भारतकोकिंगकोलिलिमिटेड
एकमिनिरत्नकम्पनी
(कोलइंडियालिमिटेडकाएकअंग)
महाप्रबंधककाकार्यालय,
चाँचविक्टोरियाक्षेत्र
पि .ओ -.बराकर, जिला - पं.बर्धमान) पं .बंगाल (
पिन – 713324 .दूरभाष – 0341-2520061/62 .
पंजीकृतकार्यालय :कोयलाभवन .कोयलानगर .धनबाद -826005 .
(झारखण्ड)
CIN: U10101JH1972GOI000918

Bharat Coking Coal Limited
A MINI RATNA Co.
(A Subsidiary of Coal India Ltd)
Office of the General Manager,
Chanch Victoria Area
P.O.-BARAKAR, DIST-PAS.BARDHAMAN(W.B.)
PIN- 713324, TeL.0341-2520061/62
Regd.Off: KoylaBhawan, Koyla Nagar, Dhanbad-826005,
CIN: U10101JH1972GOI000918,

Ref. No: BCCL/CV/ ENVT/2021/ 24

Date: 31/05/2021

To,
The Director,
Ministry of Environment, Forest, Climate Change,
Regional Office (ECZ), Bungalow No. A-2,
Shyamali Colony,
Ranchi, Jharkhand- 834002

Sub:-Six Monthly Report On Implementation Of Environmental Measures For The Period From October 2020 to March 2021 In Respect Of EC of Cluster-XVI Group Of Mines Of BCCL.

Dear Sir,

Enclosed please find herewith the six monthly reports on implementation of environmental protection measure for the period from October 2020 to March 2021 in respect of Cluster-XVI group of mines of BCCL.

Hope you will find the same in order.

Yours Faithfully

29-5-21

General Manager
CV Area

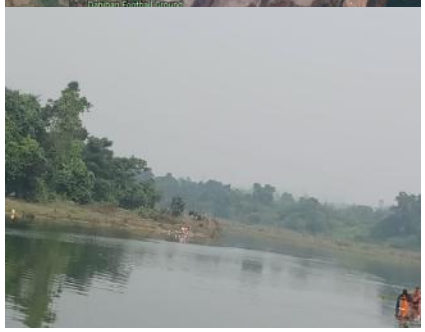
महाप्रबंधक
General Manager
सी.वी. क्षेत्र / C.V AREA
वी.सी.सी एल. / B.C.C.L

CC to: - (1) Dr. SunitaAulock, Director 1A monitoring cell, ParyavaranBhawan CGO Complex, New Delhi-110003
(2) The Incharge, Zonal Office, CPCB, Southernd Conclave, Block 502,5th& 6th Floors, 1582 Rajdanga Main Road Kolkata – 700107 (W.B)
(3) The Regional Officer, JSPCB, Hirapur, Dhanbad-826001, Jharkhand
(4) Dy.GM (Environment), BCCL, KoylaBhawan, Dhanbad.
(5) AGM, CV Area.
(6) Project Officer, DBOCP
(7) Nodal Officer (Envt), CV Area.
(8) Office Copy

PROGRESSIVE COMPLIANCE OF EC CONDITIONS OF CLUSTER- XVI

EC order no- J-11015/185/2010-IA.II (M) Dated 06.02.2013

Upto March 2021

<table>
<tr><th>Sl. no.</th><th>A. Specific Conditions by MOEF:</th><th>Progressive Compliance</th></tr>
<tr><td>i</td><td>The maximum production shall not exceed beyond that for which environmental clearance has been granted for the 5 mines of cluster XVI as below:</td><td>The approved peak production of coal for Cluster XVI is 1.963 MTPA. The production for the period between April 1st, 2020 to March 31st, 2021 is 0.819 MT.
The total production of coal for cluster XVI for the last three financial years are as followed:
<table>
<tr><th>S.No.</th><th>FY</th><th>Production (MTPA)</th></tr>
<tr><td>1.</td><td>2018-19</td><td>1.527</td></tr>
<tr><td>2.</td><td>2019-20</td><td>0.782</td></tr>
<tr><td>3.</td><td>2020-21</td><td>0.819</td></tr>
</table></td></tr>
<tr><td>ii</td><td>All the void /water bodies should be backfilled upto ground level and no OB dump at the end of mining.</td><td>It is a Post-mining condition. It will be duly complied at the suitable mining stage. Picture of inoperative Junkunder OCP Mine which is serving as water body for local community after filtration which is hereby enclosed as Annexure 1.
  </td></tr>
<tr><td>iii</td><td>Extensive plantation should be provided on either side of River;</td><td>Extensive plantation on both sides of Khudia River is already developed. Photographs of the same have been enclosed as Annexure 2.
 
  </td></tr>
<tr><td>iv</td><td>Impact of mining on ground water of the area (Impact Zone)</td><td>There is no declining trend in the Ground water level. And the</td></tr>
</table>

<table>
<tr><td></td><td>should be provided;</td><td>time series data for ground water till FY 2019-20 have been attached as Annexure 3.</td></tr>
<tr><td>v</td><td>A Garland drain should be provided</td><td>Garland drain is provided along the periphery of Kalyanchak OB Dump of DBOCP. Photographs of the same have been enclosed as Annexure 4.
  </td></tr>
<tr><td>vi</td><td>Excess water from mine after treatment should be supplied to the villagers.</td><td>At present, excess water from mine is supplied to the villages through settling pond. Location of ponds is at the south of Palasia incline and Kumarkuli Basti.

List of beneficiary villages along with mine water discharge data are attached as Annexure 5.</td></tr>
<tr><td>vii</td><td>Rejects of washery along with dry carbon slurry should be utilized in power plant and other recognized vendors.</td><td>Dahibari Washery rejects are being kept separately and is being sold through auctioning process on portal (https://www.mstcindia.co.in) to the recognized vendors.</td></tr>
<tr><td>viii</td><td>A time schedule for filling of existing and abandoned quarries be done.</td><td>Old abandoned Quarry no. 1, 2, 3 & 3/4 of Kalimati Seam at Basantimata Mine has been filled upto ground level. Abandoned quarry of NLOCP, JOCP & KOCP have been filled up.The progressive reclamation is being undertaken as per approved MCP.

Year wise Backfilling till now is as below:-

<table>
<tr><th>Sl No.</th><th>Year</th><th>Quantity (Lakh M^3)</th></tr>
<tr><td>1.</td><td>2012-13</td><td>7.25</td></tr>
<tr><td>2.</td><td>2013-14</td><td>55.00</td></tr>
<tr><td>3.</td><td>2014-15</td><td>85.75</td></tr>
<tr><td>4.</td><td>2015-16</td><td>5.00</td></tr>
<tr><td>5.</td><td>2016-17</td><td>7.00</td></tr>
<tr><td>6.</td><td>2017-18</td><td>5.00</td></tr>
<tr><td>7.</td><td>2018-19</td><td>2.00</td></tr>
<tr><td>8.</td><td>2019-20</td><td>Nil</td></tr>
<tr><td>9.</td><td>2020-21</td><td>3.493</td></tr>
</table></td></tr>
<tr><td>ix</td><td>The measure identified in the environmental plan for cluster XVI groups of mine and the conditions given in this environmental clearance letter shall be dovetailed to the implementation of the JhariaAction Plan.</td><td>Master Plan activities are dovetailed with compliance of environmental clearance conditions. 420 quarters have already been constructed and 100 families have been relocated to the newly constructed quarters.</td></tr>
</table>

x	**As there is no fire in Cluster XVI but the measure should be adopted by proponent to control spread of neighboring fire to this Cluster XVI. 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 XIV shall be undertaken.**	Time series maps are prepared regularly and the reports have been generated in the year 2014 and 2018.Latest report of Jan 2018 of NRSC is attached as **Annexure 6**.
xi	**Underground mining should be taken up after completion of reclamation of Opencast mine area after 2 years.**	Underground mining will be taken up after reclamation of OC mine.
xii	**No mining shall be undertaken where underground fires continue. Measure shall be taken to prevent/ check such fire including in old OB dump**	No mining is being undertaken where underground fire continues. Fire is liquidated by excavation of fiery coal and thereafter coal as well as OB Dump excavated is cooled by water.SOP exists for handling/fighting fire. The same has been attached as **Annexure 7.**
xiii	**A part of cluster XVI is under Barakar River and Damodar River. It was clarified that although the mine is underground, there is no coal underneath River Damodar, which would be mined. The Committee desired that the data of bore wells near River Damodar require to be monitored for permeability and seepage of waster of River Damodar.**	At present there is no underground mining operation below the River Damodar & Barakar. Working underground mine has not reached near river Damodar & Barakar and it is more than 2000 mtr. away from river bed, far away from impact of river. However, a study has been done by CMPDI which is attached as **Annexure 8.**
xiv	**The rejects of washeries in Cluster –XVI should be send to FBC based plant.**	Dahibari Washery rejects are being kept separately and are being sold through auctioning process on portal (**https://www.mstcindia.co.in**) to recognized vendors.
xv	**There shall be no external OB dumps. OB produce from the whole cluster will be 29.01 Mm^3. OB from One Patch OCP mine 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**	Action is being taken as specified in EMP for Backfilling of OB concurrent with mining. No fresh land is used for OB dumping. Proper vegetation is being developed on the OB dump to avoid erosion of soil and gully formation and also to stabilize sufficiently the OB slope. Pictures of ecologically restored OB Dumps under Cluster XVI have been attached as **Annexure 9**. All the OB dumps (seven) are within the leasehold area and are

	carried out and completed shall be reclaimed immediately thereafter.	on de-coaled area.
xvi	**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- XVI shall be drawn up and implemented.**	Edited Calendar plan of production is prepared and implemented. The schedule as per approved MCP is being followed. Please refer the calendar plan attached as **Annexure 10**. II - 80 TABLE – 8.1.(b) CALENDER PLAN (VARIANT - II) DAHIBARI QUARRY BASANTIMATA QUARRY TOTAL QUARRY COAL + JHAMA (mt.) | O.B (mm3) | S.R (m3 / t) COAL | JHAMA | TOTAL PC-1 - - - - - - - - - - - - - - - - - - C-1 - - - - - - - - - - - - - - - - - - P-1 0.35 - 0.35 1.55 4.43 - - - - - 0.35 0.00 0.35 1.55 4.43 P-2 0.78 0.02 0.80 2.65 3.31 - - - - - 0.78 0.02 0.80 2.65 3.31 P-3 1.07 0.23 1.30 2.65 2.04 - - - - - 1.07 0.23 1.30 2.65 2.04 P-4 1.05 0.25 1.30 2.65 2.04 - - - - - 1.05 0.25 1.30 2.65 2.04 P-5 1.05 0.25 1.30 2.65 2.04 - - - - - 1.05 0.25 1.30 2.65 2.04 P-6 1.05 0.25 1.30 2.65 2.04 - - - - - 1.05 0.25 1.30 2.65 2.04 P-7 1.10 0.20 1.30 2.65 2.04 - - - - - 1.10 0.20 1.30 2.65 2.04 P-8 1.10 0.20 1.30 2.65 2.04 - - - - - 1.10 0.20 1.30 2.65 2.04 P-9 1.10 0.20 1.30 2.65 2.04 - - - - - 1.10 0.20 1.30 2.65 2.04 P-10 1.05 0.25 1.30 2.55 1.96 - - - - - 1.05 0.25 1.30 2.55 1.96 P-11 1.05 0.25 1.30 2.59 1.99 - - - - - 1.05 0.25 1.30 2.59 1.99 P-12 0.80 0.20 1.00 0.76 0.76 0.30 - 0.30 2.00 6.67 1.10 0.20 1.30 2.76 2.12 P-13 0.47 0.19 0.66 0.53 0.80 0.62 0.02 0.64 2.30 3.59 1.09 0.21 1.30 2.83 2.18 P-14 1.08 0.22 1.30 2.85 2.19 1.08 0.22 1.30 2.85 2.19 P-15 1.08 0.22 1.30 2.85 2.19 1.08 0.22 1.30 2.85 2.19 P-16 1.08 0.22 1.30 2.85 2.19 1.08 0.22 1.30 2.85 2.19 P-17 1.08 0.22 1.30 2.85 2.19 1.08 0.22 1.30 2.85 2.19 P-18 1.10 0.20 1.30 2.85 2.19 1.10 0.20 1.30 2.85 2.19 P-19 1.08 0.22 1.30 2.80 2.15 1.08 0.22 1.30 2.80 2.15 P-20 1.06 0.24 1.30 2.50 1.92 1.06 0.24 1.30 2.50 1.92 P-21 1.06 0.24 1.30 1.72 1.32 1.06 0.24 1.30 1.72 1.32 P-22 0.73 0.17 0.90 0.93 1.03 0.73 0.17 0.90 0.93 1.03 TOTAL 12.02 2.49 14.51 29.18 2.01 10.27 1.97 12.24 26.50 2.17 22.29 4.46 26.75 55.68 2.08
xvii	**The void in 5 ha area shall be converted into a water reservoir of a maximum depth of 15-20 m in post mining stage and shall be gently sloped and the upper benches of the reservoir shall be stabilised with plantation and the periphery of the reservoir fenced. The abandoned pits and voids should be backfilled with OB and biologically reclaimed with plantation and or may be used for pisciculture**	It is a Post-mining closure requirement and will be duly complied.
xviii	**Mining shall be carried out as per statuette from the streams/nalas flowing within the lease and maintaining a safe distance from the Nalas flowing along the lease boundary. A safety barrier of a minimum 60m width shall be maintained along the nalas/water bodies. 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.**	Mining is being carried out as per Statute from the streams/Nalas flowing within the lease and maintaining a safe distance (>60 m) from the nalas flowing along the lease boundary.
xix	**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.**	Presently there are no active OB dumps near water bodies. The earlier OB Dump are already stabilized biologically and hence not disturbed. Further action has been taken for their eco-restoration work as per Road Map prepared by FRI, Dehradun.Photo of the same has been attached as **Annexure 9**.

<table>
<tr>
<td>xx</td>
<td>Thick green belt shall be developed along undisturbed areas, mine boundary and in mine reclamation. During post mining stage, a total of 242.09ha area would be reclaimed by planting native species in consultation with the local DFO/Agriculture Department/institution with the relevant discipline. The density of the trees shall be around 2500 plants per ha.</td>
<td>Year wise plantation (Proposed) is being done as per following plan:-
<table>
<tr><th>Year</th><th>Biologically Reclaimed Area</th></tr>
<tr><td>2013-14</td><td>1.0 Ha. (completed)</td></tr>
<tr><td>2014-15</td><td>4.6 Ha. (completed)</td></tr>
<tr><td>2015-16</td><td>4.0 Ha. (completed)</td></tr>
<tr><td>2016-17</td><td>12.5 Ha. (completed)</td></tr>
<tr><td>2017-18</td><td>7.0 Ha. (completed)</td></tr>
<tr><td>2018-19</td><td>05.0 Ha. (completed)</td></tr>
<tr><td>2019-20</td><td>10.0 Ha. (Completed)</td></tr>
<tr><td>2020-21</td><td>05.50 Ha.(Completed)</td></tr>
<tr><td>2021-22</td><td>05.0 Ha.</td></tr>
<tr><td>2022-23</td><td>05.0 Ha.</td></tr>
<tr><td>2023-24</td><td>05.0 Ha.</td></tr>
<tr><td>2024-25</td><td>05.0 Ha.</td></tr>
<tr><td>2025-26</td><td>25.0 Ha.</td></tr>
<tr><td>2026-27</td><td>35.0 Ha.</td></tr>
<tr><td>2027-28</td><td>40.0 Ha.</td></tr>
<tr><td>2028-29</td><td>73.0 Ha.</td></tr>
</table>
Total mine boundary of Basantimata Dahibari Colliery is approximately 15 km out of which 10 km approx. is already covered with plantation. Rest of the boundary will be duly covered in phase-wise manner.</td>
</tr>
<tr>
<td>xxi</td>
<td>The road should be provided with avenue plantation on both side as trees act as sink of carbon and other pollutant.</td>
<td>1700 gabion trees were planted through State Forest Department along the transportation road and siding in cluster XVI. Photograph of the same have been attached as Annexure 11.
  </td>
</tr>
<tr>
<td>xxii</td>
<td>Specific mitigative measures identified for the Jharia Coalfields in the Environmental Action Plan prepared for Dhanbad as a critically polluted are and relevant for Cluster -XVI shall be implemented.</td>
<td>Dhanbad Action Plan has been prepared in consultation with Jharkhand Pollution Control Board which includes covering of trucks etc. are complied. Activities mentioned in Dhanbad Action Planand their implementation status relevant to Cluster XVI is attached herewith as Annexure 12.</td>
</tr>
<tr>
<td>xxiii</td>
<td>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</td>
<td>Work Order had already been issued to NEERI Nagpur on 12.05.2018. And work has been started in September 2018. Field data collection for Summer season has been done; winter data has been collected. The progress report sent by NEERI is attached as Annexure 13.The final report will be shared with</td>
</tr>
</table>

	source to source (fuel wood, coal, flyash from TPPs, silica from natural dust, etc) and a Source Apportionment Study should be got carried out for the entire Jharia Coalfields. Mineralogical composition study should be undertaken on the composition of the suspended particulate matter (PM_{10} and $PM_{2.5}$) in Jharia Coalfields and also quantified. These studies would help ascertain source and extent of the air pollution, based on which appropriate mitigative measures could be taken.	JSPCB for compliance by all the stakeholders.
xxiv	**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 to dewatering of mine.**	No ground water is being utilized for the purpose of industrial use of the water and the level of ground water is not declining. Mine water has been channelized through pipelines and through discharge in to the ponds for its use for the community and irrigation purposes. Jhunkunder OCP Mine which is serving as water body for local community after filtration. During summer season filter water as well as raw water is being supplied through water tanker to local adjacent villages wherever required. Pressure Filters have been installed for the filtration of mine water being supplied to nearby habitat. Already 6 filters have been installed and are in operation.
xxv	**Regular monitoring of groundwater level and quality of the study area shall be carried out by establishing a network of existing wells and construction of new peizometers. The monitoring for quantity shall be dome four times a year in pre-monsoon (May), monsoon (August), post-monsoon (November) and winter (January) seasons and for quality including Arsenic and Fluoride during the month of May. Data thus collected shall be submitted to the Ministry of Environment & Forest and to the Central Pollution Control Board/SPCB quarterly within one month of monitoring. Rainwater harvesting measures shall be undertaken in case monitoring of water table indicates a declining trend.**	Ground water level and quality are being monitored by CMPDIL Ranchi. Analysis report for the Q.E. in September 2020 is enclosed as **Annexure 14.** Establishment of network of existing wells and construction of new piezometers are in process. For the same, tendering process has been initiated thrice without successfully finding any prospective bidder. The estimate is being revised in association with CMPDI for re-tendering. However, Ground water level is not declining. As of now water accumulated in quarries during monsoon is being extracted and being used in recharging of nearby ponds.
xxvi	**Mine discharge water shall be treated to meet standards**	The report of mine water discharge is uploaded on BCCL official

	prescribed standards 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.	website which is also given in the six monthly EC compliance report.
xxvii	**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.**	Presently, no washing facility is available at the workshop for washing of vehicles. An outside facility is being used for the same. Oil and Grease trap at Dahibari Workshop is installed. Photograph of ETP is attached as **Annexure 15** In CHP, water is used for arresting the crushed coal fines, which is ultimately let into a mine sump. The water from the sump is again recycled into the CHP. No effluents are discharged into the natural water course. 
xxviii	**Regular monitoring of subsidence movement on the surface over and around the working area and impact on natural drainage pattern, water bodies, vegetation, structure, roads, and surroundings shall be continued till movement ceases completely. In case of observation of any high rate of subsidence movement, appropriate effective corrective measures shall be taken to avoid loss of life and material. Cracks shall be effectively plugged with ballast and clayey soil/suitable material.**	There is no depillaring going on in underground mines of Cluster XVI, hence no mining induced subsidence is taking place. No subsidence has occurred during Environmental Clearance compliance period as of yet during the regular monitoring of subsidence by project officials.
xxix	**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.**	No underground mining operation is now being undertaken. Also the conditions were duly complied when underground mining was operational.
xxx	**High root density tree species shall be selected and planted over areas likely to be affected by subsidence.**	No areas have been affected by subsidence. The eco-restoration activities include species which are having high root density. The comprehensive list of species planted at eco-restoration sites

