.9	4.48	2.45	2.40	1.90	2.40	1.20	2.60	2.40	*9.90	*5.38	10.50	5.62	10.50	3.80
D-30	4.17	3.3	4.55	3.15	4.45	3.20	4.40	1.25	4.58	1.10	4.60	0.75	4.50	1.35	4.23	0.84
D-33	1.72	0.35	2.25	1.10	2.50	1.95	0.75	0.75	2.85	0.95	2.35	1.65	3.65	1.45	1.75	0.85
D-34	2.80	0.30	2.55	1.45	2.30	0.30	0.80	0.55	2.80	0.45	4.75	2.40	3.30	2.80	3.78	2.90
D-35	6.94	6.15	9.80	7.90	9.52	6.45	8.80	3.60	8.40	4.45	8.00	3.80	8.20	5.40	6.60	2.90
D-36	1.82	0.75	1.66	1.13	0.78	0.95	1.30	0.70	1.20	0.60	1.20	0.55	2.10	1.00	2.02	0.55
D-39	5.03	2.25	5.00	2.61	2.18	2.65	6.17	4.75	4.95	4.35	*12.60	*5.95	9.40	6.05	10.70	5.10
D40A	2.35	2.45	3.07	2.45	1.40	0.85	1.45	1.35	2.10	1.40	1.85	1.45	1.95	1.43	1.95	1.80
D-41	3.20	1.35	2.65	2.32	1.30	1.52	1.40	1.20	1.59	1.32	2.30	1.25	3.30	1.45	1.95	1.38
D-43	6.0	4.75	6.61	5.05	8.20	3.35	7.50	3.60	7.15	3.45	7.35	2.70	6.60	2.55	4.65	2.60
D-47	8.0	2.37	9.60	3.60	3.18	2.95	3.15	2.85	5.33	2.55	4.55	4.35	9.45	5.45	4.05	2.45
D-49	2.51	1.65	3.55	2.35	2.45	1.72	2.70	2.05	3.45	2.45	1.75	1.50	3.25	1.65	1.40	0.85
D-51	9.60	9.05	10.48	9.15	11.15	6.45	10.45	5.43	10.93	7.10	9.95	5.75	8.45	5.70	9.43	5.65
D-55	1.95	2.07	6.15	1.57	2.52	3.62	6.42	2.37	8.42	1.57	8.42	5.47	9.42	8.60	9.52	7.62
D-74	5.0	4.0	10.05	7.20	7.73	5.00	9.25	3.85	8.60	4.80	5.80	3.57	4.30	3.93	6.93	2.90
D-77	6.23	6.0	6.44	5.60	4.60	2.90	6.50	4.90	6.30	5.20	6.40	3.20	6.40	3.50	5.98	4.69
D-80	13.3	3.15	10.97	3.35	6.55	4.15	8.65	3.70	9.35	4.20	5.00	3.05	4.30	4.90	7.10	2.55
RCF (part)	*May 14*	*Nov 14*	*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*
DB22	6.48	3.03	4.59	3.53	5.38	3.33	1.93	1.63	2.34	1.93	4.93	1.63	2.63	2.25	2.31	1.38
DB23	3.95	2.13	3.38	6.04	5.30	0.90	2.05	1.90	2.85	1.75	1.60	0.80	2.50	1.95	2.00	1.10
DB24	-	8.45	9.52	8.20	10.65	6.50	5.80	3.78	8.25	5.70	9.35	3.88	5.70	3.60	6.20	5.25
DB25	3.27	2.73	3.83	2.68	3.61	1.98	3.23	2.58	3.93	1.63	-	-	3.98	2.63	2.83	2.03

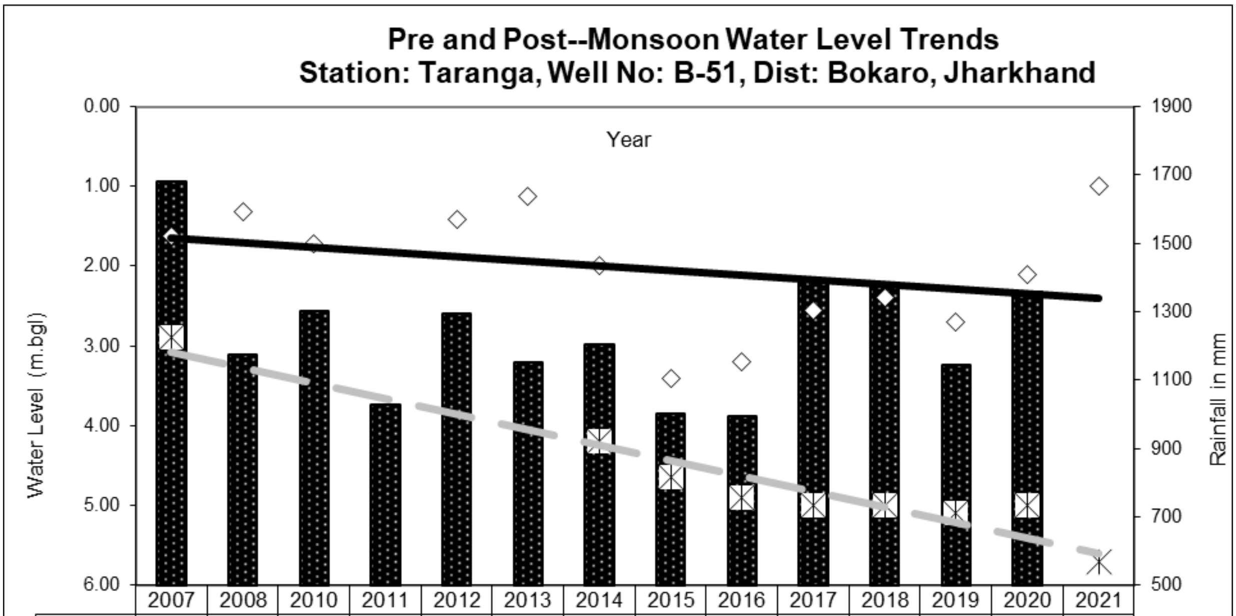
***New well**

Annexure – VI

HYDROGRAPHS OF CLUSTER-I



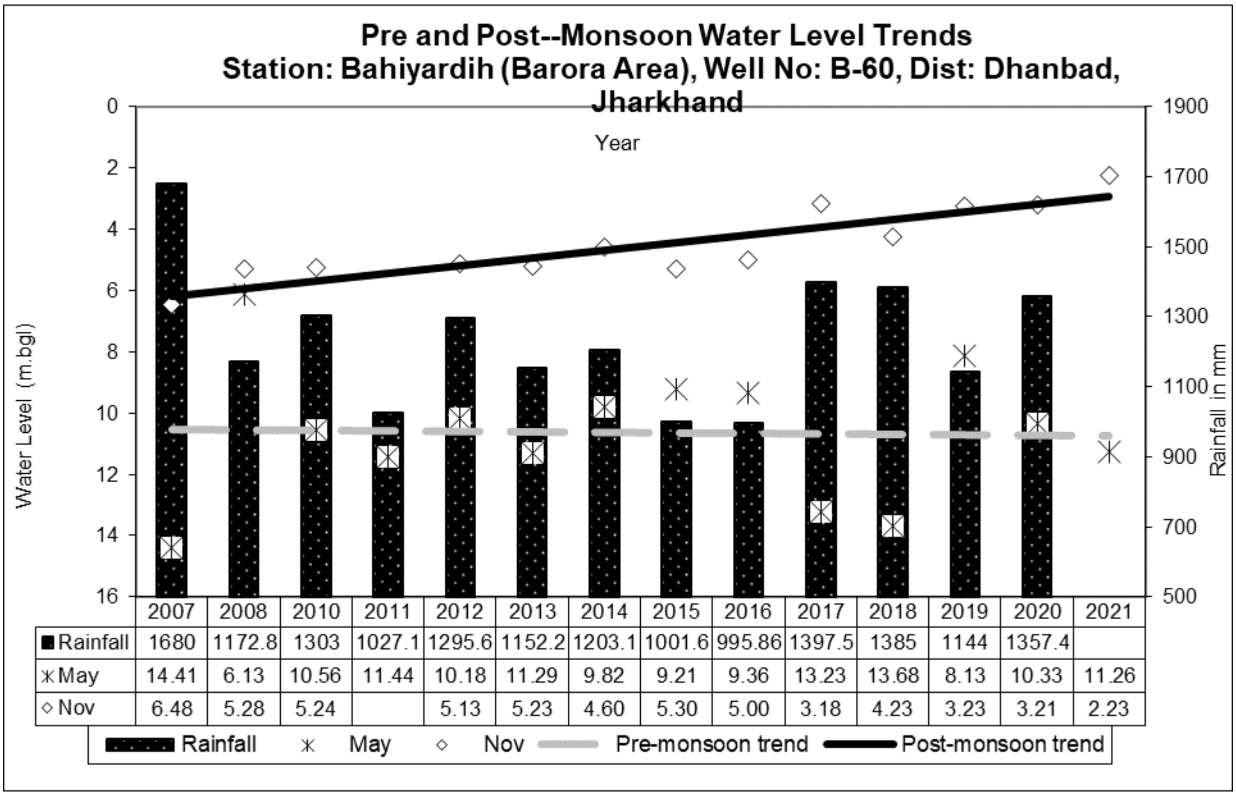
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⚹ May	8.47	8.75	9.15	7.60	9	8.01	9.50	7.40	5.60	10.00	9.65	9.45	10.00	8.38
◇ Nov	2.65	4.79	5.65		5.05	4.95	3.70	4.60	4.50	5.65	2.65		5.80	



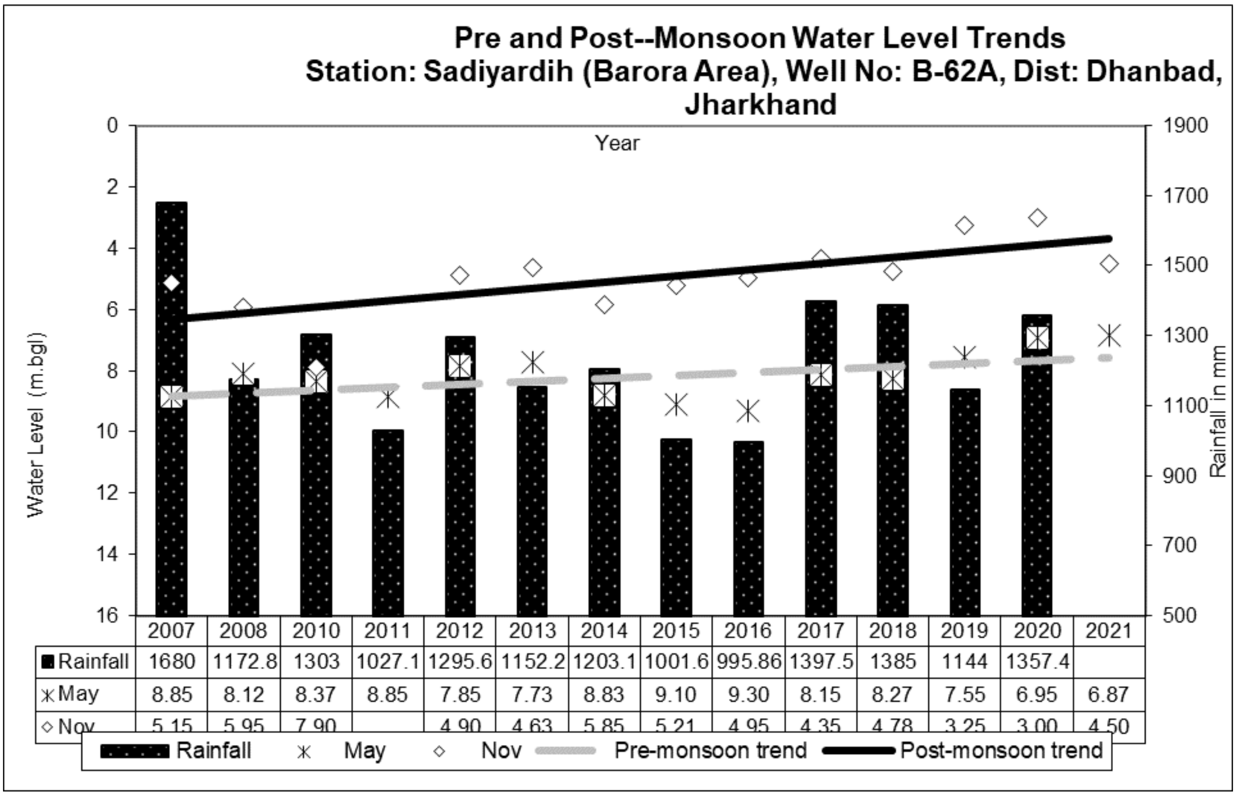
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⚹ May	2.90						4.20	4.65	4.90	5.00	5.00	5.10	5.00	5.70
◇ Nov	1.62	1.32	1.72		1.42	1.12	2.00	3.40	3.20	2.55	2.40	2.70	2.10	1.00

Annexure – VI

HYDROGRAPHS OF CLUSTER-II



	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rainfall	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
May	14.41	6.13	10.56	11.44	10.18	11.29	9.82	9.21	9.36	13.23	13.68	8.13	10.33	11.26
Nov	6.48	5.28	5.24		5.13	5.23	4.60	5.30	5.00	3.18	4.23	3.23	3.21	2.23

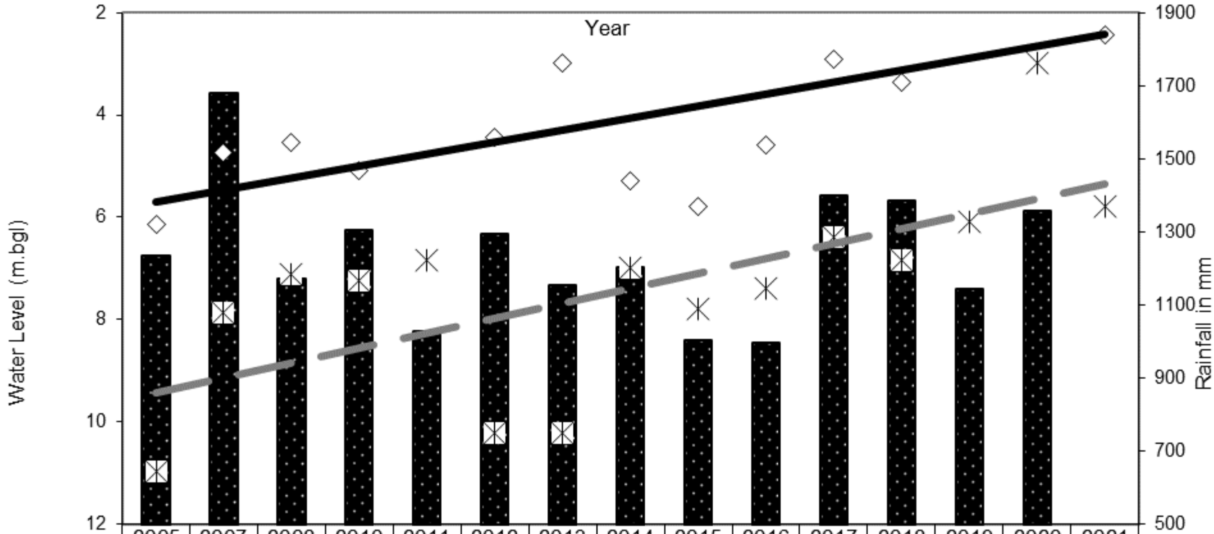


	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rainfall	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
May	8.85	8.12	8.37	8.85	7.85	7.73	8.83	9.10	9.30	8.15	8.27	7.55	6.95	6.87
Nov	5.15	5.95	7.90		4.90	4.63	5.85	5.21	4.95	4.35	4.78	3.25	3.00	4.50

Annexure – VI

HYDROGRAPHS OF CLUSTER-III

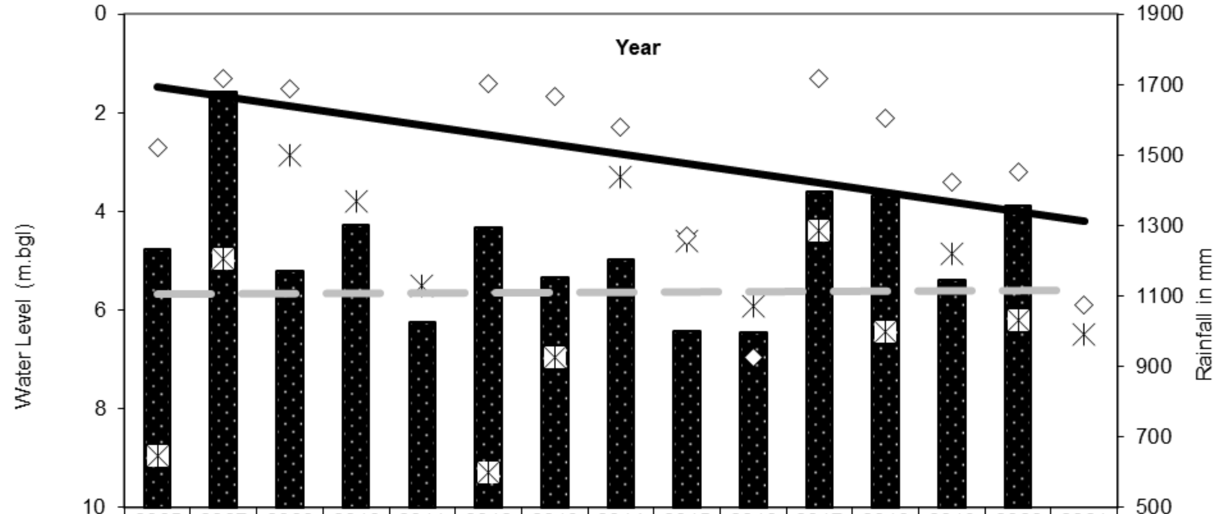
Pre and Post--Monsoon Water Level Trends
Station: Sinidih, Well No: A-25, Dist: Dhanbad, Jharkhand



	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⁎ May	10.98	7.86	7.12	7.23	6.83	10.23	10.23	7.00	7.80	7.40	6.40	6.85	6.08	2.98	5.78
◇ Nov	6.13	4.73	4.53	5.1		4.43	2.98	5.30	5.80	4.60	2.90	3.35	1.93	1.83	2.43

Rainfall ⁎ May ◇ Nov Pre-monsoon trend Post-monsoon trend

Pre and Post--Monsoon Water Level Trends
Station: Gobindpur, Well No: A-29, Dist: Dhanbad, Jharkhand



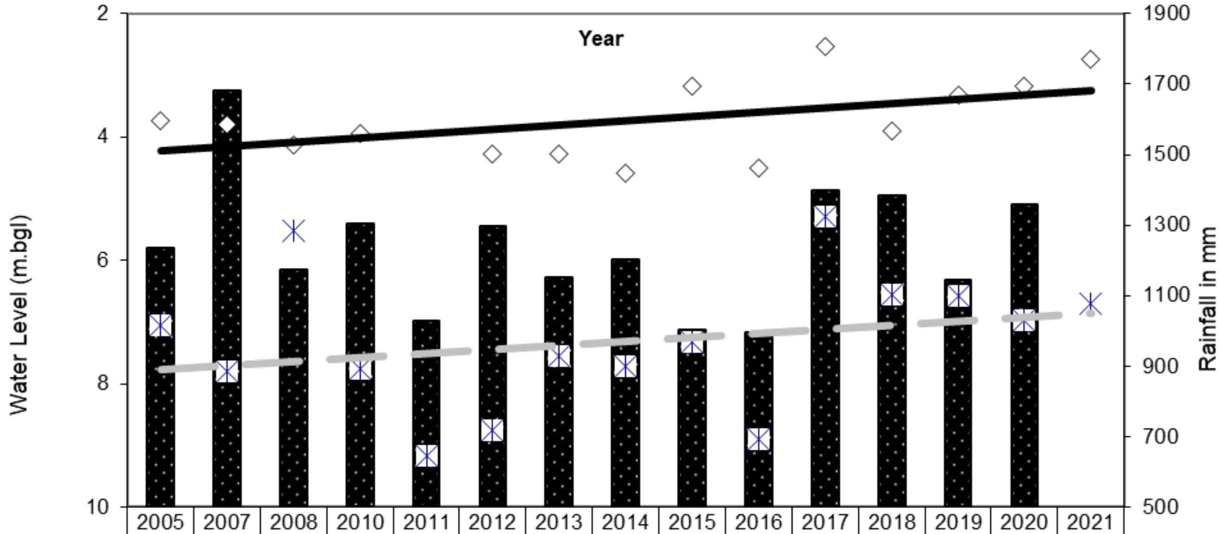
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1234	1680	1173	1303	1027	1296	1152	1203	1002	995.9	1398	1385	1144	1357	
⁎ May	8.95	4.95	2.85	3.8	5.5	9.30	6.95	3.30	4.60	5.92	4.40	6.45	4.85	6.20	6.49
◇ Nov	2.70	1.3	1.50			1.42	1.67	2.30	4.50	6.96	1.30	2.10	3.40	3.20	5.90

Rainfall ⁎ May ◇ Nov Pre-monsoon trend Post-monsoon trend

Annexure – VI

HYDROGRAPHS OF CLUSTER-IV

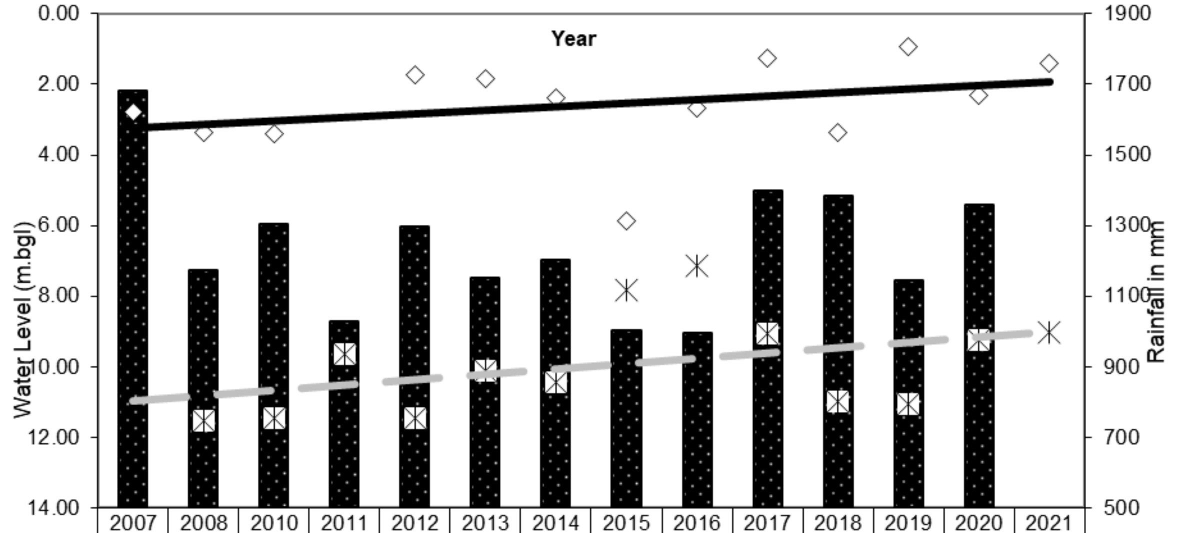
Pre and Post--Monsoon Water Level Trends
Station: Malkhera, Well No: A-26, Dist: Dhanbad, Jharkhand



	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⚹ May	7.06	7.80	5.53	7.77	9.18	8.76	7.56	7.71	7.33	8.90	5.30	6.55	6.58	6.98	6.70
◇ Nov	3.73	3.8	4.13	3.95		4.28	4.28	4.58	3.18	4.50	2.53	3.90	3.33	3.18	2.73

Rainfall ⚹ May ◇ Nov Pre-monsoon trend Posst-monsoon trend

Pre and Post--Monsoon Water Level Trends
Station: Jhinjipahari, Well No: B-65A, Dist: Dhanbad, Jharkhand

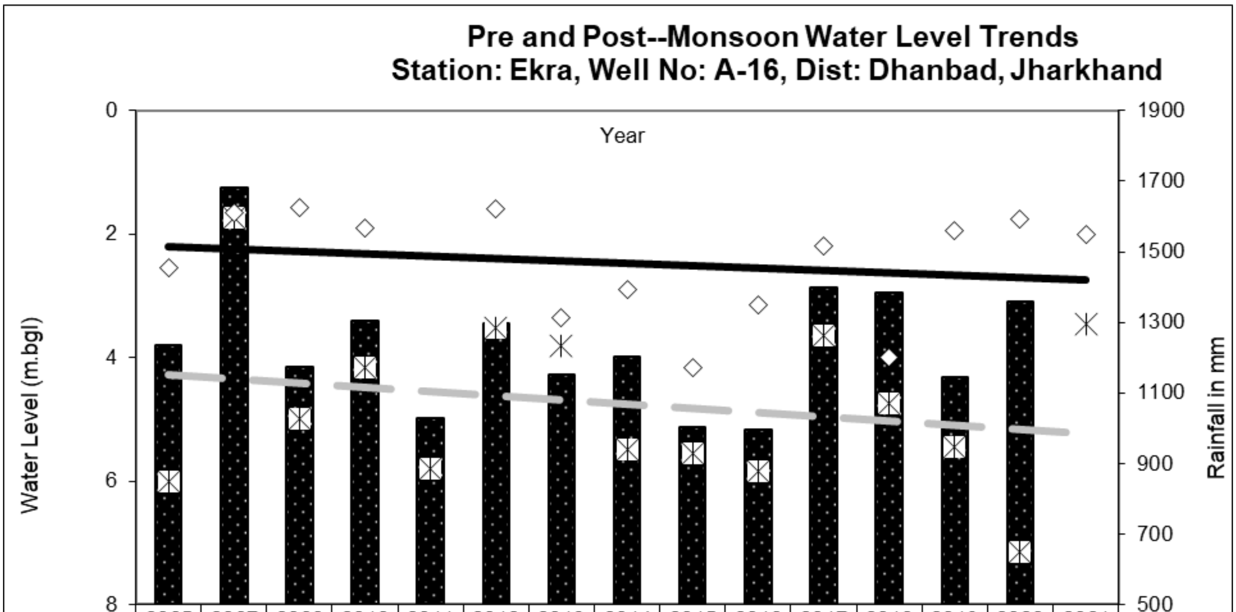


	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⚹ May		11.53	11.45	9.65	11.45	10.11	10.45	7.82	7.15	9.05	10.98	11.05	9.23	9.03
◇ Nov	2.80	3.35	3.39		1.73	1.83	2.40	5.87	2.68	1.25	3.35	0.95	2.30	1.42

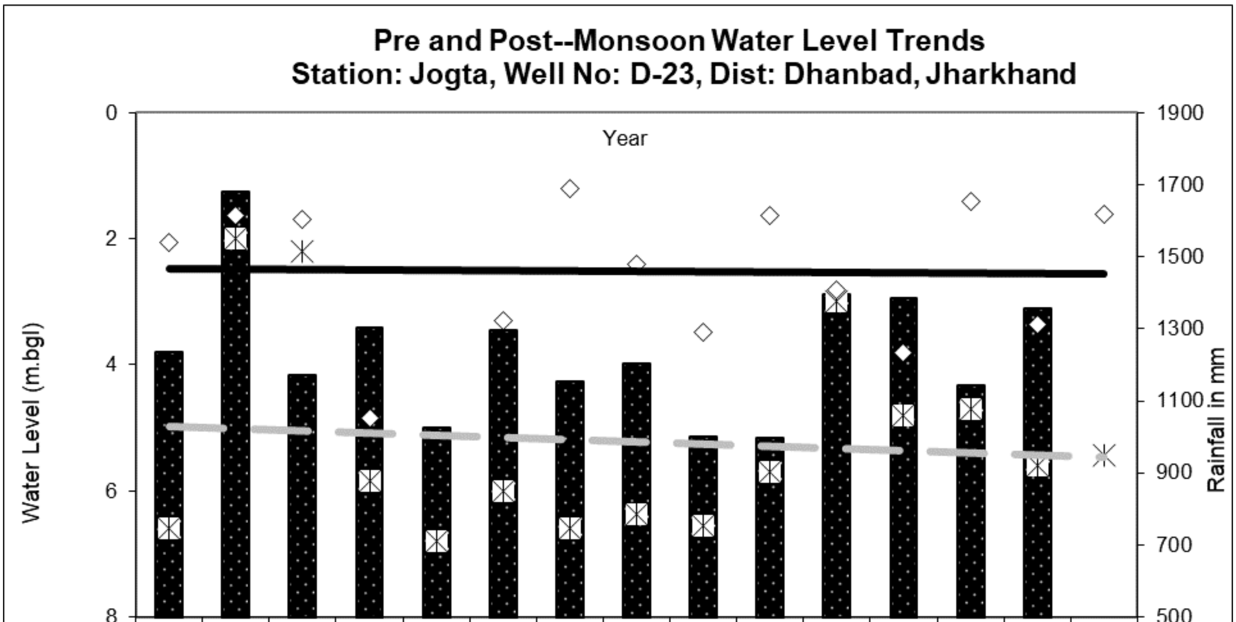
Rainfall ⚹ May ◇ Nov Pre-monsoon trend Post-monsoon trend

Annexure – VI

HYDROGRAPHS OF CLUSTER-V



	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
May	6	1.73	4.99	4.17	5.8	3.53	3.80	5.50	5.55	5.85	3.65	4.75	5.45	7.15	3.45
Nov	2.54	1.65	1.58	1.9		1.60	3.35	2.90	4.17	3.15	2.20	4.00	1.95	1.75	2.00

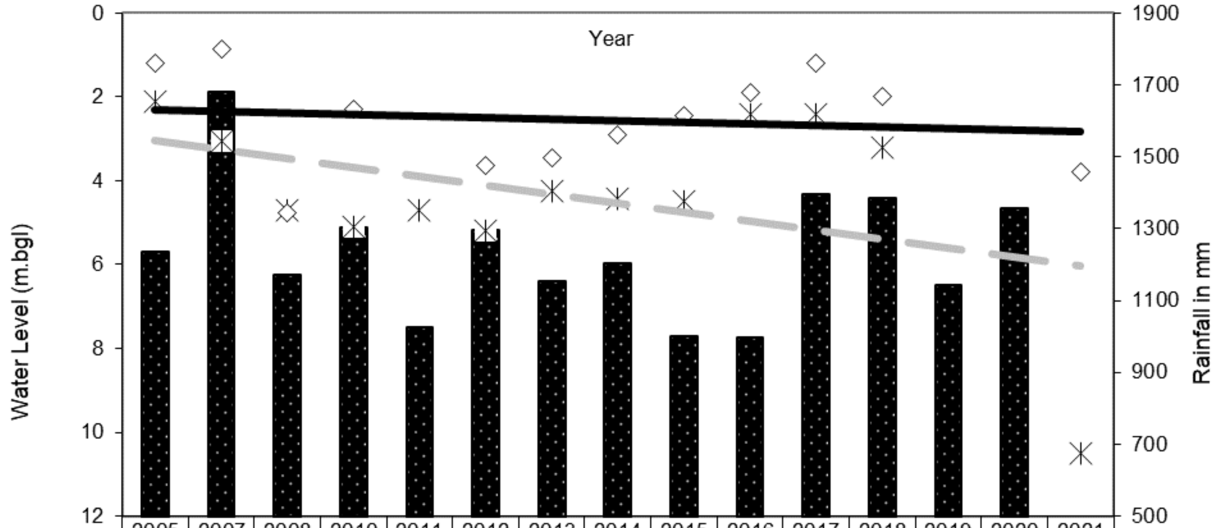


	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
May	6.6	2.00	2.20	5.85	6.8	6.00	6.60	6.38	6.55	5.70	3.00	4.80	4.70	5.60	5.43
Nov	2.05	1.62	1.70	4.85		3.30	1.20	2.40	3.48	1.63	2.80	3.80	1.40	3.35	1.60

Annexure – VI

HYDROGRAPHS OF CLUSTER-VI

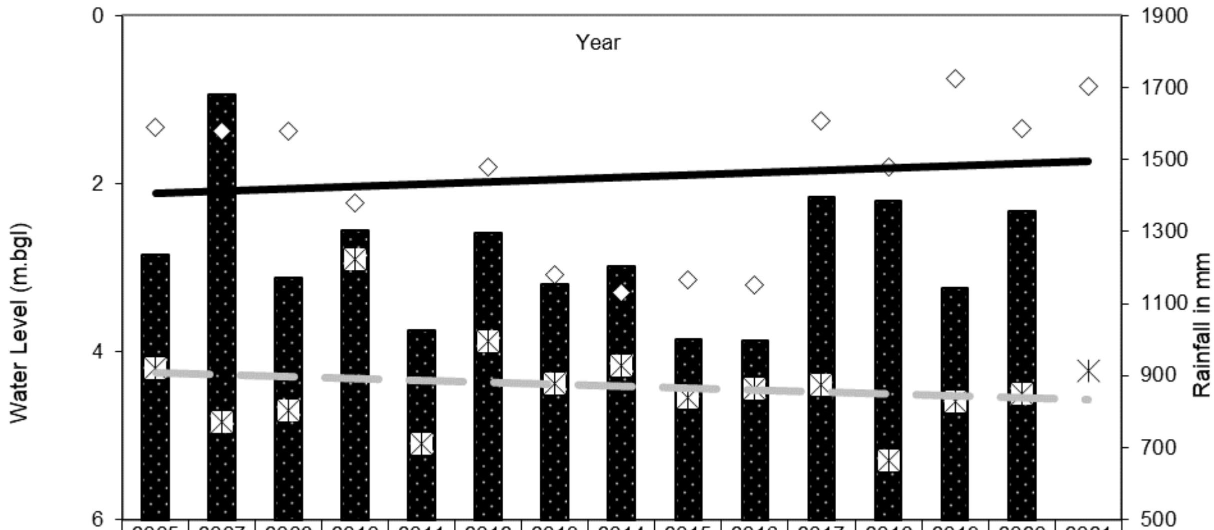
Pre and Post--Monsoon Water Level Trends
Station: Godhar, Well No: D-25, Dist: Dhanbad, Jharkhand



	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⁎May	2.1	3.04	4.70	5.1	4.7	5.20	4.26	4.42	4.48	2.40	2.40	3.20			10.50
◇Nov	1.20	0.87	4.75	2.3		3.65	3.45	2.90	2.45	1.90	1.20	2.00			3.80

Rainfall ⁎ May ◇ Nov Pre-monsoon trend Post-monsoon trend

Pre and Post--Monsoon Water Level Trends
Station: Borkiboa, Well No: D-30, Dist: Dhanbad, Jharkhand

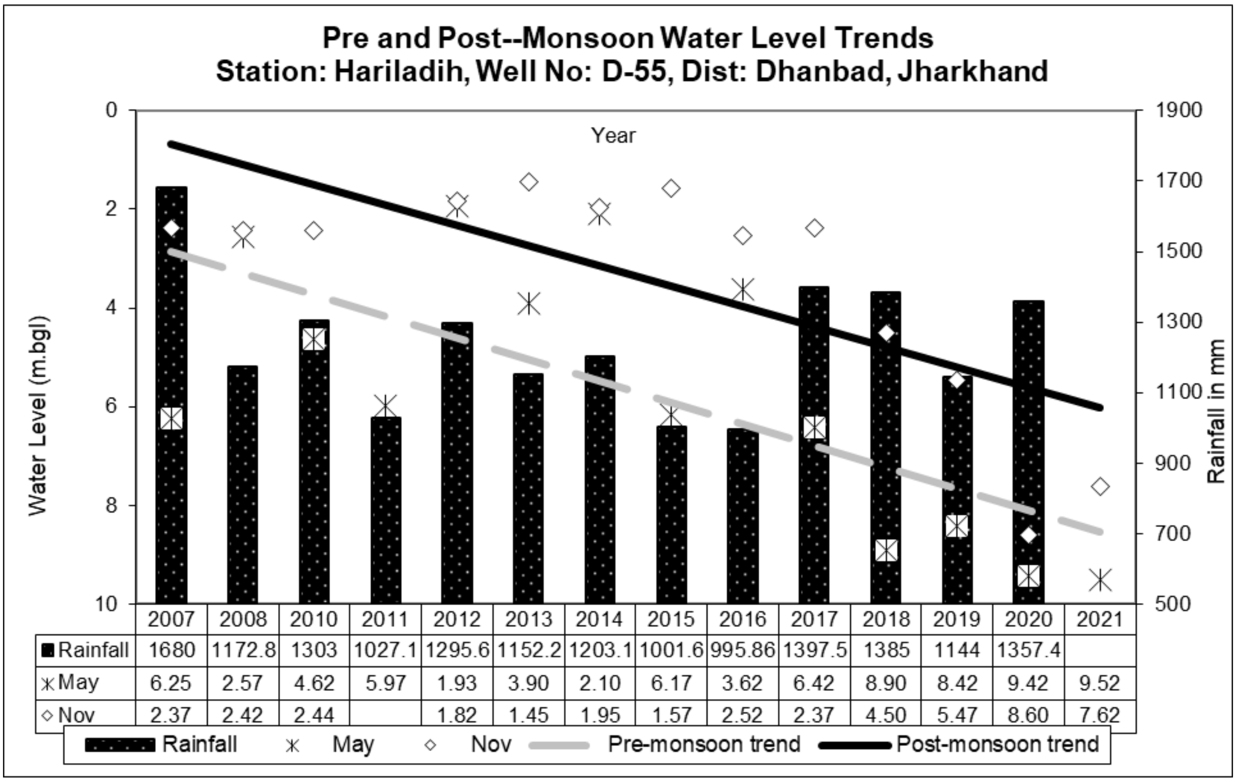


	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⁎May	4.2	4.84	4.70	2.9	5.1	3.88	4.38	4.17	4.55	4.45	4.40	5.30	4.60	4.50	4.23
◇Nov	1.33	1.37	1.37	2.23		1.80	3.08	3.30	3.15	3.20	1.25	1.80	0.75	1.35	0.84

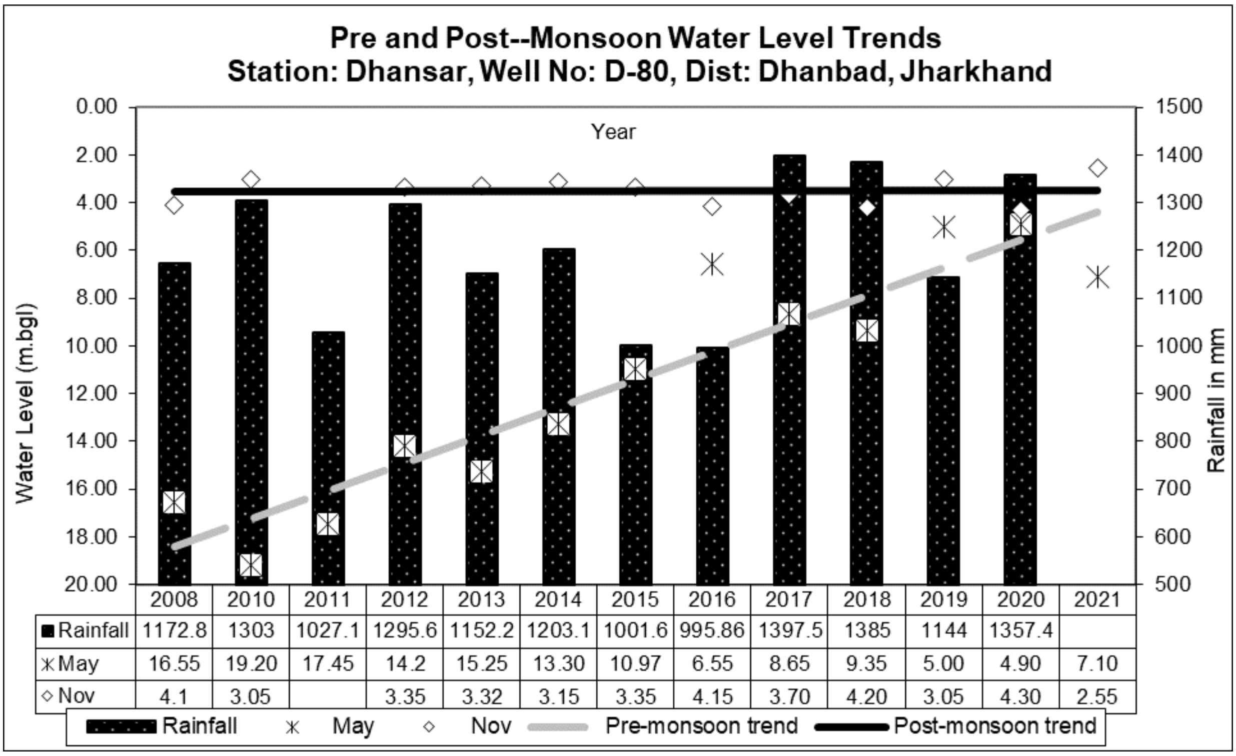
Rainfall ⁎ May ◇ Nov Pre-monsoon trend Post-monsoon trend