<table>
<tr><td></td><td></td><td>and certificate of them being high root density species has been attached as Annexure 16.</td></tr>
<tr><td>xxxi</td><td>Depression due to subsidence resulting in water accumulating within the low lying areas shall be filled up or drained out by cutting drains.</td><td>No subsidence has occurred during Environmental Clearance compliance period as of yet. Thus, depression due to subsidence has not been observed by project officials during monitoring of subsidence.</td></tr>
<tr><td>xxxii</td><td>Solid barriers shall be left below the roads falling within the blocks to avoid any damage to the roads.</td><td>It is being followed. Sufficient barriers are left for saving the surface installation and infra structures as per the statute and DGMS guidelines.</td></tr>
<tr><td>xxxiii</td><td>No depillaring operation shall be carried out below the township/colony.</td><td>No depillaring operation is being carried out below township/colony.</td></tr>
<tr><td>xxxiv</td><td>The Transportation Plan for conveyor-cum–rail for Cluster-XVI should be dovetailed with Jharia Action Plan. Road transportation of coal during Phase–I should be by mechanically covered trucks, which should be introduced at the earliest. The Plan for conveyor-cum–rail for Cluster-XIV should be dovetailed with Jharia Action Plan. The road transpiration of coal during phase–I should be by mechanically covered trucks.</td><td>Presently tarpaulin covered coal transportation is being done as there is no OEM (original equipment manufacturer) which supply mechanically covered trucks for coal transportation.
The conveyor-cum–rail system installation study is being carried out by CMPDIL and will be implemented in Phase II.
Find below the table of Road and Rail Dispatch of coal till FY 2020-21 from the mines of cluster XVI:-
<table>
<tr><td colspan="4">Till FY 2020-21</td></tr>
<tr><td></td><td>Road</td><td>Rail</td><td>Total</td></tr>
<tr><td>Coal Dispatch (million tonnes)</td><td>0.406</td><td>2.663</td><td>3.07</td></tr>
<tr><td>% Share</td><td>13.2</td><td>86.8</td><td>100.0</td></tr>
</table></td></tr>
<tr><td>xxxv</td><td>A study should be initiated to analyze extent of reduction in pollution load every year by reducing road transport.</td><td>The study regarding pollution load in aspect of Cluster XVI has been done by CMPDI, Ranchi. The Report is attached as Annexure 17.</td></tr>
<tr><td>xxxvi</td><td>R&R of 1193 nos of PAF's involved. They should be rehabilitated at cost of Rs 10171.88 lakhs as per the approved Jharia Action Plan.</td><td>The rehabilitation of 1193 PAF is being done by State Government Jharia Rehabilitation & Development Authority (JRDA) under Jharia Action Plan. Presently they are surveying the house in Cluster XVI. Final report on rehabilitation is yet to be submitted by District Collector, Dhanbad.</td></tr>
<tr><td>xxxvii</td><td>Details of transportation, CSR, R&R and implementation of environmental action plan for each of the 17 clusters should be brought out in a booklet for and submitted to Ministry.</td><td>Booklet on CSR, Transportation and R&R activities and implementation of environmental action plan is prepared and regularly maintained. The aforesaid Booklet is enclosed as Annexure 18.</td></tr>
<tr><td>xxxviii</td><td>A detailed CSR Action Plan shall be prepared for Cluster XVI croup of mines. Specific activities shall be identified for CSR of Rs 20.25/annum @ of Rs 5/ton of coal production. as recurring expenditure. The 242.09ha of area within Cluster XVI ML existing as waste land and not being acquired shall be put to</td><td>It is being complied. Since all the clusters are working in close vicinity, the CSR activities are undertaken at BCCL HQ level.</td></tr>
</table>

	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.	
xxxix	**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.**	Time series map of Land use patternin the Jharia Coal field has been carried out through CMPDI. Time Series map is attached as **Annexure 19**.The summary table is as followed: **Area Statistics** 23°50'0"N 23°45'0"N **Buffer Zone** / **Core Zone** **Class** / **Color** / **Area** (Km², % of Total) / **Area** (Km², % of Total) **Level I** / **Level II** Settlement — Rural — 9.69 — 1.81 — 0.00 — 0.00 Urban — 46.52 — 8.70 — 2.85 — 13.33 Industrial — 3.56 — 0.67 — 0.05 — 0.22 **Total Settlements** — **59.76** — **11.17** — **2.90** — **13.55** Forests — Dense Forest — 9.75 — 1.82 — 0.18 — 0.85 Open Forest — 35.54 — 6.65 — 0.66 — 3.11 Total (A) — 45.30 — 8.47 — 0.85 — 3.96 Scrubs — Scrubs (B) — 160.07 — 29.93 — 10.57 — 49.47 Plantations — Social Forestry — 2.77 — 0.52 — 0.26 — 1.21 Plantation on OB Dump — 3.33 — 0.62 — 0.32 — 1.50 Total Plantation (C) — 6.10 — 1.14 — 0.58 — 2.72 **Total Vegetation (A+B+C)** — **211.47** — **39.54** — **12.00** — **56.15** Agriculture — Fallow Land — 72.93 — 13.64 — 0.55 — 2.58 Crop Land — 12.28 — 2.30 — 0.45 — 2.10 **Total Agriculture** — **85.21** — **15.93** — **1.00** — **4.68** Mining Area — Coal Quarry — 3.11 — 0.58 — 0.50 — 2.36 Barren OB Dump — 1.59 — 0.30 — 0.78 — 3.63 **Total Mining Area** — **4.70** — **0.88** — **1.28** — **5.99** Waste Lands — Waste Land — 89.54 — 16.74 — 0.81 — 3.80 Sand Body — 6.42 — 1.20 — 0.51 — 2.39 **Total Wastelands** — **95.96** — **17.94** — **1.32** — **6.19** Water Bodies — Rivers, Lakes, Nalas etc. — 77.74 — 14.53 — 2.87 — 13.44 **All Total** — **534.84** — **100.00** — **21.37** — **100.00**
xl	**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**	Progressive Mine closure plan as per approved MCP is under implementation. Final closure plan will be submitted at appropriate time. Ecological Restoration a mix of native species are being used in mine reclamation. Approval of Mine Closure Plan is attached as **Annexure 20.**

	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.	
xli	**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 for implementing environment policy and socio-economic issues and the capacity building required in this regard.**	Executives with formal training in Environment discipline have been deputed at mine/project and area level duly supported by a multidisciplinary team at HQ level. Separate multidisciplinary environmental management cellat Area Level has already been established. Office Order of the same has been enclosed as **Annexure 21**. Community development cadre at HQ level deals with the socio-economic issues and the capacity building.
xlii	**Implementation of final mine closure plan for Cluster XVI, subject to obtaining prior approval of the DGMS in regard to mine safety issues.**	Final Mine Closure Plan, will be prepared at appropriate time.
xliii	**Corporate Environment Responsibility:** **a) The Company shall have a well laid down Environment Policy approved by the Board of Directors.** **b) The Environment Policy shall prescribe for standard operating process/procedures to bring into focus any infringements/deviation/violation of the environmental or forest norms/conditions.** **c) The hierarchical system or Administrative Order of the company to deal with environmental issues and for ensuring compliance with the environmental clearance conditions shall be furnished.** **d) To have proper checks and balances, the company shall have a well laid down system of reporting of non-compliances/violations of environmental norms to the Board of Directors of the**	A well-defined Corporate Environment Policy has already been laid down and approved by the Board of Directors. This is also posted on BCCL website. http://www.bcclweb.in/environment/CEP_04.11.2019.pdf Complied. A hierarchical system of the company to deal with environmental issues from corporate level to mine level already exists. Flow chart is attached as **Annexure 22.** Internal Monitoring mechanism for compliance of EC/FC conditions has been approved by competent authority of BCCL. The details of the same have been attached as **Annexure 23**.Moreover, BCCL board reviews Environment management every quarter.

	company and/or shareholders or stakeholders at large.	
B	**General Conditions by MOEF:**	
i	**No change in mining technology and scope of working shall be made without prior approval of the Ministry of Environment and Forests.**	No change in mining technology and scope of working has been undertaken.
ii	**No change in the calendar plan of production for quantum of mineral coal shall be made.**	The approved peak production of coal for Cluster XVI is **1.963 MTPA**. The production for the period between April 1st, 2020 to March 2021 is 0.851 MT. Calendar plan for the previous 4 FYs has also been enclosed as **Annexure24.**
iii	**Four ambient air quality monitoring stations shall be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2 and NOx monitoring. Location of the stations shall be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets in consultation with the State Pollution Control Board. Monitoring of heavy metals such as Hg, As, Ni, Cd, Cr, etc. carried out at least once in six months.**	The location of monitoring stations has been finalized after the consultation with JSPCB. The work of monitoring of ambient air quality was being done by CMPDIL. Monitoring report is enclosed as **Annexure-25.** To maintain the air quality as per applicable standard following precaution measures is being taken:- 1. Sprinkling on Transportation road. 2. Covered truck transportation 3. Plantation 4. Dust controlled blasting and drilling. 5. Regular maintenance of machineries involved in mining. Monitoring of heavy metals such as As, Ni, Pb, Cr, etc. is being done by CMPDI. The report of the same has been attached as Annexure 14.
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.**	The monitoring is done by CMPDI which is NABL accredited lab. IIT(ISM), CIMFR &PDIL Sindri have been contacted to conduct random verification of samples.
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**	To control noise levels in the work environment vehicles are regularly maintained. The noise and vibration during blasting operations are controlled by using Electronic Detonators.

	plugs/muffs.	**NOISE LEVEL DATA** Name of the Project: Cluster -XVI — Month: JULY, 2020 | Sl. No.	Station Name/Code	Category of area	Date	Noise level dB(A)Leq	*Permissible Limit of Noise level in dB(A)
---	---	---	---	---	---
1	Dahibari OCP (N22)	Industrial area	14.07.2020	60.1	75
2	Dahibari OCP (N22)	Industrial area	28.07.2020	62.1	75
3	Baeantimata UGP (N23)	Industrial area	14.07.2020	62.4	75
4	Baeantimata UGP (N23)	Industrial area	28.07.2020	58.2	75
5	Gopinathpur village (N24)	Residential area	15.07.2020	50.1	55
6	Gopinathpur village (N24)	Residential area	29.07.2020	52.1	55
7	Guliardih Village (N25)	Residential area	15.07.2020	46.5	55
8	Guliardih Village (N25)	Residential area	29.07.2020	49.3	55	 *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 — Checked By — Approved By All the workers engaged in noisy operations are provided with the Ear plugs/muffs. 30 ear plugs were procured in the FY 2019-20.
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.**	In CHP water is used for arresting the crushed coal fines, which is ultimately let into a mine sump. The water from the sump is again recycled into the CHP. No effluents are discharged into natural water course. The commissioning of workshop with washing facility at DBOCP and Oil & Grease trap has been completed.
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.**	Vehicles are properly maintained and PUC is enforced. Only tarpaulin covered and optimally loaded vehicles are allowed to carry minerals. The PUC certificate has been enclosed as **Annexure 26.**
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 analysed through a laboratory recognised under EPA Rules, 1986.**	Monitoring work is being done by CMPDIL which has a laboratory recognized under EPA rules 1986.

<table>
<tr>
<td>ix</td>
<td>Personnel working in dusty areas shall wear protective respiratory devices and they shall also be provided with adequate training and information on safety and health aspects.</td>
<td>Dust is suppressed at source by water sprinkling.Dust masks are provided to persons working in dusty areas. The details are given as follows:
<table>
<tr><th>FY</th><th>Dust Mask</th></tr>
<tr><td>2013-14</td><td>520</td></tr>
<tr><td>2014-15</td><td>650</td></tr>
<tr><td>2015-16</td><td>200</td></tr>
<tr><td>2016-17</td><td>500</td></tr>
<tr><td>2017-18</td><td>-</td></tr>
<tr><td>2018-19</td><td>-</td></tr>
<tr><td>2019-20</td><td>500</td></tr>
<tr><td>2020-21</td><td>1000</td></tr>
</table>
Training on safety & health is imparted at regular intervals (compulsorily once in 3 years) at VTCs. The relevant data is as follows:
<table>
<tr><th>Year (Jan-Dec)</th><th>VTC</th></tr>
<tr><td>2013</td><td>471</td></tr>
<tr><td>2014</td><td>555</td></tr>
<tr><td>2015</td><td>686</td></tr>
<tr><td>2016</td><td>758</td></tr>
<tr><td>2017</td><td>580</td></tr>
<tr><td>2018</td><td>387</td></tr>
<tr><td>2019</td><td>482</td></tr>
<tr><td>2020</td><td>315</td></tr>
</table>
</td>
</tr>
<tr>
<td>x</td>
<td>Occupational health surveillance programme of the workers shall be undertaken periodically to observe any contractions due to exposure to dust and to take corrective measures, if needed and records maintained thereof. The quality of environment due to outsourcing and the health and safety issues of the outsourced manpower should be addressed by the company while outsourcing.</td>
<td>Initial Medical Examination (IME) for outsourced personnel and Periodical Medical Examination (PME) of all the BCCL personnel are carried out as per the Statutes and Director General of Mines Safety (DGMS) guidelines. The PME is conducted for each personnel once in 3 years. Records of IME & PME are also being maintained. The details are as follows:
<table>
<tr><th>Year (Jan-Dec)</th><th>IME</th><th>PME</th></tr>
<tr><td>2013</td><td>-</td><td>740</td></tr>
<tr><td>2014</td><td>128</td><td>777</td></tr>
<tr><td>2015</td><td>-</td><td>682</td></tr>
<tr><td>2016</td><td>424</td><td>888</td></tr>
<tr><td>2017</td><td>231</td><td>711</td></tr>
<tr><td>2018</td><td>102</td><td>478</td></tr>
<tr><td>2019</td><td>35</td><td>930</td></tr>
<tr><td>2020</td><td>42</td><td>1140</td></tr>
</table>
</td>
</tr>
<tr>
<td>xi</td>
<td>A separate environmental management cell with suitable qualified personnel shall be set up under the control of a Senior Executive, who will report directly to the Head of the company.</td>
<td>Executives with formal training in Environment discipline have been deputed at mine/project and area level duly supported by a multidisciplinary team at HQ level. Separate multidisciplinary environmental management cell at Area Level has already been established. Office Order of the same has been enclosed as Annexure 21.
Community development cadre at HQ level deals with the socio-economic issues and the capacity building.</td>
</tr>
</table>

xii	**The funds earmarked for environmental protection measures shall be kept in separate account and shall not be diverted for other purpose. Year-wise expenditure shall be reported to this Ministry and its Regional Office at Bhubaneswar.**	It has been complied. The funds were earmarked as per EMP plan and kept in separate finance head for the expenditure to maintain environmental protection measures. Item wise expenditure on Environment protection measures in enclosed as **Annexure 27.**
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.**	Project authorities advertised in two local newspapers widely circulated around the project, informing that the project has been accorded environmental clearance. Thus, this condition has been duly complied.
xiv	**A copy of the environmental clearance letter shall be marked to concern Panchayat/ZilaParishad, Municipal corporation or Urban local body and local NGO, if any, from whom any suggestion /representation has been received while processing the proposal. A copy of the clearance letter shall also be displayed on company's website.**	It has been complied. A copy of the environmental clearance letter was marked to concerned Panchayat/Zila Parishad, Municipal corporation or Urban local body. The same has been attached as **Annexure 28.**The copy of the clearance letter is displayed on the company's website (http://www.bcclweb.in/?page_id=20425).
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.**	It has been 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.**	It has been complied. The photo of the display of critical sectoral parameters at the entrance of mine office is attached as **Annexure 29.**

xvii	**The project proponent shall submit six monthly compliance reports on status of compliance of the stipulated environmental clearance conditions (both in hard copy and in e-mail) to the respective Regional Office of the Ministry, respective Zonal Office s of CPCB and the SPCB.**	It is being complied.
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.**	Full cooperation is being provided for the regional office authorities for monitoring of Environmental Clearance conditions compliances.
xix	**The Environmental statement for each financial year ending 31 March in For –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 MoEF by E-mail .**	Environmental Statement for each financial year is submitted to the regional office of Jharkhand State pollution control board by 30th June.

26/05/2021
Project Officer
Basantimata Dahibari Colliery

29/5/21
Manager
Basantimata Dahibari Colliery

26/5/2021
Nodal Officer (Envt)
Basantimata Dahibari Colliery

29.5.21
Staff Officer (Mining)
CV Area

29/05/2021
Nodal Officer (Envt)
CV Area

29.5.21
General Manager
CV Area

Annexure 1

Annexure 2


Khudia River
Jamdahi
जम्दाही
Kalyanchak
कल्यांचक
Dahibari Football Ground

ANNEXURE 3

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A Mini Ratna Company

GROUNDWATER LEVEL & QUALITY

REPORT

FOR CLUSTER OF MINES, BCCL

(Assessment year - 2014)

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

JHARIA COALFIELD AND RANIGANJ COALFIELD (PART)

(BHARAT COKING COAL LIMITED)

MARCH – 2015

Regional Institute – II
Central Mine Planning & Design Institute Ltd.
(An ISO 9001:2000 Company)
(A Subsidiary of Coal India Ltd.)
Koyla Bhawan Complex, Koyla Nagar
DHANBAD – 826005

3.15 Monitoring of Ground Water Levels of Cluster-XVI

Cluster-XVI consists of five mines namely, Dahibari-Basantimata OC, Basantimata UG, New Laikidih OC, Laikdih Deep UG and Chunch UG under the administrative control of Chanch-Victoria Area of BCCL. This cluster of mines is located in the western part of Raniganj Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-XVI is 1964.21 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.

4 hydrograph stations (**DB-22, DB-23, DB-24 and DB-25**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of January, April, August & November'2014 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level BGL in meters			
			Jan'14	Apr'14	Aug'14	Nov'14
1	DB-22	Dahibari, Niche Basti	6.40	6.48	2.18	3.03
2	DB-23	Dahibari OC	3.85	3.95	2.32	2.13
3	DB-24	Dahibari	9.05	-	-	8.45
4	DB-25	Palasya	3.10	3.37	1.24	2.73
Average GW Level			***5.60***	***4.60***	***1.92***	***4.09***

Ground Water Level (in BGL) varies from 3.10 to 9.05 m during January, 3.37 to 6.48 m during April, 1.24 to 2.32 m during August and 2.13 to 8.45 m during November'2014 within the Core Zone of Cluster-XVI area.

Annexure – IV

GROUNDWATER SAMPLE LOCATION DETAILS

Sl No	Name of Cluster	Ground Water Sample	Dug well (CMPDI)	Location	Date of sampling
1	CLUSTER-I	GW-1	B-15	BERA VILLAGE	10.03.14
2	CLUSTER-II	GW-2	B-59	KHODOVALY VILLAGE	10.03.14
3	CLUSTER-III	GW-3	A-29	GOVINDPUR,AMBAGAN VILLAGE	10.03.14
4	CLUSTER-IV	GW-4	B-63	KESHALPUR, BATIGHAR	10.03.14
5	CLUSTER-V	GW-5	D-30	BORKIBOA VILLAGE	10.03.14
6	CLUSTER-VI	GW-6	D-25	GODHUR MORE	10.03.14
7	CLUSTER-VII	GW-7	D-80	DHANSAR MINE RESCUE STN.	11.03.14
8	CLUSTER-VIII	GW-8	D-48	NEAR GHANOODIH OC	11.03.14
9	CLUSTER-IX	GW-9	D-5	JEALGORA, NEAR P.O.	11.03.14
10	CLUSTER-X	GW-10	D-35	PATHERDIH RLY. COLONY	11.03.14
11	CLUSTER-XI	GW-11	A-32	MONNIDIH BAZAR	10.03.14
12	CLUSTER-XIII	GW-13	A-23	MACHHAYARA, BESIDE NH-32	10.03.14
13	CLUSTER-XIV	GW-14	B-23	LOHAPATTI VILLAGE	10.03.14
14	CLUSTER-XV	GW-15	B-32A	MADHUBAND VILLAGE	10.03.14
15	CLUSTER-XVI	GW-16	D-22	DAHIBARI,NICHE BASTI	11.03.14

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A Mini Ratna Company

GROUNDWATER LEVEL & QUALITY REPORT FOR CLUSTER OF MINES, BCCL

(Assessment year - 2015)

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

JHARIA COALFIELD AND RANIGANJ COALFIELD (PART)

(BHARAT COKING COAL LIMITED)

MARCH – 2016

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Central Mine Planning & Design Institute Ltd.
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Koyla Bhawan Complex, Koyla Nagar
DHANBAD – 826005

3.3 O Monitoring of Ground Water Levels of Cluster-XVI

Cluster-XVI consists of five mines namely, Dahibari-Basantimata OC, Basantimata UG, New Laikidih OC, Laikdih Deep UG and Chunch UG under the administrative control of Chanch-Victoria Area of BCCL. This cluster of mines is located in the western part of Raniganj Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-XVI is 1964.21 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.

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Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb'15	Apr'15	Aug'15	Nov'15
1	DB-22	Dahibari, Niche Basti	3.78	4.59	2.50	3.53
2	DB-23	Dahibari OC	4.33	3.38	4.16	6.04
3	DB-24	Dahibari	8.38	9.52	5.30	8.20
4	DB-25	Palasya	3.47	3.83	2.13	2.68
Average GW Level			***4.99***	***5.33***	***3.52***	***5.11***

Ground Water Level (in bgl) varies from 3.47 to 8.38 m during February, 3.38 to 9.52 m during April, 2.13 to 5.30 m during August and 2.68 to 8.20 m during November'2015 within the Core Zone of Cluster-XVI area.

cmpdi
A Mini Ratna Company

GROUNDWATER LEVEL & QUALITY

REPORT

FOR CLUSTER OF MINES, BCCL

(Assessment year - 2016)

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

JHARIA COALFIELD AND RANIGANJ COALFIELD (PART)

(BHARAT COKING COAL LIMITED)

MARCH – 2017

Regional Institute – II
Central Mine Planning & Design Institute Ltd.
(An ISO 9001:2000 Company)
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Koyla Bhawan Complex, Koyla Nagar
DHANBAD – 826006

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Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb'16	Apr'16	Aug'16	Nov'16
1	DB-22	Dahibari, Niche Basti	3.63	5.38	1.13	3.33
2	DB-23	Dahibari OC	4.26	5.30	0.53	0.90
3	DB-24	Dahibari	8.40	10.65	1.70	6.50
4	DB-25	Palasya	3.33	3.61	1.28	1.98
Average GW Level			***4.91***	***6.24***	***1.16***	***3.18***

Ground Water Level (in bgl) varies from 3.33 to 8.40 m during February, 3.61 to 10.65 m during April, 0.53 to 1.70 m during August and 0.90 to 6.50 m during November'2016 within the Core Zone of Cluster-XVI area.

GROUNDWATER LEVEL & QUALITY REPORT

FOR CLUSTER OF MINES, BCCL

(Assessment year – 2018-19)

[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 – 2019

Job no-514218177

3.3 O Monitoring of Ground Water Levels of Cluster-XVI

Cluster-XVI consists of five mines namely, Dahibari-Basantimata OC, Basantimata UG, New Laikidih OC, Laikdih Deep UG and Chunch UG under the administrative control of Chanch-Victoria Area of BCCL. This cluster of mines is located in the western part of Raniganj Coalfield in Dhanbad district of Jharkhand.

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4 hydrograph stations (**DB-22, DB-23, DB-24 and DB-25**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November'2018 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb'18	Apr'18	Aug'18	Nov'18
1	DB-22	Dahibari, Niche Basti	1.98	2.34	1.35	1.93
2	DB-23	Dahibari OC	2.00	2.85	1.20	1.75
3	DB-24	Dahibari	8.70	8.25	4.43	5.70
4	DB-25	Palasya	3.23	3.93	1.41	1.63
Average GW Level			3.98	4.34	2.10	2.75

Ground Water Level (in bgl) varies from 1.98 to 8.70 m during February, 2.34 to 8.25 m during April, 1.20 to 4.43 m during August and 1.63 to 5.70 m during November within the Core Zone of Cluster-XVI area.

GROUNDWATER LEVEL & QUALITY REPORT

FOR CLUSTER OF MINES, BCCL

(Assessment year – 2019-20)

[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 – 2020

Job no-200419012

3.3 O Monitoring of Ground Water Levels of Cluster-XVI

Cluster-XVI consists of five mines namely, Dahibari-Basantimata OC, Basantimata UG, New Laikidih OC, Laikdih Deep UG and Chunch UG under the administrative control of Chanch-Victoria Area of BCCL. This cluster of mines is located in the western part of Raniganj Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-XVI is 1964.21 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.

3 hydrograph stations (**DB-22, DB-23, DB-24**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May, August, November'2019 and January'2020, the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			May'19	Aug'19	Nov'19	Jan'20
1	DB-22	Dahibari, Niche Basti	4.93	1.38	1.63	1.73
2	DB-23	Dahibari OC	1.60	0.88	0.80	1.00
3	DB-24	Dahibari	9.35	3.20	3.88	4.80
Average GW Level			4.53	1.82	2.10	2.51

Ground Water Level (in bgl) varies from 1.60 to 9.35 m during May'19, 0.88 to 3.20 m during August'19, 0.80 to 3.88 m during November'19 and 1.00 to 4.80 m during January'20 within the Core Zone of Cluster-XVI area.

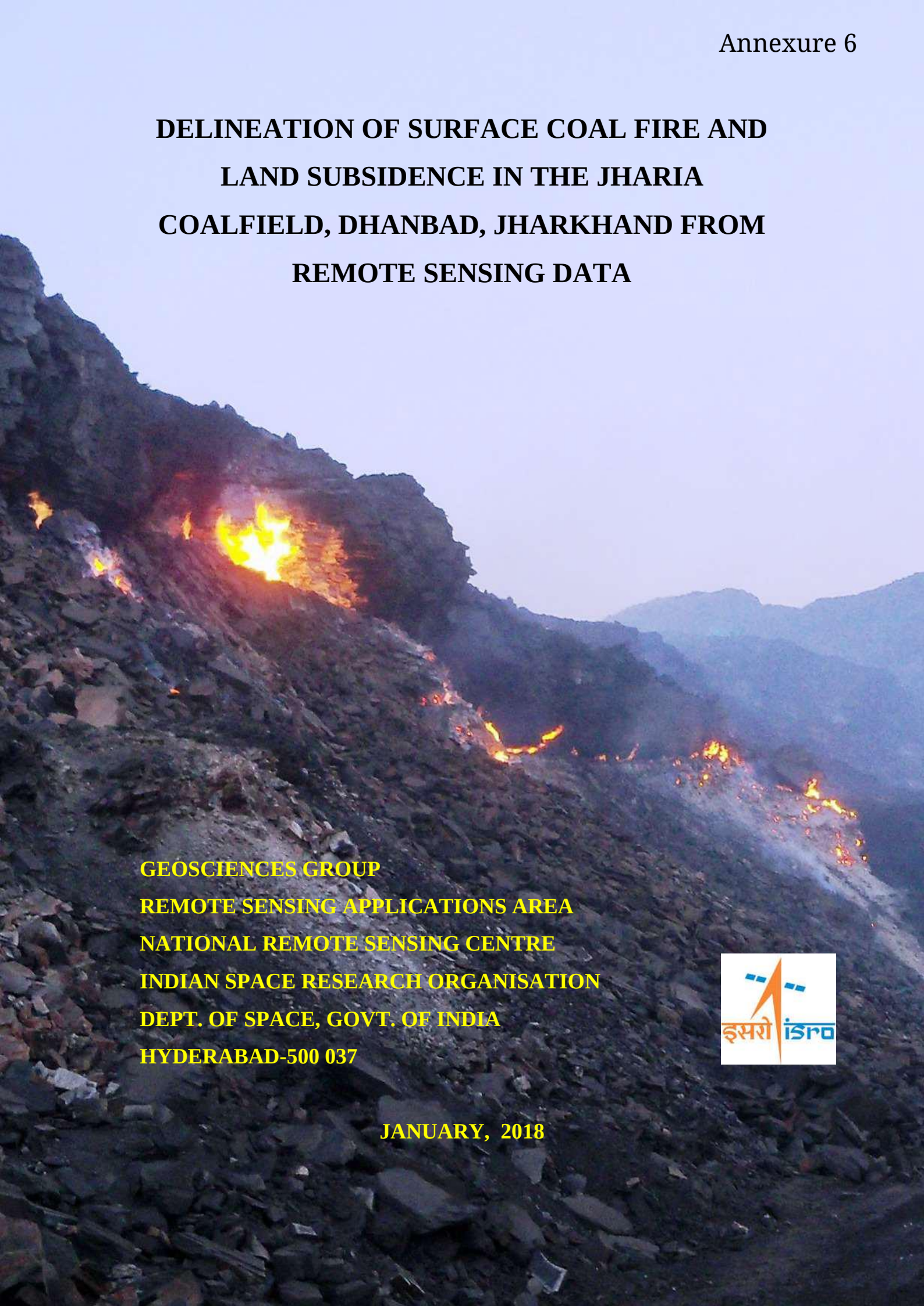
Annexure 4

ANNEXURE 5

Sl.No.	Name of the Project	Approx. Quantity of Mine water discharge (KLD)	Command Area of BCCL	Mine Status (Producing/Non-Producing)	Name of Village/Municipal area (other than BCCL where household water could be supplied	Village population	Approx. Quantity required (KLD)	Name of the village where mine water can be supplied for irrigation	Approx. Land for Irrigation (in Ha.)	Approx. Qty. required (KLD)
1.	Basantimata Dahibari Colliery	18500	CV Area	Producing	Palasia, Agarchandpur, Palasia-Dhowrah, Dahibari-Kumaribasti, Maji Tola, Dahibari Dhowrah, Patlabari, Dumarkunda, Babudangal, Rakhapara	Apprx. 10000	1500	Palasia, Agarchandpur, Palasia-Dhowrah, Dahibari-Kumaribasti, Maji Tola, Dahibari Dhowrah, Patlabari, Dumarkunda, Babudangal, Rakhapara	200	16000

Annexure 6

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

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HYDERABAD-500 037

JANUARY, 2018

PROJECT TEAM

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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

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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.

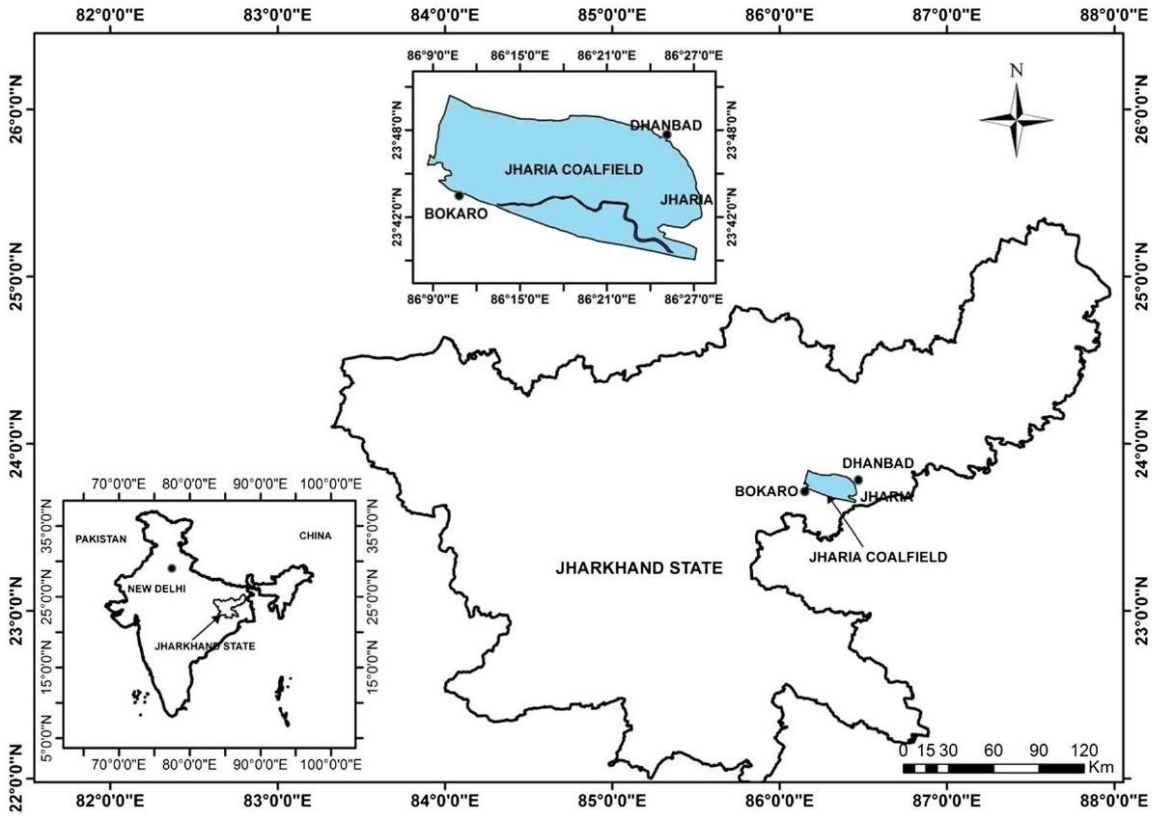

Figure 1: Study area map of Jharia Coalfied, Jharkhand

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.

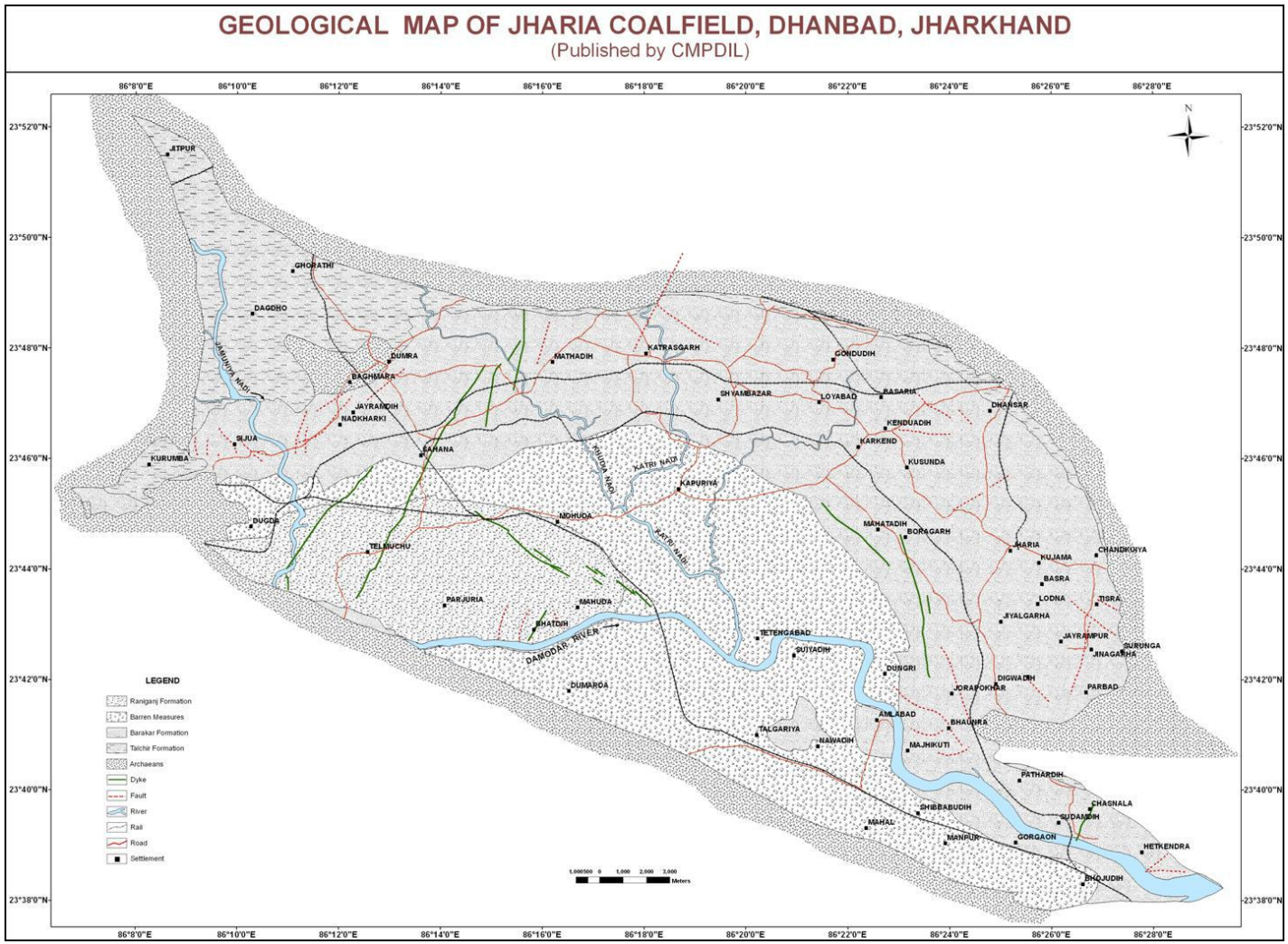

Figure 2 : Geological map of Jharia coal field, Dhanbad, Jharkhand (published by CMPIDL)

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).

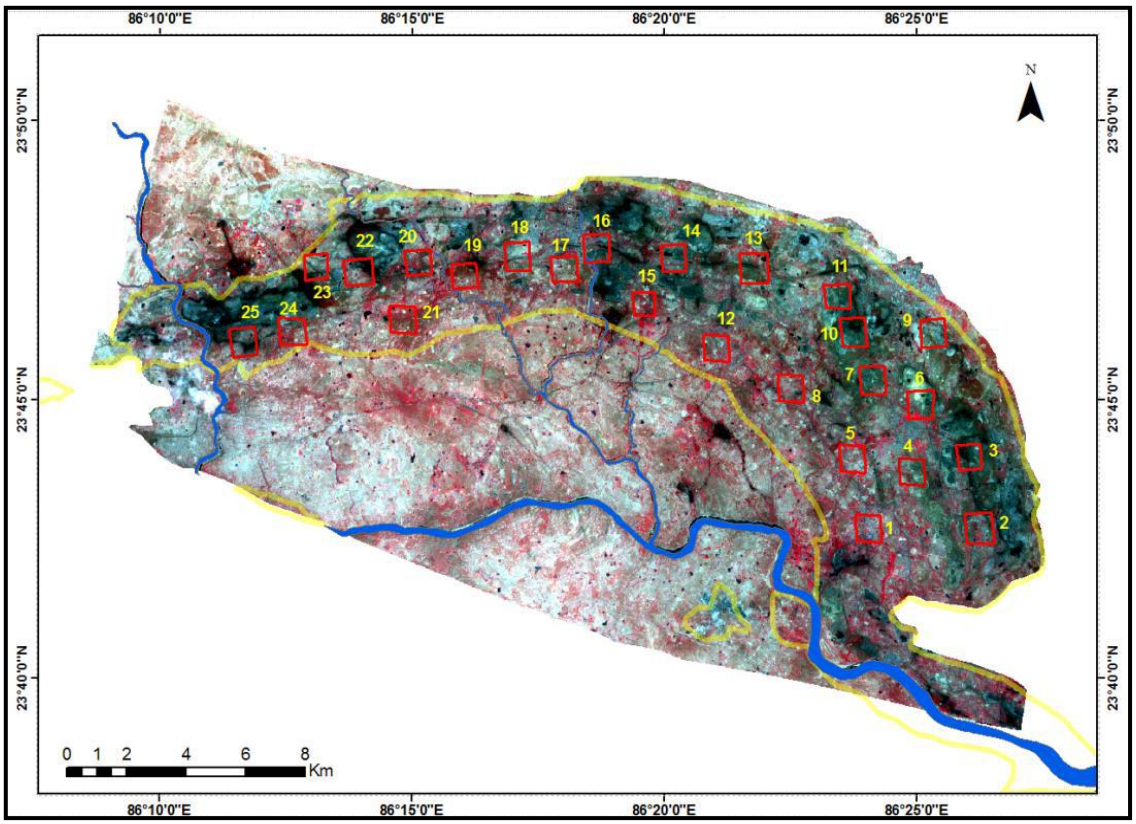

Figure 3. False colour composite image of Jharia Coalfield, with subset blocks (in red boxes) to obtain temperature values (from radiant temperature image) within the Barakar formation across the Jharia coalfield.

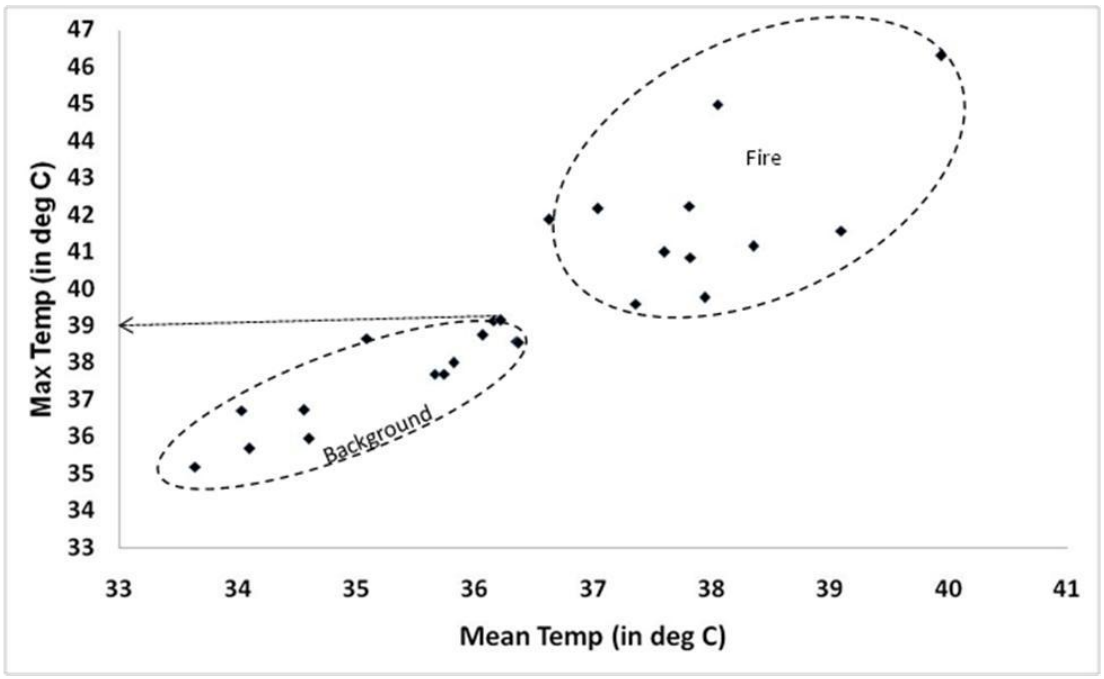

Figure 4. Maximum temperature plotted against mean temperature for various locations; cluster separation observed around 39 °C (marked with arrow)

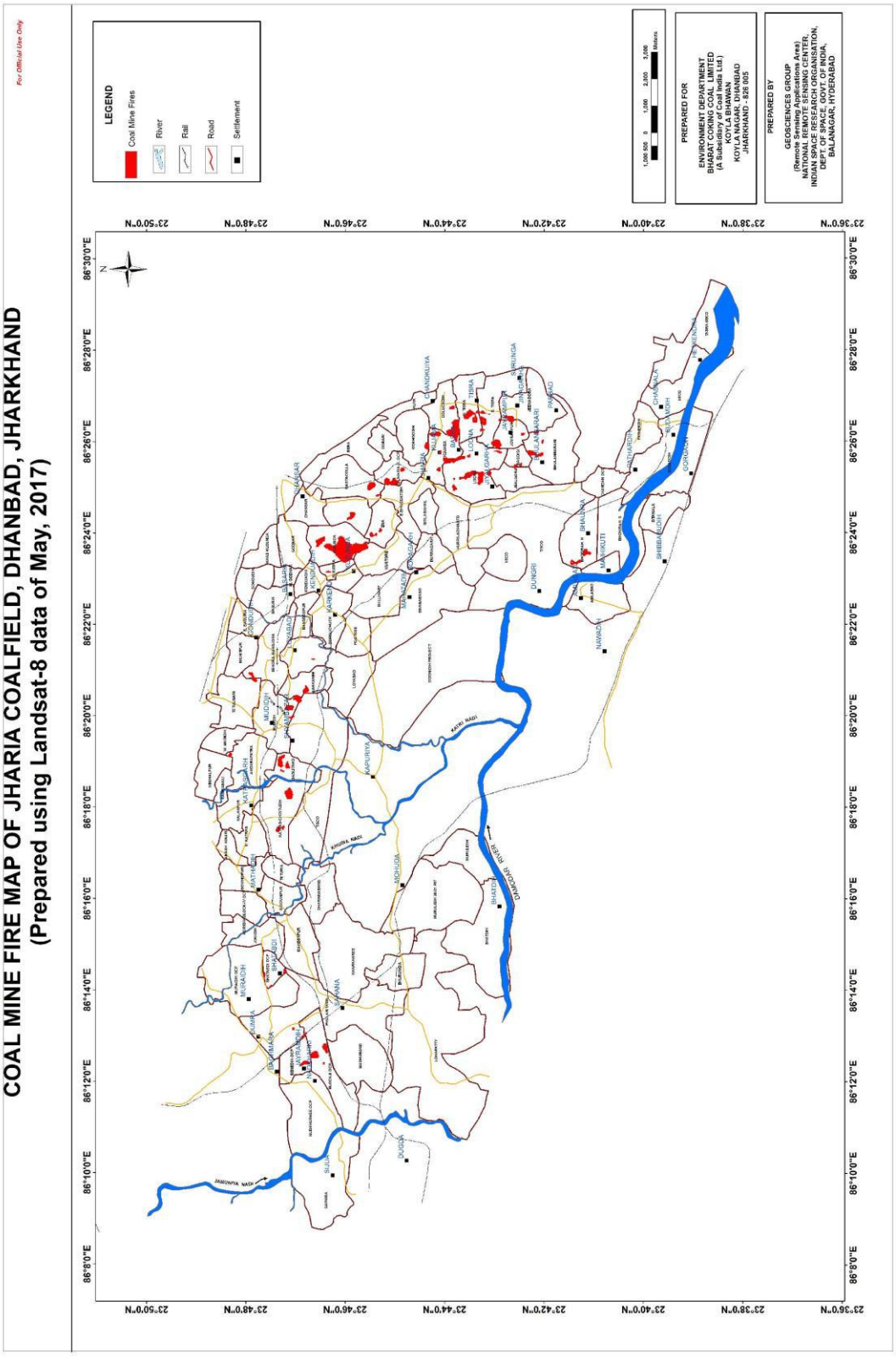

Figure 5: Coal mine fire map (May, 2017) of Jharia coal field, Dhanbad. The fire areas shown in this map have been verified in the field as per field points in figure 13.