Annexure – VI

HYDROGRAPHS OF CLUSTER-VII



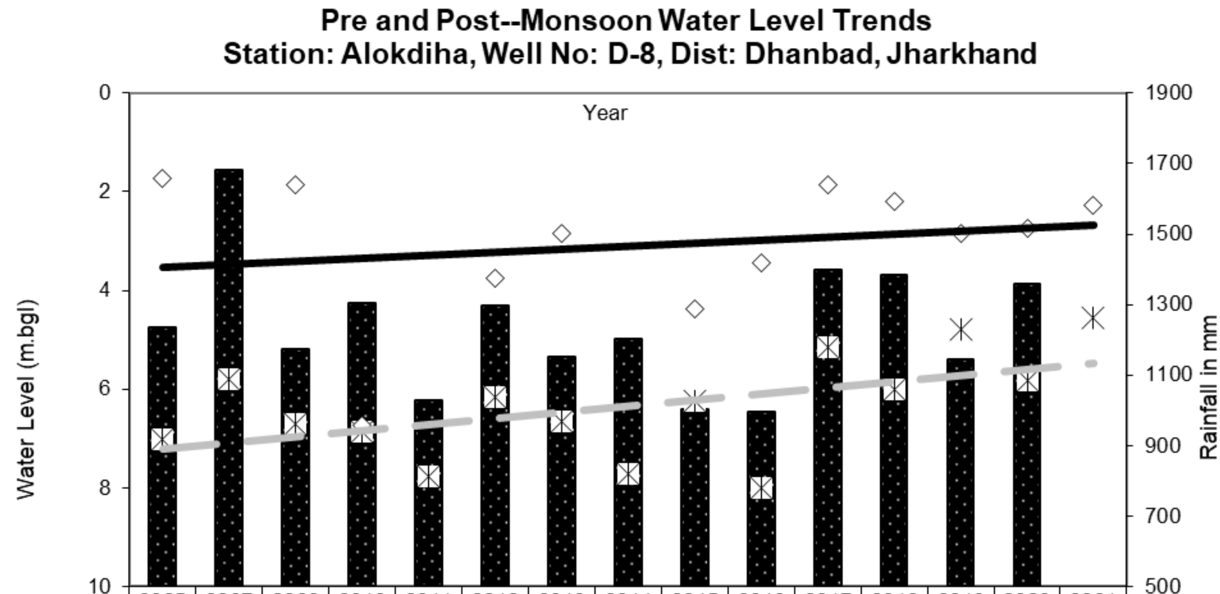
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rainfall	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
May	6.25	2.57	4.62	5.97	1.93	3.90	2.10	6.17	3.62	6.42	8.90	8.42	9.42	9.52
Nov	2.37	2.42	2.44		1.82	1.45	1.95	1.57	2.52	2.37	4.50	5.47	8.60	7.62



	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rainfall	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
May	16.55	19.20	17.45	14.2	15.25	13.30	10.97	6.55	8.65	9.35	5.00	4.90	7.10
Nov	4.1	3.05		3.35	3.32	3.15	3.35	4.15	3.70	4.20	3.05	4.30	2.55

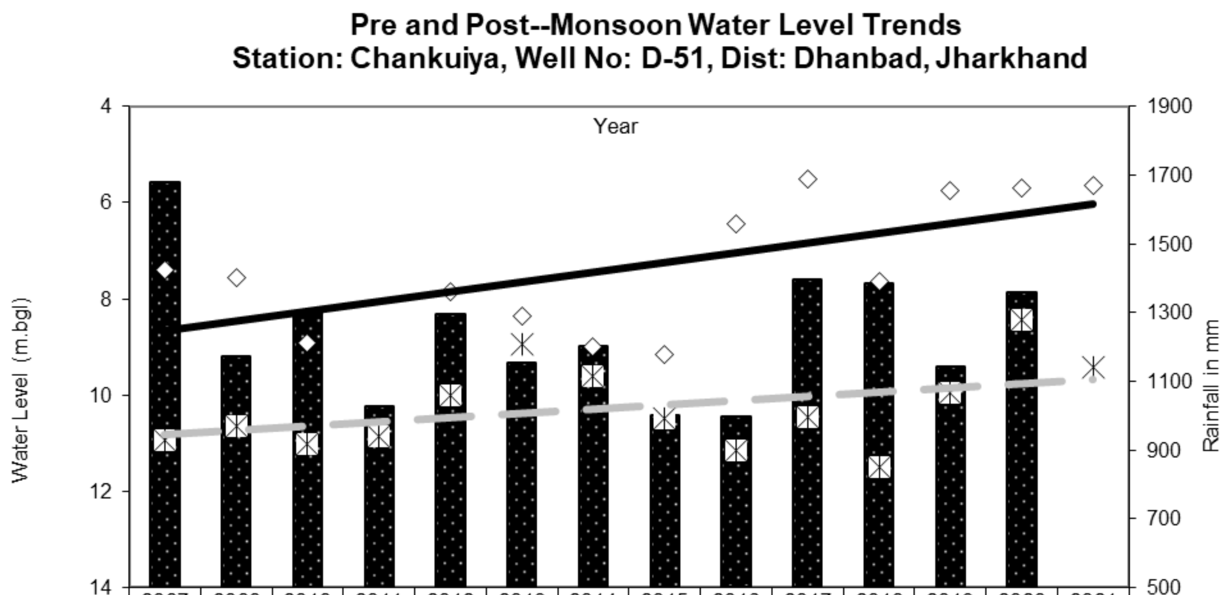
Annexure – VI

HYDROGRAPHS OF CLUSTER-VIII



	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⁎ May	7.02	5.80	6.70	6.85	7.76	6.15	6.65	7.73	6.24	8.00	5.15	6.00	4.80	5.83	4.55
◇ Nov	1.73		1.87	6.73		3.75	2.85		4.38	3.43	1.85	2.20	2.85	2.75	2.27

Rainfall ⁎ May ◇ Nov Pre-monsoon trend Post-monsoon trend



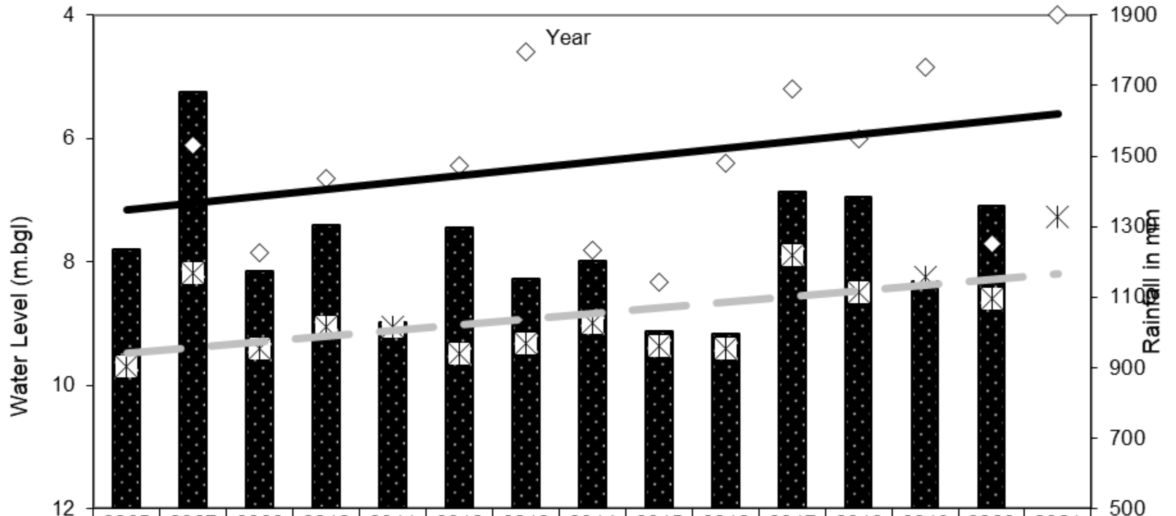
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⁎ May	10.95	10.65	11.03	10.85	10	8.94	9.60	10.48	11.15	10.45	11.50	9.95	8.45	9.43
◇ Nov	7.40	7.57	8.93		7.85	8.35	9.00	9.15	6.45	5.50	7.65	5.75	5.70	5.65

Rainfall ⁎ May ◇ Nov Pre-monsoon trend Post-monsoon trend

Annexure – VI

HYDROGRAPHS OF CLUSTER-IX

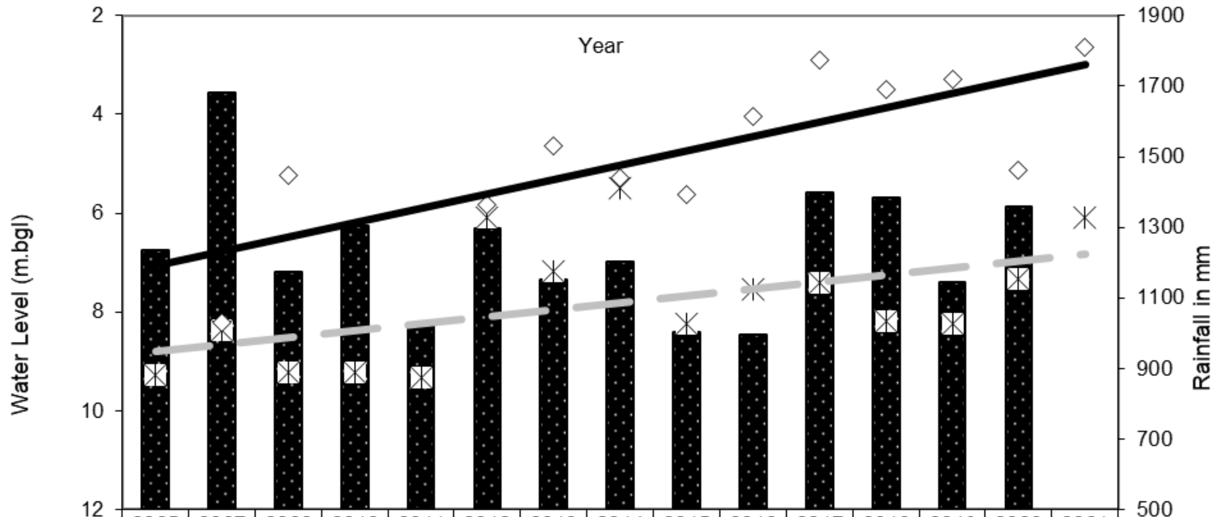
Pre and Post--Monsoon Water Level Trends
Station: Jialgora, Well No: D-5, Dist: Dhanbad, Jharkhand



	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
May	9.7	8.18	9.40	9.05	9.05	9.50	9.32	9.00	9.37	9.40	7.90	8.50	8.25	8.60	7.28
Nov		6.1	7.85	6.65		6.45	4.59	7.80	8.33	6.40	5.20	6.00	4.85	7.70	4.00

Rainfall May Nov Pre-monsoon trend Post-monsoon trend

Pre and Post--Monsoon Water Level Trends
Station: Golden Pahari, Well No: D-7, Dist: Dhanbad, Jharkhand

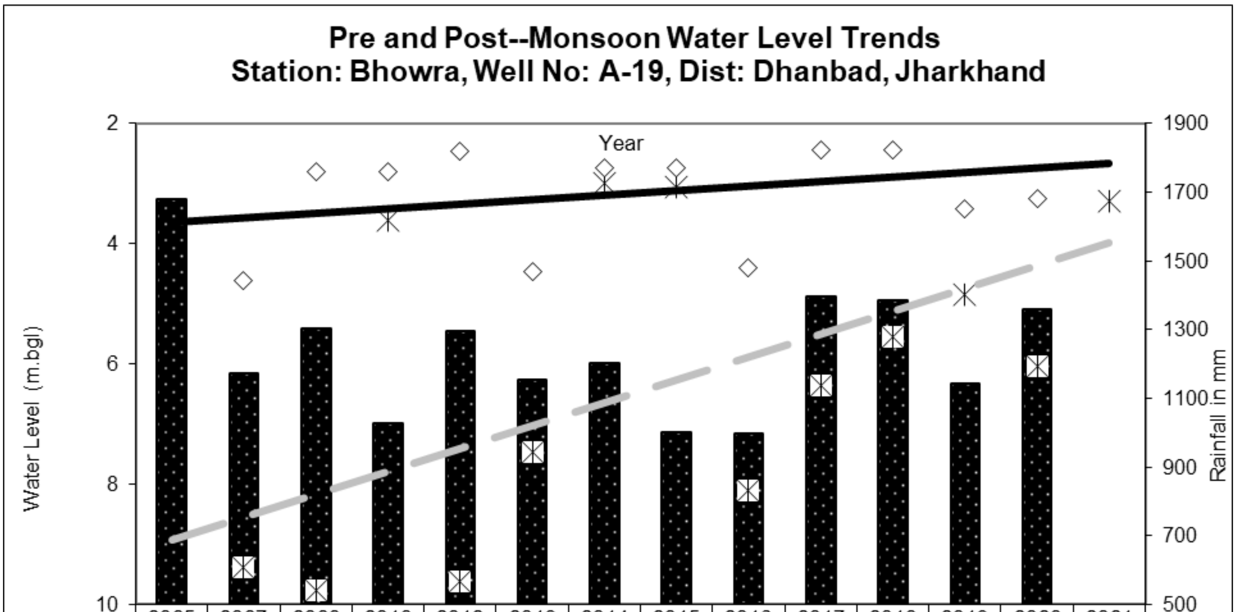


	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
May	9.28	8.38	9.23	9.23	9.33	6.08	7.19	5.50	8.25	7.53	7.40	8.20	8.23	7.33	6.08
Nov		8.21	5.23			5.83	4.63	5.28	5.61	4.03	2.90	3.50	3.28	5.13	2.63

Rainfall May Nov Pre-monsoon trend Post-monsoon trend

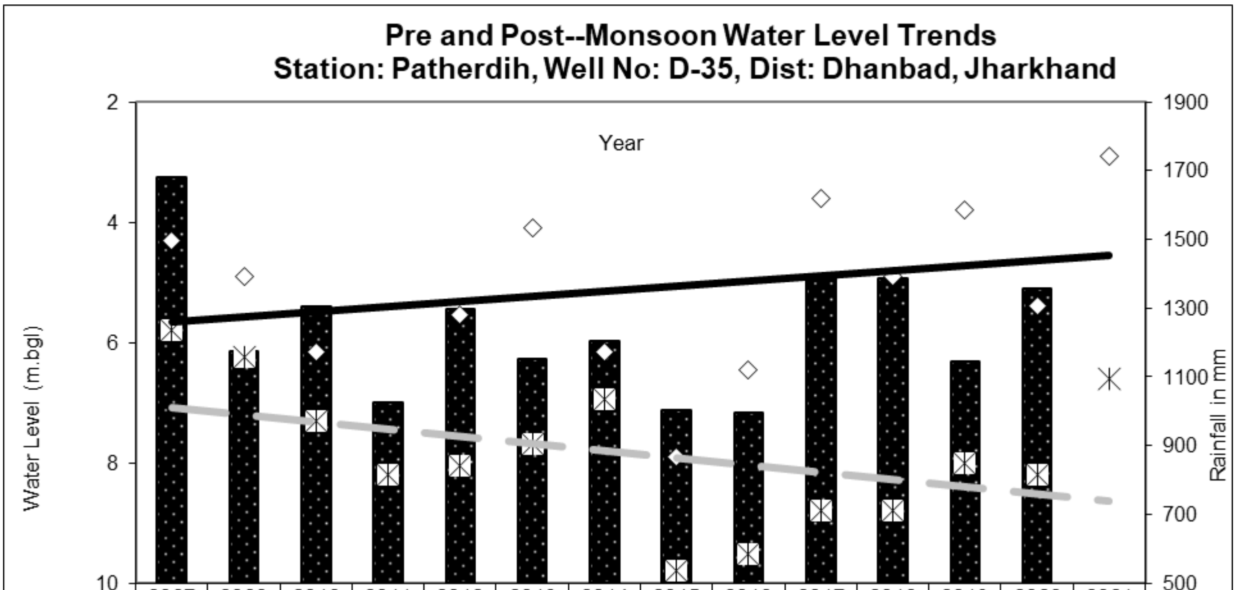
Annexure – VI

HYDROGRAPHS OF CLUSTER-X



	2005	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⋇ May	10.31	9.39	9.76	3.61	9.61	7.46	3.00	3.05	8.10	6.37	5.55	4.85	6.05	3.30
◇ Nov		4.61	2.81	2.81	2.46	4.46	2.75	2.75	4.40	2.45	2.45	3.43	3.25	1.90

Rainfall ⋇ May ◇ Nov Pre-monsoon trend Post-monsoon trend

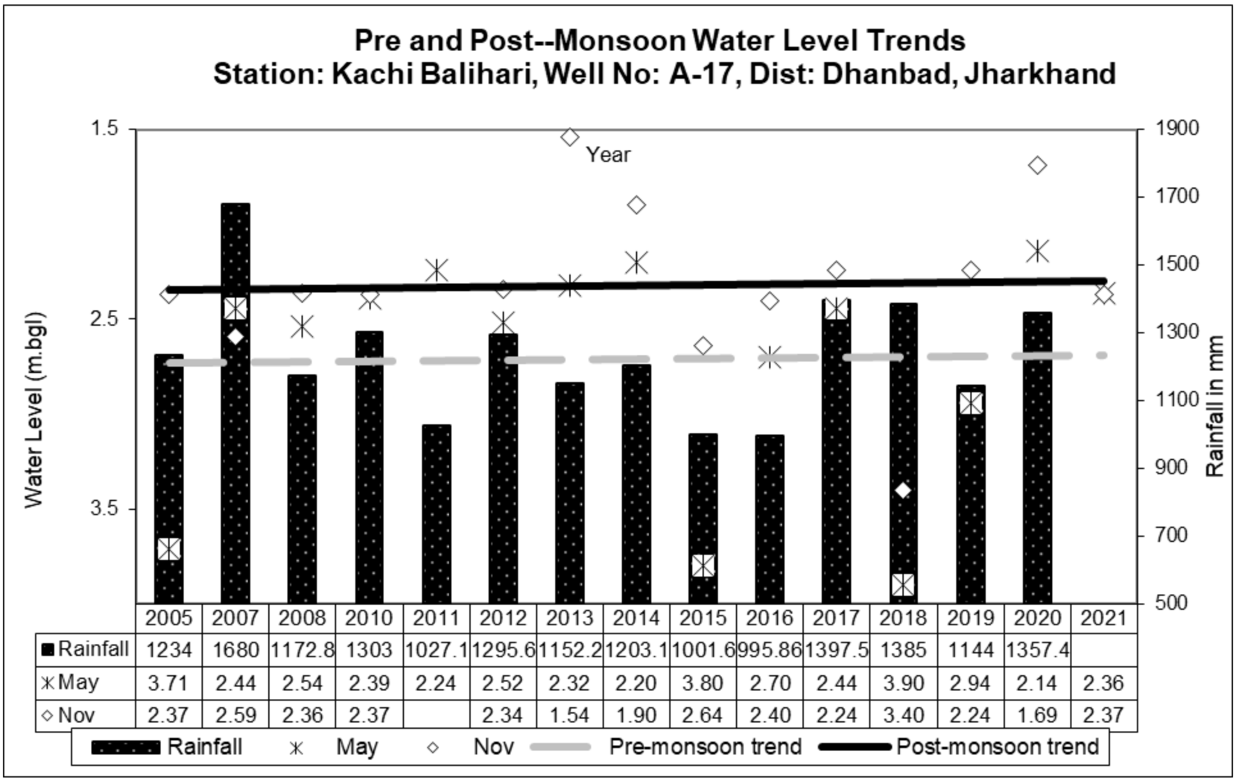


	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⋇ May	5.8	6.25	7.30	8.2	8.05	7.70	6.94	9.80	9.52	8.80	8.80	8.00	8.20	6.60
◇ Nov	4.30	4.9	6.15		5.55	4.10	6.15	7.90	6.45	3.60	4.90	3.80	5.40	2.90

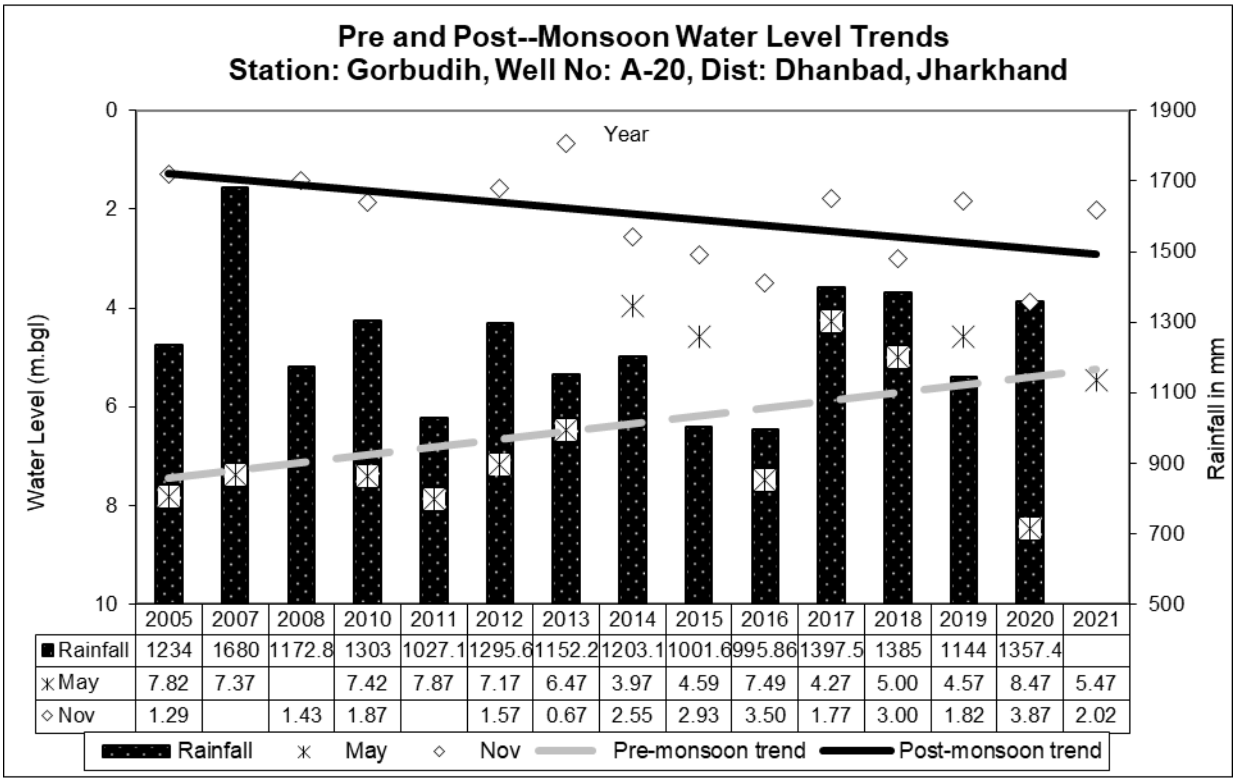
Rainfall ⋇ May ◇ Nov Pre-monsoon trend Post-monsoon trend

Annexure – VI

HYDROGRAPHS OF CLUSTER-XI



	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
May	3.71	2.44	2.54	2.39	2.24	2.52	2.32	2.20	3.80	2.70	2.44	3.90	2.94	2.14	2.36
Nov	2.37	2.59	2.36	2.37		2.34	1.54	1.90	2.64	2.40	2.24	3.40	2.24	1.69	2.37

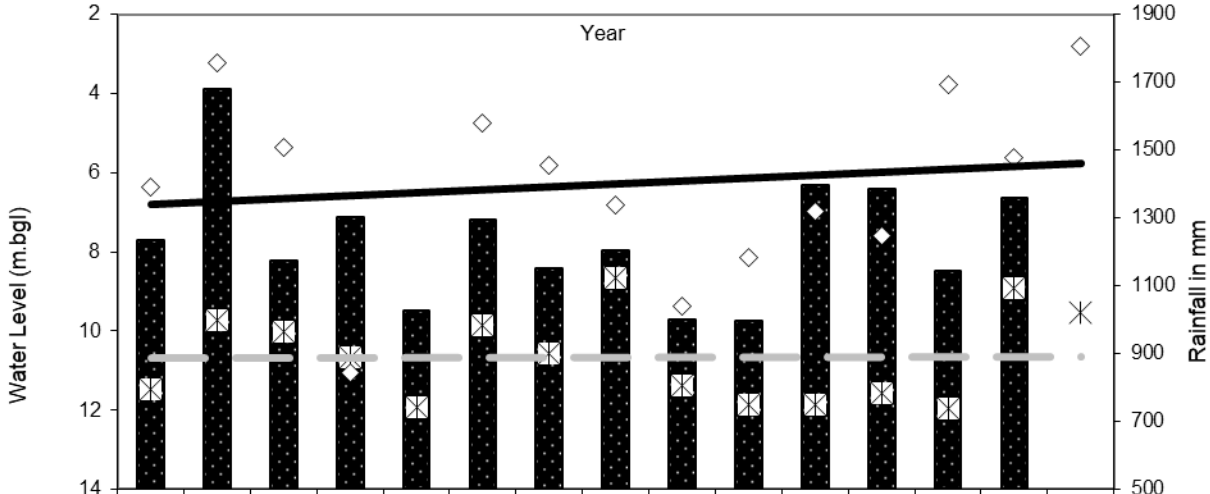


	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
May	7.82	7.37		7.42	7.87	7.17	6.47	3.97	4.59	7.49	4.27	5.00	4.57	8.47	5.47
Nov	1.29		1.43	1.87		1.57	0.67	2.55	2.93	3.50	1.77	3.00	1.82	3.87	2.02

Annexure – VI

HYDROGRAPHS OF CLUSTER-XIII

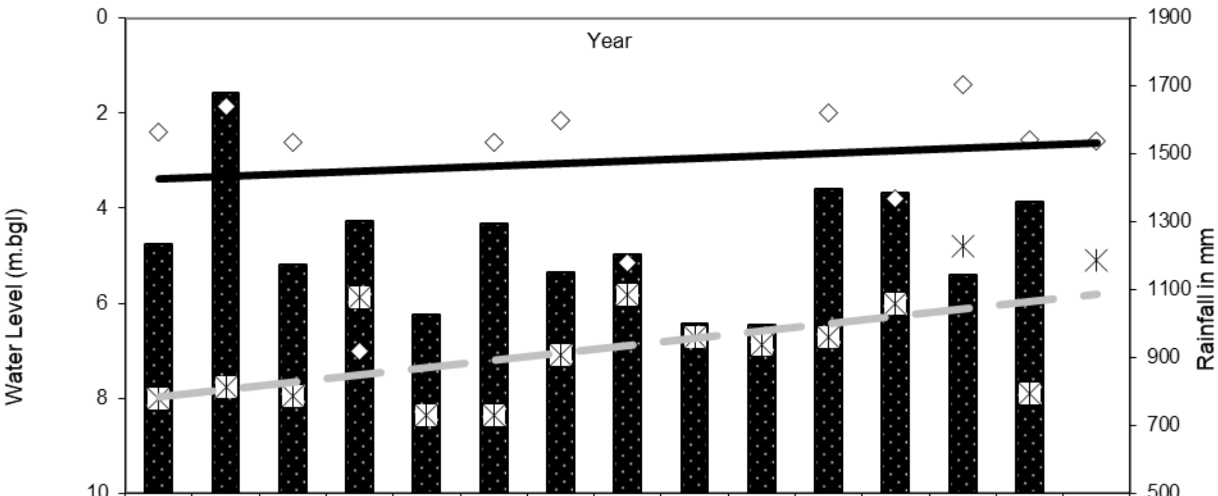
Pre and Post--Monsoon Water Level Trends
Station: Machyyara, Well No: A-23, Dist: Dhanbad, Jharkhand



	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⁎ May	11.49	9.72	10.01	10.67	11.92	9.87	10.57	8.67	11.37	11.87	11.87	11.58	11.97	8.92	9.52
◇ Nov	6.37	3.24	5.37	11.07		4.75	5.82	6.82	9.37	8.13	6.97	7.60	3.77	5.62	2.82

Rainfall ⁎ May ◇ Nov Pre-monsoon trend Post-monsoon trend

Pre and Post--Monsoon Water Level Trends
Station: Mahuda, Well No: B-25, Dist: Dhanbad, Jharkhand

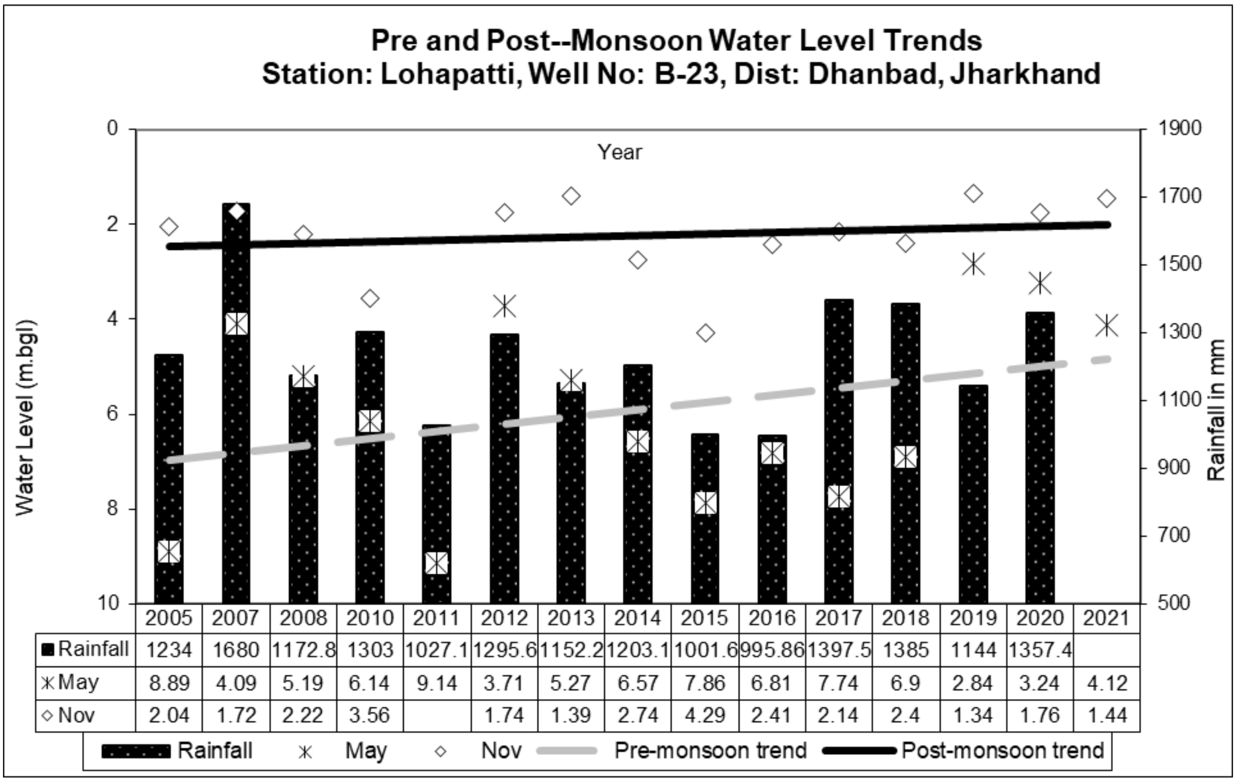


	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⁎ May	8	7.75	7.95	5.88	8.35	8.35	7.08	5.82	6.70	6.88	6.70	6.00	4.80	7.90	5.10
◇ Nov	2.40	1.85	2.60	7		2.60	2.15	5.15			2.00	3.80	1.40	2.55	2.58

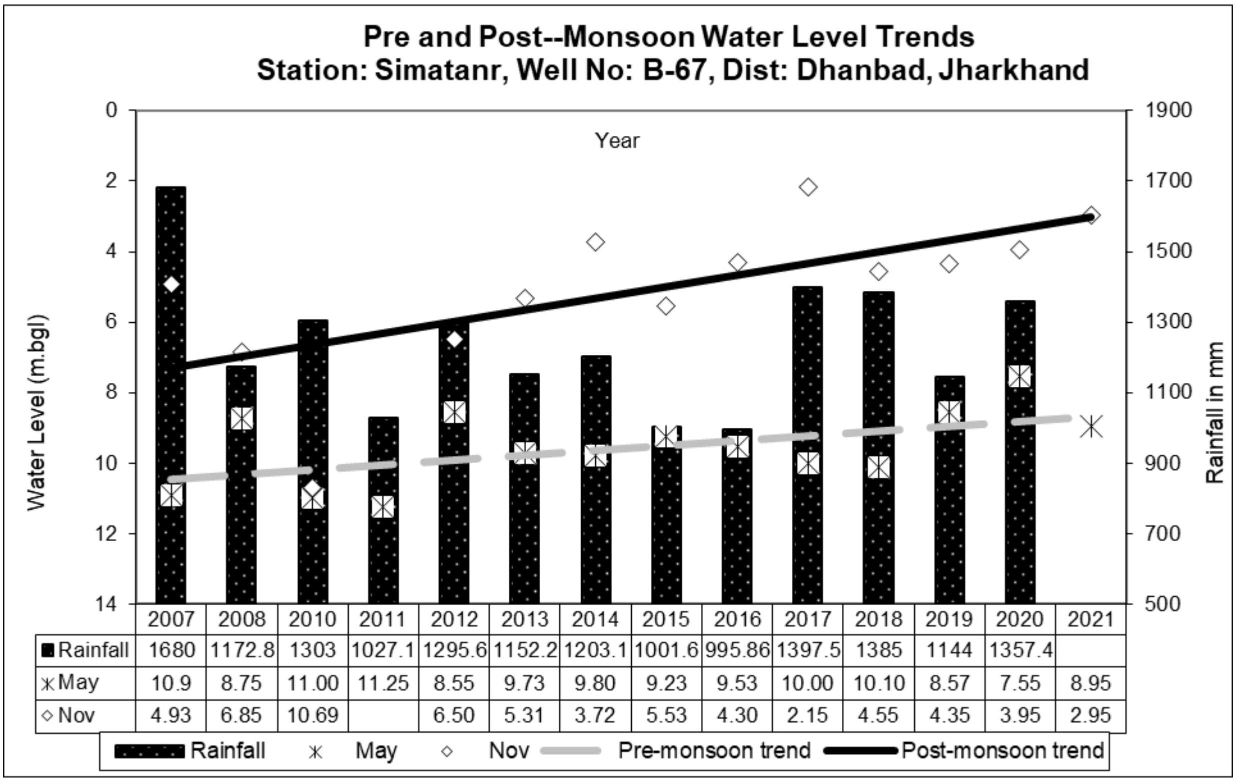
Rainfall ⁎ May ◇ Nov Pre-monsoon trend Post-monsoon trend

Annexure – VI

HYDROGRAPHS OF CLUSTER-XIV



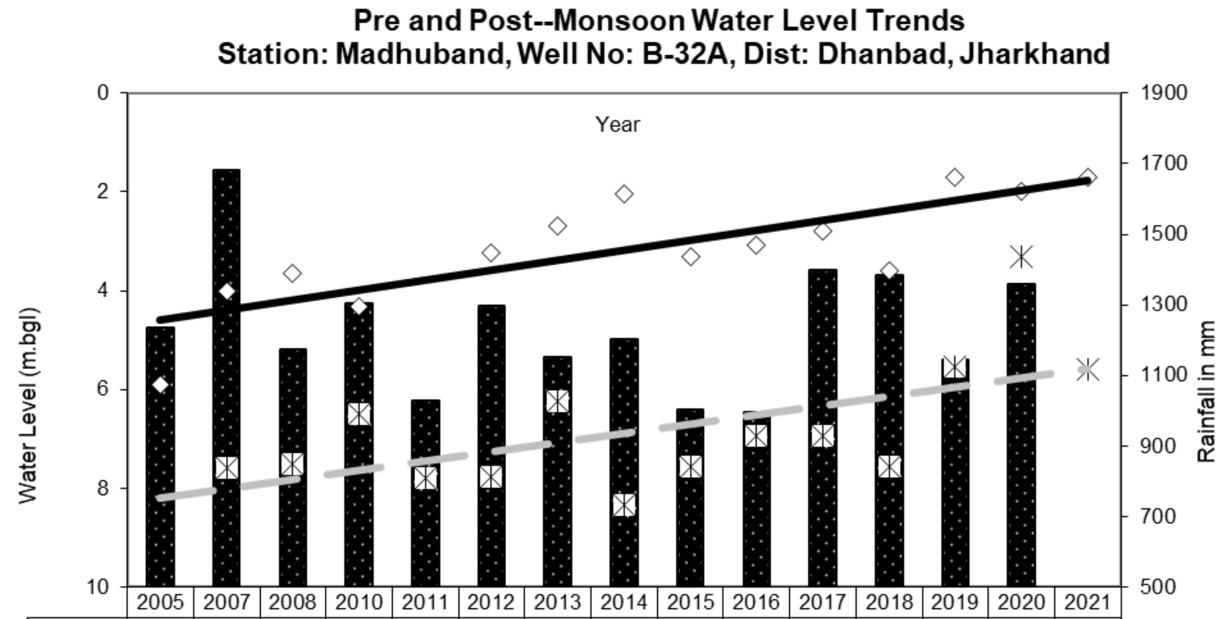
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
May	8.89	4.09	5.19	6.14	9.14	3.71	5.27	6.57	7.86	6.81	7.74	6.9	2.84	3.24	4.12
Nov	2.04	1.72	2.22	3.56		1.74	1.39	2.74	4.29	2.41	2.14	2.4	1.34	1.76	1.44



	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rainfall	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
May	10.9	8.75	11.00	11.25	8.55	9.73	9.80	9.23	9.53	10.00	10.10	8.57	7.55	8.95
Nov	4.93	6.85	10.69		6.50	5.31	3.72	5.53	4.30	2.15	4.55	4.35	3.95	2.95

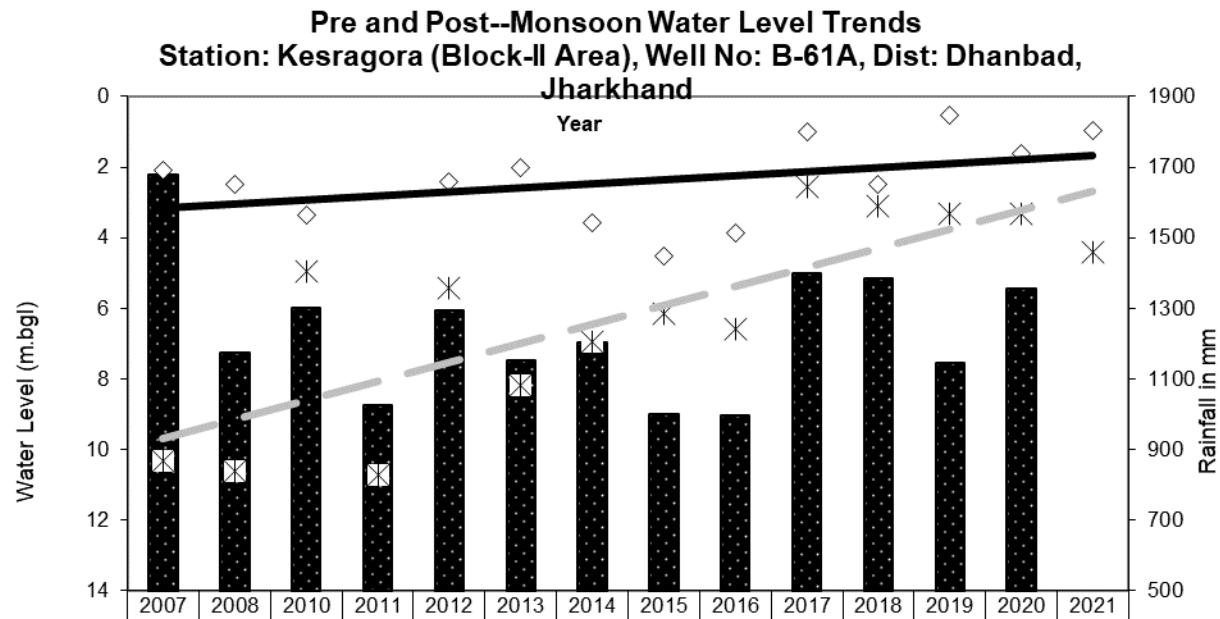
Annexure – VI

HYDROGRAPHS OF CLUSTER-XV



	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1234	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⋇ May		7.60	7.50	6.5	7.8	7.76	6.25	8.33	7.55	6.95	6.95	7.55	5.55	3.30	5.60
◇ Nov	5.90	4	3.66	4.32		3.22	2.68	2.05	3.32	3.07	2.80	3.6	1.70	2.00	1.70

Rainfall ⋇ May ◇ Nov Pre-monsoon trend Post-monsoon trend

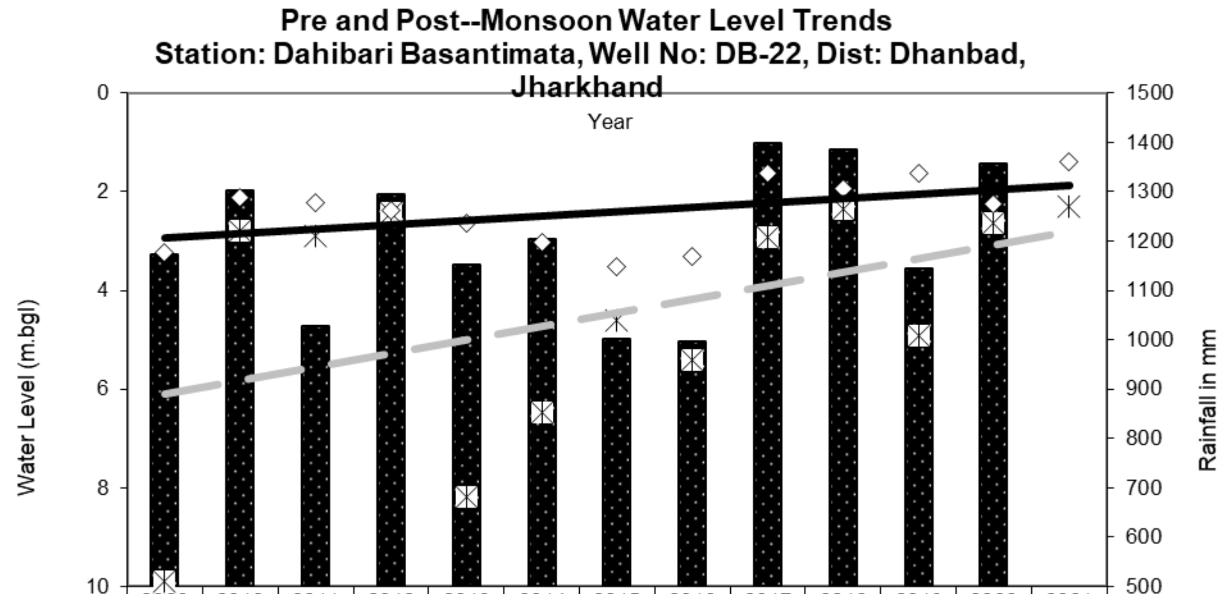


	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1680	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⋇ May	10.32	10.62	4.96	10.72	5.42	8.17	6.93	6.15	6.58	2.57	3.10	3.32	3.32	4.42
◇ Nov	2.10	2.49	3.36		2.40	2.02	3.57	4.52	3.87	1.00	2.50	0.52	1.60	0.97

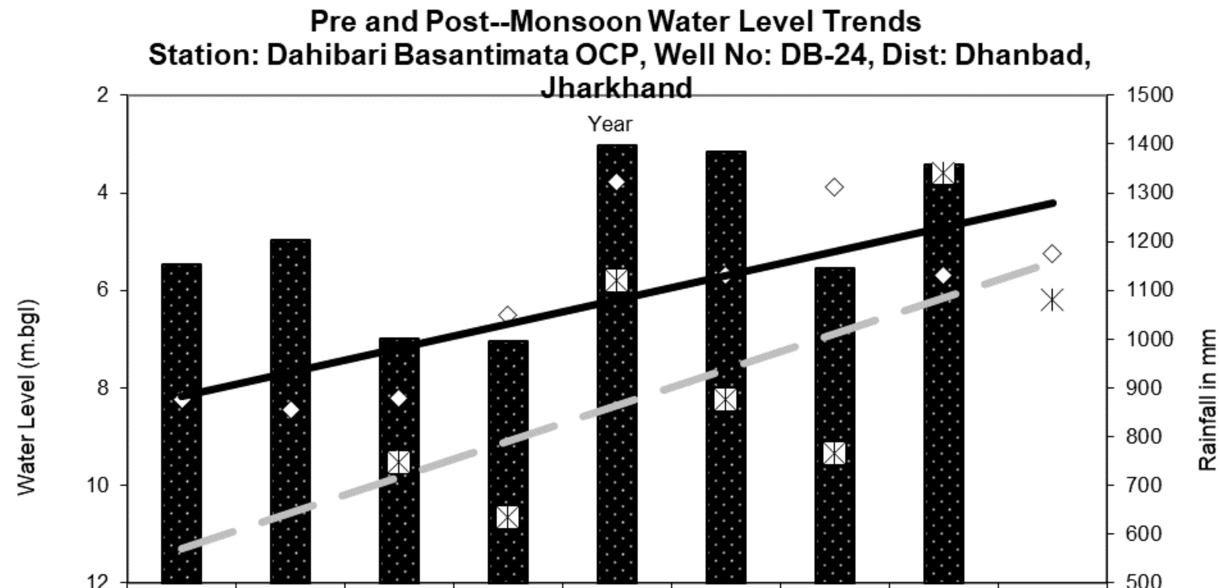
Rainfall ⋇ May ◇ Nov Pre-monsoon trend Post-monsoon trend

Annexure – VI

HYDROGRAPHS OF CLUSTER-XVI



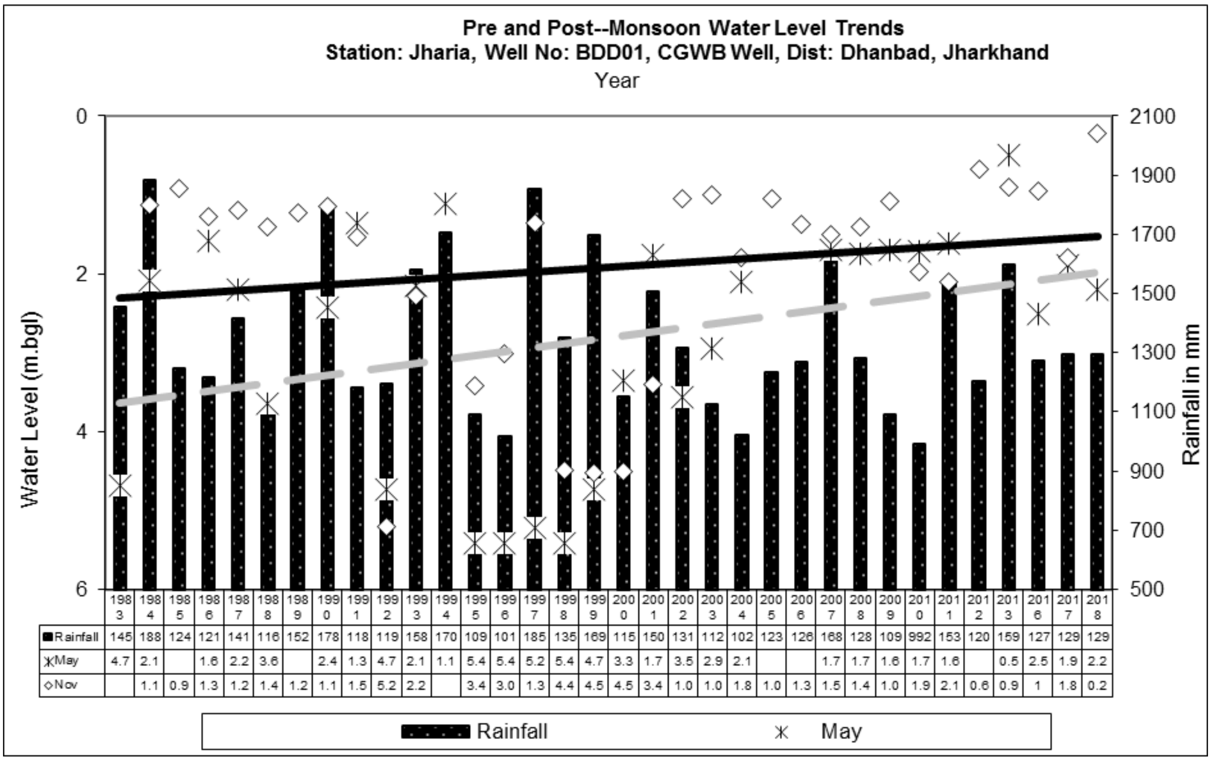
	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1172.8	1303	1027.1	1295.6	1152.2	1203.1	1001.6	995.86	1397.5	1385	1144	1357.4	
⁎ May	9.89	2.79	2.90	2.43	8.18	6.48	4.60	5.40	2.93	2.34	4.93	2.63	2.31
◇ Nov	3.23	2.11	2.23	2.38	2.64	3.03	3.53	3.30	1.63	1.93	1.63	2.25	1.38

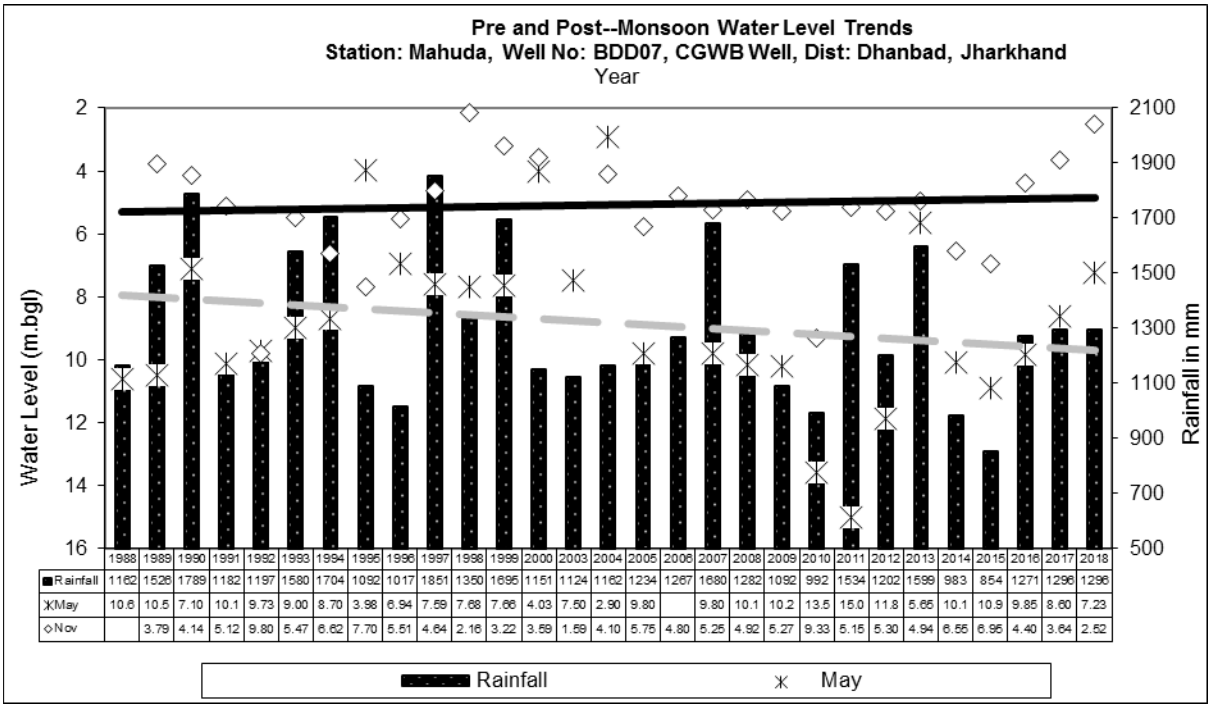


	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Rainfall	1152.15	1203.06	1001.59	995.86	1397.5	1384.95	1144.01	1357.43	
⁎ May			9.52	10.65	5.80	8.25	9.35	3.60	6.20
◇ Nov	8.25	8.45	8.20	6.50	3.78	5.70	3.88	5.70	5.25

Annexure – VI

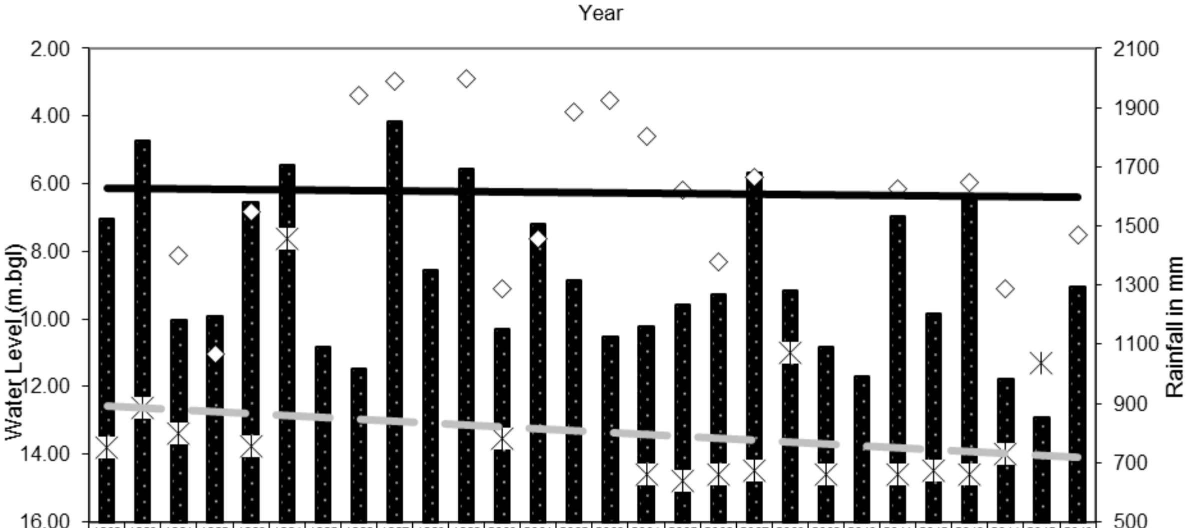
HYDROGRAPHS OF CGWB PERMANENT OBSERVATION STATIONS





HYDROGRAPHS OF CGWB PERMANENT OBSERVATION STATIONS

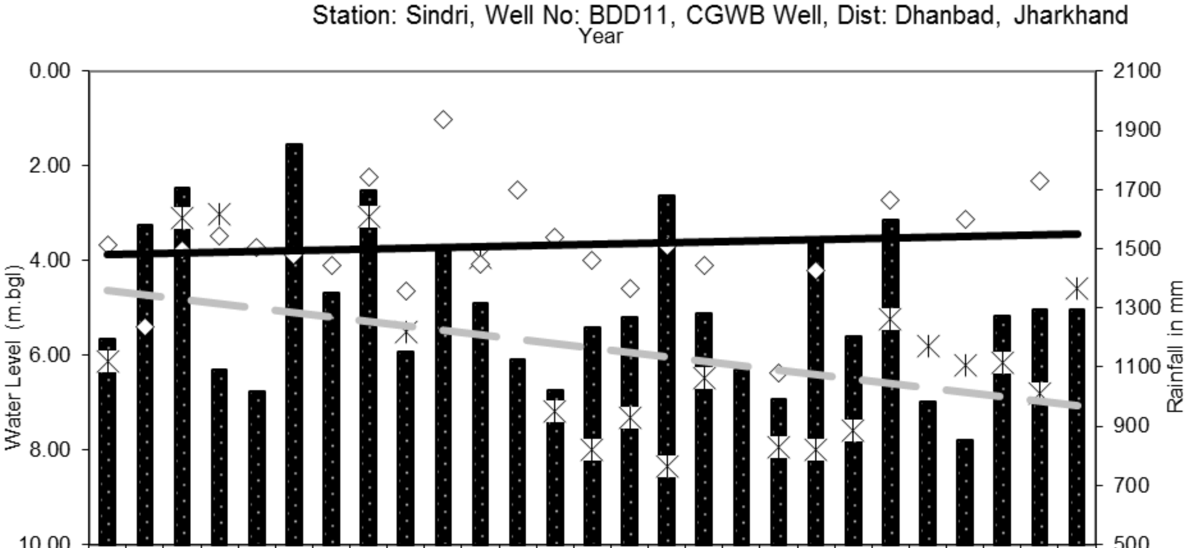
Pre and Post--Monsoon Water Level Trends
Station: Katras, Well No: BDD10, CGWB Well, Dist: Dhanbad, Jharkhand



	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

Rainfall ⋇ May

Pre and Post--Monsoon Water Level Trends
Station: Sindri, Well No: BDD11, CGWB Well, Dist: Dhanbad, Jharkhand



	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	

Rainfall ⋇ May

Annexure – VII

GROUNDWATER SAMPLE LOCATION DETAILS

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

Sl No	Name of Cluster	Ground Water Sample	Dug well (CMPDI)	Location	Sampling Date June'2021
1	CLUSTER-I	GW-1	B-15	BERA VILLAGE	16.06.2021
2	CLUSTER-II	GW-2	B-59	KHODOVALY VILLAGE	16.06.2021
3	CLUSTER-III	GW-3	A-29	GOVINDPUR,AMBAGAN VILLAGE	16.06.2021
4	CLUSTER-IV	GW-4	B-64	KESHALPUR, BATIGHAR	16.06.2021
5	CLUSTER-V	GW-5	D-30	BORKIBOA VILLAGE	16.06.2021
6	CLUSTER-VI	GW-6	D-25	GODHUR MORE	16.06.2021
7	CLUSTER-VII	GW-7	D-80	DHANSAR MINE RESCUE STN.	16.06.2021
8	CLUSTER-VIII	GW-8	D-49	NEAR GHANOODIH OC	15.06.2021
9	CLUSTER-IX	GW-9	D-5	JEALGORA, NEAR P.O.	15.06.2021
10	CLUSTER-X	GW-10	D-35	PATHERDIH RLY. COLONY	15.06.2021
11	CLUSTER-XI	GW-11	A-32	MONNIDIH BAZAR	16.06.2021
12	CLUSTER-XIII	GW-13	A-23	MACHHAYARA	16.06.2021
13	CLUSTER-XIV	GW-14	B-23	LOHAPATTI VILLAGE	16.06.2021
14	CLUSTER-XV	GW-15	B-32A	MADHUBAND VILLAGE	16.06.2021
15	CLUSTER-XVI	GW-16	DB-22	DAHIBARI,NICHE BASTI	15.06.2021

WATER QUALITY
(GROUND WATER- ALL PARAMETERS)

Year: 2020-21

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW1 16.06.2021	GW2 16.06.2021	GW3 16.06.2021			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.2	0.5	APHA, 23rd Edition ,Carmine
2	Colour,in Hazen Units	1	2	2	1	5	APHA, 23rd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	41	84	127	1.6	75	IS 3025, Part 40: 1991 R 2019 EDTA Method
4	Chloride (as Cl), mg/l, Max	47	78	124	2	250	IS-3025/32:1988, R-2019 Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA,23rd Edition, AAS-GTA
6	Fluoride (as F) mg/l, Max	0.77	0.71	0.59	0.2	1.0	APHA, 23RD Edition, Page 4-90 to , 4500 –F- D (SPADNS Method)
7	Free Residual Chlorine, mg/l, Min	<0.004	<0.004	<0.004	0.04	0.2	APHA, 23rd Edition, , 4500-Cl^- B. (Iodometric Method-I)
8	Iron (as Fe), mg/l, Max	0.28	0.2	0.2	0.2	1.0	IS 3025 Part 53 : 2003, R : 2019 , AAS-Flame Method
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 23rd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	0.24	<0.02	<0.02	0.02	0.1	APHA, 23rd Edition, 3111B, Direct Air Acetylene Flame AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	9.62	7.03	14.76	0.5	45	APHA, 23rd Edition, P-4-127, 4500 - NO_3^- B , UV-Spectrophotometric Screening Method
12	Odour	Aggreable	Aggreable	Aggreable	Qualitative	Agreeable	APHA, 23rd Edition, , 2150-C
13	pH value	7.72	7.85	7.91	0.2	6.5-8.5	IS 3025, Part 11 : 1983 R 2017 Electrometric method
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.002	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium, mg/l, Max	<0.007	<0.007	<0.007	0.007	0.01	IS -3025,part 56:2003,R-2019/APHA 23rd Edition, AAS-VGA
16	Sulphate (as SO_4) mg/l, Max	31	64	42	10	200	APHA –23rd Edition. P-4-199, 4500 SO_4^{2-} E
17	Taste	Acceptable	Acceptable	Acceptable	Qualitative	Acceptable	APHA,23rd Edition, 2160-C Flavour Rating Assesment
18	Total Alkalinity ($CaCO_3$),, mg/l, Max	105	121	137	4	200	IS 3025, Part 23: 1986 R 2019 Titration Method
19	Total Arsenic (as As), mg/l,Max	<0.006	<0.006	<0.006	0.006	0.01	IS-3025, part 37:1988,R-2019/APHA23rd Edition AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.004	<0.004	<0.004	0.04	0.05	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 23rd Edition, AAS-GTA
21	Total Dissolved Solids, mg/l, Max	425	510	622	25	500	IS 3025, Part 16: 1984 R 2017 Gravimetric method
22	Total Hardness ($CaCO_3$), mg/l, Max	226	384	487	4	200	IS 3025, Part 21, 2009 R 2019 EDTA Method
23	Turbidity, NTU, Max	2	2	3	1	5	IS 3025, Part 10 : 1984 R 2017 Nephelometric Method
24	Zinc (as Zn), mg/l, Max	<0.1	<0.1	<0.1	0.1	5	IS 3025 Part 49 : 1994,R : 2019, AAS-Flame
25	Nickel as Ni, mg/l Max	<0.01	<0.01	<0.01	0.01	0.02	IS 3025 Pat 54 : 2003,R : 2019, AAS-Flame APHA 23rd Edition, AAS-GTA

WATER QUALITY

(GROUND WATER- ALL PARAMETERS)

Year: 2021-22

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW4 16.06.2021	GW5 16.06.2021	GW6 16.06.2021			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.2	0.5	APHA, 23rd Edition ,Carmine
2	Colour,in Hazen Units	1	3	3	1	5	APHA, 23rd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	49	122	78	1.6	75	IS 3025, Part 40: 1991 R 2019 EDTA Method
4	Chloride (as Cl), mg/l, Max	74	132	60	2	250	IS-3025/32:1988, R-2019 Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA,23rd Edition, AAS-GTA
6	Fluoride (as F) mg/l, Max	0.50	0.83	0.80	0.2	1.0	APHA, 23RD Edition, Page 4-90 to , 4500 –F- D (SPADNS Method)
7	Free Residual Chlorine, mg/l, Min	<0.04	<0.04	<0.04	0.04	0.2	APHA, 23rd Edition, , 4500-Cl^- B. (Iodometric Method-I)
8	Iron (as Fe), mg/l, Max	0.41	<0.2	0.32	0.2	1.0	IS 3025 Part 53 : 2003, R : 2019 , AAS-Flame Method
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 23rd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	0.16	0.02	0.1	APHA, 23rd Edition, 3111B, Direct Air Acetylene Flame AAS-GTA
11	Nitrate (as NO_3), mg/l, Max	11.32	29.01	14.21	0.5	45	APHA, 23rd Edition, P-4-127, 4500 -NO_3^- B , UV-Spectrophotometric Screening Method
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	APHA, 23rd Edition, , 2150-C
13	pH value	8.03	7.65	7.77	0.2	6.5-8.5	IS 3025, Part 11 : 1983 R 2017 Electrometric method
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.002	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium, mg/l, Max	<0.007	<0.007	<0.007	0.007	0.01	IS -3025,part 56:2003,R-2019/APHA 23rd Edition, AAS-VGA
16	Sulphate (as SO_4) mg/l, Max	54	148	58	2	200	APHA –23rd Edition. P-4-199, 4500 SO_4^{2-} E
17	Taste	Acceptable	Acceptable	Acceptable	Qualitative	Acceptable	APHA,23rd Edition, 2160-C Flavour Rating Assesment
18	Total Alkalinity (C_aco_3),, mg/l, Max	103	119	139	4	200	IS 3025, Part 23: 1986 R 2019 Titration Method
19	Total Arsenic (as As), mg/l,Max	<0.006	<0.006	<0.006	0.006	0.01	IS-3025, part 37:1988,R-2019/APHA23rd Edition AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 23rd Edition, AAS-GTA
21	Total Dissolved Solids, mg/l, Max	455	659	522	25	500	IS 3025, Part 16: 1984 R 2017 Gravimetric method
22	Total Hardness (c_aco_3), mg/l, Max	281	531	329	4	200	IS 3025, Part 21, 2009 R 2019 EDTA Method
23	Turbidity, NTU, Max	4	2	2	1	5	IS 3025, Part 10 : 1984 R 2017 Nephelometric Method
24	Zinc (as Zn), mg/l, Max	<0.1	<0.1	0.18	0.1	5	IS 3025 Part 49 : 1994,R : 2019, AAS-Flame
25	Nickel as Ni, mg/l Max	<0.01	<0.01	<0.01	0.01	0.02	IS 3025 Pat 54 : 2003,R : 2019, AAS-Flame APHA 23rd Edition, AAS-GTA

WATER QUALITY

(GROUND WATER- ALL PARAMETERS)

Year: 2021-22

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW7 16.06.2021	GW8 15.06.2021	GW9 15.06.2021			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.2	0.5	APHA, 23rd Edition ,Carmine
2	Colour,in Hazen Units	2	2	3	1	5	APHA, 23rd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	117	65	139	1.6	75	IS 3025, Part 40: 1991 R 2019 EDTA Method
4	Chloride (as Cl), mg/l, Max	97	85	124	2	250	IS-3025/32:1988, R-2019 Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA,23rd Edition, AAS-GTA
6	Fluoride (as F) mg/l, Max	0.44	0.68	0.75	0.2	1.0	APHA, 23RD Edition, Page 4-90 to , 4500 –F- D (SPADNS Method)
7	Free Residual Chlorine, mg/l, Min	<0.04	<0.04	<0.04	0.04	0.2	APHA, 23rd Edition, , 4500-Cl^- B. (Iodometric Method-I)
8	Iron (as Fe), mg/l, Max	<0.2	0.2	<0.2	0.2	1.0	IS 3025 Part 53 : 2003, R : 2019 , AAS-Flame Method
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 23rd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	APHA, 23rd Edition, 3111B, Direct Air Acetylene Flame AAS-GTA
11	Nitrate (as NO_3), mg/l, Max	16.27	11.81	25.78	0.5	45	APHA, 23rd Edition, P-4-127, 4500 -NO_3^- B , UV-Spectrophotometric Screening Method
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	APHA, 23rd Edition, , 2150-C
13	pH value	7.71	7.35	7.86	0.2	6.5-8.5	IS 3025, Part 11 : 1983 R 2017 Electrometric method
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.002	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium, mg/l, Max	<0.007	<0.007	<0.007	0.007	0.01	IS -3025,part 56:2003,R-2019/APHA 23rd Edition, AAS-VGA
16	Sulphate (as SO_4) mg/l, Max	75	35	159	2	200	APHA –23rd Edition. P-4-199, 4500 SO_4^{2-} E
17	Taste	Acceptable	Acceptable	Acceptable	Qualitative	Acceptable	APHA,23rd Edition, 2160-C Flavour Rating Assesment
18	Total Alkalinity ($CaCO_3$),, mg/l, Max	182	115	135	4	200	IS 3025, Part 23: 1986 R 2019 Titration Method
19	Total Arsenic (as As), mg/l,Max	<0.006	<0.006	<0.006	0.006	0.01	IS-3025, part 37:1988,R-2019/APHA23rd Edition AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 23rd Edition, AAS-GTA
21	Total Dissolved Solids, mg/l, Max	783	724	889	25	500	IS 3025, Part 16: 1984 R 2017 Gravimetric method
22	Total Hardness ($CaCO_3$), mg/l, Max	440	309	554	4	200	IS 3025, Part 21, 2009 R 2019 EDTA Method
23	Turbidity, NTU, Max	1	5	2	1	5	IS 3025, Part 10 : 1984 R 2017 Nephelometric Method
24	Zinc (as Zn), mg/l, Max	<0.1	<0.1	0.1	0.1	5	IS 3025 Part 49 : 1994,R : 2019, AAS-Flame
25	Nickel as Ni, mg/l Max	<0.01	<0.01	<0.01	0.01	0.02	IS 3025 Pat 54 : 2003,R : 2019, AAS-Flame APHA 23rd Edition, AAS-GTA

WATER QUALITY

(GROUND WATER- ALL PARAMETERS)

Year: 2021-22

Sl. No	Parameter	Sampling Stations GW10 15.06.2021	GW11 16.06.2021	GW13 16.06.2021	Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.2	0.5	APHA, 23rd Edition ,Carmine
2	Colour,in Hazen Units	3	2	3	1	5	APHA, 23rd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	82	54	158	1.6	75	IS 3025, Part 40: 1991 R 2019 EDTA Method
4	Chloride (as Cl), mg/l, Max	80	39	103	2	250	IS-3025/32:1988, R-2019 Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA,23rd Edition, AAS-GTA
6	Fluoride (as F) mg/l, Max	0.54	0.60	0.43	0.2	1.0	APHA, 23RD Edition, Page 4-90 to , 4500 –F- D (SPADNS Method)
7	Free Residual Chlorine, mg/l, Min	<0.04	<0.04	<0.04	0.04	0.2	APHA, 23rd Edition, , 4500-Cl^- B. (Iodometric Method-I)
8	Iron (as Fe), mg/l, Max	<0.2	<0.2	0.2	0.2	1.0	IS 3025 Part 53 : 2003, R : 2019 , AAS-Flame Method
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 23rd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	0.18	0.02	0.1	APHA, 23rd Edition, 3111B, Direct Air Acetylene Flame AAS-GTA
11	Nitrate (as NO_3), mg/l, Max	17.24	11.47	9.23	0.5	45	APHA, 23rd Edition, P-4-127, 4500 - NO_3^- B , UV-Spectrophotometric Screening Method
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	APHA, 23rd Edition, , 2150-C
13	pH value	7.75	8.15	8.05	0.2	6.5-8.5	IS 3025, Part 11 : 1983 R 2017 Electrometric method
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.002	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium, mg/l, Max	<0.007	<0.007	<0.007	0.007	0.01	IS -3025,part 56:2003,R-2019/APHA 23rd Edition, AAS-VGA
16	Sulphate (as SO_4) mg/l, Max	99	44	183	2	200	APHA –23rd Edition. P-4-199, 4500 SO_4^{2-} E
17	Taste	Acceptable	Acceptable	Acceptable	Qualitative	Acceptable	APHA,23rd Edition, 2160-C Flavour Rating Assesment
18	Total Alkalinity (c_aco_3),, mg/l, Max	119	178	115	4	200	IS 3025, Part 23: 1986 R 2019 Titration Method
19	Total Arsenic (as As), mg/l,Max	<0.006	<0.006	<0.006	0.006	0.01	IS-3025, part 37:1988,R-2019/APHA23rd Edition AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 23rd Edition, AAS-GTA
21	Total Dissolved Solids, mg/l, Max	666	578	782	25	500	IS 3025, Part 16: 1984 R 2017 Gravimetric method
22	Total Hardness (c_aco_3), mg/l, Max	356	246	566	4	200	IS 3025, Part 21, 2009 R 2019 EDTA Method
23	Turbidity, NTU, Max	3	1	1	1	5	IS 3025, Part 10 : 1984 R 2017 Nephelometric Method
24	Zinc (as Zn), mg/l, Max	0.1	<0.1	<0.1	0.1	5	IS 3025 Part 49 : 1994,R : 2019, AAS-Flame
25	Nickel as Ni, mg/l Max	<0.01	<0.01	<0.01	0.01	0.02	IS 3025 Pat 54 : 2003,R : 2019, AAS-Flame APHA 23rd Edition, AAS-GTA

WATER QUALITY

(GROUND WATER- ALL PARAMETERS)

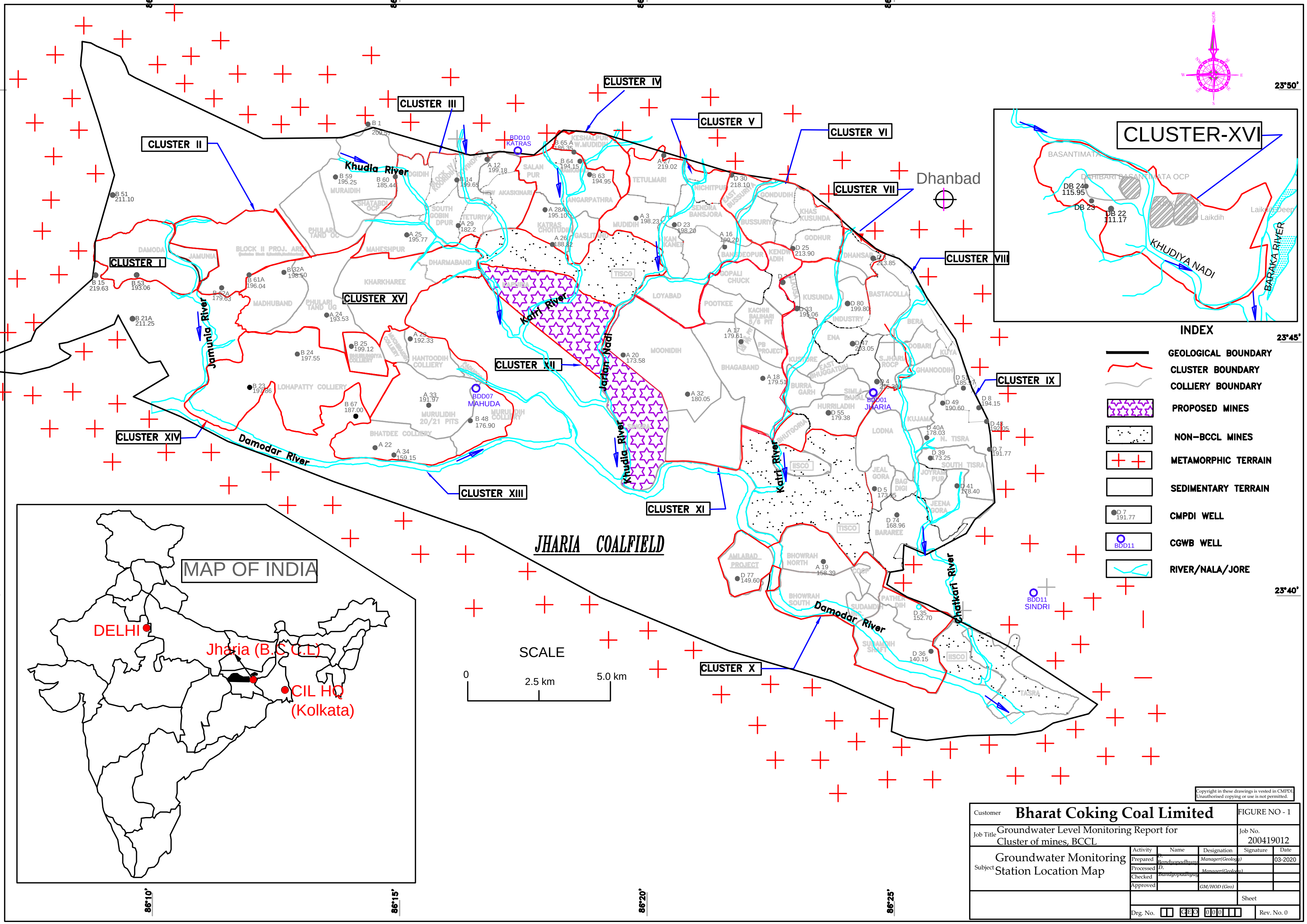
Year: 2021-22

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW14 16.06.2021	GW15 16.06.2021	GW16 15.06.2021			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.2	0.5	APHA, 23rd Edition ,Carmine
2	Colour,in Hazen Units	3	2	2	1	5	APHA, 23rd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	52	101	154	1.6	75	IS 3025, Part 40: 1991 R 2019 EDTA Method
4	Chloride (as Cl), mg/l, Max	54	136	119	2	250	IS-3025/32:1988, R-2019 Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA,23rd Edition, AAS-GTA
6	Fluoride (as F) mg/l, Max	0.61	0.78	0.55	0.2	1.0	APHA, 23RD Edition, Page 4-90 to , 4500 –F- D (SPADNS Method)
7	Free Residual Chlorine, mg/l, Min	<0.04	<0.04	<0.04	0.04	0.2	APHA, 23rd Edition, , 4500-Cl^- B. (Iodometric Method-I)
8	Iron (as Fe), mg/l, Max	<0.2	<0.2	0.2	0.2	1.0	IS 3025 Part 53 : 2003, R : 2019 , AAS-Flame Method
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 23rd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	0.10	<0.02	0.02	0.1	APHA, 23rd Edition, 3111B, Direct Air Acetylene Flame AAS-GTA
11	Nitrate (as NO_3), mg/l, Max	14.83	9.44	15.73	0.5	45	APHA, 23rd Edition, P-4-127, 4500 -NO_3^- B , UV-Spectrophotometric Screening Method
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	APHA, 23rd Edition, , 2150-C
13	pH value	8.06	7.95	7.86	0.2	6.5-8.5	IS 3025, Part 11 : 1983 R 2017 Electrometric method
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.002	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium, mg/l, Max	<0.007	<0.007	<0.007	0.007	0.01	IS -3025,part 56:2003,R-2019/APHA 23rd Edition, AAS-VGA
16	Sulphate (as SO_4) mg/l, Max	58	142	187	2	200	APHA –23rd Edition. P-4-199, 4500 SO_4^{2-} E
17	Taste	Acceptable	Acceptable	Acceptable	Qualitative	Acceptable	APHA,23rd Edition, 2160-C Flavour Rating Assesment
18	Total Alkalinity (c_aco_3),, mg/l, Max	101	127	155	4	200	IS 3025, Part 23: 1986 R 2019 Titration Method
19	Total Arsenic (as As), mg/l,Max	<0.006	<0.006	<0.006	0.006	0.01	IS-3025, part 37:1988,R-2019/APHA23rd Edition AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 23rd Edition, AAS-GTA
21	Total Dissolved Solids, mg/l, Max	569	766	807	25	500	IS 3025, Part 16: 1984 R 2017 Gravimetric method
22	Total Hardness (c_aco_3), mg/l, Max	309	539	638	4	200	IS 3025, Part 21, 2009 R 2019 EDTA Method
23	Turbidity, NTU, Max	2	3	3	1	5	IS 3025, Part 10 : 1984 R 2017 Nephelometric Method
24	Zinc (as Zn), mg/l, Max	<0.1	0.1	0.84	0.1	5	IS 3025 Part 49 : 1994,R : 2019, AAS-Flame
25	Nickel as Ni, mg/l Max	<0.01	<0.01	<0.01	0.01	0.02	IS 3025 Pat 54 : 2003,R : 2019, AAS-Flame APHA 23rd Edition, AAS-GTA