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).

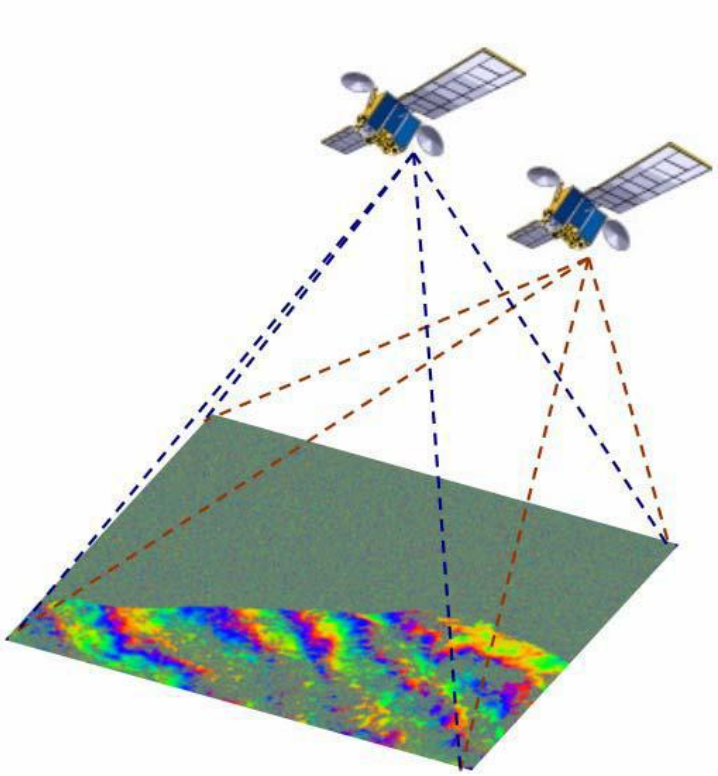

Figure 6. DInSAR acquisition scheme.

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

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

where, ΦTopo denotes the topographic component, ΦMov denotes the terrain deformation/ displacement component, ΦAtm is the noise component and ΦNoise is the thermal noise.

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

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

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.

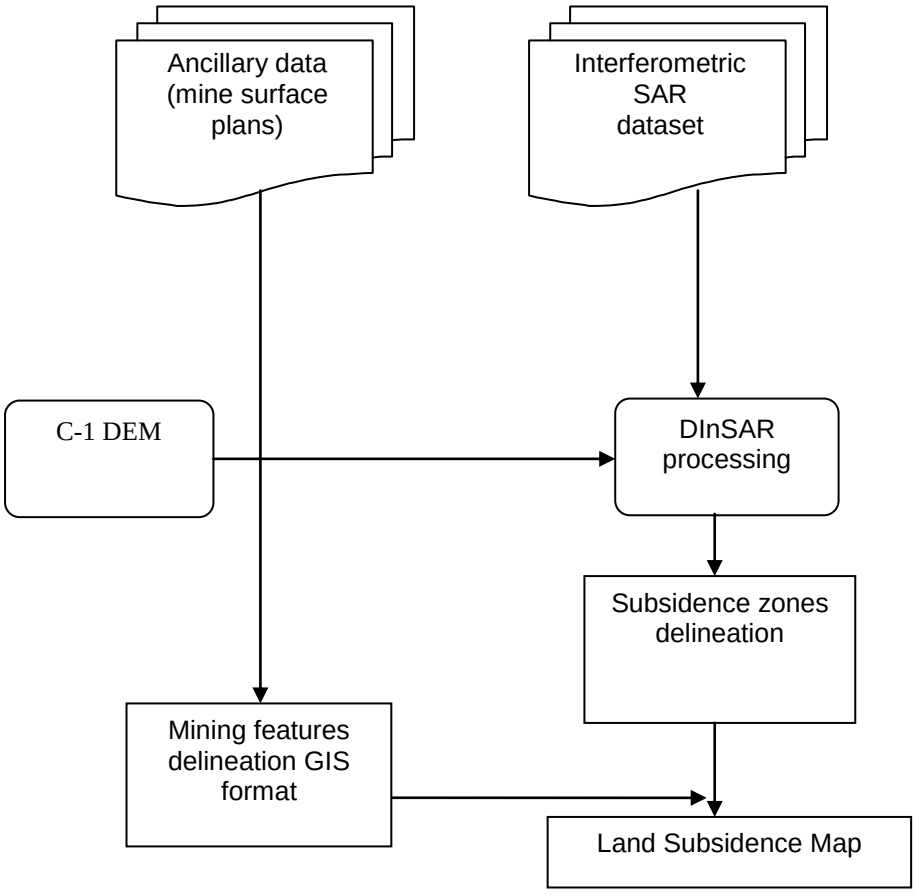

Figure 7. Work flow diagram for generating land subsidence map using DInSAR technique.

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.

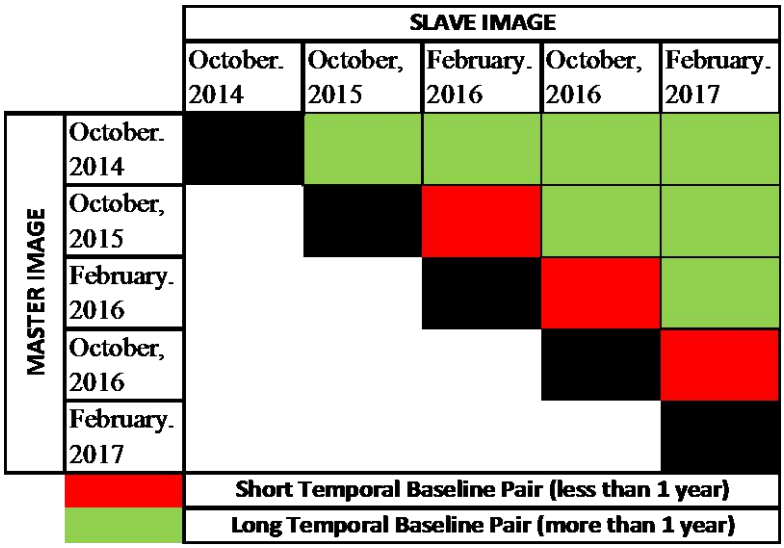

Figure 8. ALOS-PALSAR - 2 Master-Slave pairs for short and long temporal base line processing

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).

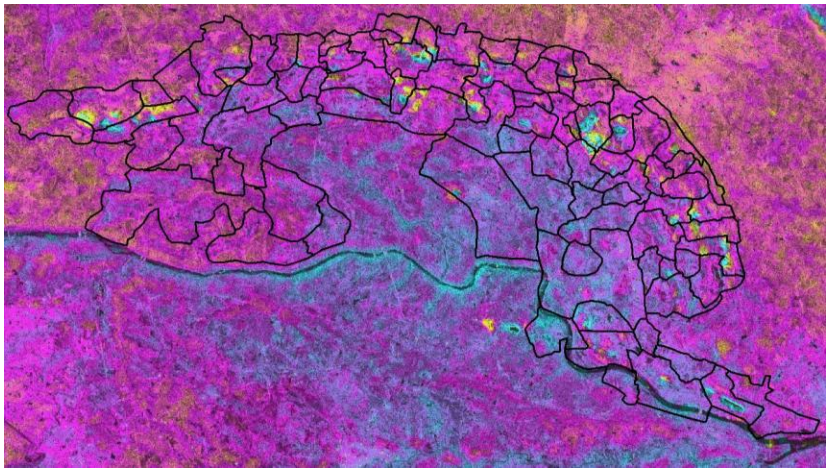

Figure 9. Fringe patterns generated from short baseline processing (e.g. Master: Oct, 16, Slave: Feb, 17).

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).

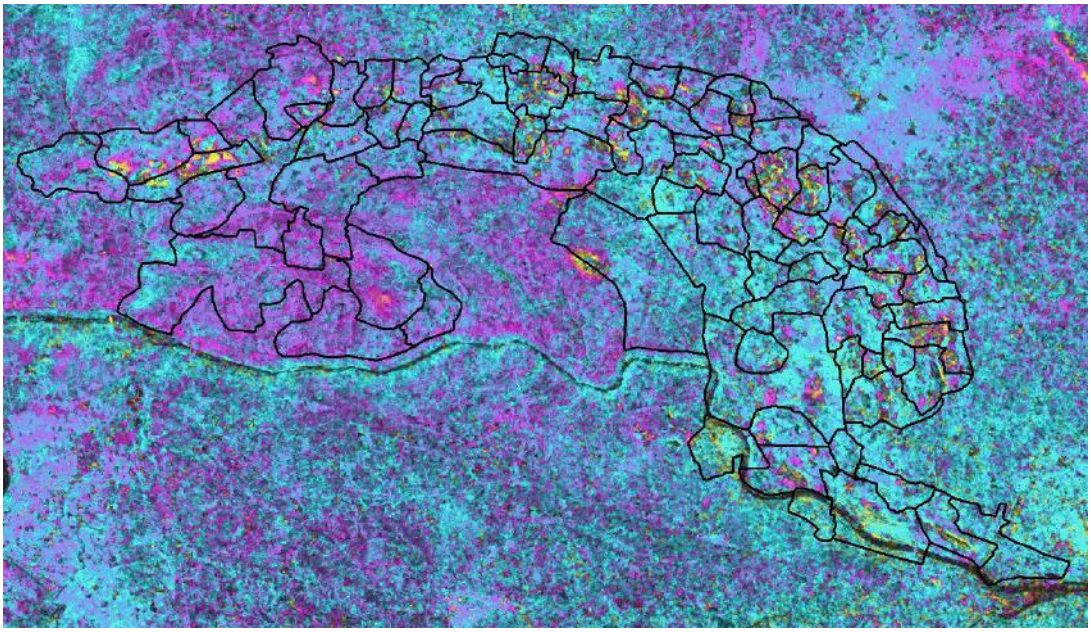

Figure 10. Fringe patterns generated from long baseline processing (e.g. Master: Oct, 15, Slave: Feb, 17).

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).

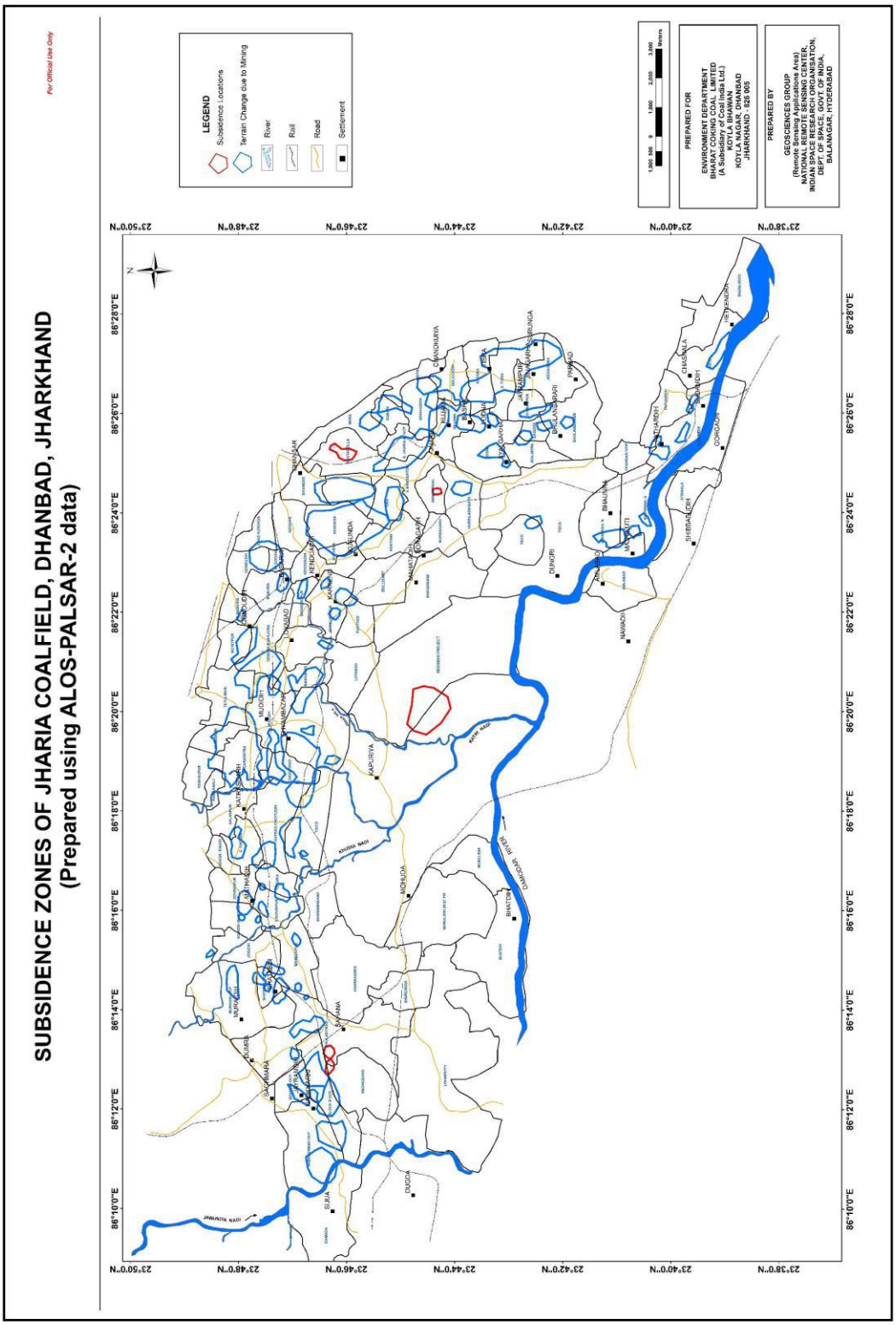

Figure 11: Subsidence map of Jharia coal field, Dhanbad.

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.

CHAPTER VII

DISCUSSIONS AND CONCLUSIONS

7.1 Discussions

7.1.1 Coal fire analysis

The present study is aimed to provide the status of coal fire in the Jharia coal field for the period of 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.*

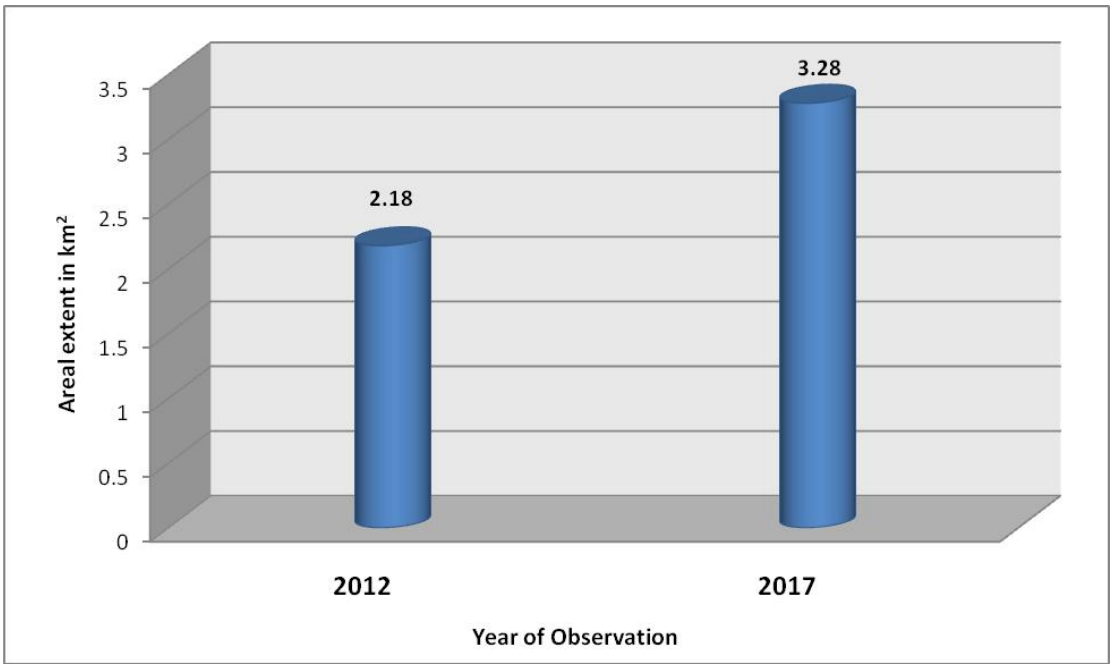

Figure 12: Total fire area statistics

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.