Abbreviations

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

GROUNDWATER MONITORING STATION LOCATION MAP



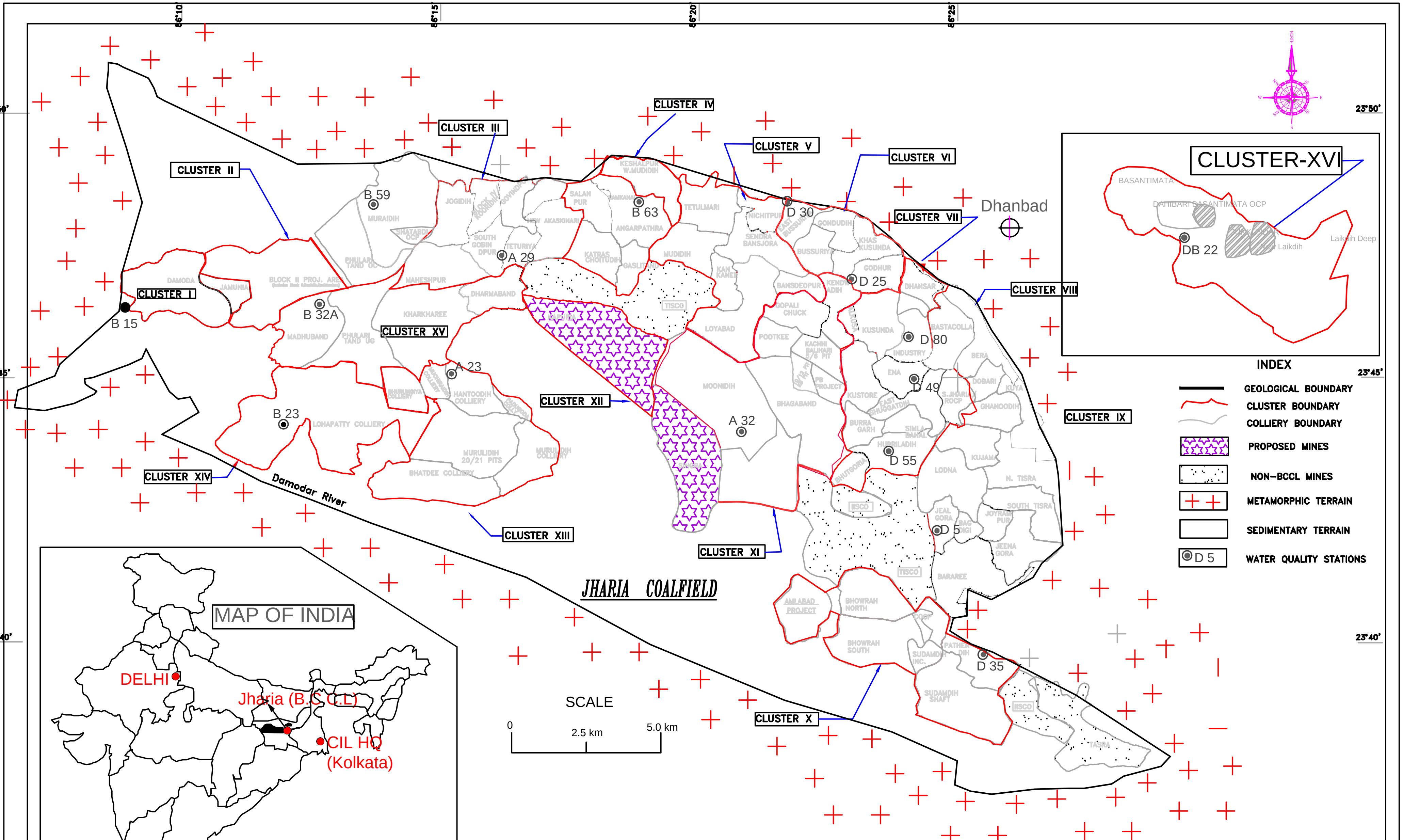
Customer	Bharat Coking Coal Limited	FIGURE NO - 1
Job Title	Groundwater Level Monitoring Report for Cluster of mines, BCCL	Job No. 200419012
Subject	Groundwater Monitoring Station Location Map	

Activity	Name	Designation	Signature	Date
Prepared	D. Bandyopadhyay	Manager(Geology)		03-2020
Processed	D. Bandyopadhyay	Manager(Geology)		
Checked				
Approved		GM/HOD (Geo)		

Sheet

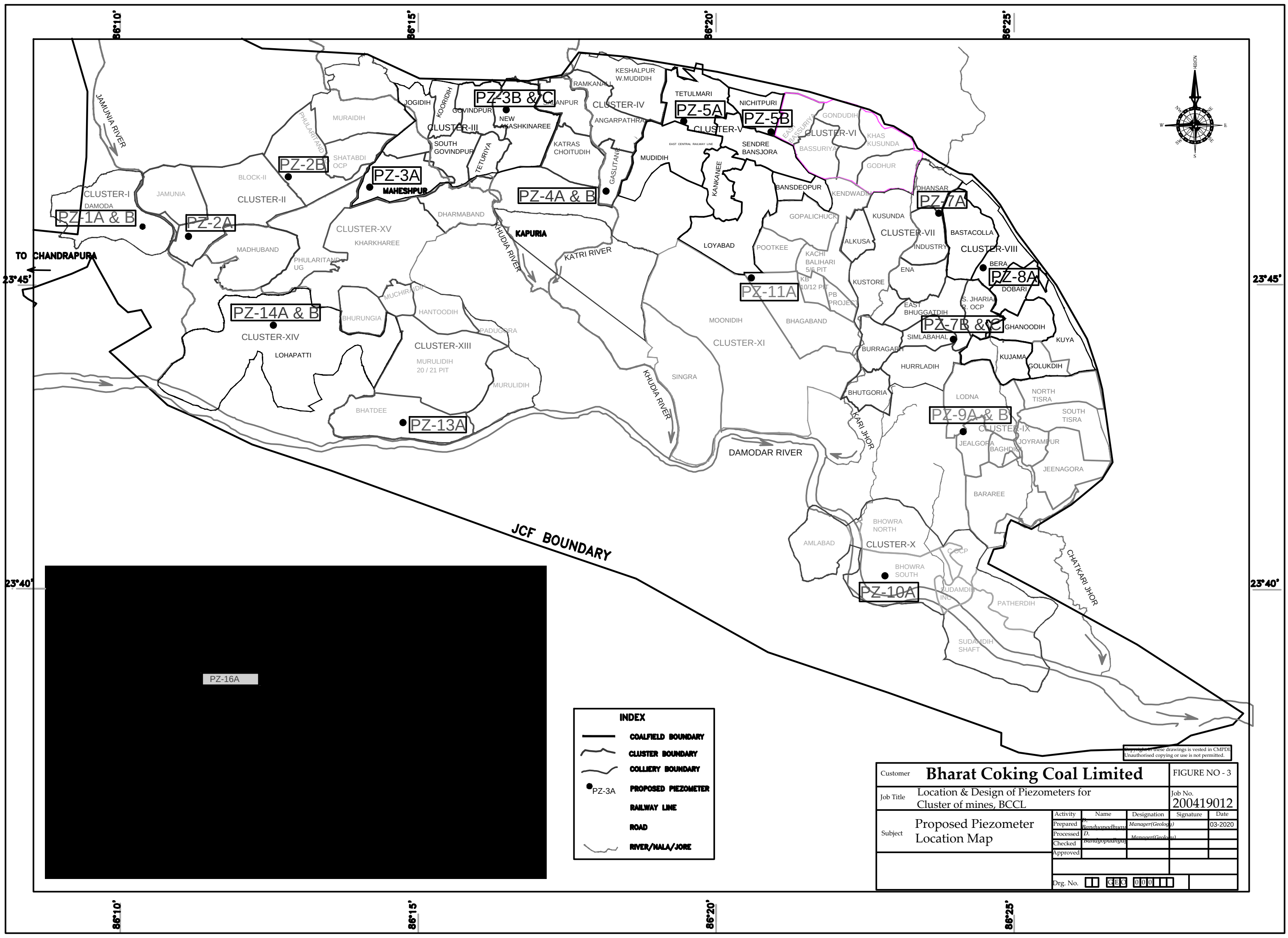
Drg. No. GEO 000 Rev. No. 0

GROUNDWATER QUALITY MONITORING STATION LOCATION MAP

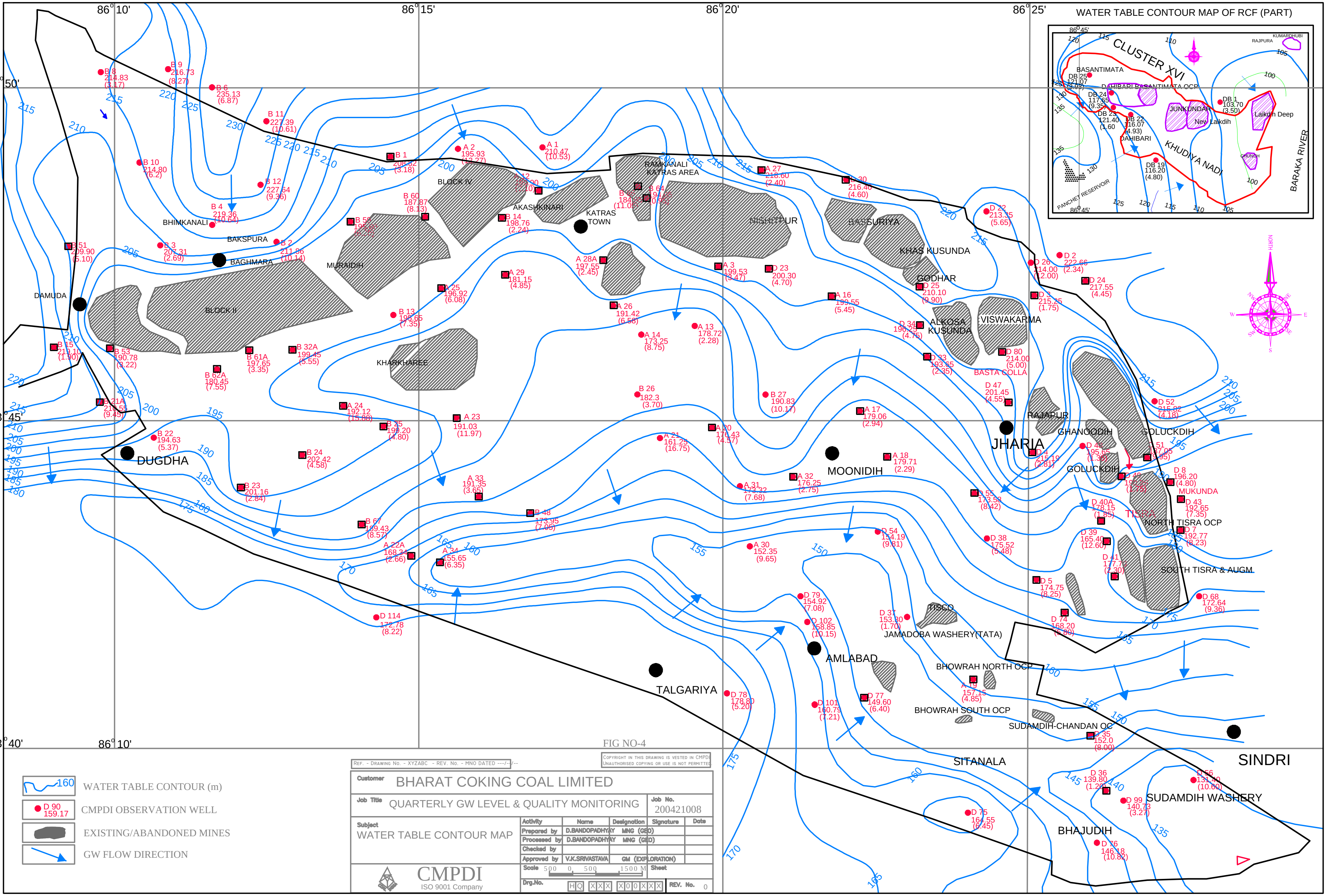


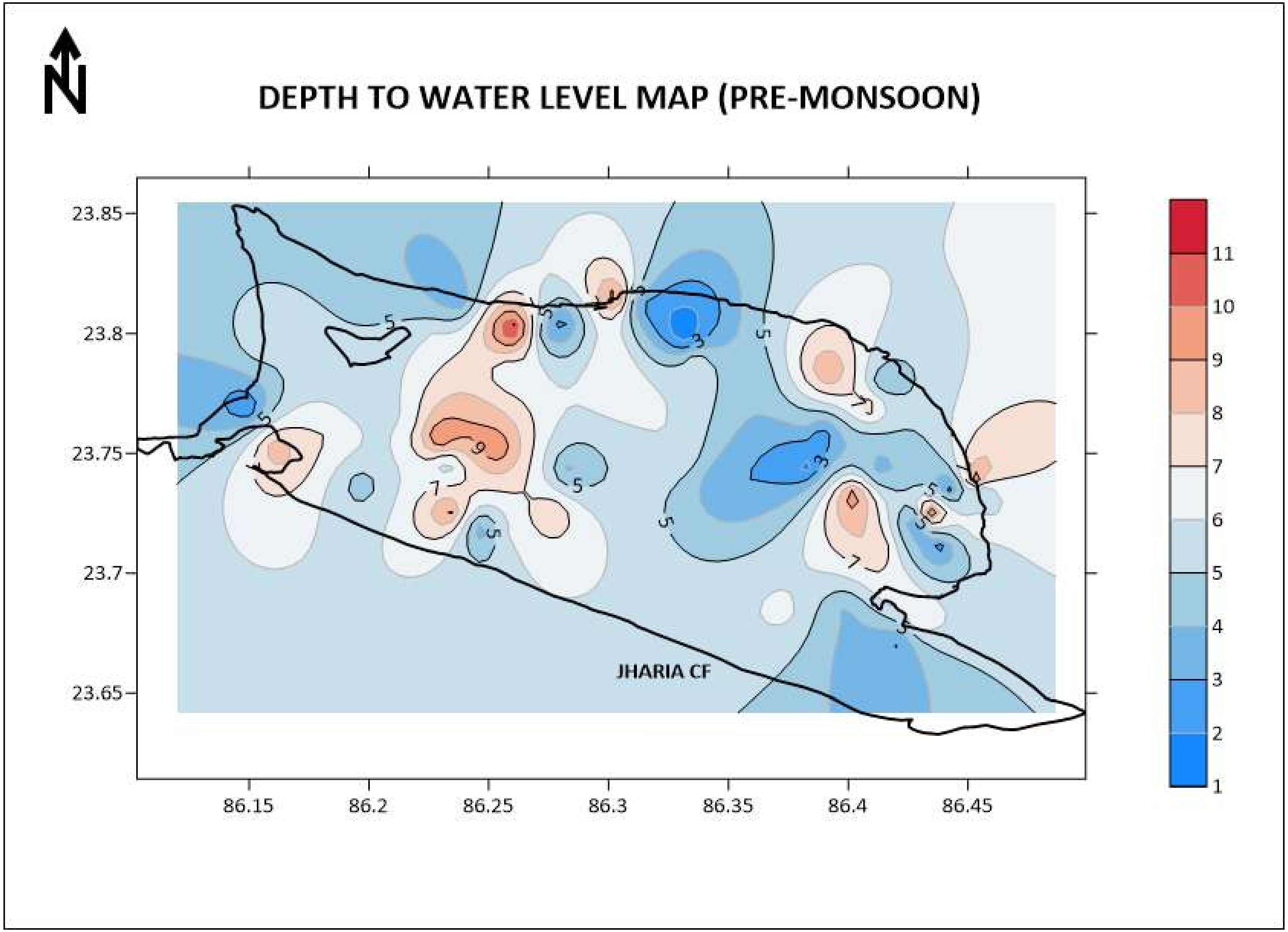
Customer **Bharat Coking Coal Limited**				FIGURE NO - 2	
Job Title Groundwater Level Monitoring Report for Cluster of mines, BCCL				Job No. 200419012	
Subject Groundwater quality monitoring Station Location Map	Activity	Name	Designation	Signature	Date
	Prepared	D. Bandyopadhyay	Manager(Geology)		03-2019
	Processed	D. Bandyopadhyay	Manager(Geology)		
	Checked				
	Approved		GM/HOD (Geo)		
				Sheet	
	Drg. No. GEO 000			Rev. No. 0	

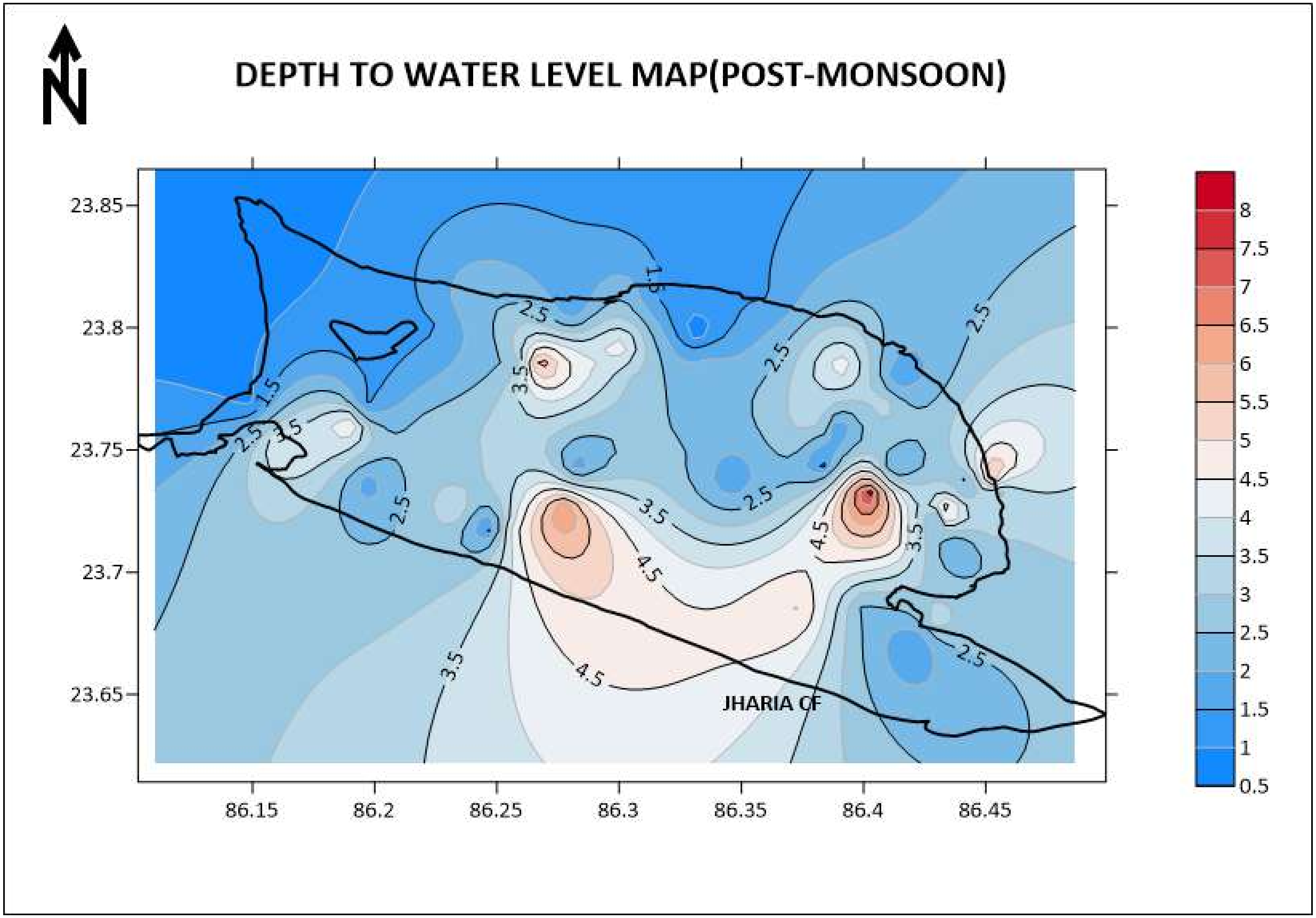
PROPOSED PIEZOMETER LOCATION MAP, JCF & RCF (part)



WATER TABLE CONTOUR MAP OF PRE-MONSOON 2020-21




DEPTH TO WATER LEVEL MAP (PRE-MONSOON)
N
JHARIA CF
23.85
23.8
23.75
23.7
23.65
86.15
86.2
86.25
86.3
86.35
86.4
86.45
11
10
9
8
7
6
5
4
3
2
1



N
DEPTH TO WATER LEVEL MAP(POST-MONSOON)
JHARIA CF
23.85
23.8
23.75
23.7
23.65
86.15
86.2
86.25
86.3
86.35
86.4
86.45
1.5
2.5
3.5
4.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5

Accreditation Board of CGWA

Certificate of Accreditation

M/s. Central Mine Planning and Design Institute Ltd. (CMPDIL)
Ranchi, Jharkhand

Has been accredited as a Ground Water Professionals to prepare reports in the Functional Areas of

- *Hydrogeological conditions in mining projects.*

Valid from : 15.02.2021
Valid thru : 14.02.2026

Certificate No. : CGWA/RGI/013
Dated : 07.07.2021

क्षेत्रीय निदेशक
Regional Director
आरजीएनजीडब्ल्यूटीआरआई
RGNGWT&RI

सदस्य
Member
आरजीएनजीडब्ल्यूटीआरआई
RGNGWT&RI

भारत सरकार
Government of India
जल शक्ति मंत्रालय
Ministry of Jal Shakti
जल संसाधन, नदी विकास और गंगा संरक्षण विभाग
Department of Water Resources, River Development & Ganga Rejuvenation
केन्द्रीय भूमि जल बोर्ड / Central Ground Water Board
राजीव गांधी राष्ट्रीय भूमि जल प्रशिक्षण एवं अनुसंधान संस्थान
Rajiv Gandhi National Ground Water Training & Research Institute
फोन / Phone No. 07712220701
ई-मेल / E-mail: rgi-cgwb@nic.in
वेबसाइट / Website: cgwb.gov.in / ngwtri.org
सेक्टर 23, तुता, अटल नगर, नया रायपुर 492016 (छ.ग.)
Sector - 23, Tuta, Atal Nagar, Naya Raipur 492016 (C.G.)

E-877816
15.11.21

File No. 29/TS/RGI/Accreditation/20-21 - 295

Date 02.08.2021

To,

The CMPDIL
Gondwana Place, Kanke Road
Ranchi, (Jharkhand)
PIN- 834031

Sub: - Accreditation Certificate – Reg.

Sir,

Please find enclosed the Certificate of Accreditation in respect of The CMPDIL for the period 2021-2026.

Please acknowledge the receipt of the Certificate

Encl : As Above

Yours Faithfully

02/08/2021
(Satish Kumar)
Regional Director
RGNGWTRI, Raipur

Quality Council of India
National Accreditation Board for Education and Training
ITPI Building, 6th Floor, 4 - A, Ring Road, I P Estate, New Delhi - 110002

CERTIFICATE OF ACCREDITATION

Under the QCI-NABET Scheme
for
Ground Water Consultant Organisation

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

CMPDI, GONDWANA PLACE, KANKE ROAD, RANCHI, JHARKHAND -834031

S.No.	SCOPE COVERAGE		
	Industrial Use	Mining Projects	Infrastructure Projects
1	Hydrogeological report: Comprehensive report on groundwater condition/situation		
2	Impact Assessment Reports without modelling studies		

Note: Names of approved Project Coordinators and Technical Area Experts are mentioned in IA AC Minutes dated Oct 14, 2021 on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in NABET's letter of accreditation bearing no. QCI/NABET/ENV/GWCO/21/57 dated Oct 27, 2021. The accreditation needs to be renewed before the expiry date by Oct 13, 2026 following due process of assessment.

Sr. Director, NABET
Issue Date : Oct 27, 2021

Certificate No.
NABET/GWCO/IA/GW021

Valid Upto
Oct 13, 2026

Ref. No. - QCI/NABET/ENV/GWCO/ACO/21/57 October 27, 2021

To,

M/s Central Mine Planning and Design Institute Limited
Gondwana Place, Kanke Road,
Ranchi, Jharkhand- 834031

Sub: Accreditation under NABET Scheme of Ground Water Consultant Organization (GWCO)

Ref.: With reference to your application No. QCI/NABET/GWCO/0011/IA dated October 22, 2020.

Dear Sir

QCI-NABET is hereby pleased to accredit 'Central Mine Planning and Design Institute Limited' for the scope coverage as mentioned in the Certificate of Accreditation.

The validity of accreditation is subject to continued compliance to the Scheme and the terms & conditions mentioned in **Annexure I to IV.**

NABET always look forward for your association and continued support.

With best regards,

27/10/2021

A K Jha
Senior Director
QCI- NABET

Annexure-I

Ref. No.: QCI/NABET/ENV/GWCO/ACO/21/57
Date October 27, 2021
Name of organization: Central Mine Planning and Design Institute Limited

Accreditation of Ground Water Consultant Organization (GWCO) under NABET Scheme

Marks obtained in various aspect of Initial Assessment

Sl. No.	Aspect	Marks Scored	Out of
1.	**Quality and performance of personnel**		
	i. Project Coordinator/s	18.29 (Average)	25
	ii. Technical Area Expert/s	13.29 (Average)	20
2.	**Infrastructure and software and hardware**	13.20	15
3.	**Field Invest. & Laboratory system**	13.80	20
4.	**Quality Management System**	10.88	15
5.	**Organizational Commitment**	4.20	5
	Total	73.66	**100**
	Overall Score	**73.66%**	

The organization has scored 73.66% overall and awarded 3-Star (★★★

Criteria for Star Rating:

S. No	Overall Score	Star Rating
1	40% to 60%	★
2	61% to 70%	★ ★
3	71% and Above	★ ★ ★

National Accreditation Board for
Testing and Calibration Laboratories

NABL

CERTIFICATE OF ACCREDITATION

ENVIRONMENT LABORATORY, REGIONAL INSTITUTE -II, CMPDI DHANBAD

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

CMPDIL, RI-2, KOYLABHAWAN, KOYLANAGAR, DHANBAD, JHARKHAND, INDIA

in the field of

TESTING

Certificate Number: TC-10122

Issue Date: 07/12/2021 **Valid Until:** 06/12/2023

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Name of Legal Identity : CENTRAL MINE PLANNING AND DESIGN INSTITUTE LTD.

Signed for and on behalf of NABL

N. Venkateswaran
Chief Executive Officer

REGISTERED OFFICE

Gondwana Place, Kanke Road
Ranchi -834 031
(Jharkhand)

REGIONAL INSTITUTES

क्षेत्रीय संस्थान-I
वेस्ट एंड, जी.टी.रोड
आसनसोल-713 301
(पश्चिम बंगाल)

क्षेत्रीय संस्थान-II
कोयला भवन, कोयला नगर
धनबाद- 826 005
(झारखंड)

क्षेत्रीय संस्थान-III
गोंदवाना प्लेस,कांके रोड
राँची- 834 031
(झारखंड)

क्षेत्रीय संस्थान-IV
जरीपटका, कस्तूरबा नगर
नागपुर-440 014
(महाराष्ट्र)

क्षेत्रीय संस्थान-V
सीपत रोड
बिलासपुर-495 001
(छत्तीसगढ़)

क्षेत्रीय संस्थान-VI
पोस्ट :जयंत कॉलरी,
जिला : सिंगरौली
पिन नं0- 486 890
(मध्य प्रदेश)

क्षेत्रीय संस्थान-VII
गृह निर्माण भवन
सचिवालय मार्ग
भुवनेश्वर-751001
(उड़ीसा)

Regional Institute - I
West End, G.T Road
Asansol - 713 301
(West Bengal)

Regional Institute - II
Koyla Bhawan, Koyla Nagar
Dhanbad - 826 005
(Jharkhand)

Regional Institute - III
Gondwana Place, Kanke Road
Ranchi- 834 031
(Jharkhand)

Regional Institute - IV
Jaripathka, Kasturba Nagar
Nagpur - 440 014
(Maharashtra)

Regional Institute - V
Seepat Road
Bilaspur - 495 001
(Chattisgarh)

Regional Institute - VI
P.O Jayant Colliery
Dist. - Singrauli
PIN - 486 890
Madhya Pradesh

Regional Institute - VII
Grih Nirman Bhawan
Sachivalaya Marg
Bhubneswar - 751 001
(Orissa)

सेन्ट्रल माईन प्लानिंग एंड डिजाइन इन्स्टीच्यूट लिमिटेड

(कोल इंडिया की अनुषंगी कम्पनी)
एक मिनी रत्न कम्पनी

Central Mine Planning & Design Institute Limited

(A Subsidiary of Coal India Limited)
A Mini Ratna Company

गोंदवाना प्लेस, काँके रोड, राँची - 834 031, भारत
दूरभाष : (91-0651) 2230002, 2230483
फैक्स : (91-0651) 2231447
वेबसाईट : www.cmpdi.co.in

Gondwana Place, Kanke Road, Ranchi - 834 031, INDIA
Phone : (91 - 0651) 2230002, 2230483
Fax : (91 - 0651) 2231447
website : www.cmpdi.co.in

REGISTERED OFFICE

Gondwana Place, Kanke Road
Ranchi -834 031
(Jharkhand)

REGIONAL INSTITUTES

क्षेत्रीय संस्थान-I
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पोस्ट :जयंत कॉलरी,
जिला : सिंगरौली
पिन नं0- 486 890
(मध्य प्रदेश)

क्षेत्रीय संस्थान-VII
गृह निर्माण भवन
सचिवालय मार्ग
भुवनेश्वर-751001
(उड़ीसा)

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Koyla Bhawan, Koyla Nagar
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(Jharkhand)

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Gondwana Place, Kanke Road
Ranchi- 834 031
(Jharkhand)

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Nagpur - 440 014
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Sachivalaya Marg
Bhubneswar - 751 001
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(कोल इंडिया की अनुषंगी कम्पनी)
एक मिनी रत्न कम्पनी

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गोंदवाना प्लेस, काँके रोड, राँची - 834 031, भारत
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website : www.cmpdi.co.in

Annexure-XI

CSR initiatives and expenditure FY 2021-22 _BCCL		
FY 2021-22		
Sl No	**Particulars**	**Expenditure incurred(in Rs. Lakh)**
1	Depository mode Financial assistance to D.C., Dhanbad for combating COVID-19 situation in Dhanbad	100.00
2	Depository mode Financial assistance to Jharkhand State Disaster Mitigation Fund for distributing home isolation kits to COVID-19 patients	25.00
3	Procurement of masks & hand wash/ sanitizers for distribution amongst public for combating COVID-19	0.72
4	Fooding through Administration department for Doctors and Frontline workers at Covid Ward, CHD, Dhanbad and other miscellaneous COVID-19 expenditure like temporary contract of doctor etc.	36.45
5	Additional financial liability on submission of fresh bills for the work "Boarding and lodging of doctors and paramedical staff engaged in COVID-19 Hospital, CHD"	22.62
6	Cleaning and sanitization of temporary quarantine centres for doctors and paramedic staff engaged in treatment of COVID 19	2.15
7	Training of Youths in Various Plastic Engineering Courses through Central Institute of Plastics Engineering and Technology (CIPET)	14.00
8	Development of 500 Nos. of Aanganwadi Centres in Dhanbad	75.00
9	SVA Survey Expenditure (All Areas)	6.96
10	Distribution of blankets during winter season	3.58
11	Submission of fresh bills for project "Training of mining sirdar for SC/ST PAPs" by PB Area	3.26
12	Submission of fresh bills for "Operation of COVID quarantine centre" by Bastacolla Area	3.80
13	Upgradation of public toilets and approach road in Central Hospital, Dhanbad	3.15
14	Submission of final bills for "Gymnasium at Ambedkar Academy, Dhanbad"	2.35
15	Reversal of Financial Liablity (medical camps)	(8.52)
16	Amount for Aanganwadi deposited in Unspent CSR Account	188.50
17	Amount for CIPET deposited in Unspent CSR Account	14.00
	Total	**493.02**

Annexure-XII

Water Supply to nearby villagers

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

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

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

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

Financial Year	**Amount paid (Rs.)**
2013-14	84,00,275
2014-15	76,77,525
2015-16	39,35,600
2016-17	36,14,075
2017-18	29,03,400
2018-19	38,71,200
2019-20	70,88,190
2020-21	10,45,220 (Up to 30.06.2020)

Annexure-XIII

STRICTLY RESTRICTED

FOR COMPANY USE ONLY RESTRICTED

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

WATER QUALITY REPORT

OF

BHARAT COKING COAL LIMITED, CLUSTER – III

(FOR THE Q.E. DECEMBER, 2021)

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

CMPDI

ISO 9001 Company

Regional Institute-II

Dhanbad, Jharkhand

CLUSTER - III

(FOR THE Q.E. DECEMBER, 2021)

CONTENTS

STRICTLY RESTRICTED
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WATER QUALITY REPORT

OF

BHARAT COKING COAL LIMITED
CLUSTER – II

(FOR THE Q.E. DECEMBER, 2021)

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

CMPDI

ISO 9001 Company

Regional Institute-II
Dhanbad, Jharkhand

EXECUTIVE SUMMARY

1.0 Introduction

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

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

2.0 Sampling location and rationale

2.1 Water sampling stations

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

2.2 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.

3.0 Methodology of sampling and analysis

3.1 Water quality

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

3.2 Heavy Metal in Ambient Air

Parameters chosen for assessment of Heavy metal in Ambient Air Quality were cadmium (Cd), Mercury (Hg), Arsenic (As), Chromium (Cr), Nickel (Ni), and Lead (Pb). Respirable Dust Samplers (RDS) & fine particulates for PM 2.5 sampler were used for sampling PM 10 & PM 2.5 respectively. These heavy metals are analyzed regularly on half yearly basis. The samples were analyzed in Environmental Laboratory of CMPDI, RI-II, Dhanbad

4.0 Results and interpretations

4.1 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines, IS.10500/2012 (Drinking water) and IS: 2296 (Surface water), are with in permissible limits.

4.2 Heavy Metal in Ambient Air

The results of Heavy metal in Ambient Air Quality are presented in tabular form for each monitoring station. The concentration of heavy metals in ambient air is well within the permissible limit.

CHAPTER - I

INTRODUCTION

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

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

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

1.1 The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akashkinaree Mine and Block IV Kooridih Mixed Mine. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster - III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and BagdighiNala.

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

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

CHAPTER – II

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

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

2.2 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

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

The location of the sampling station is at 23°47'54.00"N & 86°16'20.00"E.

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

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

ii) Govindpur Village (A7) : Industrial area

The location of the sampling station is 23°48'34.00"N & 86°18'22.00"E.

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

The location of the sampling station is 23°46'29.00"N & 86°14'37.08"E.

2.3 Results and interpretations

The results of Heavy metal in Ambient Air Quality are presented in tabular form for each monitoring station. The concentration of heavy metals in ambient air is well within the permissible limit.

AMBIENT AIR QUALITY DATA

Name of the Company: **Bharat Coking Coal Limited** Year : **2021-22.**

Name of the Cluster : **Cluster -III** PERIOD: **Q. E. DECEMBER- 2021.**

Heavy Metal Analysis report of Ambient Air Quality

SAMPLE	Cadmium(Cd) (µg/m3)	Mercury(Hg) (µg/m3)	Arsenic(As) (ng/m3)	Chromium(Cr) (µg/m3)	Nickel (Ni) (ng/m3)	Lead (Pb)(µg/m3)
Muraidih OCP (A5)	<0.001	<0.001	<0.005	0.038	2.94	0.169
Block IV Kooridih OCP (A6)	<0.001	<0.001	<0.005	0.044	2.91	0.221
Govindpur Village (A7)	<0.001	<0.001	<0.005	0.032	3.13	0.156
Kharkharee(A21)	<0.001	<0.001	<0.005	0.014	1.14	<0.005

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CHAPTER – II

WATER QUALITY MONITORING

3.1 Location of sampling sites

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

i) Drinking water quality at **Jogidih Village (DW3)**

ii) Surface water quality at **U/S of Khudia Nala (SW4)**

iii) Surface water quality at **D/S of Khudia Nala (SW5)**

iv) Surface water quality at **U/S of Bagdighi Nala (SW6)**

v) Surface water quality at **D/S of Bagdighi Nala (SW7)**
vi) Mine Effluent quality at **Jogidih (MW3)**

3.2 Methodology of sampling and analysis

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

3.3 Results & Interpretations

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

WATER QUALITY

(SURFACE WATER- ALL PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2021-22**

Name of the Cluster : **Cluster - III** Month: **Q.E. DEC, 2021**

Stations: **Date of Sampling:**

1. Upstream in Khudia nala SW-4 (wrt Cluster-3) 20/12/2021
2. Down stream in Khudia nala SW-5 20/12/2021
3. Upstream in Bagdigi Nala SW-6 20/12/2021
4. Down stream in Bagdigi Nala SW-7 20/12/2021

Sl. No	Parameter	Sampling Stations				IS: 2296	Detection Limit	BIS Standard & Method
		SW4	SW5	SW6	SW7			
1	Arsenic (as As), mg/l, Max	<0.006	<0.006	<0.006	<0.006	0.2	0.006	IS-3025,part 37:1988, R-2019/ APHA 23rd Edition AAS-VGA
2	BOD (3 days 27^{o}C), mg/l, Max	<2.0	<2.0	<2.0	<2.0	3.00	2.00	IS 3025 (Part 44) : 1993 Reaffirmed 2019 , 3 day incubation at 27°C
3	Colour	3	4	2	2	300	Qualitative	Physical/Qualitative
4	Chlorides (as Cl), mg/l, Max	36	34	75	77	600	2.00	IS-3025/32:1988, R-2019 Argentometric
5	Copper (as Cu), mg/l, Max	<2.0	<0.2	<0.2	<0.2	1.5	0.2	IS 3025/42 : 1992 R : 2019, AAS-Flame
6	Dissolved Oxygen, min.	7.8	7.7	8.1	8.0	4	0.10	IS 3025 (Part 38) : 1989, Reaffirmed 2019 Modified Winkler Azide Method
7	Fluoride (as F) mg/l, Max	0.74	0.76	0.63	0.69	1.5	0.02	APHA, 23RD Edition, Page 4-90 to , 4500 –F- D (SPADNS Method)
8	Hexavalent Chromium, mg/l, Max	<0.01	<0.1	<0.1	<0.1	0.05	0.01	IS 3025 (Part 52) : 2003,Reaffirmed 2019
9	Iron (as Fe), mg/l, Max	<0.2	<0.2	<0.2	<0.2	50	0.2	IS 3025 /53 : 2003,R : 2019 , AAS-Flame Method
10	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	<0.005	0.1	0.005	APHA, 23rd Edition, AAS-GTA
11	Nitrate (as NO_3), mg/l, Max	6.96	4.38	10.24	3.73	50	0.50	APHA, 23rd Edition, P-4-127, 4500 - NO_3^- B , UV-Spectrophotometric Screening Method
12	pH value	8.25	8.25	8.12	8.22	6.5-8.5	2.5	IS 3025, Part 11 : 1983 R 2017 Electrometric method
13	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.005	0.002	APHA, 22nd Edition 4-Amino Antipyrine
14	Selenium, mg/l, Max	<0.007	<0.007	<0.007	<0.007	0.05	0.007	IS-3025,part 56:2003, R-2019/ APHA 23rd Edition, AAS-VGA
15	Sulphate (as SO_4) mg/l, Max	169	154	162	134	400	2.00	APHA –23rd Edition. P-4-199, 4500 SO_4^{2-} E
16	Total Dissolved Solids, mg/l, Max	419	453	470	430	1500	25.00	IS 3025, Part 16: 1984 R 2017 Gravimetric method
17	Zinc (as Zn), mg/l, Max	<0.1	<0.1	<0.1	<0.1	15	0.1	IS 3025/ 49 : 1994, R : 2019, AAS-Flame

सुमन रुद्र राहुल

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WATER QUALITY

(DRINKING WATER- ALL PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2021-22.**

Name of the Cluster : **Cluster - III** Month: **Q.E.DEC, 2021**

Jogidih village DW 3 **Year: 2021-22** **Date: 23.11.2021**

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		DW3					
1	Boron (as B), mg/l, Max	<0.2			0.2	0.5	APHA, 23rd Edition ,Carmine
2	Colour,in Hazen Units	2			1	5	APHA, 23rd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	76			1.6	75	IS 3025, Part 40: 1991 R 2019 EDTA Method
4	Chloride (as Cl), mg/l, Max	76			2	250	IS-3025/32:1988, R-2019 Argentometric
5	Copper (as Cu), mg/l, Max	<0.03			0.03	0.05	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 23rd Edition, AAS-GTA
6	Fluoride (as F) mg/l, Max	0.58			0.2	1.0	APHA, 23RD Edition, Page 4-90 to , 4500 –F-D (SPADNS Method)
7	Free Residual Chlorine, mg/l, Min	<0.04			0.04	0.2	APHA, 23rd Edition, , 4500-Cl^- B. (Iodometric Method-I)
8	Iron (as Fe), mg/l, Max	2.90			0.2	1.0	IS 3025 Part 53 : 2003, R : 2019 , AAS-Flame Method
9	Lead (as Pb), mg/l, Max	<0.005			0.005	0.01	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 23rd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	0.05			0.02	0.1	APHA, 23rd Edition, 3111B, Direct Air Acetylene Flame AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	44.3			0.5	45	APHA, 23rd Edition, P-4-127, 4500 - NO_3^- B , UV-Spectrophotometric Screening Method
12	Odour	Agreeable			Qualitative	Agreeable	APHA, 23rd Edition, , 2150-C
13	pH value	7.49			0.2	6.5-8.5	IS 3025, Part 11 : 1983 R 2017 Electrometric method
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001			0.001	0.002	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium, mg/l, Max	<0.007			0.007	0.01	IS-3025,part 56:2003, R-2019/ APHA 23rd Edition, AAS-VGA
16	Sulphate (as SO_4) mg/l, Max	117			2	200	APHA –23rd Edition. P-4-199, 4500 SO_4^{2-} E
17	Taste	Acceptable			Qualitative	Acceptable	APHA,23rd Edition, 2160-C Flavour Rating Assesment
18	Total Alkalinity (c_aco_3),, mg/l, Max	135			4	200	IS 3025, Part 23: 1986 R 2019 Titration Method
19	Total Arsenic (as As), mg/l, Max	<0.006			0.006	0.01	IS-3025,part 37:1988, R-2019/ APHA 23rd Edition AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04			0.04	0.05	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 23rd Edition, AAS-GTA
21	Total Dissolved Solids, mg/l, Max	469			25	500	IS 3025, Part 16: 1984 R 2017 Gravimetric method
22	Total Hardness (c_aco_3), mg/l, Max	375			4	200	IS 3025, Part 21, 2009 R 2019 EDTA Method
23	Turbidity, NTU, Max	3.9			1	5	IS 3025, Part 10 : 1984 R 2017 Nephelometric Method
24	Zinc (as Zn), mg/l, Max	0.21			0.1	5	IS 3025 Part 49 : 1994,R : 2019, AAS-Flame
25	Nickel as Ni, mg/l Max	<0.01			0.01	0.02	IS 3025 Pat 54 : 2003,R : 2019, AAS-Flame APHA, 23rd Edition, AAS-GTA

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JSA/SA/SSA

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HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

WATER QUALITY

(MINE EFFLUENT- 27 PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2021-22.**

Name of the Cluster : **Cluster - III** Month: **Q. E. DEC, 2021**

Date of sampling: 20.12.2021

Sample Code :MW3					20.12.2021
Sl.No.	**Parameter**	**Results MW-3**	**Detection Limit**	**MOEF -SCH-VI STANDARDS Class 'A'**	**BIS Standard & Method**
1	Ammonical Nitrogen, mg/l, Max	0.4	0.02	50.0	IS 3025/34:1988, R : 2009, Nessler's
2	Arsenic (as As), mg/l, Max	<0.006	0.006	0.2	IS-3025,part 37:1988, R-2019/ APHA 23rd Edition AAS-VGA
3	B.O.D (3 days 27ºC), mg/l, Max	<2.0	2.00	30.0	IS 3025 /44:1993,R:2003 3 day incubation at 27°C
4	Colour	2	1	1-100Hazen Units	APHA,23RD Edition ,2120-B-:2017
5	COD, mg/l, Max	20	4.00	250.0	APHA 23rd Edition 5220 C Titrimetric Method
6	Copper (as Cu), mg/l, *Max*	<0.2	0.2	3.0	IS 3025(Part42): 1992 R : 2019, AAS-Flame
7	Dissolved Phosphate (as P), mg/l, Max	<0.1	0.30	5.0	IS 3025/ 31, 1988 R 2019
8	Fluoride (as F) mg/l, *Max*	0.59	0.02	2.0	APHA, 23RD Edition, Page 4-90 to , 4500 –F- D (SPADNS Method)
9	Free Ammonia, mg/l, Max	<0.01	0.01	5.0	IS:3025/34:1988, Nesseler's
10	Hexavalent Chromium, mg/l, Max	<0.01	0.01	0.1	IS 3025 (Part 52) : 2003,Reaffirmed 2019
11	Iron (as Fe), mg/l, *Max*	<0.2	0.2	3.0	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame
12	Lead (as Pb), mg/l, *Max*	<0.005	0.005	0.1	APHA, 23rd Edition, AAS-GTA
13	Manganese(as Mn), mg/l, Max	<0.2	0.2	2.0	IS-3025(Part 59):2006, R 2017 AAS-Flame /APHA, 23rd Edition, 3111B, AAS-Flame
14	Nickel (as Ni), mg/l, *Max*	<0.1	0.1	3.0	IS-3025(Part 54):2003, R:2019 AAS-Flame
15	Nitrate Nitrogen, mg/l, *Max*	9.20	0.50	10.0	APHA, 23 rd Edition,UV-Spectrphotometric
16	Oil & Grease, mg/l, Max	<2.0	2.00	10.0	IS 3025/39:1991, R : 2019, Partition Gravimetric
17	pH value	8.09	2.5	5.5 to 9.0	IS-3025/11:1983, R-2017, Electrometric
18	Phenolic compounds (as C_6H_5OH),mg/l, *Max*	<0.002	0.002	1.0	APHA, 23rd Edition 4-Amino Antipyrine
19	Selenium, mg/l, Max	<0.007	0.007	0.05	IS-3025,part 56:2003, R-2019/ APHA 23rd Edition, AAS-VGA
20	Sulphide (as S^{2-}) mg/l Max.	<0.005	0.005	2.0	APHA 23rd Edition Methylene Blue Method
21	Temperature (^oC)	20.1	Shall not exceed 5^0 C above the receiving temp.		IS-3025/09:1984, Thermometeric
22	Total Chromium (as Cr), mg/l, *Max*	<0.1	0.1	2.0	IS-3025(Part 52):2003, R:2019 AAS-Flame
23	Total Kjeldahl Nitrogen, mg/l, Max	1.4	1.00	100.0	IS:3025/34:1988, Nesseler's
24	Total Residual Chlorine, mg/l, Max	<0.04	0.04	1.0	APHA, 23rd Edition, , 4500-Cl B. (Iodometric Method-I)
25	Total Suspended Solids, mg/l, Max	34	10.00	100.0	IS 3025/17:1984, R :2017, Gravimetric
26	Zinc (as Zn), mg/l, *Max*	0.15	0.1	5.0	IS 3025 /49 : 1994, R : 2019, AAS-Flame
27	Odour	Agreeable		Qualitative	APHA, 23rd Edition, , 2150-C

All values are expressed in mg/lit unless specified.

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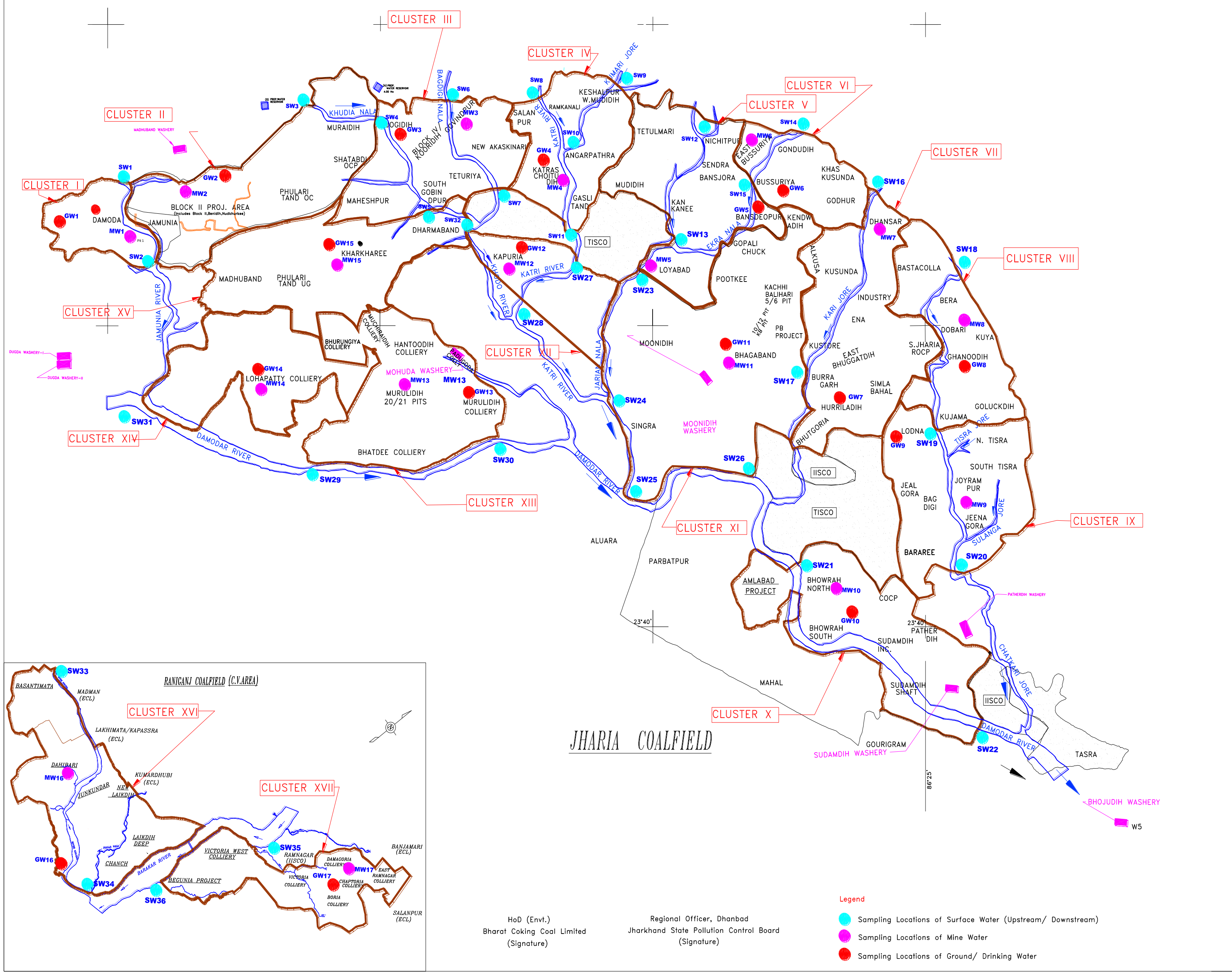
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

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	Bhagabandh 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)

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

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

(FOR THE MONTH JANUARY, 2022)

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

CMPDI

ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CONTENTS

EXECUTIVE SUMMARY

1.0 Introduction

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

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

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

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

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

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

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

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

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

3.2 Water quality

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

3.3 Noise level monitoring

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

4.0 Results and interpretations

4.1 Air quality

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

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

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

4.2 Water quality

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

4.3 Noise Level

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

INTRODUCTION

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

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

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster - III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

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

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

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

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

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

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

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

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

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

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

ii) Govindpur Village (A7) : Industrial area

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

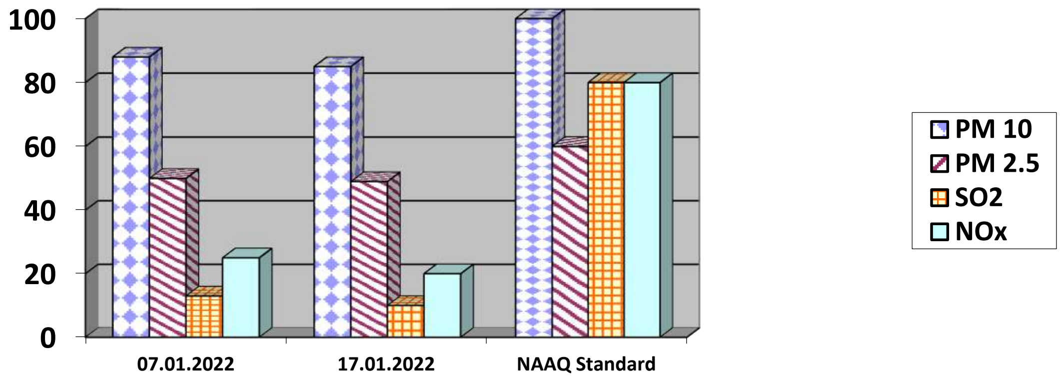
iii)Kharkharee(A21): **Industrial Area**

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

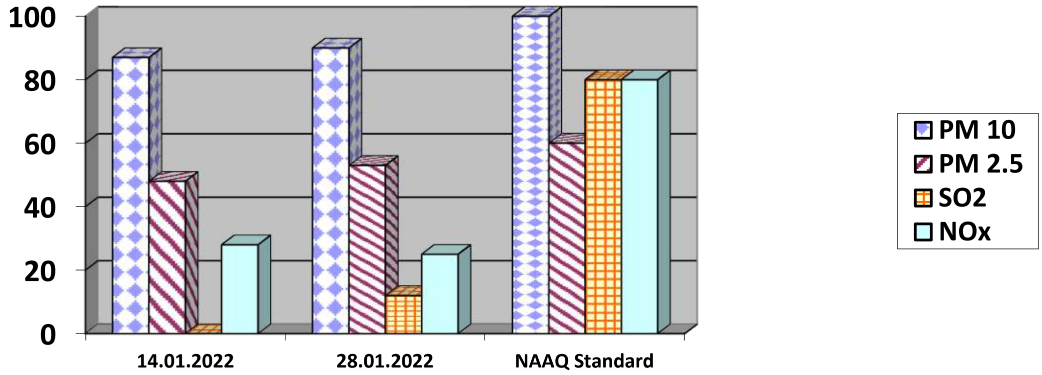
AMBIENT AIR QUALITY DATA

Cluster – III, Bharat Coking Coal limited Month: **JAN 2022** Year : **2021-22.**

Station Name: A6, Block IV		**Zone: Core**		**Category: Industrial**	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	07.01.2022	88	50	13	25
2	17.01.2022	85	49	10	20
	NAAQ Standard	100	60	80	80



Station Name: A5, Muraidih OCP		**Zone: Buffer**		**Category: Industrial**	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	14.01.2022	87	48	<10	28
2	28.01.2022	90	53	12	25
	NAAQ Standard	100	60	80	80



Note:

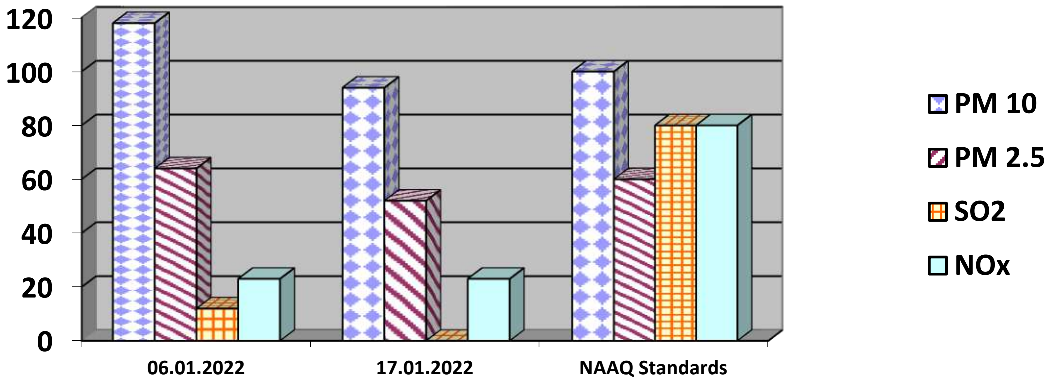
- *All values are expressed in microgram per cubic meter.*
- *24 hours duration*

Analysed By
JSA/SA/SSA

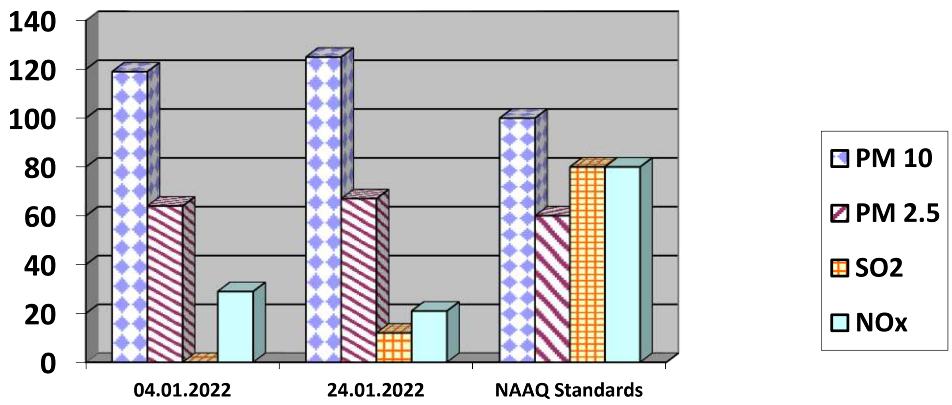
Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

Station Name: A7, Govindpur Village		Zone: Buffer		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO2**	**NOx**
1	06.01.2022	118	64	12	23
2	17.01.2022	94	52	<10	23
	NAAQ Standards	100	60	80	80



Station Name: A21 Kharkharee		Zone: Buffer		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO2**	**NOx**
1	04.01.2022	119	64	<10	29
2	24.01.2022	125	67	12	21
	NAAQ Standards	100	60	80	80



Note:

- *All values are expressed in microgram per cubic meter.*
- *24 hours duration*

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) **Mine Discharge of Govindpur (MW3)**

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

3.2 Methodology of sampling and analysis

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

3.3 Results & Interpretations

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

WATER QUALITY DATA

(EFFLUENT WATER- FOUR PARAMETERS)

Name of the Cluster: **Cluster -III**		Month: **JAN 2022**	Name of the Station: **Mine Discharge of Govindpur**	
Sl. No.	**Parameters**	**MW3** First Fortnight	**MW3** Second Fortnight	**As per MOEF General Standards for schedule VI**
		10.01.2022	17.01.2022	
1	Total Suspended Solids	46	39	*100 (Max)*
2	pH	7.94	7.96	*5.5 - 9.0*
3	Oil & Grease	<2.0	<2.0	*10 (Max)*
4	COD	20	28	*250 (Max)*

All values are expressed in mg/lit unless specified.

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

NOISE LEVEL QUALITY MONITORING

4.1Location of sampling sites

i) **Block IV (N6)**
ii) **Muraidih OCP(N5)**
iii) **Govindpur Village(N7)**
iv) **Kharkharee (N21)**

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter (NL-52 OF RION CO. Ltd. Make) during day time. Noise levels were measured for about one hour time in day time. 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 and the observed values were compared with standards prescribed by MoEFCC. The results of Noise levels recorded during day 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.

NOISE LEVEL DATA

Name of the Project : **Cluster -III**			Month: **JAN.2022**		
Sl. No.	**Station Name/Code**	**Category of area**	**Date**	**Noise level dB(A)LEQ**	***Permissible Limit of Noise level in dB(A)***
1	Muraidih (N5)	**Industrial area**	13.01.22	57.3	*75*
2	Muraidih	**Industrial area**	28.01.22	56.6	*75*
3	Block-IV(N6)	**Industrial area**	10.01.22	56.6	*75*
4	Block-IV	**Industrial area**	17.01.22	60.2	*75*
5	Govindpur/Ramkanali(N7)	**Industrial area**	06.01.22	59.8	*75*
6	Govindpur/Ramkanali	**Industrial area**	17.01.22	60.3	*75*
7	Kharkharee(N21)	**Industrial area**	06.01.22	55.3	*75*
8	Kharkharee	**Industrial area**	54.01.22	55.2	*75*

Permissible limits of Noise Level as per MOEF Gazette Notification No. GSR 742(E) dt. 25.09.2000 Standards for Coal Mines and Noise Pollution (Regulation and Control) Rules, 2000.
*** Day Time: 6.00 AM to 10.00 PM,**

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

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.

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

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

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

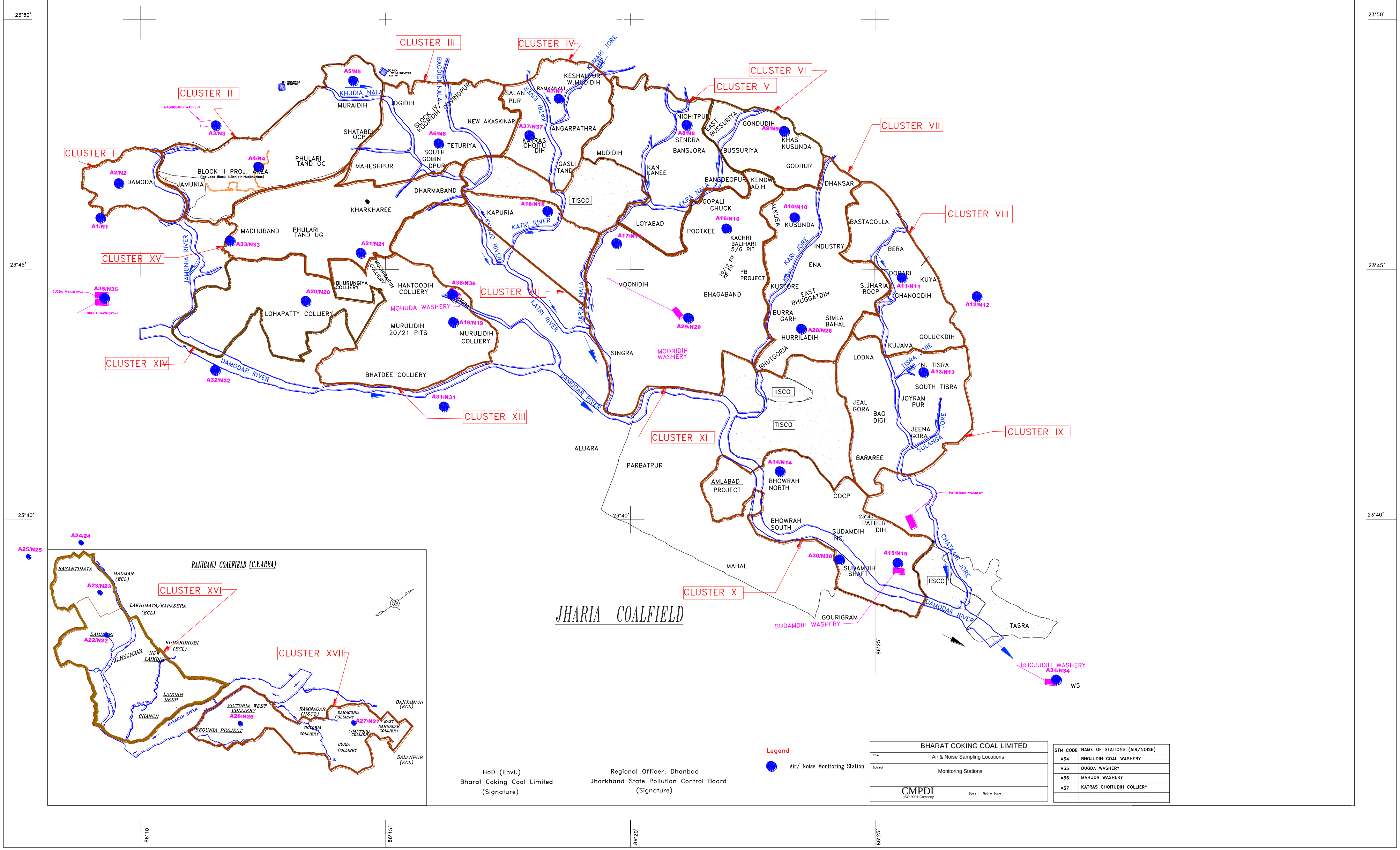
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m^3	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogendioxide (NO_2), µg/m^3	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/m^3	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m^3	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) , µg/m^3	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) , µg/m^3	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/m^3	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m^3	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m^3	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m^3	Annual *	01	01	-Solvent extraction followed byHPLC/GC analysis
Arsenic (As), ng/m^3	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m^3	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



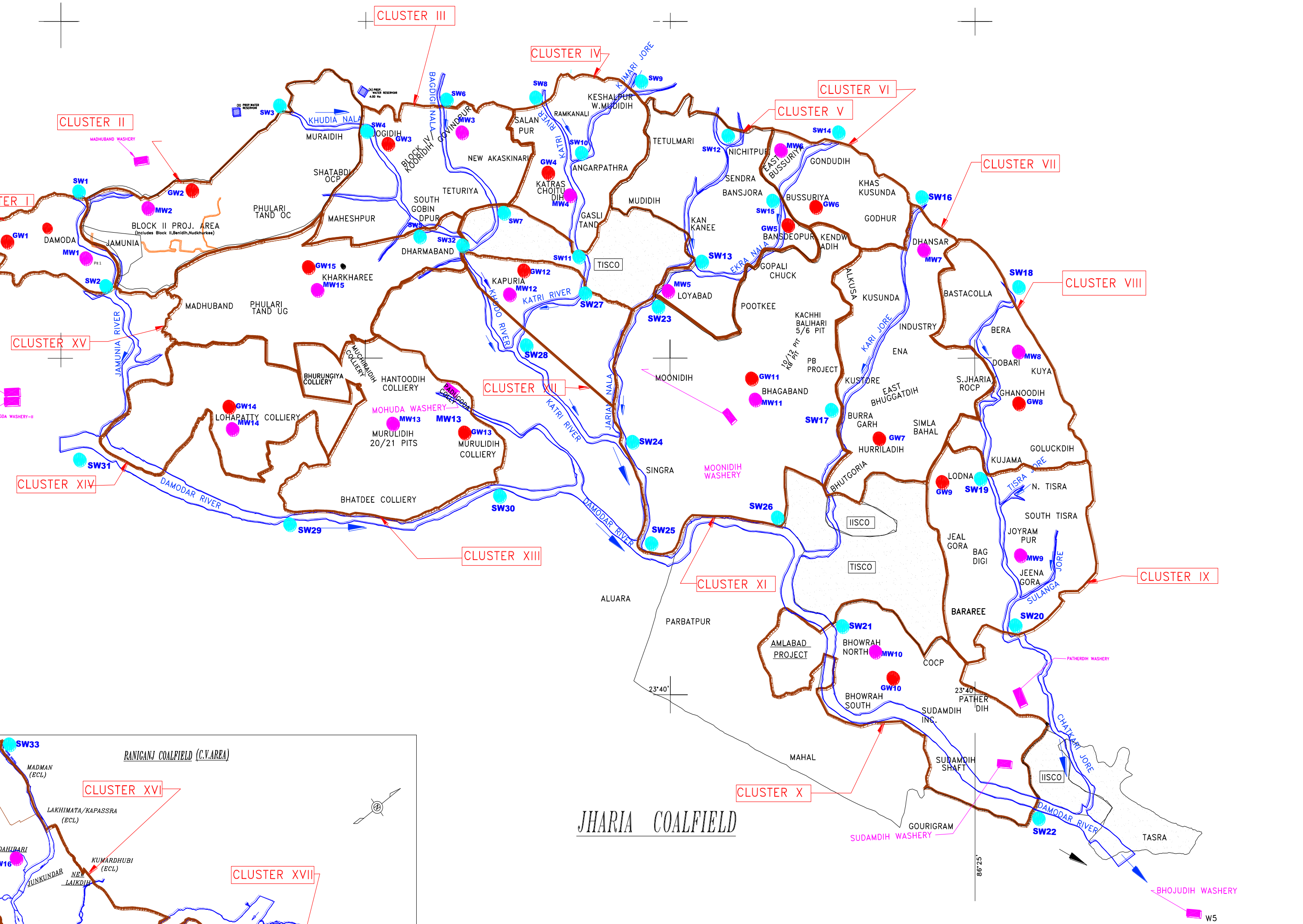
STN CODE	NAME OF STATIONS (AIR/NOISE)
A34	BHOJUDIH COAL WASHERY
A35	DUGDA WASHERY
A36	MAHUDA WASHERY
A37	KATRAS CHOITUDIH COLLIERY

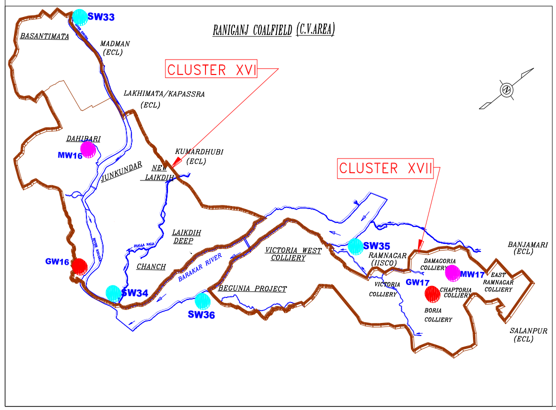
BHARAT COKING COAL LIMITED
Title: Air & Noise Sampling Locations
Subject: Monitoring Stations
CMPDI
ISO 9001 Company
Scale: Not to Scale

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

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

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	Bhagabandh 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

Legend

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

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

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

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

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

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

(FOR THE MONTH FEBRUARY, 2022)

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

CMPDI

ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CONTENTS

EXECUTIVE SUMMARY

1.0 Introduction

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

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

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

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

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

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

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

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

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

3.2 Water quality

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

3.3 Noise level monitoring

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

4.0 Results and interpretations

4.1 Air quality

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

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

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

4.2 Water quality

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

4.3 Noise Level

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

INTRODUCTION

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

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

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster - III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

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

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

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

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

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

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

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

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

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

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

ii) Govindpur Village (A7) : Industrial area

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

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

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

AMBIENT AIR QUALITY DATA

Cluster – III, Bharat Coking Coal limited Month: **FEB 2022** Year : **2021-22.**

Station Name: A6, Block IV		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	10.02.2022	122	65	<10	26
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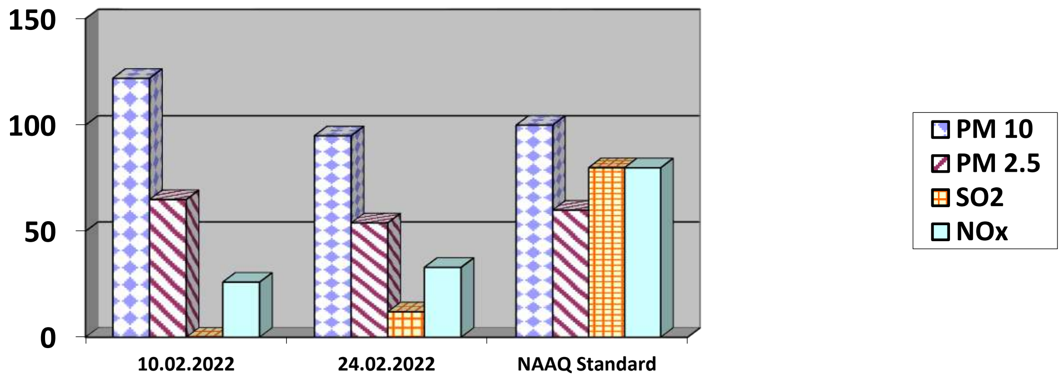

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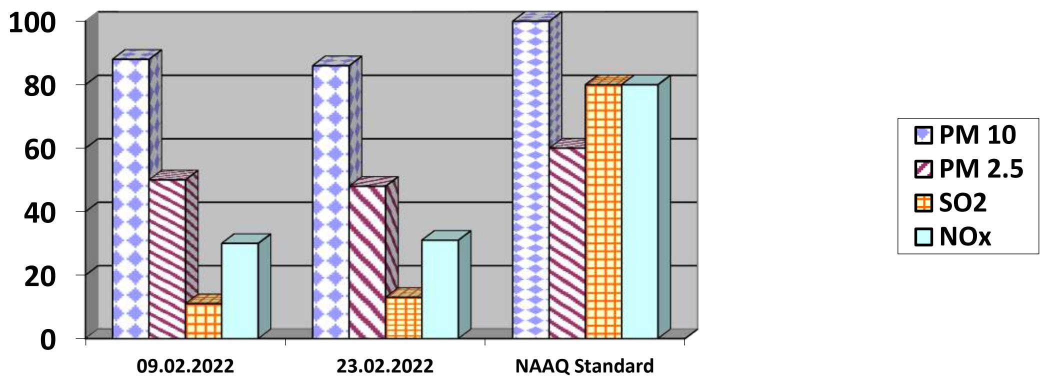

Note:

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Lab In Charge
RI-2, CMPDI, Dhanbad

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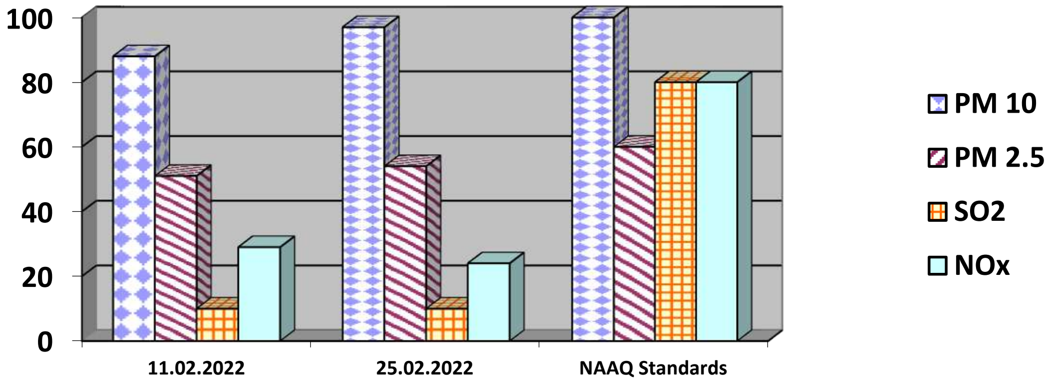
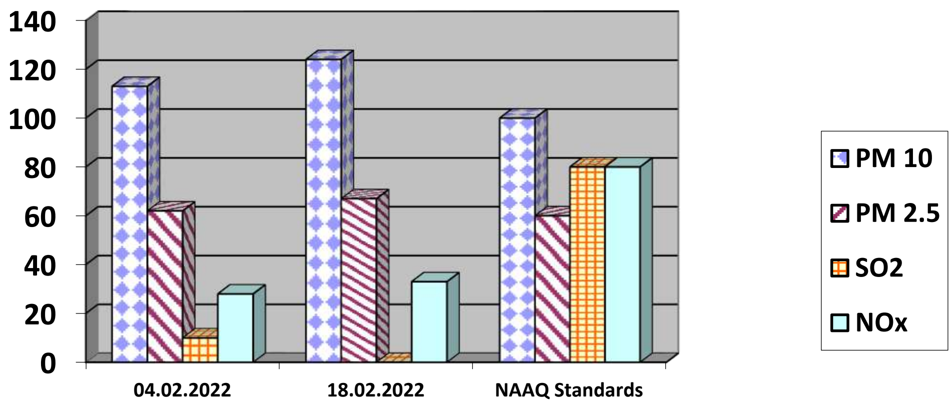
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

Station Name: A7, Govindpur Village		Zone: Buffer		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO2**	**NOx**
1	11.02.2022	88	51	10	29
2	25.02.2022	97	54	10	24
	NAAQ Standards	100	60	80	80



Station Name: A21 Kharkharee		Zone: Buffer		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO2**	**NOx**
1	04.02.2022	113	62	10	28
2	18.02.2022	124	67	<10	33
	NAAQ Standards	100	60	80	80



Note:

- *All values are expressed in microgram per cubic meter.*
- *24 hours duration*

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) Mine Discharge of Govindpur (MW3)

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

3.2 Methodology of sampling and analysis

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

3.3 Results & Interpretations

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

WATER QUALITY DATA

(EFFLUENT WATER- FOUR PARAMETERS)

Name of the Cluster: **Cluster -III**		Month: **FEB 2022**	Name of the Station: **Mine Discharge of Govindpur**	
Sl. No.	**Parameters**	**MW3** First Fortnight	**MW3** Second Fortnight	**As per MOEF General Standards for schedule VI**
		14.02.2022	28.02.2022	
1	Total Suspended Solids	44	38	*100 (Max)*
2	pH	7.95	7.88	*5.5 - 9.0*
3	Oil & Grease	<2.0	<2.0	*10 (Max)*
4	COD	48	40	*250 (Max)*

All values are expressed in mg/lit unless specified.

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

NOISE LEVEL QUALITY MONITORING

4.1Location of sampling sites

i) **Block IV (N6)**
ii) **Muraidih OCP(N5)**
iii) **Govindpur Village(N7)**
iv) **Kharkharee (N21)**

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter (NL-52 OF RION CO. Ltd. Make) during day time. Noise levels were measured for about one hour time in day time. 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 and the observed values were compared with standards prescribed by MoEFCC. The results of Noise levels recorded during day 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.