References

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

Annexure –I

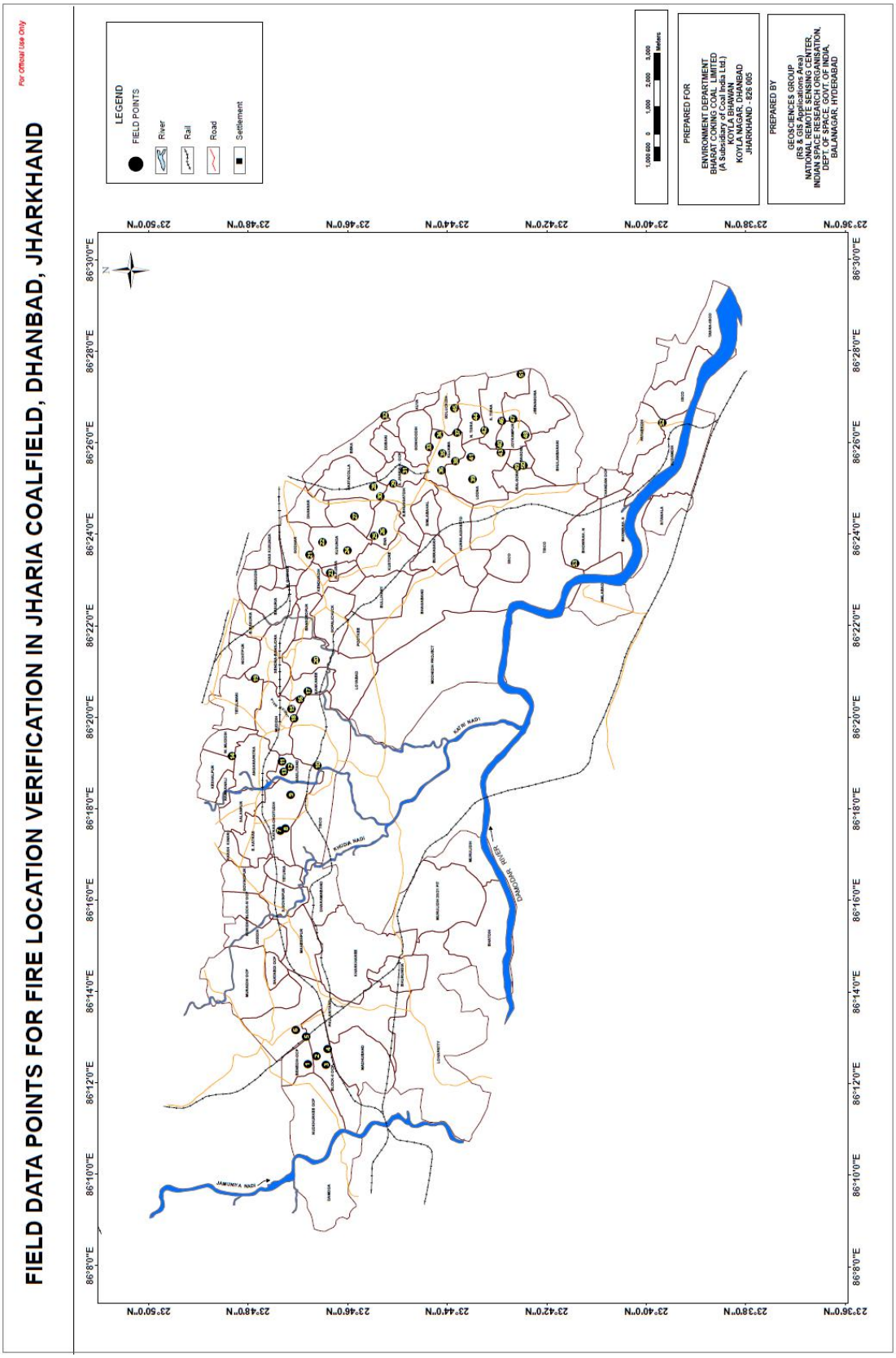

Figure 13. Field data points for coal fire verification

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

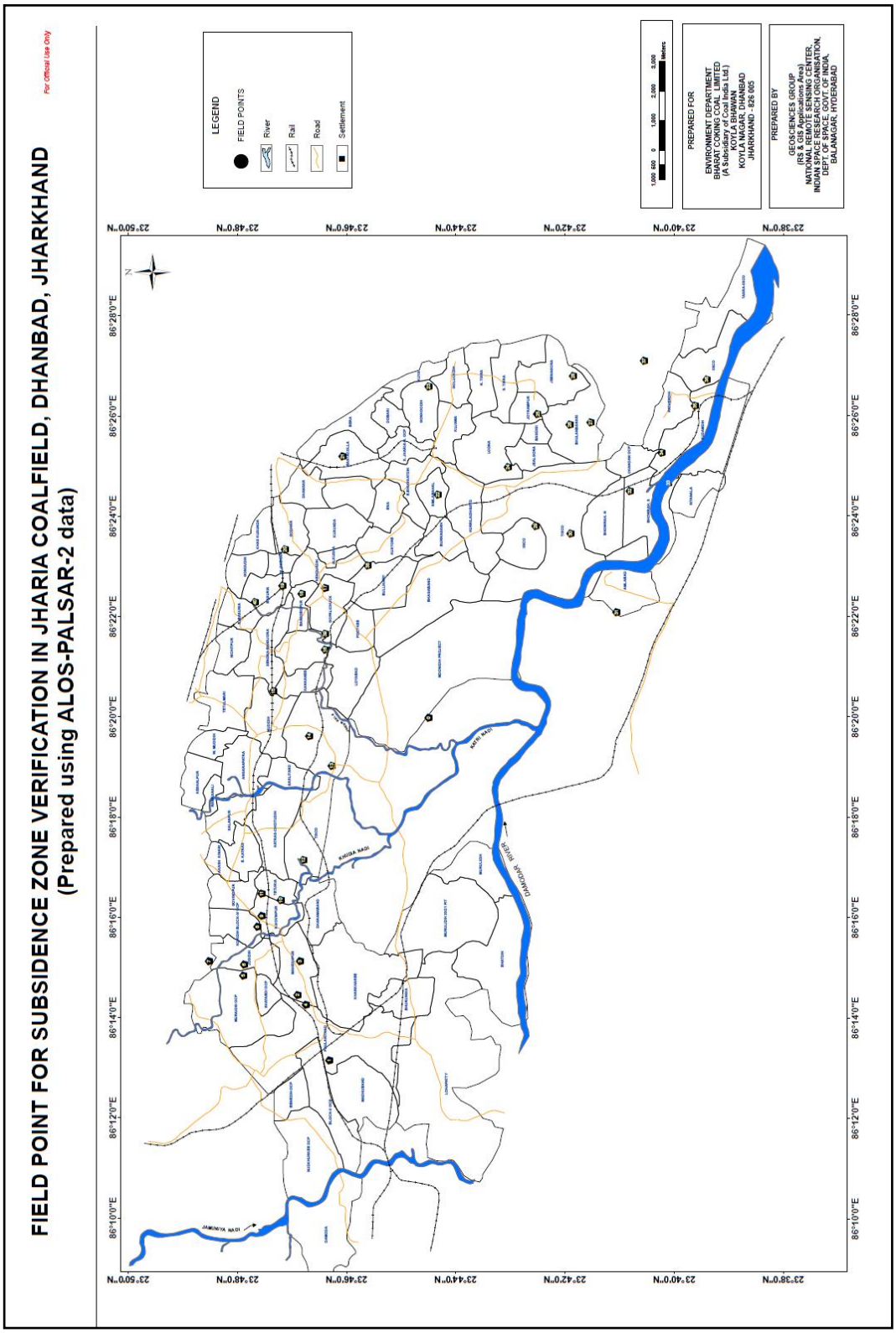

Figure 14. Field data points for subsidence verification

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.

Annexure 7

भारत कोकिंग कोल लिमिटेड
(कोल इंडिया लिमिटेड का एक अंग)
बसंतीमाता-दहीबाड़ी कोलियरी

(10)

फायर फाइटिंग के लिए " सुरक्षित कार्य पद्धति "(एसओपी)

फायर फाईटिंग के समय निम्न लिखित **" सुरक्षित कार्य पद्धति "** का प्रयोग (अनुपालन) करने की जिम्मेवारी फायर फाईटरों की होगी :–

1. सभी फायर फाईटिंग कर्मी अपने शिफ्ट प्रभारी अथवा सुपरवाईजर के आदेश बिना कार्य आरम्भ नहीं करेगें ।
2. फायर फाईटिंग के सदस्य कार्य स्थल पर प्रदत्त सुरक्षा उपकरण जैसे– जुता,टोपी ,फायर एवं फ्लुरोसेण्ट जैकेट का प्रयोग अवश्यक ही करेगें ।
3. फायर फाईटिंग का कार्य आरम्भ करने से पहले आग वाली जगह का अच्छे से निरीक्षण करेगें तथा किसी भी कोयला अथवा ओवी में लगी आग पर पैर नहीं रखेगें ।
4. फायर फाईटिंग के पहले फायर क्षेत्र के नजदीक किसी सुरक्षित जगह का चुनाव कर खड़े होगें जहाँ से सुरक्षित रूप से पानी डाला जा सकें ।
5. आग पर पानी मारते समय किसी समय हवा चलने की दिशा के विरूद्ध खड़े नहीं होगे । ताकि स्टीम वर्न (वाष्प जलन) से बचा जाय ।
6. किसी भी दशा में फेस एज(बेन्च के किनारे) की तरफ नहीं जायेगें अथवा उधर पीठ करके कार्य नहीं करेगें ।
7. आग पर पानी डालते समय अपने आप को आग से सुरक्षित दूरी पर रखेगें एवं अगर कोई सहकर्मी भी हो तो उसे भी सावधान कर दूर कर देगें ।
8. फेस में हाई वाल से भी आवश्यक सुरक्षित दूरी बनाये रखेगें किसी भी ऐसी जगह नहीं खड़े होगे जहाँ झूला हो ।
9. फेस में कोई भी खराबी या कमी दिखाई पड़े तो तुरन्त कार्य बन्द कर इसकी जानकारी शिफ्ट अधिकारी एवं ओभरमेन को देगें ।
10. जगह सुरक्षित घोषित किये जाने अथवा पाली अधिकारी द्वारा आवश्यक निरीक्षण के बाद ही पुनः कार्य आरम्भ करेगें ।
11. पानी पाईप को इधर उधर करते समय आवश्यक सावधानी बरतेगें ताकि हाईवाल से कोई वस्तु उनपर या वह स्वयं बेन्च से नीचे न गिरे ।

फायर फाईटिंग कार्य में लगाते समय पाली प्रभारी अथवा ओभरमेन की निम्नलिखित जिम्मेवारी होगी :–

1. फायर क्षेत्र की विधिवत जाँच करेगें कि उस जगह कार्य करना सुरक्षित हैं अथवा नहीं ।
2. कार्य क्षेत्र के नजदीकी हाईवाल का मुआयना करेगें कि कही कोई खतरनाक हैंगिंग तो नहीं हैं ।
3. कर्मियों को कार्य सम्बन्धी आवश्यक सुरक्षा टिप्स (सुझाव) देगें ।
4. अगर कोई खतरनाक काम हो रहा हो तो वह कार्य अपनी उपस्थिति एवं देखरेख में करायेगें अन्यथा कार्य बन्द रखेगें ।
5. अगर फायर क्षेत्र डेवलप्प गैलेरी के उपर हो तो पाली प्रभारी कोलियरी सर्वेक्षक से सम्पर्क कर गैलेरी की वास्तविक स्थिति की जानकारी लेगें एवं इस सम्बन्धित एक प्लान भी प्राप्त करेगें ।

प्रबंधक के आदेशानुसार
बसंतीमाता-दहीबाड़ी कोलियरी

भारत कोकिंग कोल लिमिटेड
(कोल इंडिया लिमिटेड का एक अंग)
दहिबाड़ी ओसीपी

अग्नि प्रभावित सामाग्री हेन्डलिंग का S.O.P.

1. पानी का उचित प्रेशर हो जिससे कि गर्म कोयला और फायरी सामाग्री को लोड करने में असुविधा न हो।
2. अग्नि प्रभावित क्षेत्र के पास किसी प्रकार का तेल का लिकेज वाला मशीन का व्यवहार न हो।
3. अग्नि प्रभावित क्षेत्र में डम्पर खड़ा करने के पहले उस स्थान को पूरी तरह पानी से भिंगाया जाय।
4. गर्म मैटेरियल लोड होने के पहले ठीक तरह से पानी से भीगाया जाए तब उसे डम्प में ट्रांसपोर्टींग किया जाए।
5. गर्म मैटेरियल को अलग जगह डम्प किया जाए और पुन: पानी से भीगाया जाए।
6. सभी मशीन जिनका प्रयोग गर्म मैटेरिल में किया जाए उनमें फायर Extingwasher आवश्य लगा हो।
7. गर्म मैटेरियल में जो व्यक्ति कार्य करते हो उनके लिए उचित व्यवस्था हो।
8. अग्नि प्रभावित क्षेत्र में जो भी कार्य हो वह Supervisor या Mining Official के देख रेख में हो।
9. जब अग्नि प्रभावित क्षेत्र के आस-पास ब्लास्टिंग हो तो निम्नलिखित बातों का ध्यान रखें:
   क) Blast Holes के अन्दर तापमान की मापी कि जाए, अगर उनका तापमान 80'C से अधिक हो तो उसे Charge न किया जाए। इसका एक Record रखा जाए। हर होल के तापमान का Record एक पुस्तिका में रखा जाए।
   ख) सभी Blast होल को पानी से भर कर रखा जाए।
   ग) सिर्फ सलरी Explosive का व्यवहार करें, किसी दुसरे Explosive का नहीं।
   घ) किसी अन्य cast booster का उपयोग न करें।
   ङ) Detonating fuel को गर्म स्थान पर न रखें इसे ठंडे बालू पर रखें।
   च) होल की संख्या लिमिट हो जिससे कि Charging और Blasting एक बार में पूरी हो जाए।
   छ) Sleeping होल की अनुमति नही है।
   ज) Blasting Operation सिर्फ Blasting officer के देख रेख में हो।

प्रबंधक के आदेशानुसार
दहीबाड़ी ओसीपी

Annexure 8

HYDROGEOLOGICAL STUDY

FOR

STUDY OF BORE WELLS NEAR DAMODAR RIVER FOR PERMEABILITY AND SEEPAGE OF WATER OF RIVER DAMODAR CLUSTER-XVI MINES OF BCCL

CHANCH VICTORIA AREA

RANIGANJ COALFIELD

FOR

BHARAT COKING COAL LIMITED

(A Subsidiary of Coal India Limited)

Dhanbad -826005

(Jharkhand State)

Prepared by

Certificate of accreditation vide No. NABET/EIA/1720/ RA 0092 valid till Aug'2021

Central Mine Planning and Design Institute

(A Subsidiary of Coal India Limited)

Hydrogeology Section of Exploration Division

Ranchi-834008 (Jharkhand)

SEPTEMBER 2020

PERSONNEL ASSOCIATED

FIELD EXERTION

Debasis Bandyopadhyay	Manager (Geology)
Afatab Alam	Manager (Geology)

DATA ANALYSIS AND INTERPRETATION

Debasis Bandyopadhyay	Manager (Geology)
Afatab Alam	Manager (Geology)
Rohit Singh	Manager (Remote Sensing)
Poulomi Baksi	Deputy Manager (Geology)
Swagata Dutta	Assisstant Manager (Geology)
Kumar Vaibhav	Assisstant Manager (Env.)

REPORT PRE[PARATION & DOCUMENTATION

Debasis Bandyopadhyay	Manager (Geology)

OVERALL GUIDANCE

Dr. A.K.Panda	General Manager (Exploration)
Prabhu Prasad	General Manager (Geology)

CONTENT

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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-/18/3117-3119(H) दिनांक : 10.11.2018

सेवा में,
महाप्रबंधक (व्यवसाय विकास)
सी.एम.पी.डी.आइ.एल, गोंदवाना प्लेस, कांके रोड
रांची -834031 (झारखंड)

Sub: Proposal for the study of bore wells near Damodar River for permeability and seepage of water of River Damodar

महोदय,

This is to inform that as per the specific condition no. xiii of Environment Clearance of Cluster XVI mentions

"A part of Cluster XVI is under Barakar river and Damodar river. It was clarified that although the mine is underground, there is no coal underneath river Damodar, which would be mined. The committee desired that the data of bore wells near river Damodar require to be monitored for permeability and seepage of water of river Damodar".

Thus, in this regard you are requested to submit a proposal for taking up the study for monitoring of bore wells near Damodar river for permeability and seepage of water of river Damodar for compliance of the above said EC condition. This is for your kind information and further necessary action.

भवदीय

10/11/18
उप-महाप्रबंधक (पर्यावरण)

Copy To:
1. **GM (P&P)- for kind information**
2. **GM (Expl), CMPDI,HQ, Gondwana Place, Kanke Road Ranchi, 834031**

Objective of the Study

Cluster-XVI mines of BCCL consisting of three closed Underground mines (Basantimata UG, Laikdih Deep UG, Chunch UG), two opencast mines [New Laikdih OC (closed) and Dahibari-Basantimata OCP (operating)] is located in Govindpur administrative Block of Dhanbad District of Jharkhand state. This Coal mining area falls in the control of Chanch-Victoria Area, Raniganj Coalfield of Bharat Coking Coal Limited.

Environmental Clearance (EC) has already been issued by MoEF&CC, New Delhi for this Cluster of mines for coal production with a specific condition to comply. The condition no. xiii, it is stated that "***Study of bore wells near Damodar River for permeability and seepage of water of River Damodar***" has to be conducted by BCCL. Hydrogeology Section of Exploration Division of CMPDI (HQ), Ranchi has conducted the study as per the work order issued by BCCL (Job No- 200419013) during F.Y. 2019-20.

The objective of the study is to monitoring of wells (dug well / bore well / Piezometer) for permeability and seepage of water from River (Damodar River, Barakar River and Khudia River / adjacent aquifers) into coal mine voids/pits of Cluster-XVI mines, BCCL.

Details of the study

The Hydrogeological study has been conducted to identify and establish the connectivity in between River water/surface water, groundwater and mine water in the Cluster-XVI mines of BCCL. The scope of the study is described below:

i. Monitoring of bore wells, dug wells and piezometers near Damodar River, Barakar River and Khudia River has been conducted during 2018, 2019 & 2020 in the Cluster-XVI mine area (study area).
ii. The permeability & seepage from the aquifers has been determined using Aquifer Pump test in the study area.
iii. The Geological setup and Hydrogeological condition of the area has been delineated to identify the critical interaction in between groundwater, surface water and mine water of the study area.

iv. Delineation of the aquifers and their extant has been done using borehole data available during coal exploration by MECL/CMPDI in the area.
v. Drainage pattern and Watershed morphometric analysis has been conducted for understanding of the river flow characteristics.
vi. Hydrogeological cross-section has been configured considering the multi-aquifer flow system in the study area for understanding of the flow and interaction in between groundwater, surface/river water and mine water.
vii. Present and previous Coal mining activity in the study area is discussed for better understanding of the subsurface activities and limitations of the detailed study in the area.
viii. Historical groundwater level data (bore wells, dug wells and piezometers) of shallow / deeper aquifers and trend analysis has been furnished. Identification of the recharge and discharge area using Water Table Contour map of the study area are configured.
ix. Groundwater Resource Estimation using GEC-2015 Methodology has been conducted in Cluster-XVI mine area.
x. Water budgeting of the Khudia River Micro-watershed has been calculated.
xi. Surface water, groundwater and mine water quality data analysis.

Approach, Methodology and Data collection

The detailed and integrated Hydrogeological study has been conducted starting from drainage pattern/watershed morphometry, aquifer delineation, water level and quality data analysis, surface and sub-surface mining activity, aquifer pumping test, groundwater resource estimation and Water budgeting of the Micro-watershed. The purpose of the study is to ***identify and establish the connectivity in between River water/surface water, groundwater and mine water and to assess the impact of mine pumping of the Cluster-XVI mines of BCCL into adjacent groundwater and surface water regime***. The field exertion and basic data collection has been done during 2018-19 and 2019-20. The data analysis, interpretation has been executed during 2019-20 and 2020-21.

1.0 Introduction

Cluster-XVI mines of BCCL consisting of three closed Underground mines (Basantimata UG, Laikdih Deep UG, Chunch UG), two opencast mines [New Laikdih OC (closed) and Dahibari-Basantimata OCP (operating)] is located in Govindpur administrative Block of Dhanbad District of Jharkhand state. This Coal mining area falls in the control of Chanch-Victoria Area, Raniganj Coalfield of Bharat Coking Coal Limited. The Cluster-XVI mines is located between latitude $23^0$42'20" to $23^0$45'40" N and longitudes $86^0$43'35" to $85^0$52'40" E.

Table No-1: The latitudes & longitudes of Cluster-XVI mines, BCCL.

Sr. No	Name of the mine	Latitude (North)	Longitude (East)	Remarks
1	Dahibari Basantimata OCP	23°42'20" to 23°44'40"	86°43'35" to 86°47'06"	Operating
2	Basantimata UG	23°43'20" to 23°44'40"	86°43'35" to 86°46'00"	Closed
3	New Laikdih OC	23°43'15" to 23°44'10"	86°46'30" to 86°47'30"	Closed
4	Laikdih Deep UG	23°44'19" to 23°45'40"	86°50'20" to 86°52'40"	Closed
5	Chanch UG	23°44'19" to 23°45'40"	86°50'20" to 86°52'40"	Closed

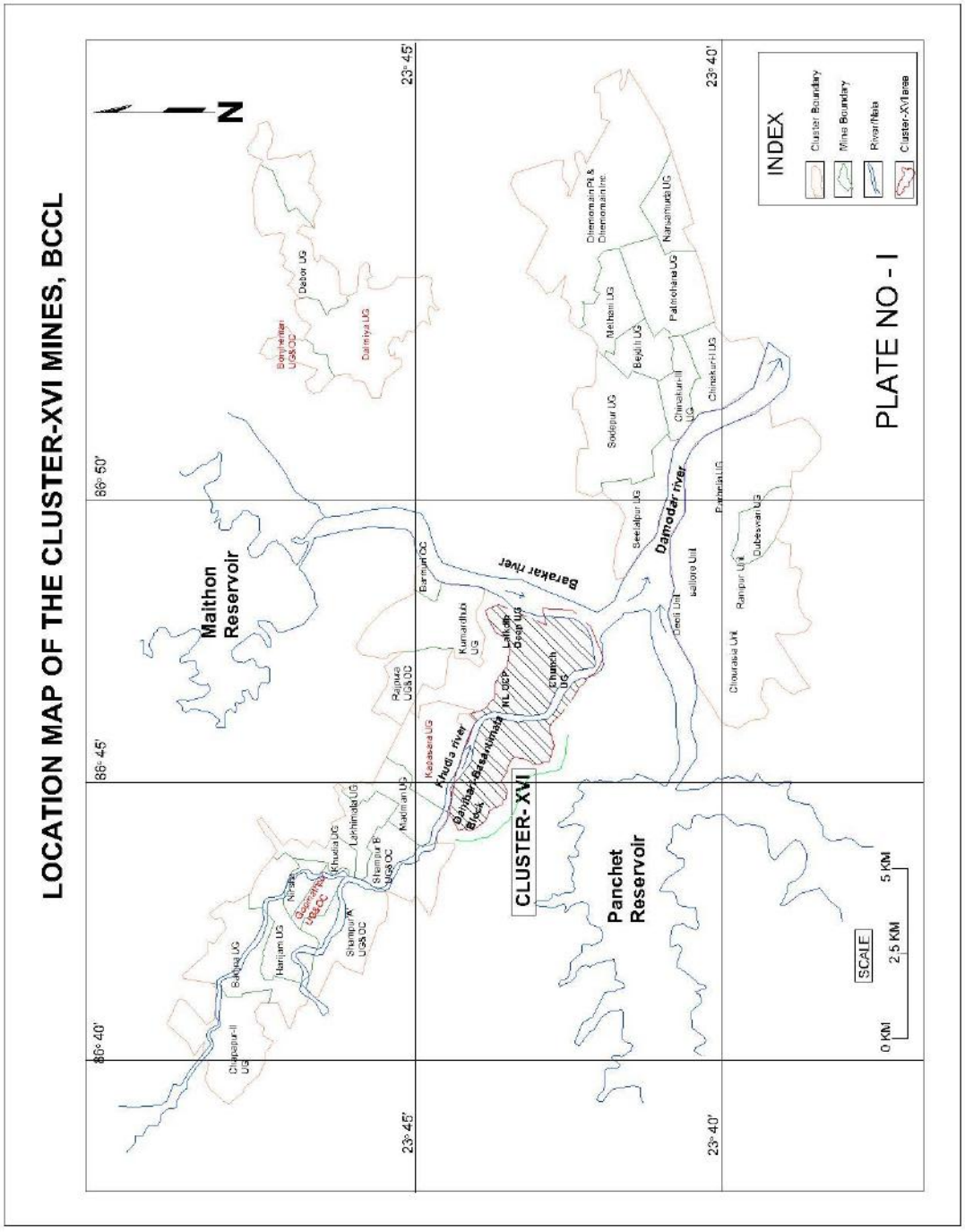
The area is covered by Survey of India Toposheet No 73 I/10 and I/14. (RF 1:50,000). The Cluster area is about 50 km east of Dhanbad town, 1.6 km to the north of Mugma Railway station and 7 km north-east of Barakar railway Station. The Cluster can be approached from the National Highway no.2. The Block is bounded by Khudia river in south-west, Barakar River in east and by Metamorphic in south (***Plate No-I: Location map)***.