NOISE LEVEL DATA

Name of the Project : **Cluster -III**			Month: **FEB.2022**		
Sl. No.	**Station Name/Code**	**Category of area**	**Date**	**Noise level dB(A)LEQ**	***Permissible Limit of Noise level in dB(A)***
1	Muraidih (N5)	**Industrial area**	09.02.22	57.2	*75*
2	Muraidih	**Industrial area**	23.02.22	58.7	*75*
3	Block-IV(N6)	**Industrial area**	11.02.22	58.8	*75*
4	Block-IV	**Industrial area**	25.02.22	59.3	*75*
5	Govindpur/Ramkanali(N7)	**Industrial area**	11.02.22	59.9	*75*
6	Govindpur/Ramkanali	**Industrial area**	25.02.22	60.6	*75*
7	Kharkharee(N21)	**Industrial area**	05.02.22	58.4	*75*
8	Kharkharee	**Industrial area**	18.02.22	59.1	*75*

Permissible limits of Noise Level as per MOEF Gazette Notification No. GSR 742(E) dt. 25.09.2000 Standards for Coal Mines and Noise Pollution (Regulation and Control) Rules, 2000.
*** Day Time: 6.00 AM to 10.00 PM,**

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JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

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.

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

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

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

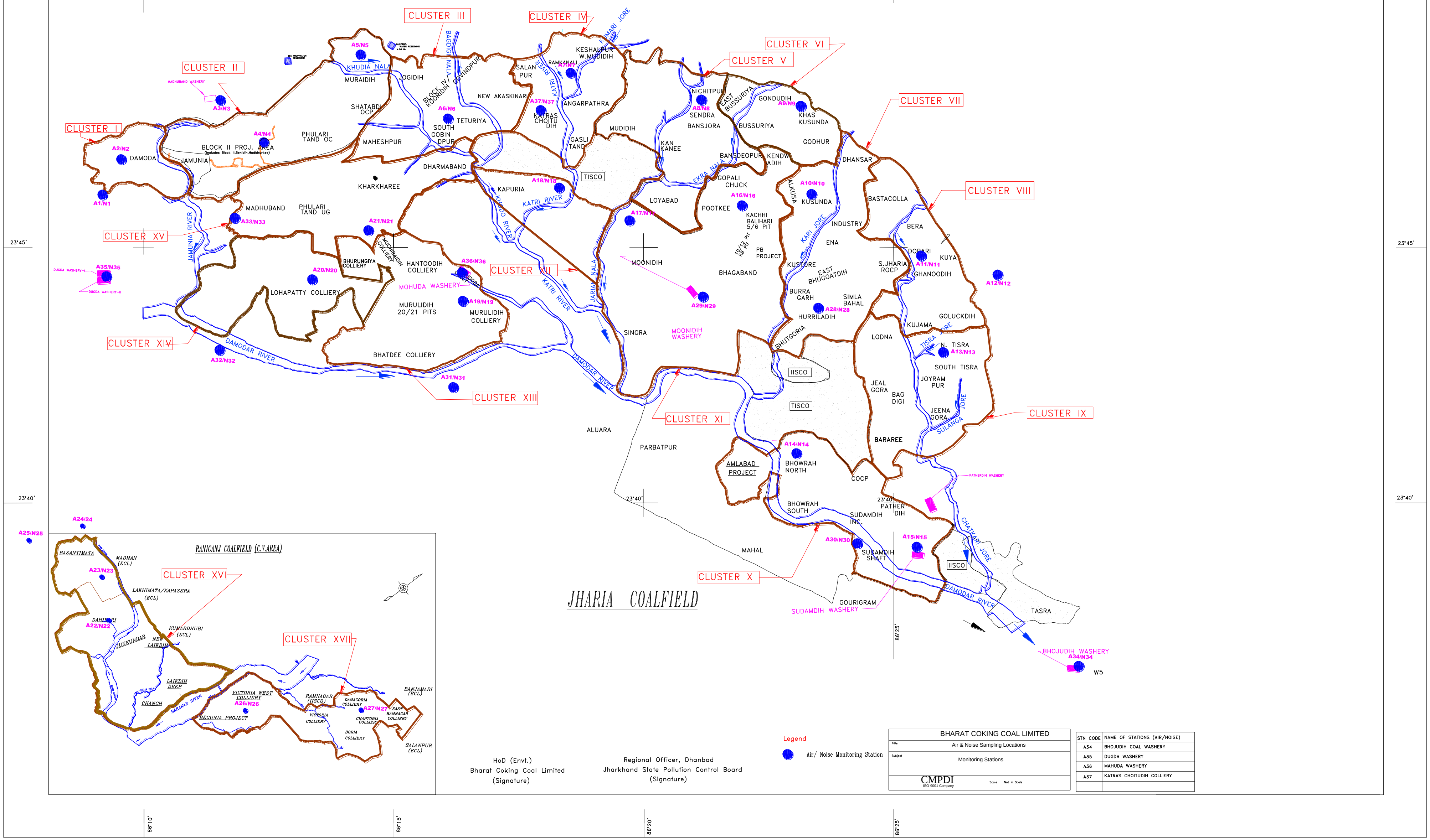
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet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

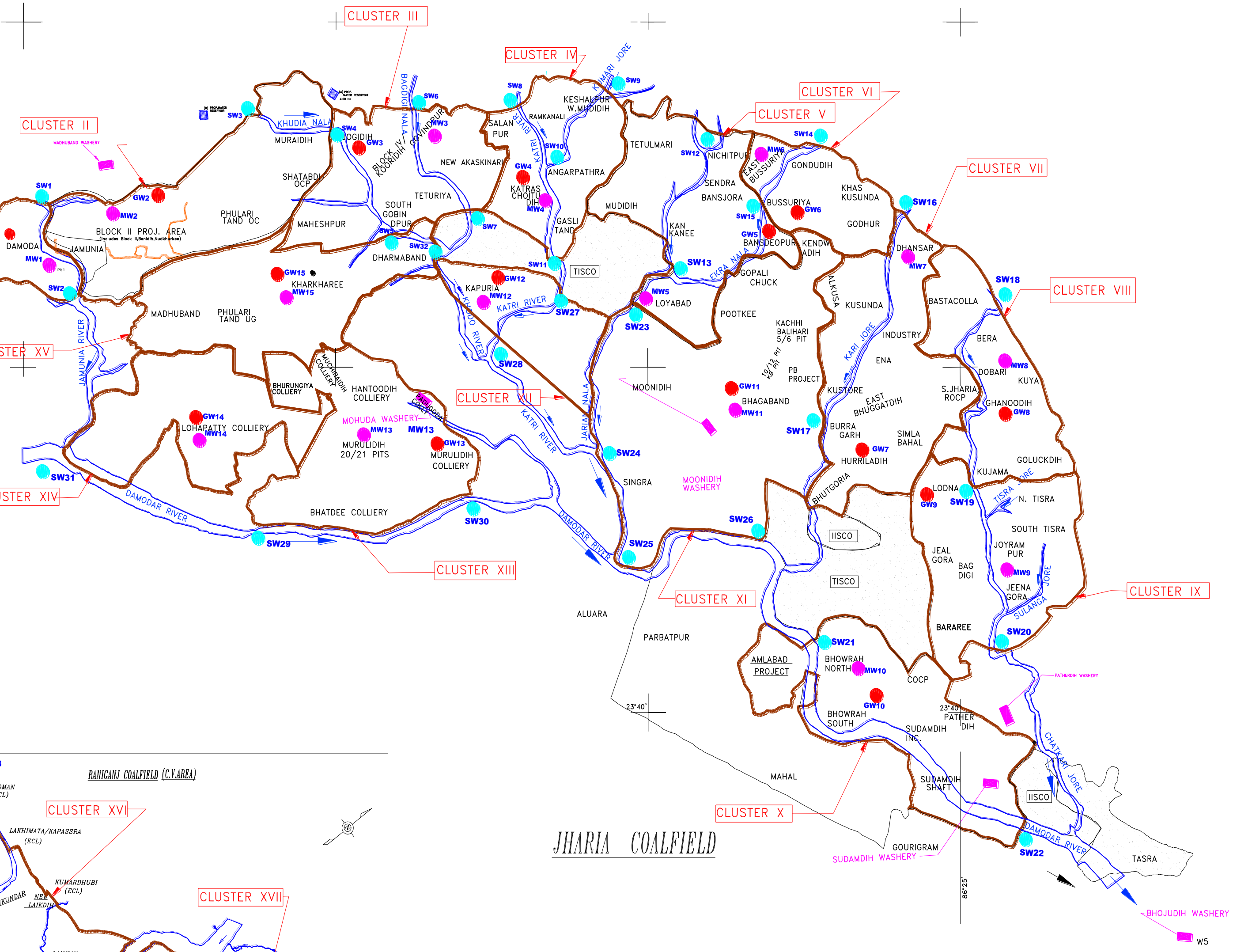
NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

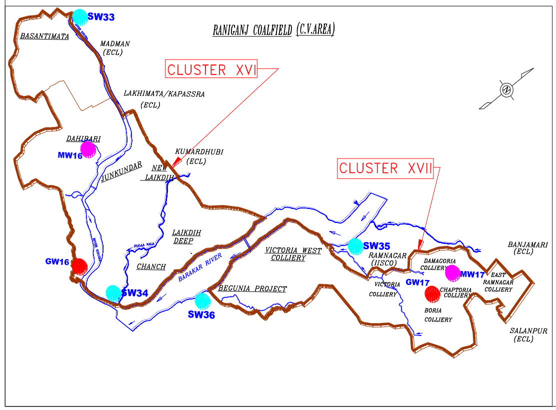
Location of Air & Noise Monitoring Stations in BCCL



STN CODE	NAME OF STATIONS (AIR/NOISE)
A34	BHOJUDIH COAL WASHERY
A35	DUGDA WASHERY
A36	MAHUDA WASHERY
A37	KATRAS CHOITUDIH COLLIERY

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	Bhagabandh 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

Legend

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

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

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

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

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

(FOR THE MONTH MARCH, 2022)

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

CMPDI

ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CONTENTS

EXECUTIVE SUMMARY

1.0 Introduction

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

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

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

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

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

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

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

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

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

3.2 Water quality

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

3.3 Noise level monitoring

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

4.0 Results and interpretations

4.1 Air quality

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

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

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

4.2 Water quality

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

4.3 Noise Level

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

INTRODUCTION

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

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

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster - III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

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

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

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

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

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

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

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

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

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

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

ii) Govindpur Village (A7) : Industrial area

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

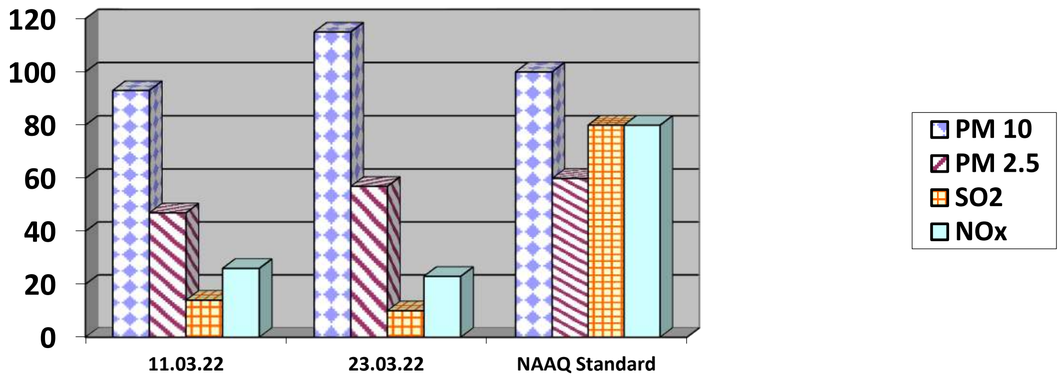
iii)Kharkharee(A21): **Industrial Area**

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

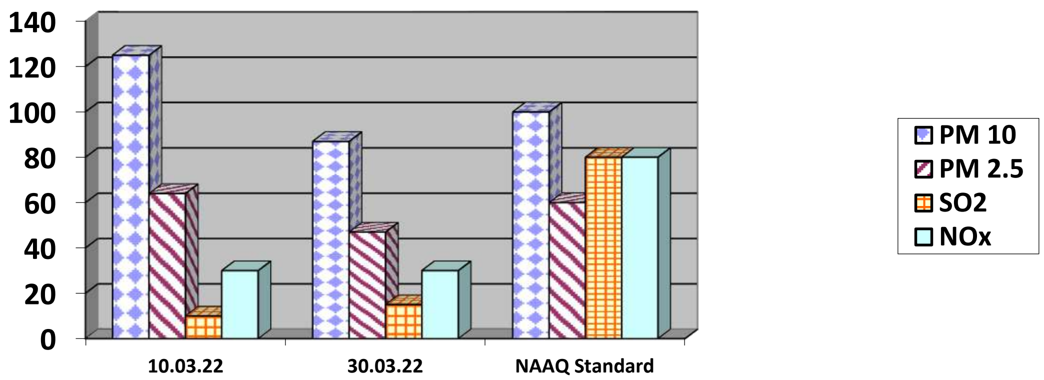
AMBIENT AIR QUALITY DATA

Cluster – III, Bharat Coking Coal limited Month: **MARCH 2022** Year : **2021-22.**

Station Name: A6, Block IV		**Zone: Core**		**Category: Industrial**	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	11.03.22	93	47	14	26
2	23.03.22	115	57	10	23
	NAAQ Standard	100	60	80	80



Station Name: A5, Muraidih OCP		**Zone: Buffer**		**Category: Industrial**	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	10.03.22	125	64	10	30
2	30.03.22	87	47	15	30
	NAAQ Standard	100	60	80	80



Note:

- *All values are expressed in microgram per cubic meter.*
- *24 hours duration*

Analysed By
JSA/SA/SSA

Checked By
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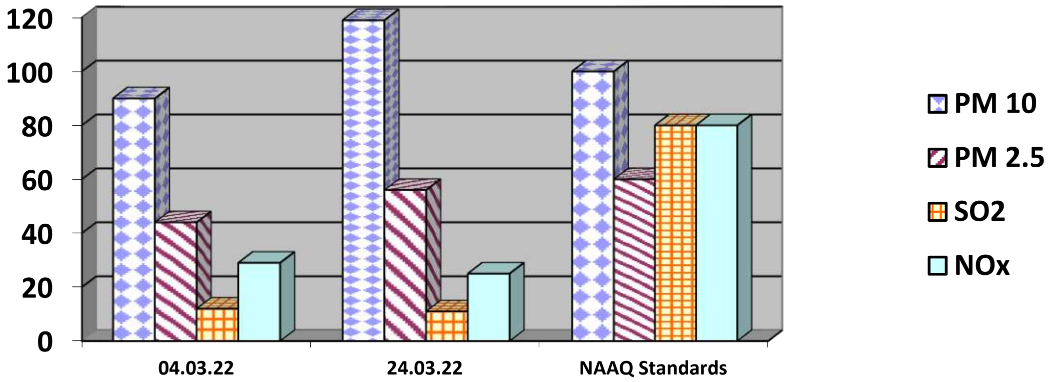
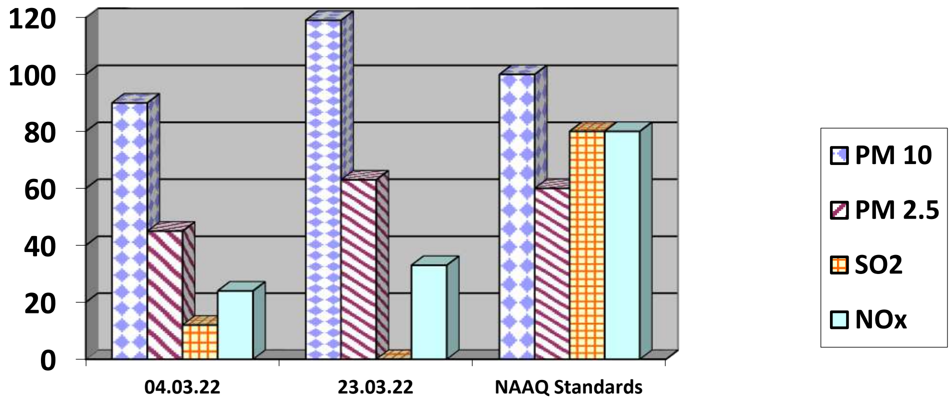
Approved By
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

Station Name: A7, Govindpur Village		Zone: Buffer		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO2**	**NOx**
1	04.03.22	90	44	12	29
2	24.03.22	119	56	11	25
	NAAQ Standards	100	60	80	80



Station Name: A21 Kharkharee		Zone: Buffer		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO2**	**NOx**
1	04.03.22	90	45	12	24
2	23.03.22	119	63	<10	33
	NAAQ Standards	100	60	80	80



Note:

- *All values are expressed in microgram per cubic meter.*
- *24 hours duration*

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JSA/SA/SSA

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RI-2, CMPDI, Dhanbad

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HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) Mine Discharge of Govindpur (MW3)

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

3.2 Methodology of sampling and analysis

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

3.3 Results & Interpretations

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

WATER QUALITY DATA

(EFFLUENT WATER- FOUR PARAMETERS)

Name of the Cluster: **Cluster -III**		Month: **MARCH 2022**	Name of the Station: **Mine Discharge of Govindpur**	
Sl. No.	**Parameters**	**MW3** First Fortnight	**MW3** Second Fortnight	**As per MOEF General Standards for schedule VI**
		14.03.2022	21.03.2022	
1	Total Suspended Solids	39	46	*100 (Max)*
2	pH	7.95	7.81	*5.5 - 9.0*
3	Oil & Grease	<2.0	<2.0	*10 (Max)*
4	COD	40	48	*250 (Max)*

All values are expressed in mg/lit unless specified.

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RI-2, CMPDI, Dhanbad

NOISE LEVEL QUALITY MONITORING

4.1Location of sampling sites

i) **Block IV (N6)**
ii) **Muraidih OCP(N5)**
iii) **Govindpur Village(N7)**
iv) **Kharkharee (N21)**

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter (NL-52 OF RION CO. Ltd. Make) during day time. Noise levels were measured for about one hour time in day time. 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 and the observed values were compared with standards prescribed by MoEFCC. The results of Noise levels recorded during day 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.

NOISE LEVEL DATA

Name of the Project : **Cluster -III**			Month:**MARCH2022**		
Sl. No.	**Station Name/Code**	**Category of area**	**Date**	**Noise level dB(A)LEQ**	***Permissible Limit of Noise level in dB(A)***
1	Muraidih (N5)	**Industrial area**	11.03.2022	55.2	*75*
2	Muraidih	**Industrial area**	22.03.2022	57.2	*75*
3	Block-IV(N6)	**Industrial area**	11.03.2022	59.3	*75*
4	Block-IV	**Industrial area**	24.03.2022	57.6	*75*
5	Govindpur/Ramkanali(N7)	**Industrial area**	07.03.2022	59.3	*75*
6	Govindpur/Ramkanali	**Industrial area**	24.03.2022	57.3	*75*
7	Kharkharee(N21)	**Industrial area**	03.03.2022	59.2	*75*
8	Kharkharee	**Industrial area**	24.03.2022	56.8	*75*

Permissible limits of Noise Level as per MOEF Gazette Notification No. GSR 742(E) dt. 25.09.2000 Standards for Coal Mines and Noise Pollution (Regulation and Control) Rules, 2000.
*** Day Time: 6.00 AM to 10.00 PM,**

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

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.

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

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

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

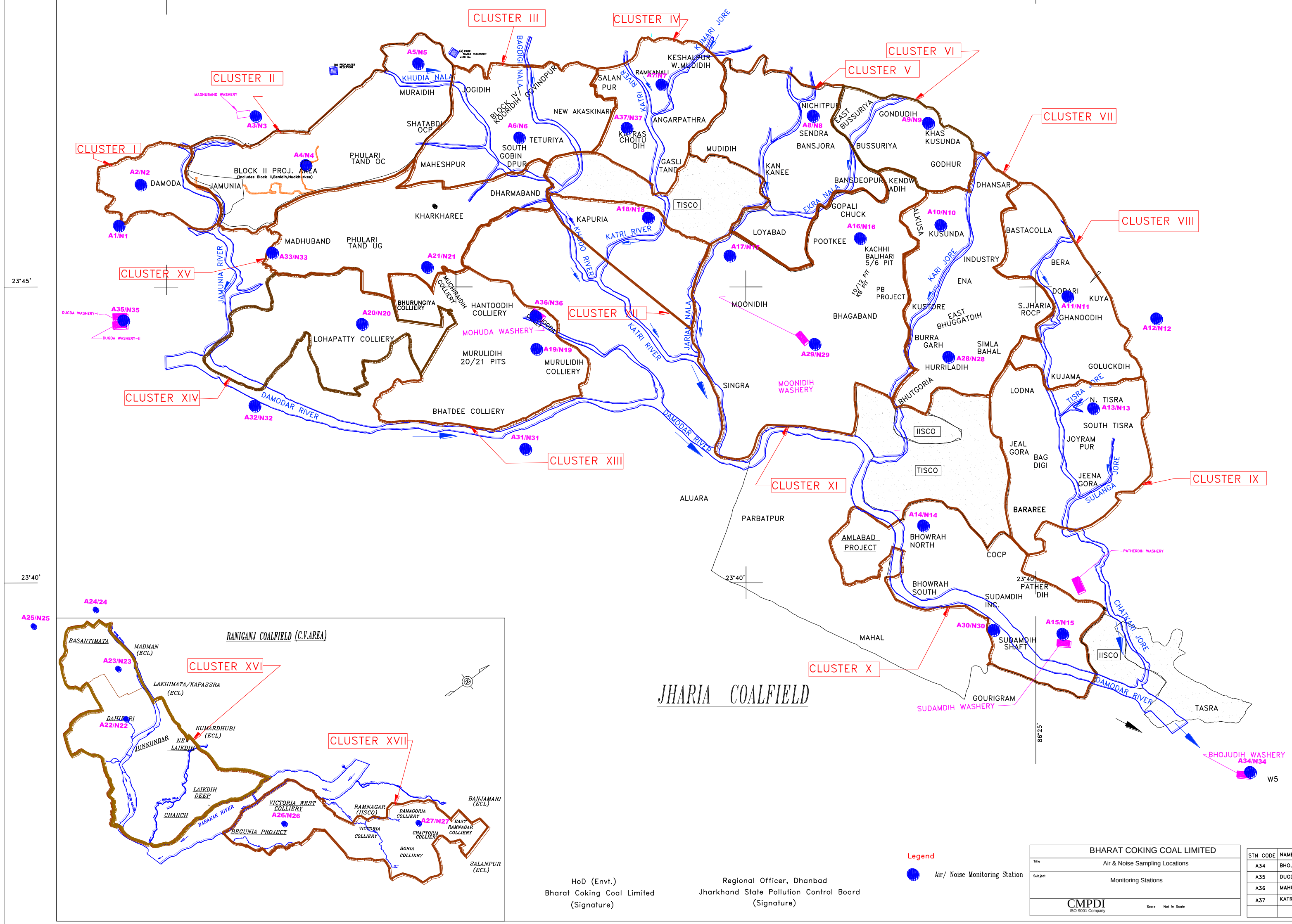
Pollutant	**Time Weighted Average**	**Concentration in Ambient Air**		**Methods of Measurement**
		Industrial, Residential, Rural and other Areas	**Ecologically Sensitive Area (Notified by Central Government)**	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method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



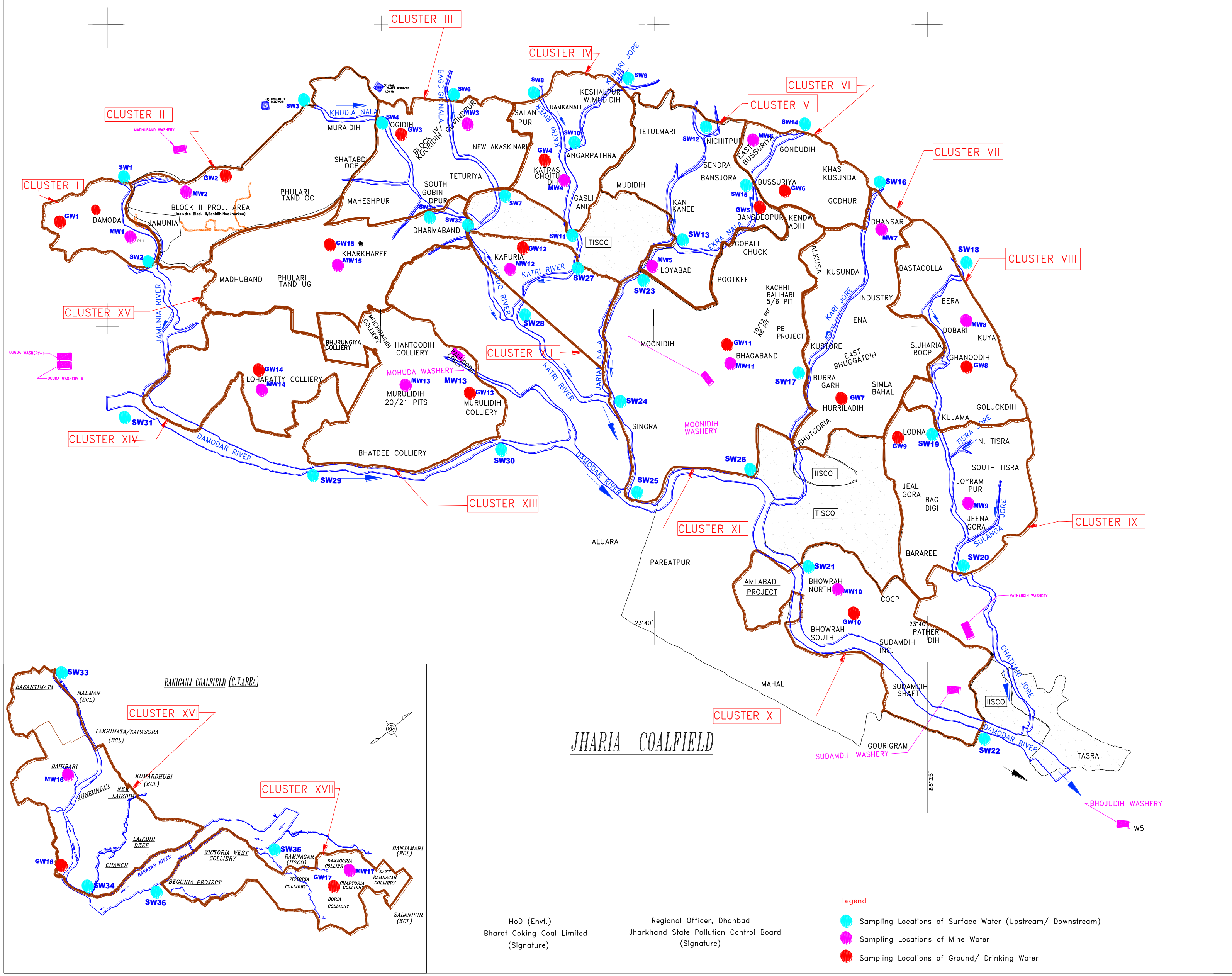
HoD (Envt.)
Bharat Coking Coal Limited
(Signature)

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

BHARAT COKING COAL LIMITED	
Title	Air & Noise Sampling Locations
Subject	Monitoring Stations
CMPDI ISO 9001 Company	Scale Not in Scale

STN CODE	NAME OF STATIONS (AIR/NOISE)
A34	BHOJUDIH COAL WASHERY
A35	DUGDA WASHERY
A36	MAHUDA WASHERY
A37	KATRAS CHOITUDIH COLLIERY

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	Bhagabandh 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

Legend

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

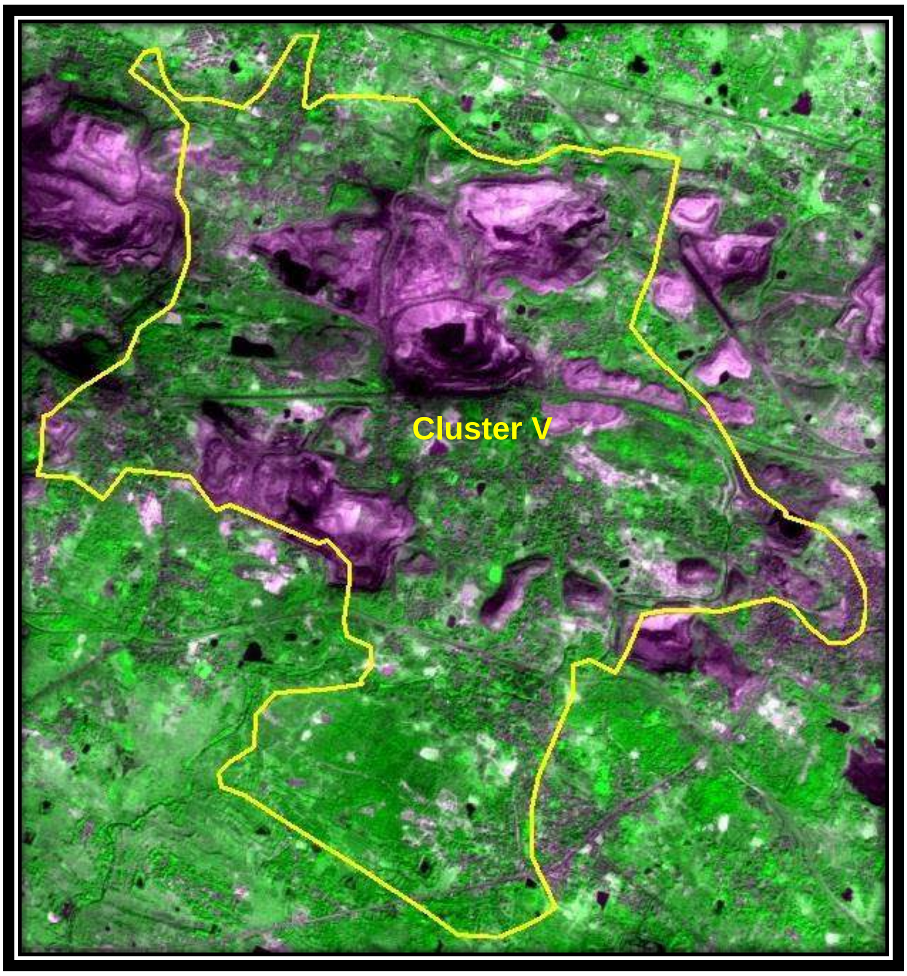
HoD (Envt.)
Bharat Coking Coal Limited
(Signature)

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

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

Annexure-XIV

Land Reclamation/ Restoration Monitoring of five Clusters of (Opencast + Underground) Coal Mines of Bharat Coking Coal Limited based on Satellite Data of the Year 2020



Submitted to

Bharat Coking Coal Limited

Land Reclamation/ Restoration Monitoring of five Clusters of (Opencast + Underground) Coal Mines of Bharat Coking Coal Limited based on Satellite Data of the Year 2020

March-2021

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

CONTENTS

Executive Summary

1. Project — Land reclamation/ restoration monitoring of five clusters of (Opencast + Underground) coal mines of Bharat Coking Coal Ltd. (BCCL), based on satellite data, on every three-year basis.

2. Objective — Objective of land reclamation/ restoration monitoring is to assess the area of backfilled, plantation, social forestry, active mining area, water bodies, and distribution of wasteland, agricultural land and forest in the leasehold area of the project. This will help in assessing the progressive status of mined land reclamation and to take up remedial measures, if any, required for environmental protection.

3. Salient Findings

- Out of 5 Clusters of mines viz. III, V, VIII, IX and XVII considered for land reclamation monitoring during the year 2020-21; XVII cluster of mines is added during the year 2020-21. These clusters consist of mainly opencast mines.

- Out of the total mine leasehold area of 7988.22 Ha. of the 05 clusters producing less than 5mcm (Coal+OB) annually considered for monitoring during the year 2020-21; total excavated area is 1300.74 Ha. out of which 27.81 Ha. area (2.14%) has been planted on backfill (Biological Reclamation) and 657.49 Ha. area (50.55%) is under backfilling (Technical Reclamation) and 615.44 Ha. area (47.31%) under active mining. Cluster wise details of land reclamation of the above Clusters is given in Table-1.

- Total area under plantation (green cover) covers an area of 645.75 Ha. which is 8.08% of total leasehold area.

- This report and the findings will be considered as basis for further monitoring and reclamation related activities.

Table 1

Land Reclamation Status in five Clusters (Underground + Opencast Mines) of BCCL based on Satellite Data of the Year 2020

Table - 1 Status of Land Reclamation in 5 clusters of BCCL based on Satellite Data of the Year 2020

(Area in Hectare)

Sl. No.	Cluster No.	Total Leasehold Area		Technical Reclamation: Area under Backfilling		Plantation: Biological: Plantation on Excavated / Backfilled Area		Plantation: Other Plantations: Plantation on External OB Dumps		Plantation: Other Plantations: Social Forestry, Avanue Plantation Etc.		Area under Active Mining		Total Excavated Area		Total Area under Plantation (% Green Cover Generated in Leasehold)		Total Area under Reclamation	
1	*2*	*3*		*4*		*5*		*6*		*7*		*8*		*9 (=4+5+8)*		*10 (=5+6+7)*		*11(=4+5)*	
		2017	2020	2017	2020	2017	2020	2017	2020	2017	2020	2017	2020	2017	2020	2017	2020	2017	2020
1	Cluster III	1552.53	1552.53	55.87	60.37	3.89	3.89	21.11	21.11	128.07	162.33	101.50	104.79	161.26	169.05	153.07	187.33	59.76	64.26
				34.65%	35.71%	2.41%	2.30%					62.94%	61.99%			9.86%	12.07%	37.06%	38.01%
2	Cluster V	1724.52	1724.52	162.09	187.59	7.19	7.19	23.85	23.85	105.29	105.29	112.24	103.52	281.52	298.30	136.33	136.33	169.28	194.78
				57.58%	62.89%	2.55%	2.41%					39.87%	34.70%			7.91%	7.91%	60.13%	65.30%
3	Cluster VIII	1331.95	1331.95	161.86	206.91	13.72	9.93	21.97	21.97	24.70	24.70	111.06	124.49	286.64	341.33	60.39	56.60	175.58	216.84
				56.47%	60.62%	4.79%	2.91%					38.75%	36.47%			4.53%	4.25%	61.25%	63.53%
4	Cluster IX	1967.22	1967.22	77.53	77.53	6.80	6.80	41.79	41.79	168.58	168.58	181.85	217.24	266.18	301.57	217.17	217.17	84.33	84.33
				29.13%	25.71%	2.55%	2.25%					68.32%	72.04%			11.04%	11.04%	31.68%	27.96%
5	Cluster XVII	-	1412.00	-	125.09	-	0.00	-	5.00	-	43.33	-	65.40	-	190.49	-	48.32	-	125.09
					65.67%		0.00%						34.33%				3.42%		65.67%
	TOTAL	**6576.22**	**7988.22**	**457.35**	**657.49**	**31.60**	**27.81**	**108.72**	**113.72**	**426.64**	**504.23**	**506.65**	**615.44**	**995.60**	**1300.74**	**566.96**	**645.75**	**488.95**	**685.30**
				45.94%	**50.55%**	**3.17%**	**2.14%**					**50.89%**	**47.31%**			**8.62%**	**8.08%**	**49.11%**	**52.69%**

(% is calculated with respect to Excavated Area as applicable)

Note: In reference of the above Table, different parameters are classified as follows: (Cluster XVII started from current year)
1. Area under Biological Reclamation includes Areas under Plantation done on Backfilled Area Only.
2. Area under Technical Reclamation includes Area under Barren Backfilling only.
3. Area under Active Mining Includes Coal Quarry, Advance Quarry Site and Quarry filled with water etc., if any.
4. Social Forestry and Plantation on External OB Dumps are not included in Biological Reclamation and are put under separate categories as shown in the above Table.
5. (%) calculated in the above Table is in respect to Total Excavated Area except for "Total Area under Plantation" where % is in terms of "Leasehold Area"'.

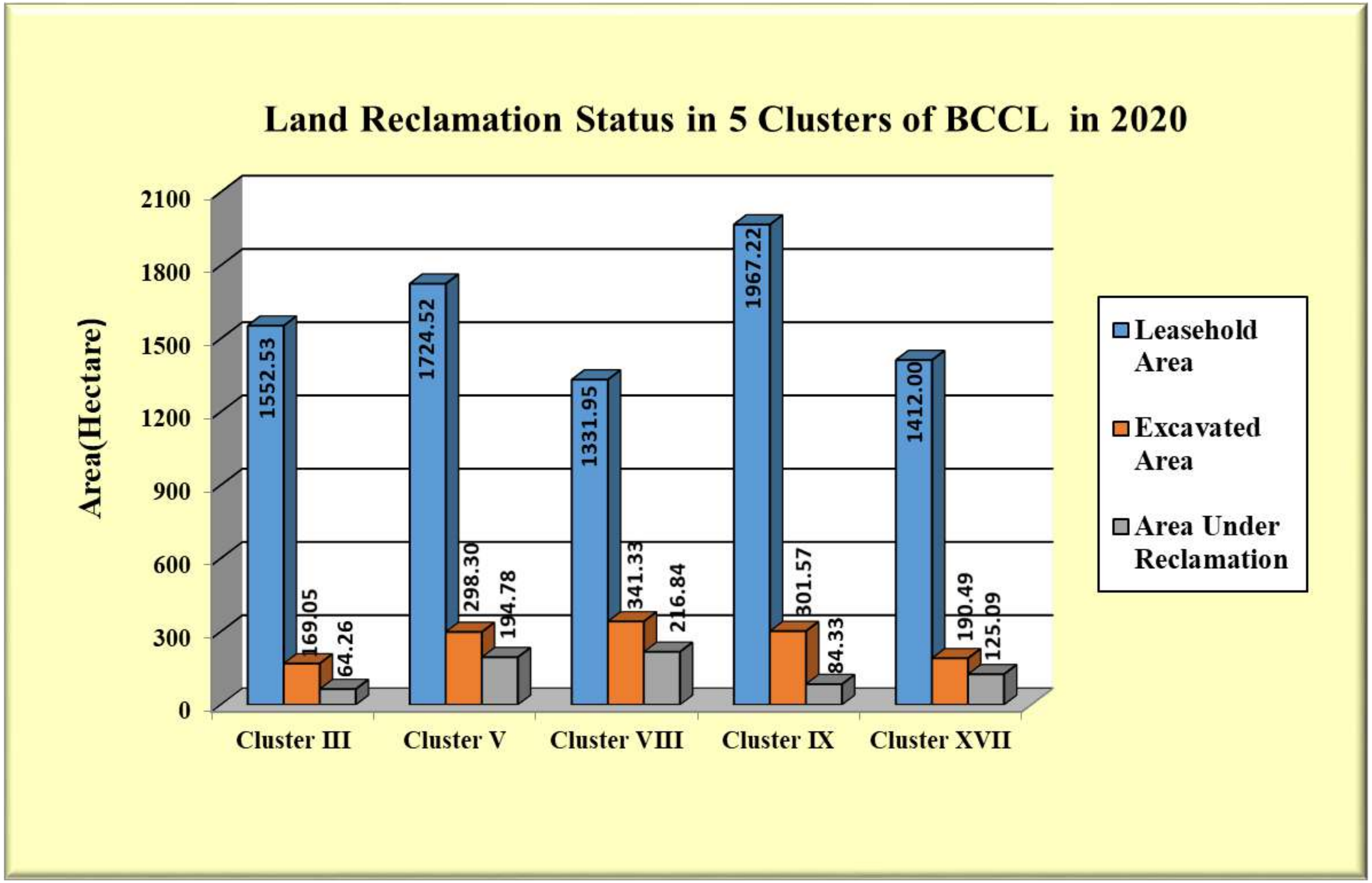


Fig. 1: Cluster wise Land Reclamation Status in five Clusters - 2020 (BCCL)

1. Background

1.1 Land is the most important natural resource which embodies soil, water, flora, fauna and total ecosystem. All human activities are based on the land which is the scarcest natural resource in our country. Mining is a site specific industry and it could not be shifted anywhere else from the location where mineral occurs. It is a fact that surface mining activities do affect the land environment due to ground breaking. Therefore, there is an urgent need to reclaim and restore the mined out land for its productive use for sustainable development of mining. This will not only mitigate environmental degradation, but would also help in creating a more congenial environment for land acquisition by coal companies in future.