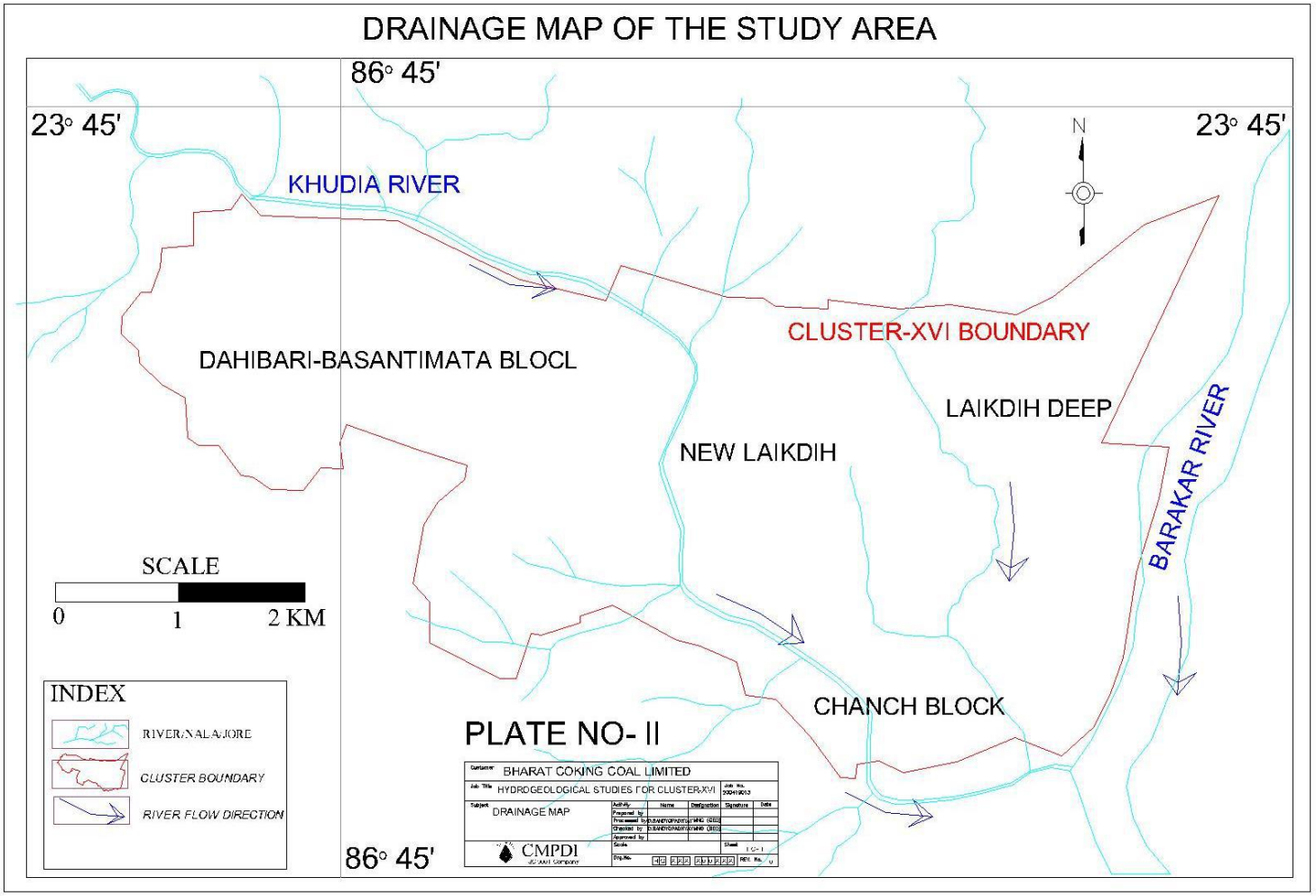
2.0 Topography

The area has low relief terrain with gentle undulating topography. The ground elevation of the Cluster ranges from 100 m to 140 m above M.S.L. and general slope is towards south-east direction, towards Barakar River and Damodar River. The natural topography of the core mining area has been obliterated to a certain extent by a network of open cast mines. However, relatively higher

grounds are formed of metamorphic rocks (contour level varies from 130 – 160 m), which are generally devoid of vegetation while the lower grounds capped by soil and alluviums are used for cultivation. There are a number of ponds and tanks in the area.

Plate No-I: Location Map of the Cluster-XVI Mines, BCCL




DRAINAGE MAP OF THE STUDY AREA
86° 45'
23° 45'
23° 45'
N
KHUDIA RIVER
CLUSTER-XVI BOUNDARY
DAHIBARI-BASANTIMATA BLOCL
LAIKDIH DEEP
NEW LAIKDIH
BARAKAR RIVER
SCALE
0
1
2 KM
INDEX
RIVER/NALA/JORE
CLUSTER BOUNDARY
RIVER FLOW DIRECTION
CHANCH BLOCK
PLATE NO- II
BHARAT COKING COAL LIMITED
HYDROGEOLOGICAL STUDIES FOR CLUSTER-XVI
DRAINAGE MAP
CMPDI
86° 45'

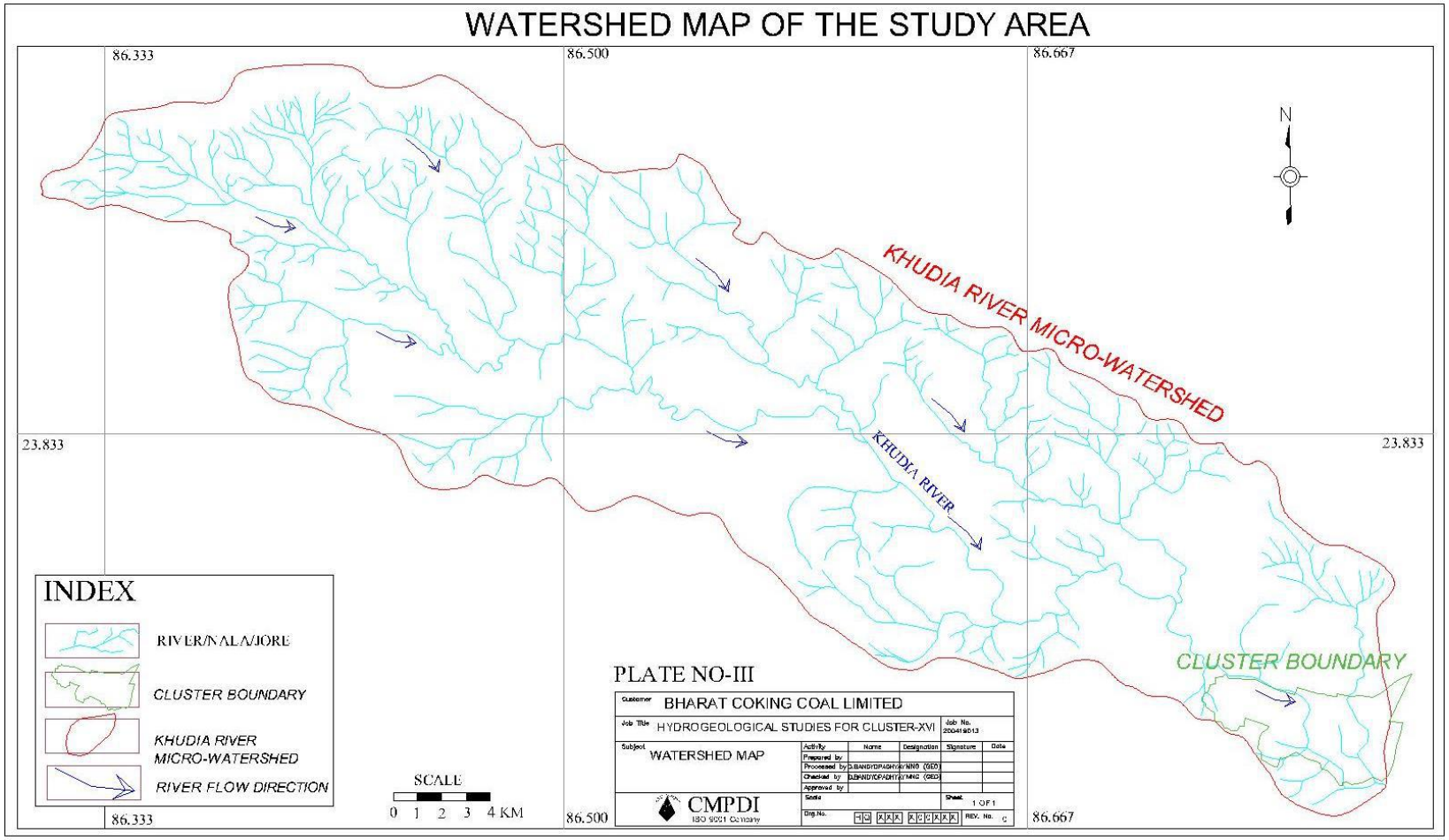
3.0 Drainage system

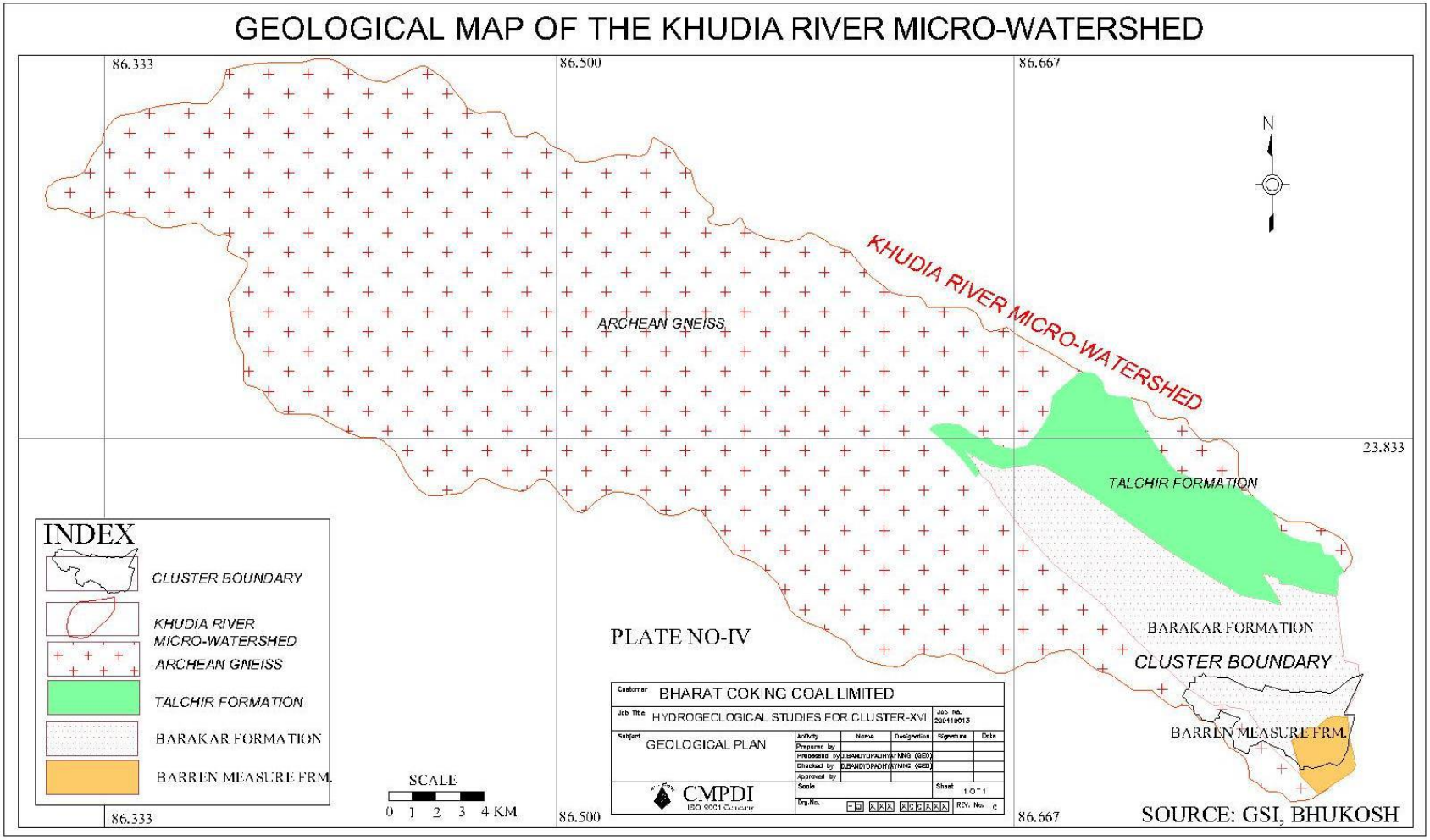
The study area is drained by Khudia river (4th order) and it is flowing along the northern boundary and central part of the study area. Khudia river flows from north-west to south-east direction and then turning towards the east direction and later meeting the Barakar River (6th order stream, H.F.L. of 102.84 m) at the south-east boundary of the Cluster-XVI. There is a local nala (3rd Order) flowing within the study area from north-east to south-west direction and joins Khudia River near the confluence of Barakar River. Barakar River is flowing along the eastern boundary of the study area from north to south direction and joins Damodar River around 1.50 km south from Cluster-XVI boundary. Damodar River and Barakar River are the master drainages of the area. Damodar River flowing from west to east direction at a minimum distance of around 0.530 km from study area. The drainage pattern of the area is mostly dendritic. The drainage map of the study area has been prepared on topographic map of scale 1:50,000 & enclosed as ***Plate No – II***.

Surface water body: There are few ponds in the area, and two nos. of reservoirs in the study area. Maithon reservoir in Barakar River located around 3.90 km towards the north and Panchet Reservoir in Damodar River located around 0.53 km towards south-west. Both surface water reservoirs are located in non-coal bearing hard rock area.

4.0 Watershed description

The study area comes under watershed of Barakar River and Khudia River which are part of the middle stage of Damodar River sub-basin. The core zone of the study area mostly comes under Khudia River watershed with the watershed area of around 596.40 sq. km. A small part of the study area also comes under the Barakar River watershed (around 3162 sq. km.). The total leasehold area of the Cluster-XVI mines is 20.1821 sq.km. There are Opencast mining activity within the watershed area by ECL and BCCL (***Plate No-III: Watershed Map***).


WATERSHED MAP OF THE STUDY AREA
86.333
86.500
86.667
23.833
N
KHUDIA RIVER MICRO-WATERSHED
KHUDIA RIVER
CLUSTER BOUNDARY
INDEX
RIVER/NALA/JORE
CLUSTER BOUNDARY
KHUDIA RIVER MICRO-WATERSHED
RIVER FLOW DIRECTION
SCALE
0 1 2 3 4 KM
PLATE NO-III
BHARAT COKING COAL LIMITED
HYDROGEOLOGICAL STUDIES FOR CLUSTER-XVI
WATERSHED MAP
CMPDI


GEOLOGICAL MAP OF THE KHUDIA RIVER MICRO-WATERSHED
86.333
86.500
86.667
23.833
N
KHUDIA RIVER MICRO-WATERSHED
ARCHEAN GNEISS
TALCHIR FORMATION
BARAKAR FORMATION
CLUSTER BOUNDARY
BARREN MEASURE FRM.
INDEX
CLUSTER BOUNDARY
KHUDIA RIVER MICRO-WATERSHED
ARCHEAN GNEISS
TALCHIR FORMATION
BARAKAR FORMATION
BARREN MEASURE FRM.
SCALE
0 1 2 3 4 KM
PLATE NO-IV
Customer BHARAT COKING COAL LIMITED
Job Title HYDROGEOLOGICAL STUDIES FOR CLUSTER-XVI
Job No. 200419013
Subject GEOLOGICAL PLAN
CMPDI
ISO 9001:2015
SOURCE: GSI, BHUKOSH

5.0 Climate, Rainfall and Evapotranspiration

The study area falls in the sub-humid region Jharkhand state adjacent to West Bengal and Jharkhand order. The maximum temperature rises as high as 45°C during summer (April to middle of June) and falls down to minimum of 10°C during winter (December to January). The area receives fair to moderate rainfall, the annual precipitation is received between June to September. The rainfall detail (Source: IMD, Govt. of India portal) is given below:

Table No – 2A: Rainfall statistic of the study area (IMD, Govt. of India).

District / Station	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
Dhanbad	**2014**	10.3	35.1	16.3	2	86.6	113.2	277.9	249.9	161	30.9	0	0
	2015	12.1	1.2	5.2	52.6	14.7	159.4	333.7	189.6	78	8.3	0	0
	2016	1.9	17.6	2.7	0.4	45.7	147.7	236.3	424.5	369.5	25.3	0	0
	2017	9.5	0	10.6	17.6	45.6	123.3	560.3	174.6	123.1	176.2	0	0
	2018	0	0	0	63.9	45.6	186.7	243.6	196.7	127.2	21.5	0	17.5

The rainfall detail during monsoon season (Source: BCCL, CV Area, Dahibari-Basantimata, Rain gauge station) is given below:

Table No – 2B: Rainfall statistic of the study area (IMD, Govt. of India).

District / Station	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
CV Area	**2017**	4.5	0.0	0.0	17.6	40.5	88.0	737.0	169.5	74.50	232.5	0.0	0.0
	2018	5.5	0.0	8.5	60.5	45.0	70.5	194.9	141.4	115.5	230.4	0.0	8.5
	2019	6.5	10.0	0.0	40.5	43.5	82.0	175.8	141.6	313.8	138.0	0.0	10.0

Potential Evapotranspiration data is considered using FAO-PPP-17 Penman (Frere and Popov, 1979) data already made for Indian continent. Ref. Potential Evapotranspiration estimation for India condition, Central Research Institute for Dryland Agriculture, Hyderabad. Nearest station Ranchi, Jharkhand has been considered (***Annexure-I***).

6.0 General Geology of the Area

The Cluster-XVI mines is located in the western part of Raniganj Coalfield. The Raniganj Coalfield represents the eastern most coal basin in the Damodar Valley Basin Belt. It is almost elliptical in shape and covers an area of about 1530 sq. km. The coalfield is bounded by the latitude 23º 30' and 23º 52' North and longitude 86º 25' and 87º 37' East and the major part falls in the Bardhaman District of West Bengal and rest part in Jharkhand. The coal bearing formations in the Cluster-XVI area belong to Barakar Formation of the Lower Gondwana Group in the west of Barakar River in Dhanbad Dist, of Jharkhand.

6.1 Geology of the Block

The Cluster-XVI mining area is covered by all the various types of rocks belonging to Barakar Formation of Lower Gondwana Group under a moderately thick cover of soil, alluvium and sandy soil. The stratigraphic succession and occurrence of the various coal seams of the block, have been deciphered mainly on the basis of the sub-surface data obtained both by exploratory drilling and the available mine plan from the collieries, is given below:

Table No-3: Stratigraphic Succession of the Geological Block

Stratigraphic units & Formations		Lithology
Recent		Alluvium, Sandy soil
---------- Unconformity ----------		
Post Gondwana		Ultrabasic Dykes and Sills
Lower Gondwana Group	Barakar Formation	Very coarse to medium grained sandstone, variety of shale, fireclay lances and Coal Seams
	Barren Measure	Sand stone and iron shale
	Talchir Formation	Fine grained greenish sandstone with fresh feldspar grains

The major portion of the study area is covered by alluvium and sandy soil of recent age, which range in thickness from 2.22 to 8.28 m and occupy lower

grounds, which are mostly cultivated. Metamorphic rocks cap the higher grounds, mainly in the southern part of the block. The thickness of the top formation up to weathered mantle varies from 3.35 to 49.50 m, made up of alluvium, sandy soil with consolidated weathered Barakar sandstone and is underlain by the coal bearing rocks of Barakar Formation. Two post-Gondwana mica-peridotite (Lamprophyre) dykes run across the block from NW to SE.