1.2 Keeping above in view, Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/ENV/2017/DP/8391 dated 22.06.2017 to Central Mine Planning & Design Institute (CMPDI), Ranchi, for monitoring of clusters with coal mines (both underground and open cast projects) having less than 5 million 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 capacity, but from 2017 the same was carried out cluster wise for mines of BCCL. For operational reasons and convenience, underground and opencast mines (often with multiple overlapping seams), have now been clustered together. The result of land reclamation status of all such mines are hosted on the website of CIL, (www.coalindia.in), CMPDI (www.cmpdi.co.in) and the concerned coal companies in public domain. Detailed report is submitted to Coal India and respective subsidiaries.

1.3 Land reclamation monitoring of all cluster coal mining projects would also comply the statutory requirements of Ministry of Environment, Forest & Climate Change (**MoEF&CC**). Such monitoring would not only facilitate in taking timely mitigation measures against environmental degradation, but would also enable coal companies to utilize the reclaimed land for larger socio-economic benefits in a planned way.

1.4 Present report is embodying the finding of the study based on satellite data of the year 2020 carried out for five clusters of mines comprising both underground and OC projects for Bharat Coking Coal Ltd.

2. Objective

Objective of the land reclamation/restoration monitoring is to assess the area of backfilled, plantation, OB dumps, social forestry, active mining area, settlements and water bodies, distribution of wasteland, agricultural land and forest land in the leasehold area of the project. This is an important step taken up for assessing the progressive status of mined land reclamation and for taking up remedial measures, if any, required for environmental protection.

3. Methodology

There are number of steps involved between raw satellite data procurement and preparation of final map. National Remote Sensing Centre (NRSC) Hyderabad, being the nodal agency for satellite data supply in India, provides only raw digital satellite data, which needs further digital image processing for extracting the information and map preparation before uploading the same in the website. Methodology for land reclamation monitoring is given in fig 2. Following steps are involved in land reclamation/ restoration monitoring:

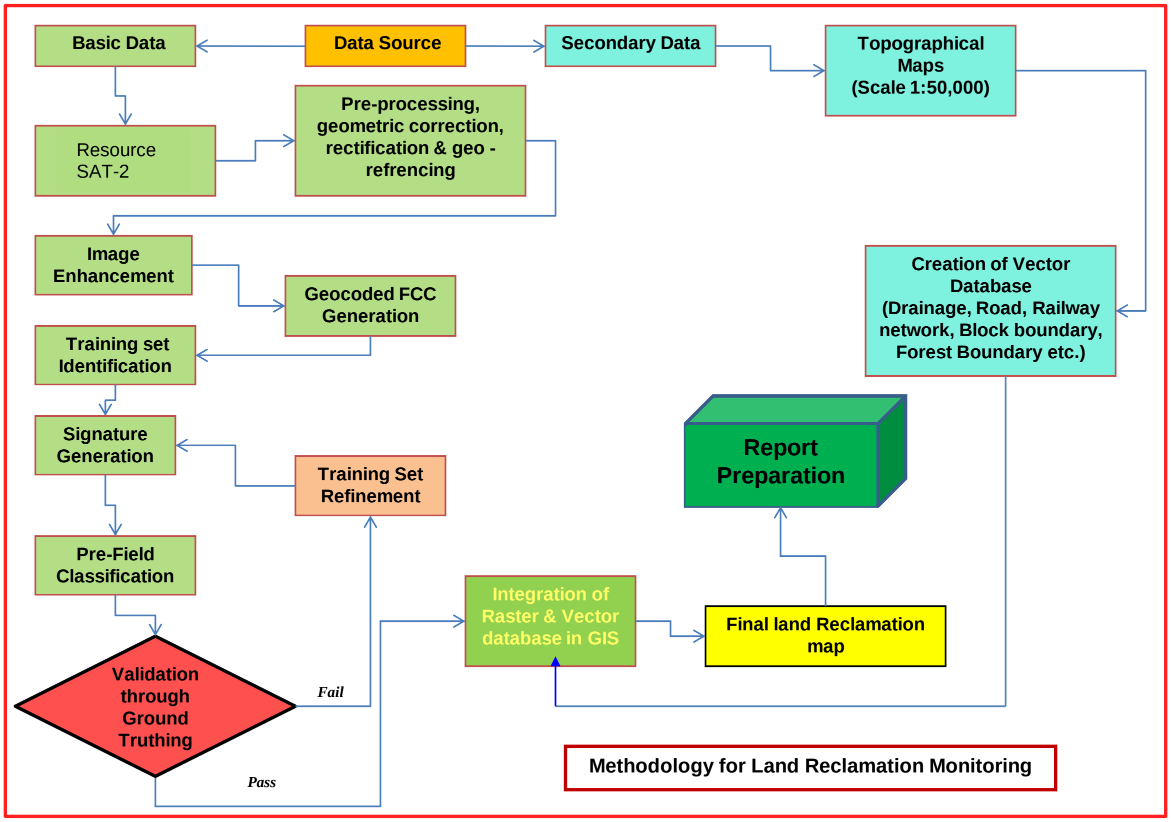


Fig. 2: Methodology of Land Reclamation Monitoring

3.1 Data Procurement: After browsing the data quality and date of pass on internet, supply order for data is placed to NRSC. Secondary data like leasehold boundary, toposheet are procured for creation of vector database.

3.2 Satellite Data Processing: Satellite data are processed using ERDAS IMAGINE digital image processing s/w. Methodology involves the following major steps:

- **Rectification & Geo-referencing:** Inaccuracies in digital imagery may occur due to 'systematic errors' attributed to earth curvature and rotation as well as 'non-systematic errors' attributed to satellite receiving station itself. Raw digital images may contain geometric distortions, which make them unusable as maps. Therefore, geo-referencing is required for correction of image data using ground control points (GCP) to make it compatible with the new series WGS-84 compatible 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 14.0 s/w. and enhance the image quality for interpretation.

- **Training set selection**

  Training set requires to be selected, so that software can classify the image data accurately. The image data are analysed based on the interpretation keys. These keys are evolved from certain fundamental image-elements such as tone/colour, size, shape, texture, pattern, location, association and shadow. Based on the image-elements and other geo-technical elements like land form, drainage pattern and physiography; training sets were selected/identified for each land use/cover class. Field survey was carried out by taking selective traverses in order to collect the ground information (or reference data) so that training sets are selected accurately in the image. This was intended to serve as an aid for classification.

- **Classification and Accuracy assessment**

  Image classification is carried out using the maximum likelihood algorithm. The classification proceeds through the following steps: (a) calculation of statistics [i.e. signature generation] for the identified training areas, and (b) the decision boundary of maximum probability based on the mean vector, variance, covariance and correlation matrix of the pixels. After evaluating the statistical parameters of the training sets, reliability test of training sets is conducted by measuring the statistical separation between the classes that resulted from computing divergence matrix. The overall accuracy of the classification was finally assessed with reference to ground truth data.

- **Area calculation**

  The area of each land use class in the leasehold is determined using ERDAS IMAGINE v. 14.0 s/w.

- **Overlay of Vector data base**

  Vector data base is created based on secondary data. Vector layer like drainage, railway line, leasehold boundary, forest boundary etc. are superimposed on the image as vector layer in the Arc GIS database.

- **Pre-field map preparation**

  Pre-field map is prepared for validation of the classification result.

3.3 Ground Truthing:

Selective ground verification of the land use classes are carried out in the field and necessary corrections if required, are incorporated before map finalization.

3.4 Land reclamation database on GIS:

Land reclamation database is created on GIS platform to identify the temporal changes identified from satellite data of different cut - of dates. The database boundary shape files (.shp), kml files and the maps thus prepared confirm to the WGS-84 datum and UTM projected co-ordinate system.

4. Land Reclamation Status in Bharat Coking Coal Ltd.

4.1 Following 5 clusters of mines comprising both underground and opencast projects of Bharat Coking Coal Ltd. have been taken up for land reclamation monitoring during the year 2020-21:

- Cluster III
- Cluster V
- Cluster VIII
- Cluster IX
- Cluster XVII

4.2 Cluster wise Land Reclamation status of above mentioned clusters in BCCL is given in Table 1 and also shown graphically in Fig 1. Area statistics of different land use classes present in the mine leasehold of the above projects for the year 2020 are shown in Table 2. Land use maps derived from the satellite data are shown in Plate 1 - 5. Different land use classes based on satellite data are depicted in bar charts in Fig. 3 - 7.

4.3 Study reveals that out of total mine leasehold area of 7988.22 ha. of the 5 clusters of mines (Underground + Opencast) of BCCL mentioned above taken for this study in 2020-21, total excavated area is 1300.74 ha. out of which 27.81 ha. (2.14%) has been planted (*Biologically Reclaimed*), 657.49 ha. (50.55%) is under backfilling (*Technically Reclaimed*) and balance 615.44 ha. (47.31%) is under active mining.

4.4 Land reclamation monitoring for cluster XVII of BCCL is taken up for the first time in the year 2020-21. Hence comparison of this cluster in year 2020 has not been made with respect to year 2017. The data thus generated in the year 2020 will be considered as base data for comparison of land reclamation of this cluster of mines at the interval of every three year.

4.5 Study reveals that out of five clusters of mines of BCCL considered for reclamation monitoring in 2020, the area under total plantation (Green Cover) is maximum in Cluster IX i.e 217.17 ha., followed by Cluster III with 187.33 ha., Cluster V with 136.33 ha., Cluster VIII with 56.60 ha. and Cluster XVII with 48.32 ha.

4.6 Out of the 5 Clusters in BCCL considered for satellite data based land reclamation monitoring in 2020, Cluster XVII tops with 65.67% reclamation followed by Cluster V with 65.30%, Cluster VIII with 63.53%, Cluster III with 38.01% and Cluster IX with 27.96%.

4.7 In Cluster VIII, it is revealed that area under plantation on backfill (Biological Reclamation) has decreased from 13.72 ha. in the year 2017 to 9.93 ha. in the year 2020. This decrease of 3.79 ha. area in Biological reclamation is due to rehandling of backfill. Hence total area under plantation on backfill has decreased from 31.60 ha. (Yr 2017) to 27.81 ha. (Yr 2020).

4.8 On comparing the status of land reclamation for the year 2020 with respect to the year 2017 it is evident from the analysis that area under land reclamation has increased from 488.95 ha. (Yr 2017) to 685.30 ha. (Yr 2020). This increase of 196.35 ha. area under land reclamation is due to increase in reclamation activities in Cluster III, V & VIII as well as addition of Cluster XVII.

4.9 This study will again be carried out after an interval of three years to assess the progress and changes in land reclamation in the above clusters.

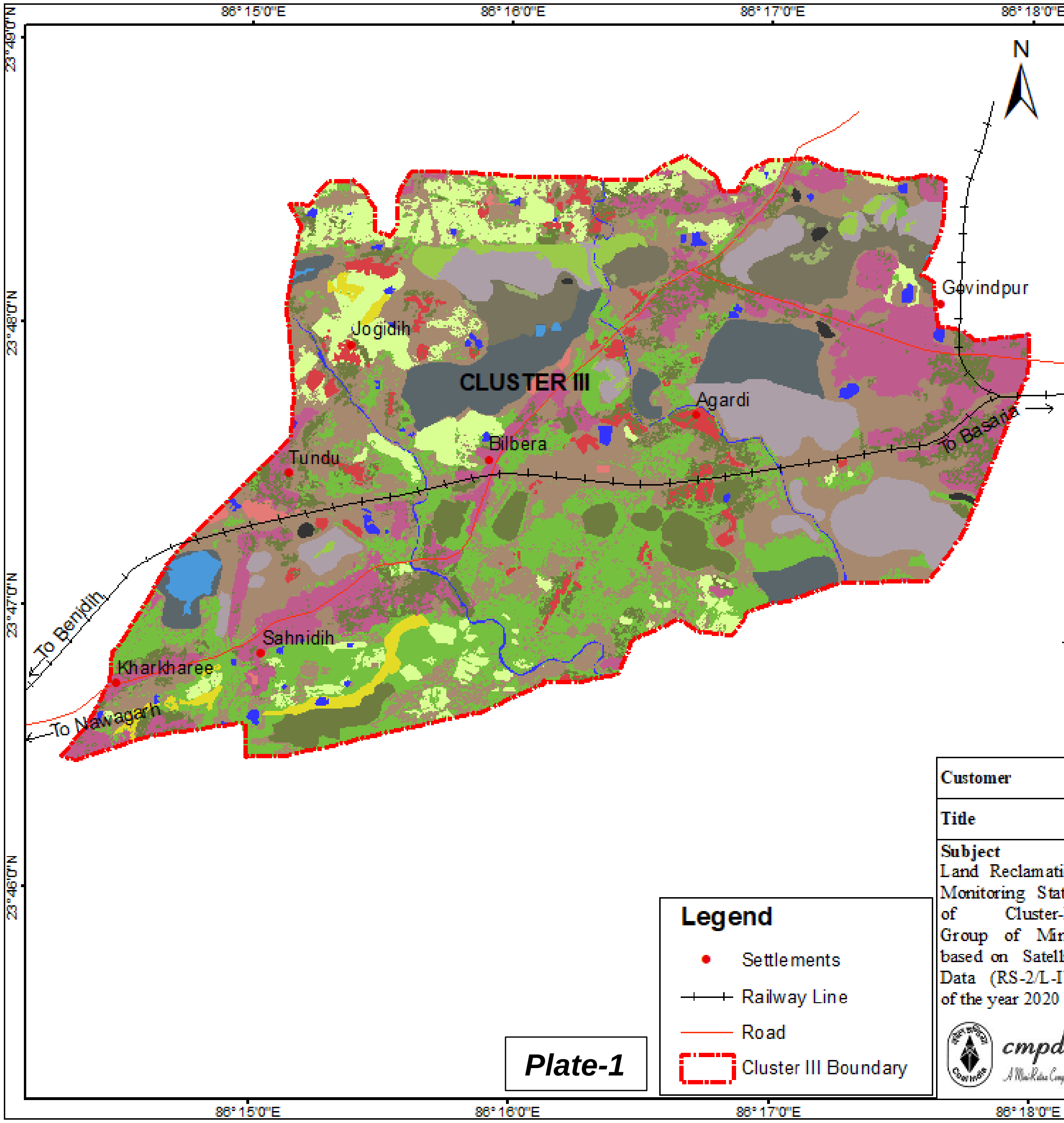
Table 2

Cluster wise Area Statistics of Land Use/ Cover classes in five Clusters of (OC+UG) mines of BCCL based on Satellite Data of the year 2020

Status of Land Reclamation in 5 Clusters of (UG+OC) mines of Bharat Coking Coal Ltd. based on Satellite data of the Year 2020

(Area in Hectare)

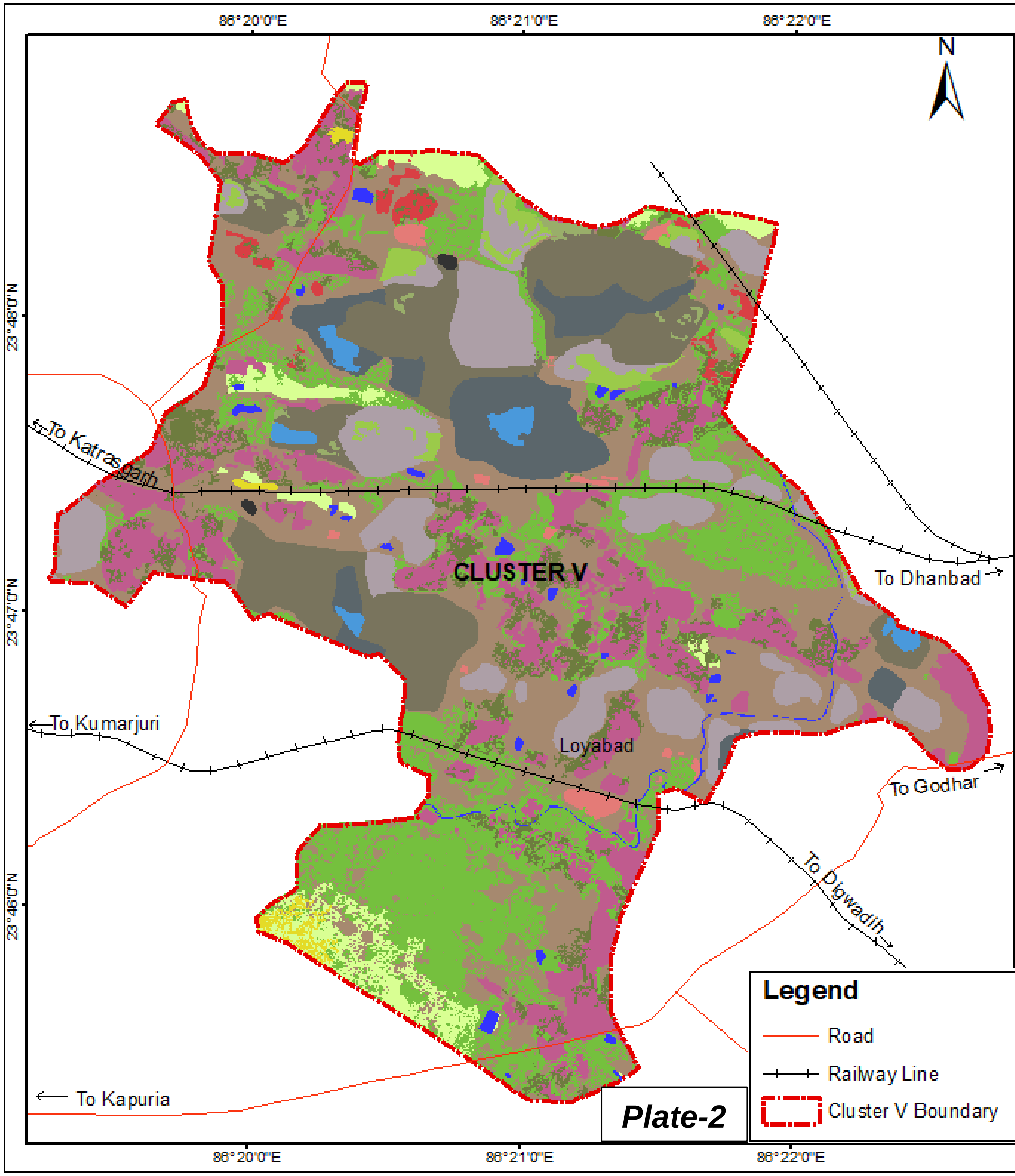
		CLUSTER III		CLUSTER V		CLUSTER VIII		CLUSTER IX		CLUSTER XVII		TOTAL	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FORESTS	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Forest (A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCRUBS	**Scrubs (B)**	271.78	17.51	320.90	18.61	157.58	11.83	346.67	17.62	178.99	12.68	1275.92	15.97
PLANTATION	Social Forestry/Avenue Plantation	162.33	10.46	105.29	6.11	24.70	1.85	168.58	8.57	43.33	3.07	504.23	6.31
	Plantation on OB Dump	21.11	1.36	23.85	1.38	21.97	1.65	41.79	2.12	5.00	0.35	113.72	1.42
	Plantation on Backfill (Biological Reclamation)	3.89	0.25	7.19	0.42	9.93	0.75	6.80	0.35	0.00	0.00	27.81	0.35
	Total Plantation (C)	187.33	12.07	136.33	7.91	56.60	4.25	217.17	11.04	48.32	3.42	645.75	8.08
	Total Vegetation (A+B+C)	**459.11**	**29.57**	**457.23**	**26.51**	**214.18**	**16.08**	**563.84**	**28.66**	**227.31**	**16.10**	**1921.67**	**24.06**
	Coal Dump	3.58	0.23	1.70	0.10	3.72	0.28	4.89	0.25	0.00	0.00	13.89	0.17
ACTIVE MINING	Coal Quarry	94.89	6.11	87.72	5.09	101.43	7.62	191.65	9.74	56.82	4.02	532.51	6.67
	Advance Quarry Site	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Quarry Filled With Water	9.90	0.64	15.80	0.92	23.06	1.73	25.59	1.30	8.58	0.61	82.93	1.04
	Total Area under *Active Mining*	**104.79**	**6.75**	**103.52**	**6.00**	**124.49**	**9.35**	**217.24**	**11.04**	**65.40**	**4.63**	**615.44**	**7.70**
	Barren OB Dump	126.59	8.15	174.62	10.13	152.06	11.42	166.03	8.44	44.48	3.15	663.78	8.31
RECLAIMED	Area Under Backfilling (Technical Reclamation)	60.37	3.89	187.59	10.88	206.91	15.53	77.53	3.94	125.09	8.86	657.49	8.23
	Total Area under Mine Operation	**295.33**	**19.02**	**467.43**	**27.10**	**487.18**	**36.58**	**465.69**	**23.67**	**234.97**	**16.64**	**1950.60**	**24.42**
WASTELAND	Waste Lands	426.21	27.45	472.92	27.42	373.70	28.06	581.57	29.56	112.68	7.98	1967.08	24.62
	Fly Ash Pond / Sand Body	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.76	0.48	6.76	0.08
	Total Wasteland	**426.21**	**27.45**	**472.92**	**27.42**	**373.70**	**28.06**	**581.57**	**29.56**	**119.44**	**8.46**	**1973.84**	**24.71**
WATERBODIES	Reservoir, Nallah, Ponds	18.74	1.21	13.66	0.79	13.95	1.05	23.33	1.19	31.81	2.25	101.49	1.27
	Total Waterbodies	**18.74**	**1.21**	**13.66**	**0.79**	**13.95**	**1.05**	**23.33**	**1.19**	**31.81**	**2.25**	**101.49**	**1.27**
AGRICULTURE	Crop Lands	16.60	1.07	8.41	0.49	16.63	1.25	0.00	0.00	69.45	4.92	111.09	1.39
	Fallow Lands	122.68	7.90	58.64	3.40	58.63	4.40	43.56	2.21	472.71	33.48	756.22	9.47
	Total Agriculture	**139.28**	**8.97**	**67.05**	**3.89**	**75.26**	**5.65**	**43.56**	**2.21**	**542.16**	**38.40**	**867.31**	**10.86**
SETTLEMENTS	Urban Settlement	173.86	11.20	220.71	12.80	99.22	7.45	232.31	11.81	214.25	15.17	940.35	11.77
	Rural Settlement	33.95	2.19	13.97	0.81	60.71	4.56	47.79	2.43	31.36	2.22	187.78	2.35
	Industrial Settlement	6.05	0.39	11.55	0.67	7.75	0.58	9.13	0.46	10.69	0.76	45.17	0.57
	Total Settlements	**213.86**	**13.77**	**246.23**	**14.28**	**167.68**	**12.59**	**289.23**	**14.70**	**256.31**	**18.15**	**1173.31**	**14.69**
	Grand Total	**1552.53**	**100.00**	**1724.52**	**100.00**	**1331.95**	**100.00**	**1967.22**	**100.00**	**1412.00**	**100.00**	**7988.22**	**100.00**



Area Statistics - Cluster III (2020)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**271.78**	**17.51**
Plantation Area	Social Forestry		162.33	10.46
	Plantation on OB		21.11	1.36
	Plantation on Backfill		3.89	0.25
	Total Plantation Area (C)		**187.33**	**12.07**
	Total Vegetation (A+B+C)		**459.11**	**29.57**
Agriculture Land	Crop land		16.60	1.07
	Fallow Land		122.68	7.90
	Total Agriculture Land		**139.28**	**8.97**
Waste Land	Waste Land		426.21	27.45
	Sand Body		0.00	0.00
	Total Waste Land		**426.21**	**27.45**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		94.89	6.11
	Barren OB Dump		126.59	8.15
	Back Fill		60.37	3.89
	Coal Dump		3.58	0.23
	Water Filled Qry		9.90	0.64
	Total Mining Area		**295.33**	**19.02**
Settlements	Urban Settlements		173.86	11.20
	Rural Settlements		33.95	2.19
	Industrial Settlements		6.05	0.39
	Total Settlement Area		**213.86**	**13.77**
Water Body	**River/ Ponds**		**18.74**	**1.21**
	Total Area		**1552.53**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 561410027
Subject Land Reclamation Monitoring Status of Cluster-III Group of Mines based on Satellite Data (RS-2/L-IV) of the year 2020	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Dy. Mgr(Geology)		
	Checked	B.K Choudhary	Ch. Mgr(RSC)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi A Mini Ratna Company	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQREM20 R2 A4 CL-III				RevNo.0



Area Statistics - Cluster V (2020)

Classes: Level-I	Classes: Level-II	Colour	Core Zone: Area (Ha)	Core Zone: % of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**320.90**	**18.61**
Plantation Area	Social Forestry		105.29	6.11
	Plantation on OB		23.85	1.38
	Plantation on Backfill		7.19	0.42
	Total Plantation Area (C)		**136.33**	**7.91**
	Total Vegetation (A+B+C)		**457.23**	**26.51**
Agriculture Land	Crop land		8.41	0.49
	Fallow Land		58.64	3.40
	Total Agriculture Land		**67.05**	**3.89**
Waste Land	Waste Land		472.92	27.42
	Sand Body		0.00	0.00
	Total Waste Land		**472.92**	**27.42**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		87.72	5.09
	Barren OB Dump		174.62	10.13
	Back Fill		187.59	10.88
	Coal Dump		1.70	0.10
	Water Filled Qry		15.80	0.92
	Total Mining Area		**467.43**	**27.10**
Settlements	Urban Settlements		220.71	12.80
	Rural Settlements		13.97	0.81
	Industrial Settlements		11.55	0.67
	Total Settlement Area		**246.23**	**14.28**
Water Body	**River/ Ponds**		**13.66**	**0.79**
	Total Area		**1724.52**	**100.00**

Customer	Bharat Coking Coal Limited			
Title	Land Reclamation Monitoring of BCCL Clusters			Job No. 561410027
Subject Land Reclamation Monitoring Status of Cluster-V Group of Mines based on Satellite Data (RS-2/L-IV) of the year 2020	Activity	Name	Designation	Signature
	Prepared	A. Parida	Dy. Mgr(Geology)	
	Checked	B K Choudhary	Ch. Mgr(RSC)	
	Approved	R. Kumar	GM(Geomatics)	
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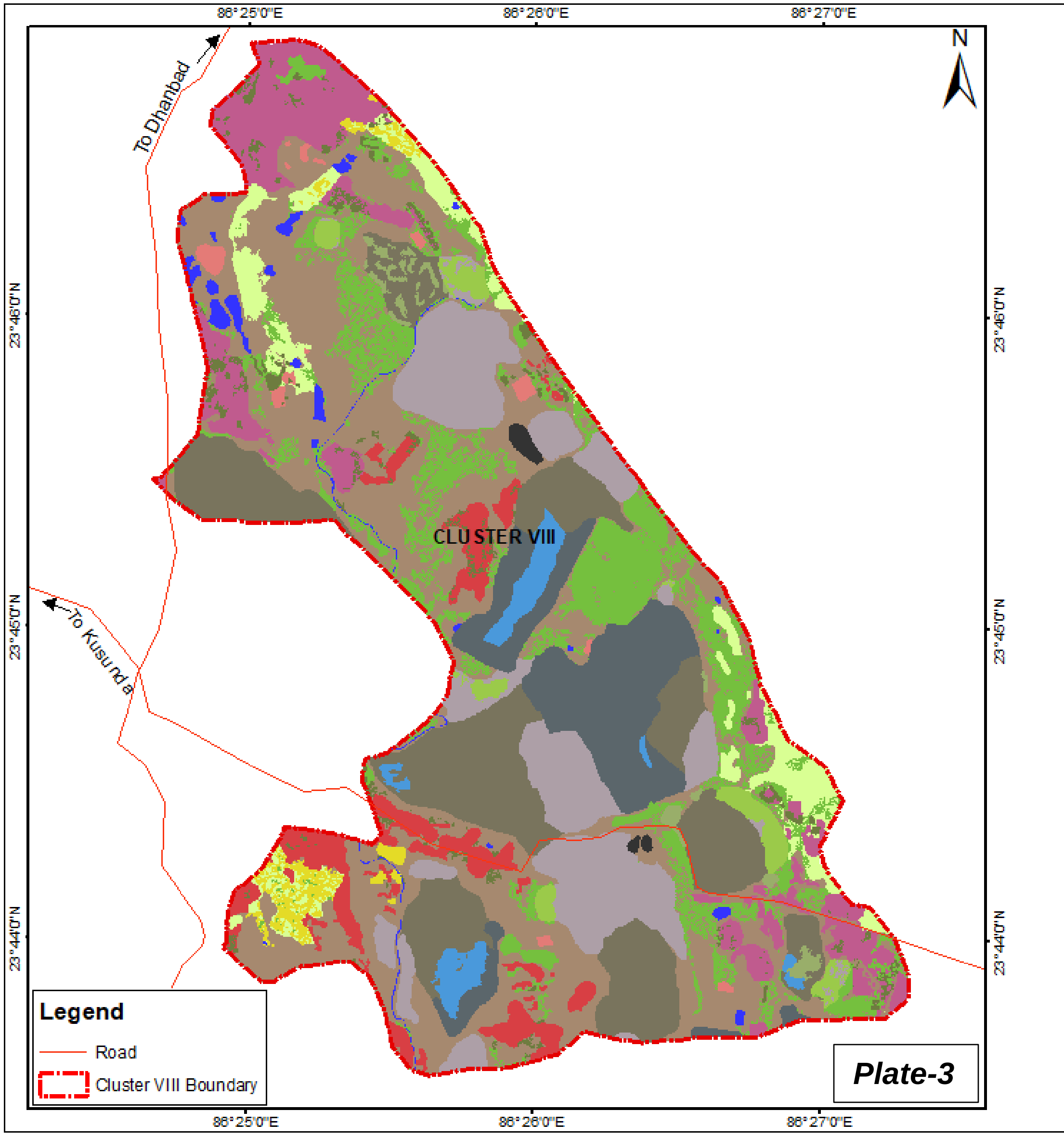
	Drg No. HQ REM 20 R2 A4 CL-V			Rev No.0



Area Statistics - Cluster VIII (2020)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**157.58**	**11.83**
Plantation Area	Social Forestry		24.70	1.85
	Plantation on OB		21.97	1.65
	Plantation on Backfill		9.93	0.75
	Total Plantation Area (C)		**56.60**	**4.25**
	Total Vegetation (A+B+C)		**214.18**	**16.08**
Agriculture Land	Crop land		16.63	1.25
	Fallow Land		58.63	4.40
	Total Agriculture Land		**75.26**	**5.65**
Waste Land	Waste Land		373.70	28.06
	Sand Body		0.00	0.00
	Total Waste Land		**373.70**	**28.06**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		101.43	7.62
	Barren OB Dump		152.06	11.42
	Back Fill		206.91	15.53
	Coal Dump		3.72	0.28
	Water Filled Qry		23.06	1.73
	Total Mining Area		**487.18**	**36.58**
Settlements	Urban Settlements		99.22	7.45
	Rural Settlements		60.71	4.56
	Industrial Settlements		7.75	0.58
	Total Settlement Area		**167.68**	**12.59**
Water Body	**River/ Ponds**		**13.95**	**1.05**
	Total Area		**1331.95**	**100.00**

Customer	Bharat Coking Coal Limited			
Title	Land Reclamation Monitoring of BCCL Clusters			Job No. 561410027
Subject Land Reclamation Monitoring Status of Cluster-VIII Group of Mines based on Satellite Data (RS-2/L-IV) of the year 2020	Activity	Name	Designation	Signature
	Prepared	A. Parida	Dy. Mgr(Geology)	
	Checked	B.K Choudhary	Ch. Mgr(RSC)	
	Approved	R. Kumar	GM(Geomatics)	
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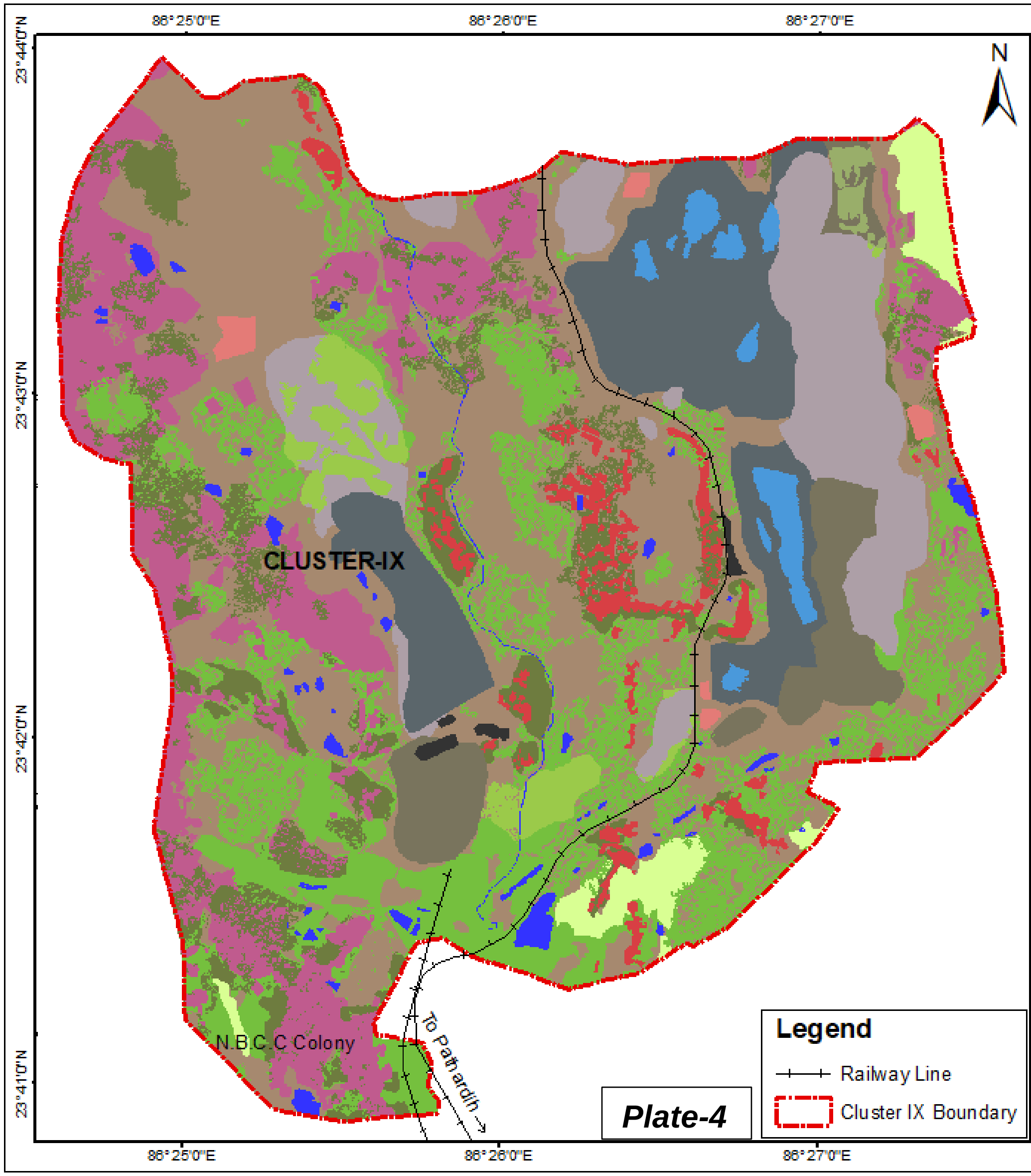
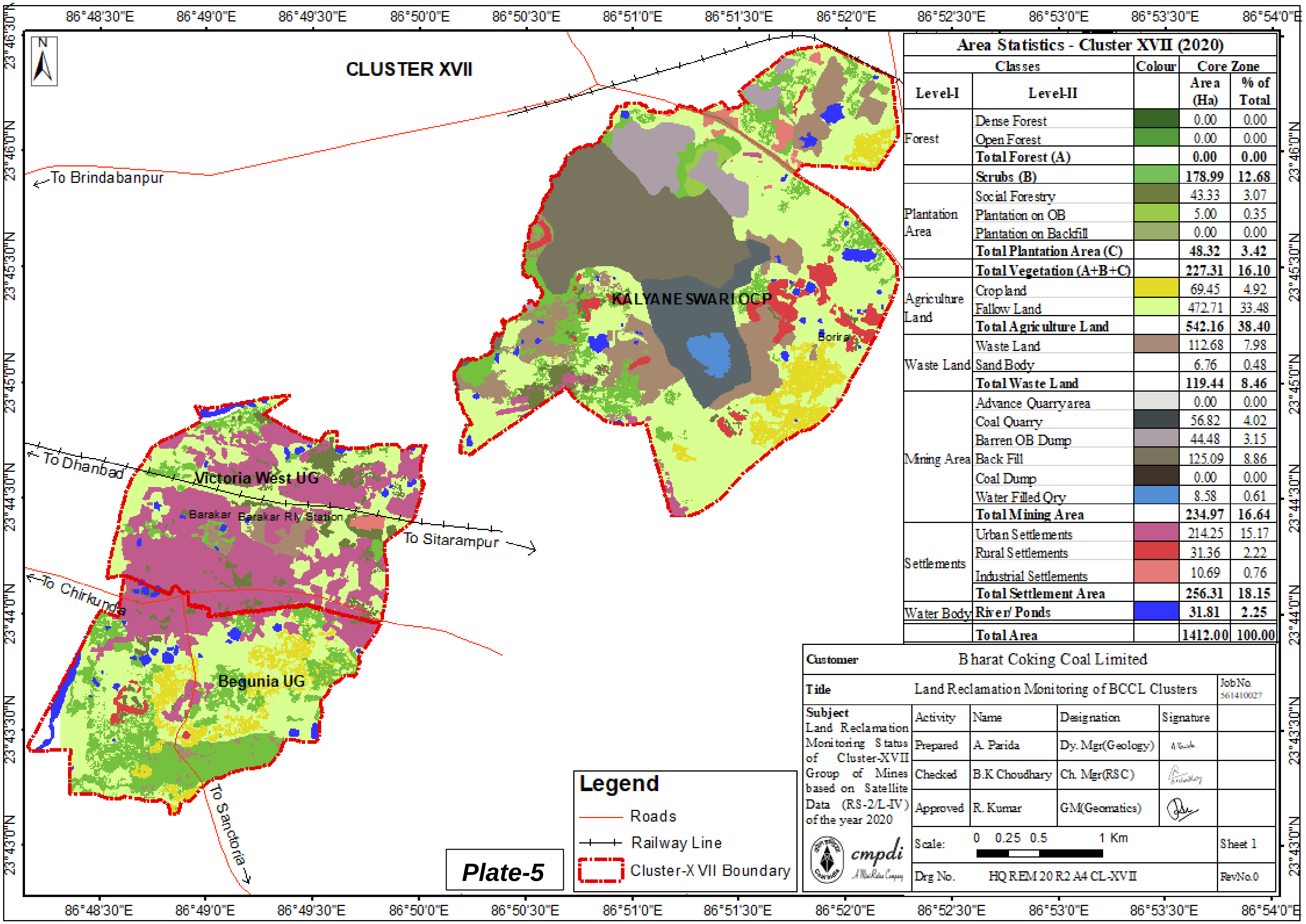
	Drg No. HQ REM 20 R2 A4 CL-VIII			RevNo 0



Area Statistics - Cluster IX (2020)

Level-I	Level-II	Colour	Core Zone Area (Ha)	Core Zone % of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**346.67**	**17.62**
Plantation Area	Social Forestry		168.58	8.57
	Plantation on OB		41.79	2.12
	Plantation on Backfill		6.80	0.35
	Total Plantation Area (C)		**217.17**	**11.04**
	Total Vegetation (A+B+C)		**563.84**	**28.66**
Agriculture Land	Crop land		0.00	0.00
	Fallow Land		43.56	2.21
	Total Agriculture Land		**43.56**	**2.21**
Waste Land	Waste Land		581.57	29.56
	Sand Body		0.00	0.00
	Total Waste Land		**581.57**	**29.56**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		191.65	9.74
	Barren OB Dump		166.03	8.44
	Back Fill		77.53	3.94
	Coal Dump		4.89	0.25
	Water Filled Qry		25.59	1.30
	Total Mining Area		**465.69**	**23.67**
Settlements	Urban Settlements		232.31	11.81
	Rural Settlements		47.79	2.43
	Industrial Settlements		9.13	0.46
	Total Settlement Area		**289.23**	**14.70**
Water Body	**River/ Ponds**		**23.33**	**1.19**
	Total Area		**1967.22**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 561410027
Subject Land Reclamation Monitoring Status of Cluster-IX Group of Mines based on Satellite Data (RS-2/L-IV) of the year 2020	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Dy. Mgr(Geology)		
	Checked	B.K. Choudhary	Ch. Mgr(RSC)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi A Mini Ratna Company	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No.	HQ REM 20 R2 A4 CL-IX			Rev No. 0



Area Statistics - Cluster XVII (2020)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**178.99**	**12.68**
Plantation Area	Social Forestry		43.33	3.07
	Plantation on OB		5.00	0.35
	Plantation on Backfill		0.00	0.00
	Total Plantation Area (C)		**48.32**	**3.42**
	Total Vegetation (A+B+C)		**227.31**	**16.10**
Agriculture Land	Cropland		69.45	4.92
	Fallow Land		472.71	33.48
	Total Agriculture Land		**542.16**	**38.40**
Waste Land	Waste Land		112.68	7.98
	Sand Body		6.76	0.48
	Total Waste Land		**119.44**	**8.46**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		56.82	4.02
	Barren OB Dump		44.48	3.15
	Back Fill		125.09	8.86
	Coal Dump		0.00	0.00
	Water Filled Qry		8.58	0.61
	Total Mining Area		**234.97**	**16.64**
Settlements	Urban Settlements		214.25	15.17
	Rural Settlements		31.36	2.22
	Industrial Settlements		10.69	0.76
	Total Settlement Area		**256.31**	**18.15**
Water Body	**River/ Ponds**		**31.81**	**2.25**
	Total Area		**1412.00**	**100.00**

Customer	Bharat Coking Coal Limited			
Title	Land Reclamation Monitoring of BCCL Clusters			Job No. 561410027
Subject Land Reclamation Monitoring Status of Cluster-XVII Group of Mines based on Satellite Data (RS-2/L-IV) of the year 2020	Activity	Name	Designation	Signature
	Prepared	A. Parida	Dy. Mgr(Geology)	
	Checked	B.K Choudhary	Ch. Mgr(RSC)	
	Approved	R. Kumar	GM(Geomatics)	
cmpdi A Mini Ratna Company	Scale: 0 0.25 0.5 1 Km			Sheet 1
	Drg No.	HQ REM 20 R2 A4 CL-XVII		RevNo.0

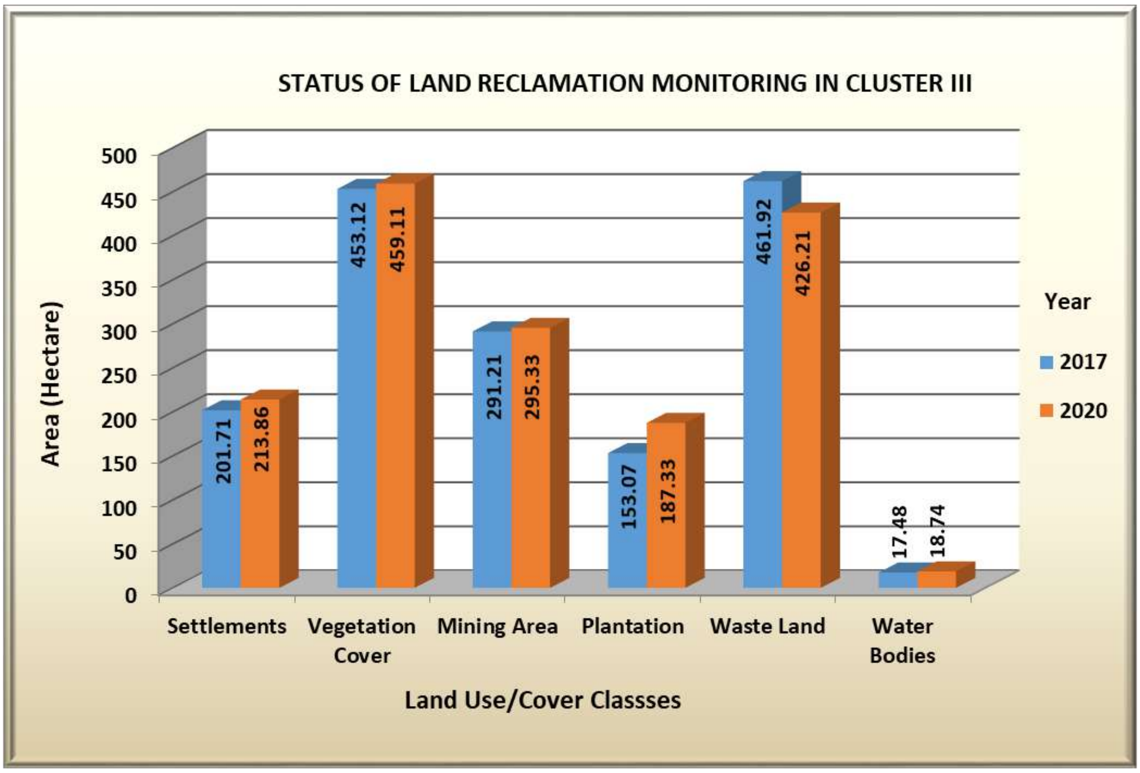


Fig. 3: Land Reclamation Status of Cluster III

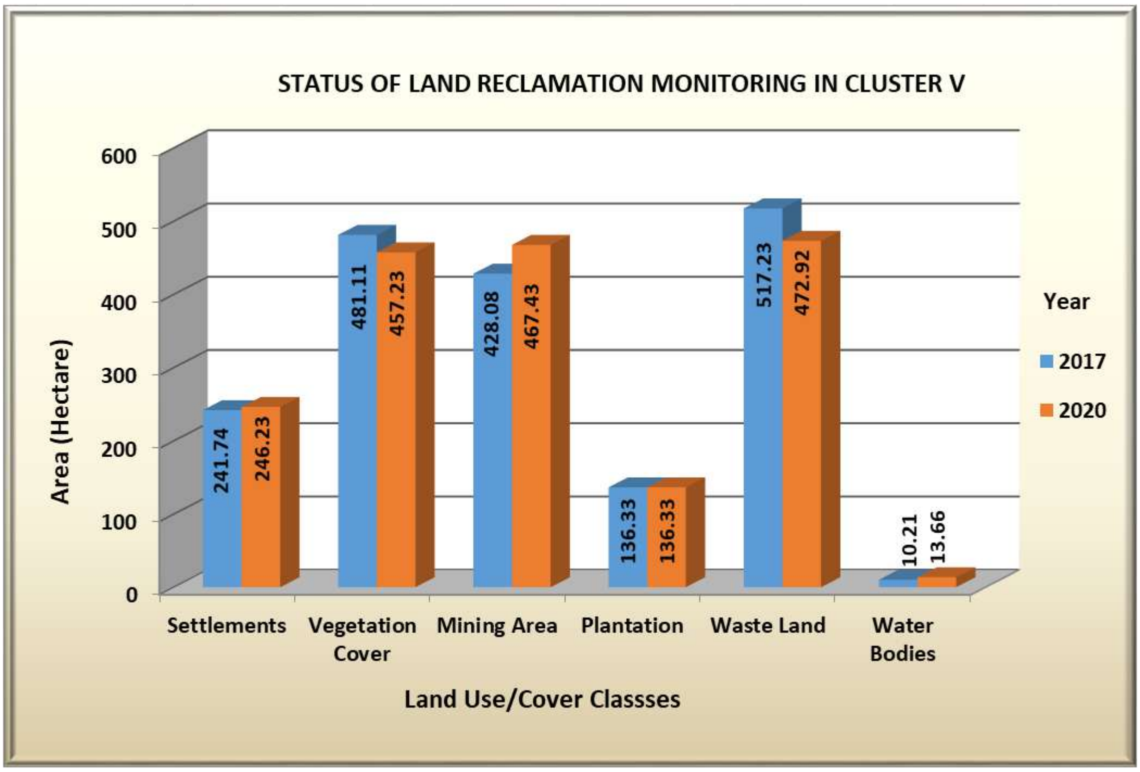


Fig. 4: Land Reclamation Status of Cluster V

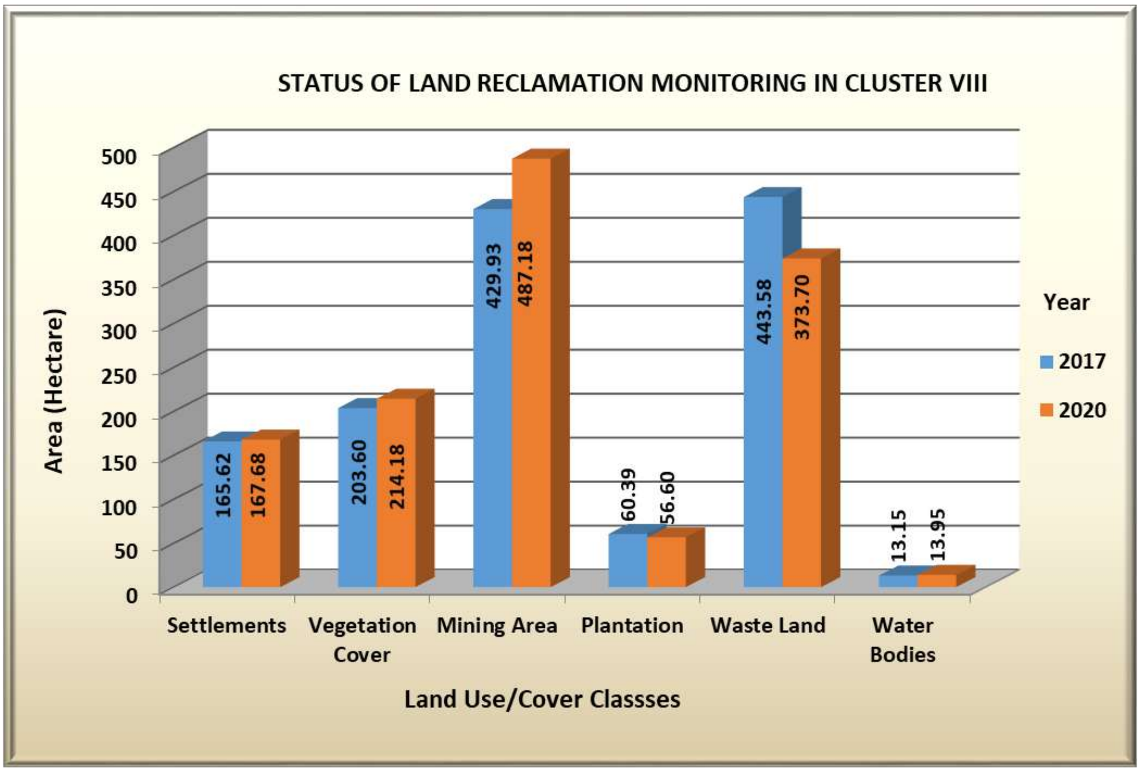


Fig. 5: Land Reclamation Status of Cluster VIII

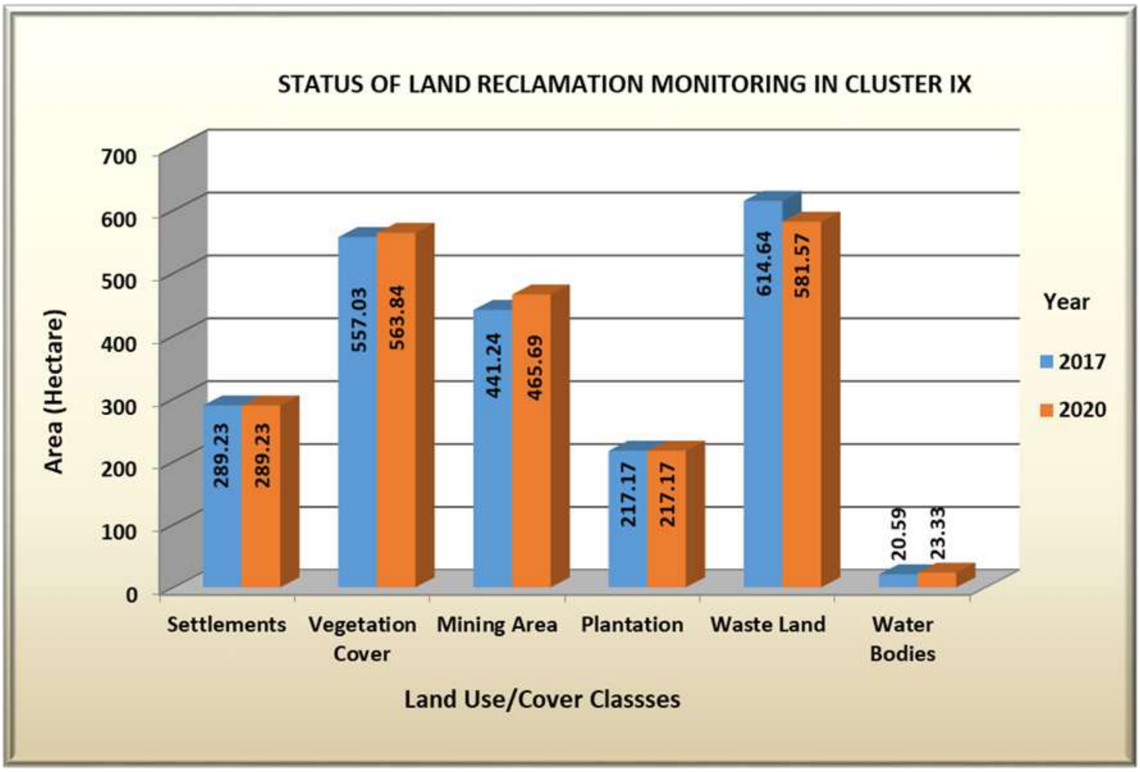


Fig. 6: Land Reclamation Status of Cluster IX

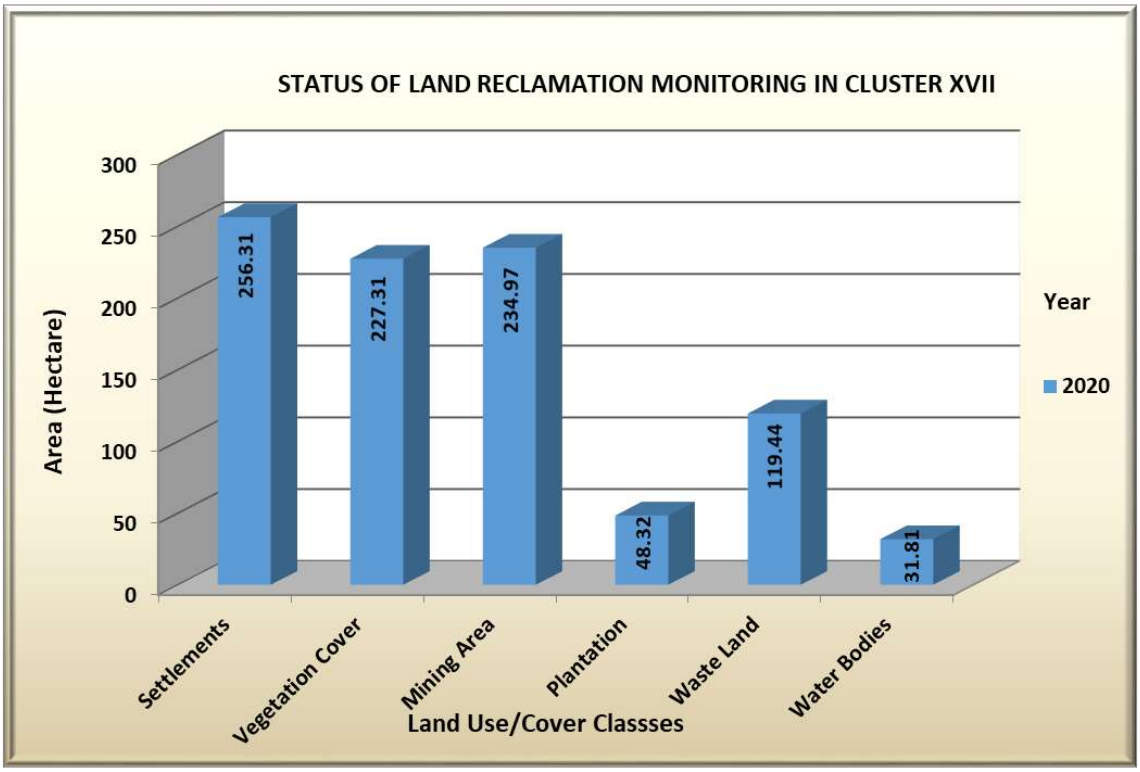


Fig. 7: Land Reclamation Status of Cluster XVII

Photo 1: Plantation on OB dump, Cluster III

Photo 2: Eco Restoration Site, Cluster V

Photo 3: Plantation on OB Dump, Cluster V

Photo 4: Plantation on OB Dump, Cluster VIII

Photo 5: Gokul Eco Cultural Park, Cluster IX

Photo 6: Plantation in Cluster XVII

Central Mine Planning & Design Institute Ltd.
(A Subsidiary of Coal India Ltd.)
Gondwana Place, Kanke Road, Ranchi 834031, Jharkhand
Phone : (+91) 651 2230001, 2230002, 2230483, FAX (+91) 651 2231447, 2231851
Wesite : www.cmpdi.co.in, Email : cmpdihq@cmpdi.co.in

Annexure-XV

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/GM/Ar.-III/Envt/2022-23/14 **Dated: 18.05.2022**

To
HoD (Env)
Koyla Bhawan, BCCL

Sub: Expenditure details as per EIA/EMP (FY 2021-22) for Cluster-III group of Mines, BCCL

Dear Sir

With reference to above mentioned subject; kindly find herewith the attached expenditure details as per EIA/EMP for Cluster-III group of Mines, BCCL

This is for your kind information.

Encl: As above

Yours faithfully

18/5/22

AGM/Nodal Officer (Env)
Govindpur Area

Copy for kind information:

1. General Manager, Govindpur Area

Revenue Expenditure on Environment Management (Cluster-III)

Sl. No.	Element	Annually Recurring Cost (Rs. in Lakhs) as per EIA/EMP	Actual cost incurred (Lakhs) FY 2021-22	Remarks
1.	Pollution control	20.00	24.19	Water Sprinkling on haul roads, railway siding and public roads.
2.	Pollution monitoring	5.00	31.768196	As per information provided by Env department, HQ; Being done by CMPDIL RI-II, Dhanbad
3.	Occupational health	5.00	15.55	Expenditure incurred on purchase of safety shoes, ear plugs, Safety helmets, goggles, medical kits etc. for persons engaged in mining activities.
4.	Green belt & biological reclamation	10.00	28.75 (05 nos. of Manpower with EMS@ Rs. 1575)	Manpower Cost incurred on biological reclamation of OB dumps
			28.20	Expenditure on completion work of OB plantation on 23.5 Ha and maintenance work on 9.5 Ha by DFO, Dhanbad.
5.	Corporate Social Responsibility	138.45	CSR: 493*	Being dealt at HQ level. Cluster-III is contributor for the same.
6.	Corpus fund for mine closure	130.00	303.26	Deposited in Escrow account.
7.	Water cess and consent to operate	6.00	NIL	CTO fee for Cluster-III with RLS (SILO)
8.	Others (Lump sum)	5.00	NIL	As per data provided by Env Dept, HQ. Monitoring of Eco restoration sites by FRI Dehradun
9.	Mine Reclamation	25.00	190.7**	** 50% of cost deposited in escrow amount with interest for FY 2021-22. Reimbursement is subjected to Third party audit of the claim as per approved Mine Closure Plan.
	Total *	**344.45**	**622.42**	

*** Cost of CSR expenditure done at corporate level is not included.**

18/5/22
Addl. General Manager
Govindpur Area

18/05/22
Area Finance Manager
Govindpur Area

Sharma
AM (Env)
Govindpur Area

General Manager Govindpur Area ...

Capital cost of Environment Management for Cluster-III

Sl. No.	Activity head as per EMP	Item	Unit Name	Year	Cost (Lakhs)	Remarks
1.	Pollution abatement cost including providing 02 additional water sprinklers.	Procurement of two Mobile water Sprinkler (28 KL Capacity)	New Akashkinaree Colliery	2013-14	126.67	As per information provided by Colliery.
			Block-IV Colliery	2020-21	162.84	
2.	Development of green belt (100 Ha and the left out area will be taken up during mine closure period) (Rs. 1 lakh per Ha)	Advance work for bamboo gabion plantation	Advance work for bamboo gabion plantation in Maheshpur, Jogidih, Govindpur Colliery	2021-22	17.29	By DFO, Dhanbad
3.	Dust suppression & extraction in coal handling plant & feeder breaker	Procurement of 3 nos. trolley mounted fog cannon	SLG Railway Siding	2021-22	20.85	
4.	EMP Report	Preparation of EIA and EMP report	Cluster-III	2012-13	89.34851	As per information provided Env Dept, BCCL HQ
5.	Industrial sewage treatment in workshop	Construction of Oil & Grease trap	New Akashkinaree Colliery and Block-IV Colliery	2020-21	22.40	As per details provided by Area Civil Deptt.
6.	Cost of Anti-pollution measures in mine & Industrial area	Construction of Coal transportation Road	Block-IV Colliery	2020-21	5.78	WBM Road for coal transportation. As per details provided by Area Civil Deptt.
			SLG Siding	2020-21	17.72	
			Maheshpur Colliery	2019-20	21.08	
			New Akashkinaree Colliery	2019-20	19.74	
7.	Other provisions	Construction of Toe wall around OB dump	Maheshpur Colliery	2020-21	9.61268	As per details provided by Area Survey Deptt.
		Construction of Rain Water Harvesting Arrangement	New Akashkinaree Colliery	2021-22	8.40	As per details provided by Area Civil Deptt.

18/5/22

Addl. General Manager
Govindpur Area

18/05/22

Area Finance Manager
Govindpur Area

AM (Env)
Govindpur Area

Annexure- XVI

BHARAT COKING COAL LIMITED
A Mini Ratna Company
(A Subsidiary of Coal India Ltd.)
Office of the General Manager
Govindpur Area No.III
PO- Sonardih, DHANBAD – 828125
Contact No: 0326-2392162 email- cgmgovindpur@bccl.gov.in

Ref: BCCL: AR.III:GM:20: 18

Dated: 13.04.2020

To
Panchayat Sachiwalay,
Tundoo Panchayat,
KalludihPanchayat,
AkashkinareePanchayat,
BahiyardihPanchayat,
Jamua Panchayat

Sub: Copy of Environmental Clearance granted to Cluster-III group of Mines, BCCL by Ministry of Environment & Forest

Dear Sir

Kindly find herewith the attached copy of Environmental Clearance granted to Cluster-III group of Mines, BCCL by Ministry of Environment & Forest.

This is for your kind information.

Encl: As above

Yours faithfully

13/04/2020.

Addl. General Manager/ Nodal Officer (Env)
Govindpur Area

Copy to:

1. General Manager, Govindpur Area- for kind information
2. HoD (Env), Koyla Bhawan, BCCL- for kind information

अमित कुमार ड्रोलिया, सीए

झरिया के लोगों ने कहा

आम बजट से जनता को राहत नहीं मिली है। बेरोजगार युवकों को रोजगार का अवसर नहीं मिला है। बजट ने सभी को निराश किया है। इसका खमियाजा चुनाव में कांग्रेस को भुगतना पड़ेगा।

संजीव सिंह, संयुक्त महामंत्री जमसं।

बजट कहीं से संतोषप्रद नहीं है। निराशाजनक बजट है। आम जनता पर बोझ बढ़ेगा। उद्योग खोलने पर कोई ध्यान नहीं दिया गया है।

एसके बख्शी, केंद्रीय उपाध्यक्ष सीटू

आम बजट में बेरोजगारों के लिए कुछ नहीं किया गया। आम लोगों पर बोझा लादा गया

शिवबालक पासवान, माकपा

कांग्रेस ने जनता को निराश किया है। जनता इस बार आम बजट का जवाब बैलेट से देगी।

मुनिलाल राम, झाविमो

आम बजट जनविरोधी और महंगाई बढ़ाने वाला है। आंकड़ों के जाल में यूपीए ने फंसा कर जनता को दिग्भ्रमित किया है।

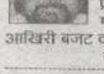
राजकुमार अग्रवाल, भाजपा नेता

आम बजट से जनता को उतनी राहत नहीं मिलेगी जितना होने वाले चुनाव को रखकर जनता ने उम्मीद लगा रखी थी।

डॉ. जेके सिन्हा, निदेशक आइएसएल

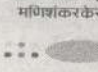
बजट संतुलित है। लेकिन आम जनता को ध्यान में नहीं रखा गया है। जनता को निराशा हाथ लगी है।

अनूप साव, पार्षद



आम बजट का बोझ जनता के सिर पर पड़ा है। जनता को कोई राहत नहीं मिली है।

हरीश जोशी, अधिवक्ता



बजट से महंगाई बढ़ेगी। यह बजट वोट को प्रभावित करनेवाला वित्त मंत्री चिदंबरम का आखिरी बजट कहलाएगा।

कादिर अंसारी, व्यवसायी

बजट में व्यवसायियों पर कोई ध्यान नहीं दिया गया है। लोगों को भी इससे कोई फायदा नहीं है।

मणिशंकरकेसरी, पूर्व जिलाध्यक्ष चैंबर

ऑफ कॉमर्स सुशील नारनोली

लोक सुनवाई की सूचना

सड़क परिवहन एवं राजमार्ग मंत्रालय, भारत सरकार द्वारा बिहार राज्य के अन्तर्गत राष्ट्रीय उच्चपथ संख्या–30A फतुहा–बाढ़ खण्ड का दो लेन पक्की पटरी सहित चौड़ीकरण परियोजना का प्रस्ताव है। इसकी कुल लम्बाई लगभग 72.390 कि०मी० है। यह उच्चपथ पटना जिला के फतुहा से प्रारम्भ होकर नालंदा जिला के चण्डी, हरनौत होते हुए बाढ़ (पटना) तक जायगी। इस राजमार्ग में तीन बाईपास क्रमशः दनियाँवा, हरनौत एवं बाढ़ में प्रस्तावित है, इसके अतिरिक्त इसमें उपमार्ग, पुल, पुलिया, भूमिगत मार्ग, रूकाव स्थल एवं टॉल प्लाजा आदि की व्यवस्था होगी। परियोजना का कुल लागत 420.70 करोड़ है। इस परियोजना मार्ग में कोई राष्ट्रीय उद्यान, वन्य–जीव अभ्यारण्य नहीं है।

पर्यावरण एवं वन मंत्रालय, भारत सरकार के पर्यावरणीय प्रभाव मूल्यांकन (ई.आई.ए.) अधिसूचना, 2006 एवं उसमें संशोधित अधिसूचना के आलोक में प्रस्तावित योजना की पर्यावरणीय स्वीकृति हेतु ई.आई.ए. रिपोर्ट तैयार किया गया है, जिसमें सम्भावित कुप्रभावों के नियत्रण हेतु उपाय दर्शाये गये हैं। ई.आई.ए. प्रतिवेदन एवं ई.आई.ए. सार–प्रतिवेदन को संबंधित जिलाधिकारी, जिला परिषद् एवं महाप्रबंधक जिला उद्योग केन्द्र के कार्यालयों के साथ–साथ पर्षद मुख्यालय, पटना में कार्यालय कार्य दिवस के दौरान देखी जा सकती है। वैसे व्यक्ति जो इस परियोजना से प्रभावित होने वाले हों, अपना सुझाव/प्रतिक्रिया इस सूचना के प्रकाशित होने के 30 दिनों के अन्दर पर्षद को उपलब्ध करा सकते हैं।

स्थानीय जनता की प्रतिक्रिया/सुझाव आमंत्रित करने हेतु लोक सुनवाई कार्यक्रम निम्नवत् है :–

दिनांक	समय	लोक–सुनवाई का स्थल
05.04.2013 (शुक्रवार)	3.00 बजे अपराह्न	प्रखंड कार्यालय, हरनौत, नालंदा
06.04.2013 (शनिवार)	3.00 बजे अपराह्न	प्रखंड कार्यालय, बाढ़, पटना

सभी संबंधित से अनुरोध है कि उपरोक्त कार्यक्रम में उपस्थित होने का कष्ट करेंगे।

सदस्य–सचिव

BIHAR

बिहार राज्य प्रदूषण नियंत्रण पर्षद

बेल्ट्रॉन भवन, शास्त्रीनगर, पटना – 800 023
दूरभाष नं०–0612–2261250 / 2282265, फैक्स–0612–2281050
वेबसाईट–http://bspcb.bih.nic

क्षेत्रीय कार्यालय फोन नं. 01482-241153

राजस्थान राज्य प्रदूषण नियन्त्रण मण्डल

18, आजाद नगर, पन्नाधाय सर्किल, भीलवाड़ा

राप्रनिम/क्षेका भील/राज/ दिनांक

पर्यावरणीय स्वीकृति हेतु लोक सुनवाई के लिए आम सूचना

1. सर्वसाधारण को सूचित किया जाता है कि मैसर्स भारतीय राष्ट्रीय राजमार्ग प्राधिकरण, परियोजना क्रियान्वयन इकाई, ए 11, चन्द्रकिरण, रीको हाउसिंग कॉलोनी, ब्यावर ने प्रस्तावित राष्ट्रीय राजमार्ग संख्या 148–डी 109.750 कि.मी. राष्ट्रीय राजमार्ग–8 (जिला–राजसमन्द) से 64.200 कि.मी., राष्ट्रीय राजमार्ग–79 गुलाबपुरा (जिला भीलवाड़ा) तक की चौड़ाई एवं सुदृढ़करण से संबन्धित प्रार्थना पत्र मय दस्तावेज पर्यावरणीय स्वीकृति से पूर्व आवश्यक लोक सुनवाई हेतु प्रस्ताव राजस्थान राज्य प्रदूषण नियंत्रण मण्डल (यहाँ तथा बाद में मण्डल के नाम से अभिलिखित) को प्रस्तुत किया गया है।
2. और चूंकि मैसर्स भारतीय राष्ट्रीय राजमार्ग प्राधिकरण, परियोजना क्रियान्वयन इकाई, ए 11, चन्द्रकिरण, रीको हाउसिंग कॉलोनी, ब्यावर ने राजस्थान राज्य प्रदूषण नियंत्रण मण्डल को उक्त परियोजना की पर्यावरणीय स्वीकृति से पूर्व आवश्यक लोक सुनवाई हेतु मण्डल को आवेदन प्रस्तुत किया है। उक्त परियोजना हेतु वन एवं पर्यावरण मंत्रालय, भारत सरकार, नई दिल्ली द्वारा जारी अधिसूचना संख्या एस. ओ. 1533 दिनांक 14.09.2006 के अनुसार लोक सुनवाई हेतु इस आशय की सूचना जारी कर 30 दिवस का नोटिस दिया जाना आवश्यक है।
3. उक्त परियोजना से सम्बन्धित EIA/EMP Report एवं संक्षिप्त कार्यकारी सार अभिलेख निम्न कार्यालयों में अवलोकनार्थ उपलब्ध है :–
   (1) जिला कलेक्टर, राजसमन्द।
   (2) जिला उद्योग केन्द्र, राजसमन्द।
   (3) जिला परिषद, राजसमन्द।
   (4) तहसील कार्यालय, भीम, जिला–राजसमन्द।
   (5) कार्यालय पंचायत समिति, भीम, तहसील–भीम, जिला–राजसमन्द।
   (6) कार्यालय उपखण्ड मजिस्ट्रेट, भीम, तहसील–भीम, जिला–राजसमन्द।
   (7) क्षेत्रीय कार्यालय, राजस्थान राज्य प्रदूषण नियंत्रण मण्डल, भीलवाड़ा।
   (8) पर्यावरण विभाग, राजस्थान सरकार, शासन सचिवालय, जयपुर।
   (9) राजस्थान राज्य प्रदूषण नियन्त्रण मण्डल, 4 पर्यावरण मार्ग, संस्थानिक क्षेत्र, झालाना डूंगरी, जयपुर।
   (10) क्षेत्रीय कार्यालय, पर्यावरण एवं वन मंत्रालय, पंचम तल केन्द्रीय भवन, सेक्टर एच, अलीगंज, लखनऊ।

अतः सर्व साधारण को नोटिस के माध्यम से एतद् द्वारा सूचित किया जाता है कि वे उक्त परियोजना के पर्यावरणीय स्वीकृति से संबंधित लोक सुनवाई हेतु दिनांक 02.04.2013 को 1.00 पी.एम. पर कार्यालय उपखण्ड मजिस्ट्रेट, भीम, तहसील–भीम, जिला –राजसमन्द में उपस्थित होकर अपने लिखित / मौखिक आक्षेप / सुझाव प्रस्तुत कर सकते है।

इस संबंध में लिखित आपेक्ष / सुझाव इस सूचना के प्रकाशन की तिथि से 30 दिवस के अन्दर क्षेत्रीय कार्यालय, राजस्थान राज्य प्रदूषण नियंत्रण मण्डल, भीलवाड़ा को भी दिये जा सकते है।

(वी. एस. सांखला) क्षेत्रीय अधिकारी

NORTH EASTERN RAILWAY

Notification No.:-23/2013

IMPORTANT NOTICE FOR THE RAIL PASSENGERS

It is notified for the information of general public that provision of one additional AC-2 Tier coach in train no. 18191/18192 Chhapra-Kanpur Anwarganj Utsarg Express, notified earlier vide this office Notification No. 108/2012 dated 21.12.2012, is being further extended on experimental basis as under:-

Train No. & Name	Station From	Originating Date	Last Date
18191 Chhapra-Kanpur Anwarganj Utsarg Exp	Chhapra	01-03-13	30-06-13
18192 Kanpur Anwarganj-Chhapra Utsarg Exp.	Kanpur Anwarganj	02-03-13	01-07-13

CPRO/T-104 Chief Pass Trans., Manager, Gorakhpur

Railway Vigilance Mobile Helpline No.:0551-158210 (for Complaints regarding Corruptions)

"SERVING CUSTOMERS WITH A SMILE"

Bharat Coking Coal Limited

(A Subsidiary of Coal India Limited)

This is to bring into notice of all concerned that the following 09 (Nine) Clusters of BCCL consisting of 63 Mines and 02 washeries are granted Environmental Clearances by Ministry of Environmental and forests.

Sl. No.	Name of the Cluster	Sanction order number and date
1.	**Cluster-I** (Damoda Group of 3 Mines - Damoda (Albion Section) OCP, Damoda UGP and Damuda BJ Section OCP) Group of Mines (of 0.9 MTPA normative and 1.17 MTPA (peak) in a combined ML area of 575 ha) of M/s Bharat Coking Coal Ltd., located in Jharia Coalfields, Block Chandrapur, Dist. Dhanbad, Jharkhand.	J-11015/93/2009-1A.II (M) dated 5th Feb. 2013
2.	**Cluster-II** (5 mines of a combined prod. capacity 15.55 MTPA with a peak production of 20.215 MTPA) in a combined ML area of 2025.71 ha) of M/s Bharat Coking Coal Ltd., located in Jharia Coalfields, Dist. Dhanbad, Jharkhand.	J-11015/35/2011-1A.II (M) dated 6th Feb. 2013
3.	**Cluster-III** (7 mines of a peak production of 3.6 MTPA in a combined ML area of 1420.61 ha) of M/s Bharat Coking Coal Ltd., located in Jharia Coalfields, Dist. Dhanbad, Jharkhand (EC based on TOR granted on 04.11.2010).	J-11015/213/2010 1A.II (M) dated 6th Feb. 2013
4.	**Cluster-IV** (6 mines with production capacity 2.851 MTPA (Normative) 3.706 MTPA (Peak) in a combined ML area of 1123.79 ha) of M/s Bharat Coking Coal Ltd., located in Jharia Coalfields, Dist. Dhanbad, Jharkhand excluding Gasitand Colliery UG.	J-11015/212/2010-1A.II (M) dated 6th Feb. 2013
5.	**Cluster-V** (7 mines of a 4.854 (Normative) and 6.311 (Peak) production of MTPA in a combined ML area of 1957.08 ha) of M/s Bharat Coking Coal Ltd., located in Jharia Coalfields, Dist. Dhanbad, Jharkhand (EC based on TOR granted on 16.03.2011).	J-11015/01/2011-1A.II (M) dated 11th Feb. 2013
6.	**Cluster-VII** (combined capacity 6.227 MTPA with a peak prodn. of 8.16 MTPA in a combined ML area of 2127.7 ha) of M/s Bharat Coking Coal Ltd., located in Jharia Coalfields, Dist. Dhanbad, Jharkhand (EC based on TOR granted on 09.12.2010) (excluding Kustore UG and East Bhuggatdih).	J-11015/236/2010-1A.II,(M) dated 6th Feb. 2013
7.	**Cluster-X** (5 mines of 1.762 MTPA of normative and peak production of 2.289 MTPA in a combined ML area of 2057.95 ha) and Sudamdih Coal Washery (Within the lease hold of Sudamdih Shaft Mine) of 1.6 MTPA of normative and 2.08 MTPA peak production for a area of 18 ha) of M/s Bharat Coking Coal Ltd., located in Jharia Coalfields, Dist. Dhanbad, Jharkhand (EC based on TOR granted on 09.02.2011).	J-11015/380/2010-1A.II (M) dated 6th Feb. 2013
8.	**Cluster-XVI** - Coalmines (Dahibari-Basantimata OCP, Basantimata under Ground Mine, New Laikdih OCP (including Dahibari Coal Washery), Laikdih Deep UG, Chanch UG) (normative 1.51 MTPA and 1.963 MTPA peak in a combined ML area of 1964.21 ha) and Dahibari washery of 1.6 MTPA in the area of 12 ha of M/s Bharat Coking Coal Ltd., in Dist. Dhanbad, Jharkhand (EC based on TOR granted on 28.05.2010).	J-11015/185/2010-1A.II (M) dated 6th Feb. 2013
9.	**Cluster-VIII** Group of 10 Mines (combined capacity 4.31 MTPA with a peak prodn. of 5.603 MTPA in a combined ML area of 1183.92 ha (1200.41 ha-16.49 ha=1183.92 ha) of M/s Bharat Coking Coal Ltd., located in Jharia Coalfields, Dist. Dhanbad, Jharkhand.	J-11015/298/2010 1A.II (M) dated 15th Feb. 2013

The copy of the clearance letter is available with the Jharkhand State Pollution Control Board and may also be seen at the website of the Ministry of Environmental and forests at http://envfor.nic.in and on the official website of BCCL at http://www.bccl.gov.in