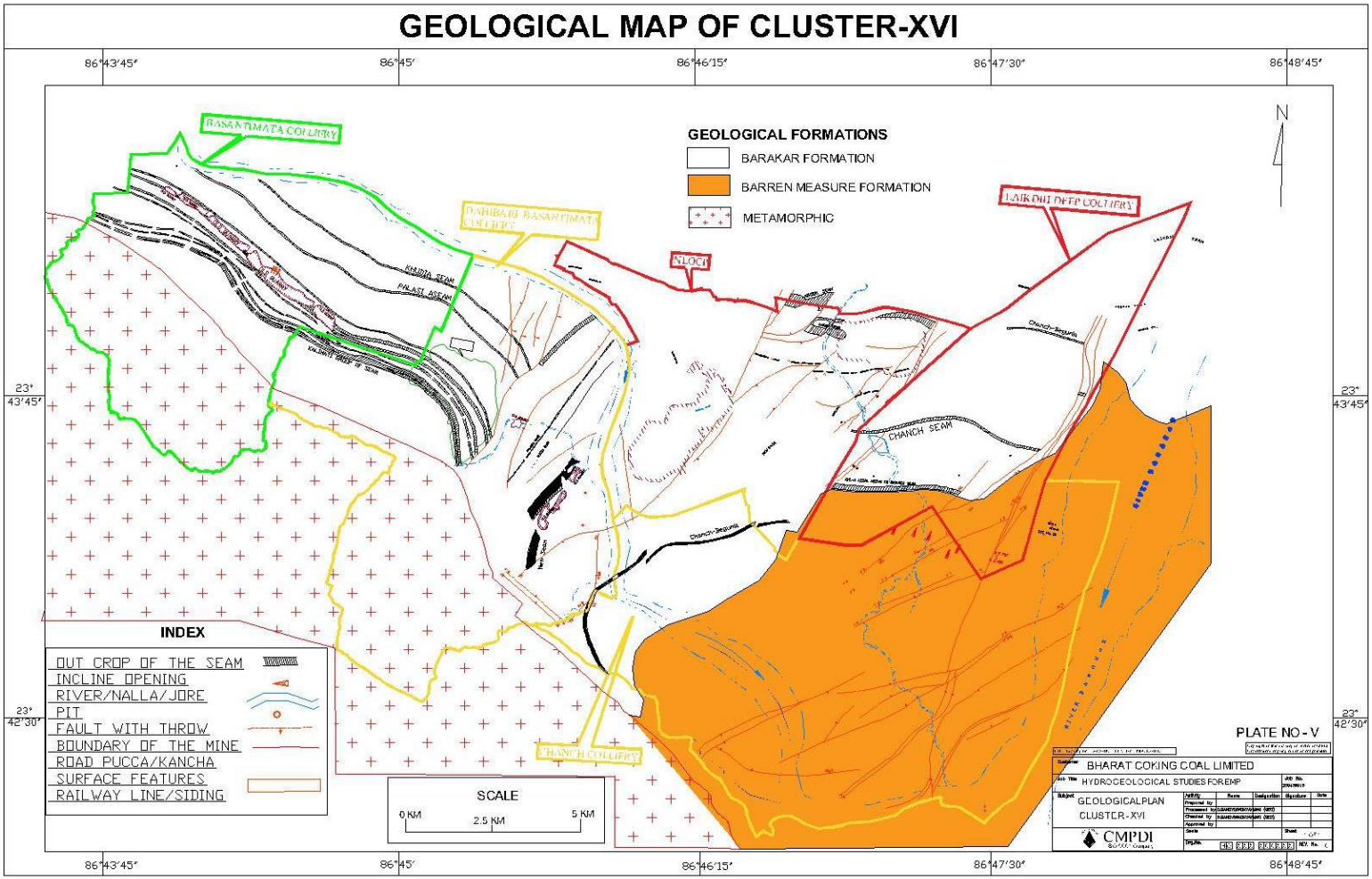
Barakar Formation, occurring below the soil covers, consists of sandstone, argillaceous sandstone, arenaceous shale, carbonaceous shale, grey shale and coal seams. The sandstone generally varies from white to yellow in colour and is hard and compact. The grain size mostly varies from medium to very coarse, often gritty. The lower part of Barakar formation consists of coarse grained sandstone and pebble bed. The sandstones are rich in feldspar (arkosic to sub-arkosic); although quartz arenite and ortho-quartzite type are also common. The feldspar is everywhere altered.

Barren Measure predominantly comprises sandstone with iron shale and is exposed in the south-east of the study area.

Fine-grained greenish sandstone with fresh feldspar grain is very common in ***Talchir Formation***. Shale is dark grey to black in colour. These are generally micaceous and even rarely carbonaceous.

The general strike of the formation is NW-SE and the dip of the formation varies from 12^0 to 28^0 towards North. The mine area is structurally affected by 4 faults; the faults are trending from 60^0E to 60^0W. The throw of the faults is varying from 30.0 to 150.0 m. There are number of N-S trending minor in-seam faults having through ranging from 1.0 to 2.0 m encountered. The Geological map of the study area is given in **Plate No – V**.

(**Geological Report on Exploration for Coal, Dahibari-Basantimata Block and Chanch Block of Raniganj Coalfield**).


GEOLOGICAL MAP OF CLUSTER-XVI
86°43'45"
86°45'
86°46'15"
86°47'30"
86°48'45"
23° 43'45"
23° 42'30"
BASANTIMATA COLLIERY
DAHIBARI BASANTIMATA COLLIERY
N-LOCK
LAIKDIH DEEP COLLIERY
CHANCH COLLIERY
GEOLOGICAL FORMATIONS
BARAKAR FORMATION
BARREN MEASURE FORMATION
METAMORPHIC
N
KHUDIA SEAM
PINASI SEAM
CHANCH SEAM
INDEX
OUT CROP OF THE SEAM
INCLINE OPENING
RIVER/NALLA/JORE
PIT
FAULT WITH THROW
BOUNDARY OF THE MINE
ROAD PUCCA/KANCHA
SURFACE FEATURES
RAILWAY LINE/SIDING
SCALE
0 KM
2.5 KM
5 KM
PLATE NO - V
BHARAT COKING COAL LIMITED
HYDROGEOLOGICAL STUDIES FOR EMP
GEOLOGICAL PLAN
CLUSTER - XVI
CMPDI

7.0 Hydrogeological Setup of the study area

The permeable formation i.e., sandstone within Gondwana Formation behaves as an aquifer. The coal seams and shales developed act as impermeable beds i.e. aquiclude. The Cluster-XVI area is covered by Barakar Formation with recent soil, alluvium and sandy soil capping. Based on the sub-surface geological data generated from the exploratory boreholes, the disposition of aquifers has been described below:

Type of Aquifers/Hydro Stratigraphic Units (HSU)

1. Consolidated aquifer (Barakar sandstone and Archean metamorphic)
2. Unconsolidated aquifer (river bed loose sand)

Unconfined aquifer: In the study area, alluvium/soil, sandy soil together with weathered sandstone of Barakar Formation laying above the top most seam constitute the material for top unconfined aquifer. The thickness varies from 2.22 m to 8.28 m and is underlain by consolidated weathered Barakar sandstone. From the borehole logs and depth of open wells tapping aquifer it can be seen that the thickness of this aquifer ranges from 3.35 to 49.50 m. The average thickness of the aquifer is 25.00 m.

Outside of the coal bearing Gondwana basin area, weathered metamorphic rocks including granite gneiss, hornblende gneiss, schist and pegmatite etc. also constitute unconfined aquifer. The thickness of the unconfined aquifer in hard rock areas varies up to 14.45 m.

In general, alluvium possess moderate to high porosity and infiltration factor. Thus, the ground water potential is generally moderate to high in alluvium while it is poor in hard, compact sandstone and metamorphic rocks. In the unconfined aquifer, ground water moves laterally through the inter-granular spaces in the sandstone.

Semi-confined aquifer: The deep-seated sandstone partings between top and bottom most working coal seam in the area have favourable conditions for occurrence of semi-confined to confined aquifers. These aquifers are mainly

made up of fine to coarse grained, hard, compact and cemented sandstone with intercalation of shale and sandstone are separated by impervious bed i.e. coal seams. The grain size mostly varies from fine to coarse, often gritty. Sandstone of lower part of Barakar Formation is coarse grained, often content pebble bed. In these lower aquifers the ground water movement is controlled mainly through joints and fractures (i.e., secondary porosity). Presence of intercalated shale and carbonaceous shale beds reduced the permeability of the aquifer with depth, the lower aquifers are generally poor in potential. These semi-confined aquifers can be called ***multi aquifer system*** due to the presence of clay, shale and persistent impervious thick coal seams.

Table No-4A: Hydro-Stratigraphic units (HSU) of the Dahibari-Basantimata Block

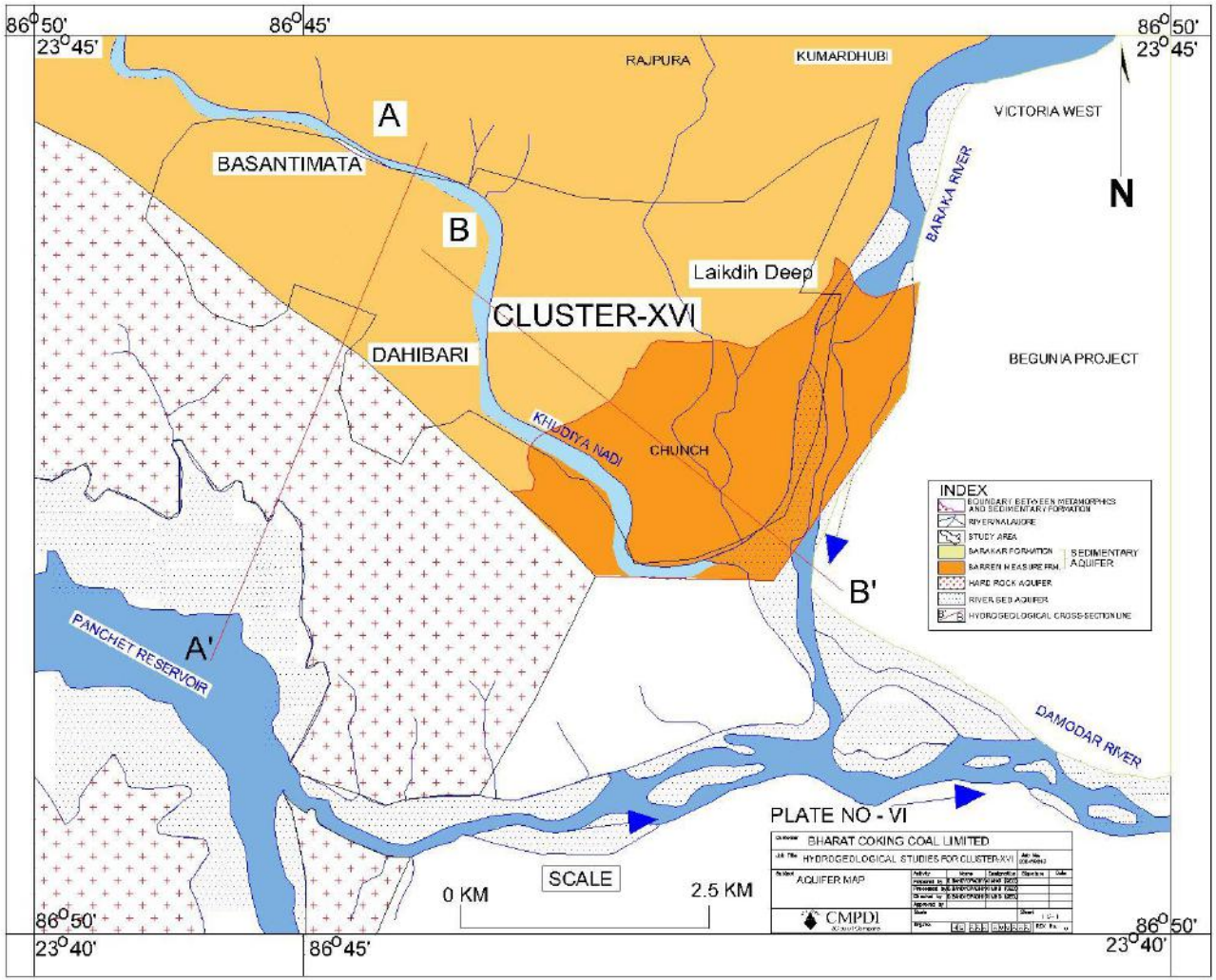
Aquifer	Formation description	Thickness approximate (in m)
Unconfined	Alluvium, sandy soil, Sand and weathered Barakar sandstone	5.87 to 44.15
Aquiclude	Khudia seam	1.76 to 3.08
Semi-confined	Medium to coarse grained sandstone	15.00 to 37.00
Aquiclude	Palasia seam	0.88 to 3.56
Semi-confined	Coarse grained sandstone	30.00 to 57.00
Aquiclude	Gopinathpur Top seam **(working)**	0.48 to 2.65
Semi-confined	Fine to medium grained sandstone with intercalation of shale & sandstone	2.00 to 22.00
Aquiclude	Gopinathpur Bottom seam **(working)**	2.27 to 12.22
Semi-confined	Coarse grained sandstone (Grit) with shaly sandstone	4.00 to 31.00
Aquiclude	Brindabanpur Top seam **(working)**	1.22 to 7.28
Semi-confined	Fine to medium grained sandstone with Shale	1.00 to 16.00
Aquiclude	Brindabanpur Bottom seam **(working)**	0.42 to 4.27
Semi-confined	Medium grained sandstone with shale sandstone intercalations	7.00 to 24.00
Aquiclude	Kalimati Group of Seams with split sections **(working & proposed for future production)**	12.30 (Average)

Table No-4B: Hydro-Stratigraphic units (HSU) of the Chanch Block

Aquifer	Formation description	Thickness approximate (in m)
Unconfined	Alluvium, sandy soil, Sand and weathered Barakar sandstone	3.35 to 49.50
Aquiclude	Chanch-Begunia seam	1.12 to 3.35
Semi-confined	Medium to coarse grained sandstone	5.0 to 87.00
Aquiclude	Jograt seam	1.25 to 2.05
Semi-confined	Coarse grained sandstone	3.25 to 95.00
Aquiclude	Laikdih seam	2.5 to 24.25
Semi-confined	Medium grained sandstone with intercalation of shale & sandstone	4.00 to 71.00
Aquiclude	New seam	1.10 to 10.52
Semi-confined	Fine to medium grained sandstone (Grit) with shaly sandstone	10.5 to 65.00

On the basis of the disposition of different geological formations, an Aquifer Map of the study area has been prepared. In this map the horizontal (***Plate No-VI***) and vertical (***Plate No - VII A & B***) disposition of different aquifer system (Unconfined, Semi-confined, River bad loose sand aquifer, Hard rock/ Fractured aquifer etc.) and their extent are shown. Therefore, the critical interplay and groundwater movement through different aquifer system in the study area can be understood.

AQUIFER MAP OF THE STUDY AREA



In general, Hydrogeological regime is mostly controlled by topography, climate, Geological Formations, groundwater condition and associated phenomena such as the mode of occurrence, direction and velocity of water flow, the quantity of water present in the formation, the groundwater reserve, the recharge-discharge process, the infiltration phenomena and the type and change of chemical quality of water in space and time.

Coal mining by opencast and underground method creates dis-equilibrium in environmental scenario of the area and disturbs/change the groundwater movement. The critical interaction between shallow and deeper aquifers is also affected due to mining activity in particular. Pre-mining hydrogeological scenario / parameters are to be established as datum lines and these parameters are to be monitored periodically during active and post-mining stages to assess the impact on groundwater regime/environment due to the mining activity and also to suggest remedial measures to minimize the impact.

Generally, changes to hydrogeological regime occur temporarily at different phases of mining activities are as below:

1. The pre-mining phase represents a system that has evolved over a long period which is relatively unchanging set of hydrological and hydro-chemical constituents existed.
2. The active mining phase represents a period of continued disruption and dis-equilibrium of total hydrogeological regime.
3. The reclamation phase represents a period in which the hydrological and hydro-chemical system starts to adjust to the newly created conditions of reclamation.
4. The post-mining phase represents a period in which the system has a major extent, adjusted to the post-mining conditions so that the rate of change in the ground water system is small relative to phase 2 and 3.

The hydrogeological regime has been projected from the geological and hydrogeological data which may represent the existing hydrogeological set-up of Cluster-XVI mine area of BCCL.

The strike, dip and disposition of the coal seams as per the Geological map of the study area (**Plate No-V**), there are two segments. The Basantimata Colliery and western part of Dahibari-Basantimata Colliery, the strike of the coal seams (sedimentary formation) are along north/west – south/east and dipping towards north-east direction. In the rest of the part of the Cluster-XVI mines, the eastern part of Dahibari-Basantimata Colliery, Chanch Colliery, New Laikdih Colliery and Laikdih Deep Colliery, the strike of the coal seams (sedimentary formation) are swings from south-west to north-north-east direction and dipping towards south-east direction.

There are total four types of different aquifer system prevails in the study area with critical interaction with each other. These aquifers are, unconfined aquifer, soft rock/sedimentary aquifer (Talchir, Barakar & Barren Measure Formations), hard rock/metamorphic aquifer and river bed/unconsolidated loose sand aquifer. The disposition of these aquifers considering the mining activity in the study area are shown in **Plate No-XII**.

The typical groundwater movement within aquifers are shown in the schematic hydrogeological cross-section lines along A-A’ and B-B’. Considering the geological model of the area, the groundwater movement direction mainly divided into two parts. A-A’ cross-section profile showing the movement and connectivity of the water in between Damodar River/Panchet dam, Dahibari-Basantimata Colliery area and Khudia River. Whereas, the B-B’’ cross-section profile showing the movement and connectivity of the water in between Barakar River, Khudia River and Dahibari-Basantimata Colliery, Chanch Colliery, New Laikdih Colliery, Laikdih Deep Colliery area (**Plate No-XII)**.

8.0 Present and previous coal mining activities

The **New Laikdih OCP Colliery** is located in the northern part of the Cluster-XVI mines and situated in Dhanbad district of Jharkhand. Kumardubi Railway Station is within 5.5 km to the north-west and Old G.T.Road is 2.5 km north of the Colliery. It has lease hold area of about 3.05 sq. km. At present the mine is non-producing and declared abandoned in the year 1998.

The **Laikdih Deep Colliery** is located in the north-eastern part of the Cluster-XVI mines, beside Barakar River. Kumardubi Railway Station is within 2.5 km to the north-west and old G.T.Road is 1.0 km north of the Colliery. It has lease hold area of about 2.81 sq. km. At present the mine is non-producing, due to thinning of coal seams and existence of numerous faults in the working of seam. The working was discontinued in the year of 1999 and since no production is being done from the colliery. The extent of mine workings has been shown in **Plate No-VIIA.**

The **Chanch Colliery** is located in the southern part of the Cluster-XVI mines, near the confluence of Khudia nala and Barakar River. Kumardubi Railway Station is within 3.5 km to the north-west of the colliery and Old G.T.Road is 3.0 km north of the Colliery. It has lease hold area of about 5.7543 sq. km. At present the mine is non-producing. The Chanch seam was completely exhausted and abandoned. The extent of mine workings has been shown in **Plate No-VIIB**.

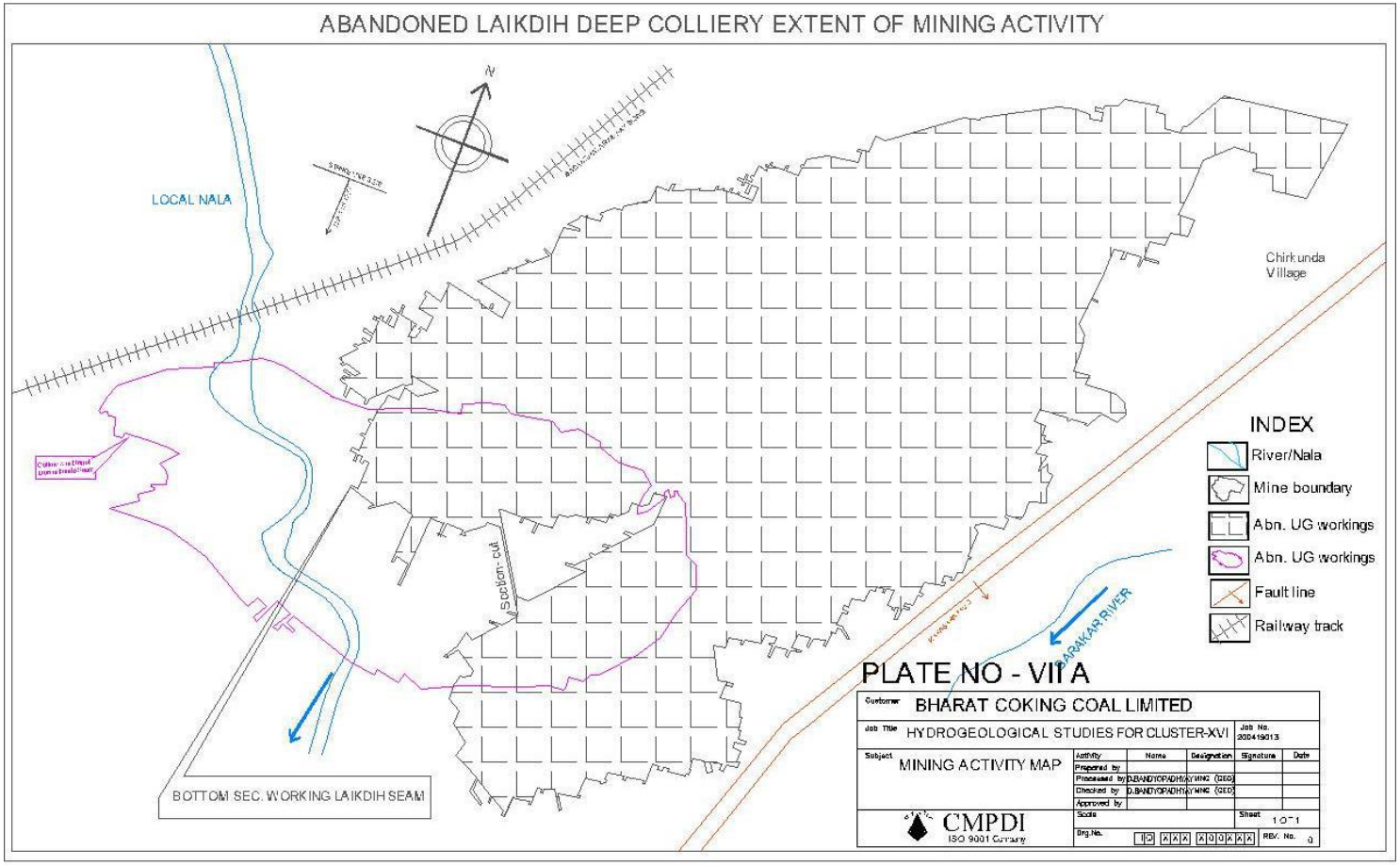
Dahibari-Basantimata OC (operating) and Basantimata UG (closed in April'2019) are within the **Dahibari-Basantimata Block.** The block is bounded by Khudia river in the north and the east and by metamorphics to the south. The area of the mining block is 8.0268 sq. km. Total eight Coal bearing horizons are found within the Block. Out of which one seam is medium coking coal (New Seam) and other seven seams are non-coking coal, namely Khudia, Palasia,

Gopinathpur Top, Gopinathpur Bottom, Brindabanpur Top, Brindabanpur Bottom and Kalimati Group of seams.

In **Dahibari-Basantimata UG,** the seams already worked are Palasia, Gopinathpur Top & Bottom and Brindabanpur Top. Total mineable reserve was estimated at about 5.052 MT and produced at 0.21 MTY (Peak 0.273 MTY) capacity. The mine was developed extensively by manual and B&P method using SDL. Depillaring with Caving has been proposed as final operation of coal production in this mine. Depth of the working will vary from 15 – 150 m. Basantimata underground mine was consists of three production units namely No.1 Incline (Gopinathpur Top seam), No. 12 Incline (Brindabanpur Top/East) and No. 18 Incline (Brindabanpur Top/West). The extent of mine workings has been shown in **Plate No-VIIC**.

Dahibari-Basantimata OCP is only operating mine at present with capacity of 1.69 MTY. Gopinathpur Top & Bottom, Brindabanpur Top & Bottom and Kalimati group of seams. The present mine is being operated with Kalimati Group of Seams as base by Shovel–Dumper Combination. Overburden will be dumped externally. The total depth of the mine is approx. 80-150 m and the life of the mine is 16 years (as per EC, 2013).

Considering the previous and present coal mining activity in the Cluster-XVI leasehold area, there is no suitable location available in between Damodar River / Barakar River / Khudia River and abandoned or active coal voids to construct boreholes for the purpose of water level monitoring. Therefore, existing monitoring network of dug wells, piezometers and bore wells of domestic use have been considered.


ABANDONED LAIKDIH DEEP COLLIERY EXTENT OF MINING ACTIVITY
LOCAL NALA
Chirkunda Village
Section - cut
BOTTOM SEC. WORKING LAIKDIH SEAM
BARAKAR RIVER
INDEX
River/Nala
Mine boundary
Abn. UG workings
Abn. UG workings
Fault line
Railway track
PLATE NO - VI A
Customer BHARAT COKING COAL LIMITED
Job Title HYDROGEOLOGICAL STUDIES FOR CLUSTER-XVI
Job No. 200419013
Subject MINING ACTIVITY MAP
Activity Name Designation Signature Date
Prepared by
Processed by D.BANDYOPADHYAYMNG (GEO)
Checked by D.BANDYOPADHYAYMNG (GEO)
Approved by
CMPDI
ISO 9001 Company
Scale
Sheet 1 OF 1
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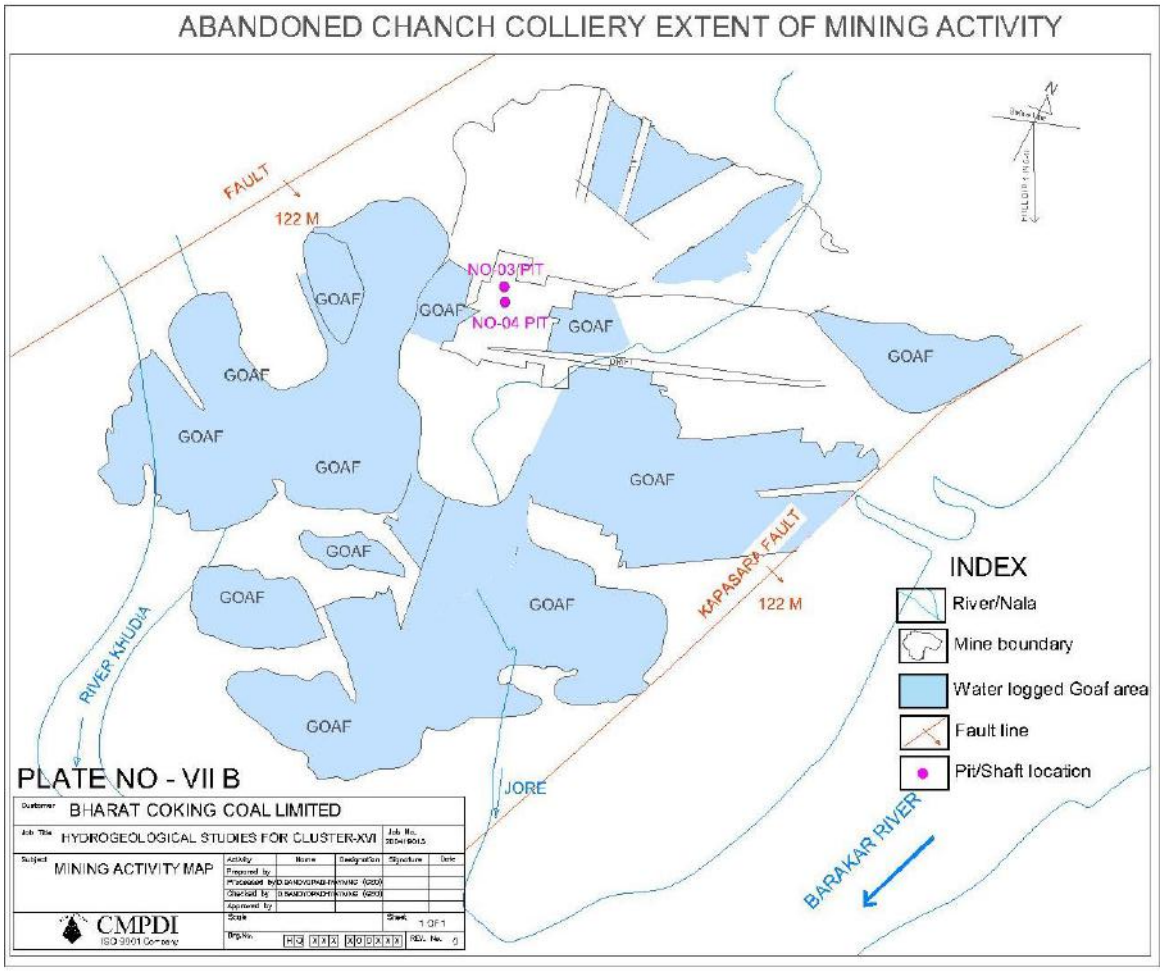
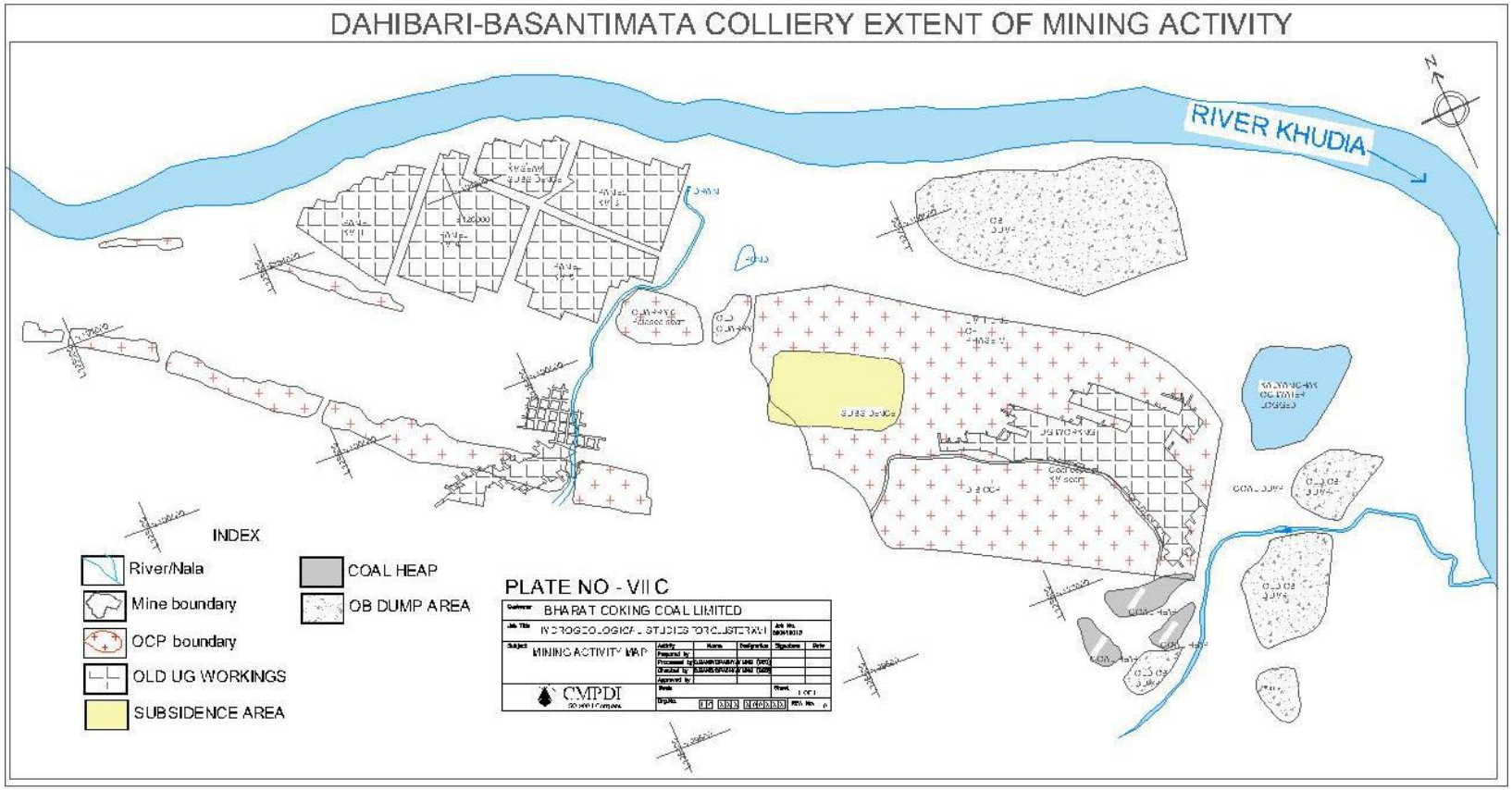

ABANDONED CHANCH COLLIERY EXTENT OF MINING ACTIVITY
FAULT
122 M
NO-03 PIT
NO-04 PIT
GOAF
RIVER KHUDIA
KAPASARA FAULT
122 M
JORE
BARAKAR RIVER
INDEX
River/Nala
Mine boundary
Water logged Goaf area
Fault line
Pit/Shaft location
PLATE NO - VII B
BHARAT COKING COAL LIMITED
HYDROGEOLOGICAL STUDIES FOR CLUSTER-XVI
MINING ACTIVITY MAP
CMPDI


DAHIBARI-BASANTIMATA COLLIERY EXTENT OF MINING ACTIVITY
RIVER KHUDIA
INDEX
River/Nala
Mine boundary
OCP boundary
OLD UG WORKINGS
SUBSIDENCE AREA
COAL HEAP
OB DUMP AREA
PLATE NO - VII C
BHARAT COKING COAL LIMITED
HYDROGEOLOGICAL STUDIES FOR CLUSTER-XI
MINING ACTIVITY MAP
CMPDI

8.1 Seepage from mines

Open cast mine (Dahibari-Basantimata OCP and New Laikdih OC) can be simulated as a large diameter well/sink and the mine seepage is contributed mainly from the saturated formation lying above the working seam. Thus, the mine seepage is directly proportional to the aquifer and mine parameters. New Laikdih OC is abandoned and waterlogged at present.

Table No - 5: Mine water seepage in Dahibari-Basantimata OCP.

Aquifer	Mine Face	Avg. Face length (m)	Avg saturated thickness (m) (Aquifer)	Permeability K (m/day)	Hydraulic gradient (I)	Mine inflow **(m^3/day)**
Un-confined	NE-Dip	1165	12.5	1.22	0.02	355.0
	NW-Strike	1525	12.5	1.22	0.02	465.0
Semi-confined	NE-Dip	550	70.0	0.441	0.02	340.0
	NW-Strike	900	60.0	0.441	0.02	475.0
Estimated Mine Seepage (m^3/day)						**1635.0**
Considered: 25-35% of seepage water is affected by Coal Fire						**1060.0**

Underground mining activity would exposed/ punctured the semi-confined aquifers, thereby the total system would be converted into water table condition and a cone of depression would be formed by the gravity drainage from different aquifer zones. The mine seepage is directly proportional to the mine void area and working mine depth. The all underground mines of Cluster-XVI (***Dahibari-Basantimata UG, Chanch UG, Laikdih Deep UG***) at present are closed and pumping is done only at Laikdih Deep UG to meet domestic requirement. Mine water seepage in abandoned UG mines cannot be estimated due to paucity of data and presence of unquantified water filled goaf areas. However, around 530 cum/day of water is presently pumping from Laikdih Deep UG Mine.

Items	**DB OCP**	**DB UG**	**Chanch UG**	**Laikdih Deep UG**	**New Laikdih OC**	**Total Seepage**
Mine Seepage	1060.0 cum/day	Nil	Nil	530.0 cum/day	Nil	1590 cum/day

9.0 Groundwater level condition

To collect the representative groundwater levels in the study area, CMPDI has established a monitoring network with 17 nos. of dug wells (DB), 02 nos. of bore wells (BH) and 01 no of piezometer (PZ) spread over the study area. The location map of these groundwater level monitoring stations are shown in **Plate No- VIII**. Out of which 06 nos. of dug-wells (DB- 01, 19, 22, 23, 24 & 25) and 02 nos. of bore wells (BH-1 & 2) are located within the Cluster-XVI mines leasehold area. Groundwater level data of the dug wells are representative of the top unconfined aquifer. The water level of the bore wells and Piezometer are representative of the deep seated sedimentary/metamorphic aquifer of the study area. Water level monitoring in these hydrograph stations has been done in pre-monsoon as well as in post monsoon season. The well field inventory data and groundwater level data (***Annexure-II***) are shown below:

Table No-6: Well field inventory data of the study area.

Well No.	Location	Formation	Owner	Use	M.P (m)	Depth (m)	Dia. (m)	R.L AMSL
DB-1	Laikadih	Barakar	BCCL	Domestic	1.00	14.96	2.55	107.0
DB-2	Sulibari	Barakar	Govt	Domestic	0.73	21.20	1.80	121.0
DB-2A	Sulibari	Barakar	Govt	Domestic	0.60	13.88	1.80	121.0
DB-7	Hatinal	Raniganj	R.Mandol	Domestic	0.75	10.30	1.75	103.0
DB-8	Chungei	BM	Govt	Domestic	0.73	6.45	1.80	107.0
DB-9	Barakar	Barakar	Govt	Domestic	0.42	9.63	1.80	112.0
DB-18	Taldanga	Barakar	Govt	Domestic	0.65	16.30	3.00	--
DB-19	Luchibad	Barakar	DVC	Domestic	0.70	9.80	4.00	120.0
DB-20	Napura	Alluvium	Govt	Domestic	0.40	7.10	3.00	121.0
DB-21	Panchet	Metamorphic	Govt	Domestic	0.25	8.95	1.50	125.0
DB-22	Dahibari	Barakar	Govt	Domestic	0.67	10.65	2.40	121.0
DB-23	Substation	Barakar	BCCL	Domestic	0.70	8.00	2.30	123.0
DB-24	Dahibari	Barakar	BCCL	Domestic	0.60	13.70	3.60	127.0
DB-25	Palasya	Barakar	Govt	Domestic	0.37	5.25	1.55	125.0
DB-26	Patlabari	Metamorphic	Govt	Domestic	0.60	11.00	3.10	145.0
DB-27	Ledaharia	Metamorphic	Govt	Domestic	0.60	8.84	1.20	154.0
DB-32	Bhalsudha	Barakar	Govt	Domestic	0.65	6.77	1.80	121.0
DB-47	Mugma	Barakar	Govt	Domestic	0.68	19.25	3.00	123.0
PZ-2/ MG/KP-01	Kumardubi	Barakar	ECL	Piezometer	0.50	102.0	0.15	125.0
BH-01	Chanch	Barakar	Private	Domestic	0.35	65.0	0.15	118.0
BH-02	Patlabari	Metamorphic	Private	Domestic	0.50	85.0	0.15	135.0

M.P-measuring point, R.L-Relative level, Dia-Diameter of well. All values in meters.

Table No-6A: Historical Groundwater level data of the study area.

WELL NO.		Water level Below Ground Level (in meters)										
	YR.	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
DB-1	May	6.15	7.05	8.20	6.60	7.62	8.00	8.40	3.17	3.50	3.5	3.85
	Nov	4.75	7.06	4.00	5.00	4.84	3.38	3.08	2.70	2.80	3.2	3.3
DB-2	May	18.07	4.46	-	-	-	-	-	2.97	2.82	1.87	4.77
	Nov	3.24	2.42	-	-	-	-	-	1.67	3.37	3.77	3.27
DB-2A	May	11.55	8.51	3.50	6.15	3.55	5.41	5.08	-	-	5.20	5.40
	Nov	3.47	2.54	3.00	3.29	2.42	1.97	2.57	0.82	2.12	1.92	0.97
DB-7	May	4.35	5.29	9.25	5.85	7.03	5.73	7.26	1.60	3.28	4.10	4.25
	Nov	2.05	8.17	4.17	2.27	5.45	6.27	4.37	2.45	1.80	3.60	4.55
DB-8	May	3.62	4.28	3.97	-	4.53	5.27	4.53	1.77	3.37	3.37	3.47
	Nov	1.57	3.00	2.12	2.52	3.27	2.74	3.29	1.22	1.33	2.09	2.27
DB-9	May	4.05	4.78	2.18	1.88	2.93	2.13	2.58	2.91	1.58	1.58	1.68
	Nov	0.93	0.93	0.95	0.98	1.08	1.13	2.13	1.58	1.58	0.68	0.58
DB-18	May	13.58	12.25	-	-	-	-	-	1.85	1.85	3.75	3.85
	Nov	13.22	11.20	-	-	7.03	5.40	-	1.45	1.55	1.33	1.40
DB-19	May	5.22	5.16	6.25	4.75	4.80	6.33	5.48	5.40	4.80	4.25	4.60
	Nov	3.25	4.34	3.30	3.34	3.30	3.62	4.07	3.20	3.45	3.3	3.25
DB-20	May	6.38	6.70	6.20	6.20	6.45	5.33	5.60	5.65	3.80	3.45	3.60
	Nov	3.25	5.41	2.90	2.80	1.94	3.60	3.24	2.10	4.00	-	-
DB-21	May	8.05	3.45	4.76	8.50	8.45	6.33	6.81	5.31	1.75	5.6	5.75
	Nov	5.35	7.85	0.30	6.25	4.05	5.35	6.55	7.53	5.25	0.35	0.35
DB-22	May	9.83	2.79	2.90	2.43	8.18	6.48	4.59	9.73	1.93	4.28	4.93
	Nov	3.23	2.11	2.23	2.38	2.64	3.03	3.53	3.33	1.63	1.93	1.63
DB-23	May	4.47	1.50	3.25	2.90	5.05	3.95	3.38	5.50	2.05	1.8	1.60
	Nov	2.15	2.10	2.70	2.33	3.10	2.13	6.04	0.90	1.90	1.25	0.80
DB-24	May	9.05	8.25	-	-	-	-	9.52	8.90	5.80	8.3	9.35
	Nov	4.30	8.98	-	4.62	8.25	8.45	8.20	6.50	3.78	1.4	0.88
DB-25	May	4.65	4.09	4.03	3.96	1.33	3.27	3.83	3.08	3.23	2.03	2.23
	Nov	2.83	2.99	2.13	1.18	2.53	2.73	2.68	1.98	2.58	-	-
DB-26	May	8.20	8.32	10.10	7.00	7.70	5.94	6.42	8.44	6.90	6.6	6.90
	Nov	3.77	7.37	4.00	4.10	4.10	4.90	4.32	2.83	3.82	4.16	3.90
DB-27	May	7.10	7.30	8.20	6.50	6.30	6.89	7.24	12.10	6.35	7.3	7.90
	Nov	3.42	6.35	3.10	3.45	2.96	3.80	3.18	2.25	2.68	3.02	2.70
DB-32	May	2.90	3.41	3.25	3.10	2.45	3.37	2.92	2.27	1.95	4.85	4.95
	Nov	1.40	2.47	3.35	1.45	1.35	1.65	2.90	1.35	1.35	2.2	2.35
DB-47	May	17.62	17.92	8.16	-	3.00	5.07	8.77	8.12	5.12	8.32	8.42
	Nov	3.02	15.17	7.72	3.32	2.58	2.28	5.76	2.62	2.97	2.98	3.12

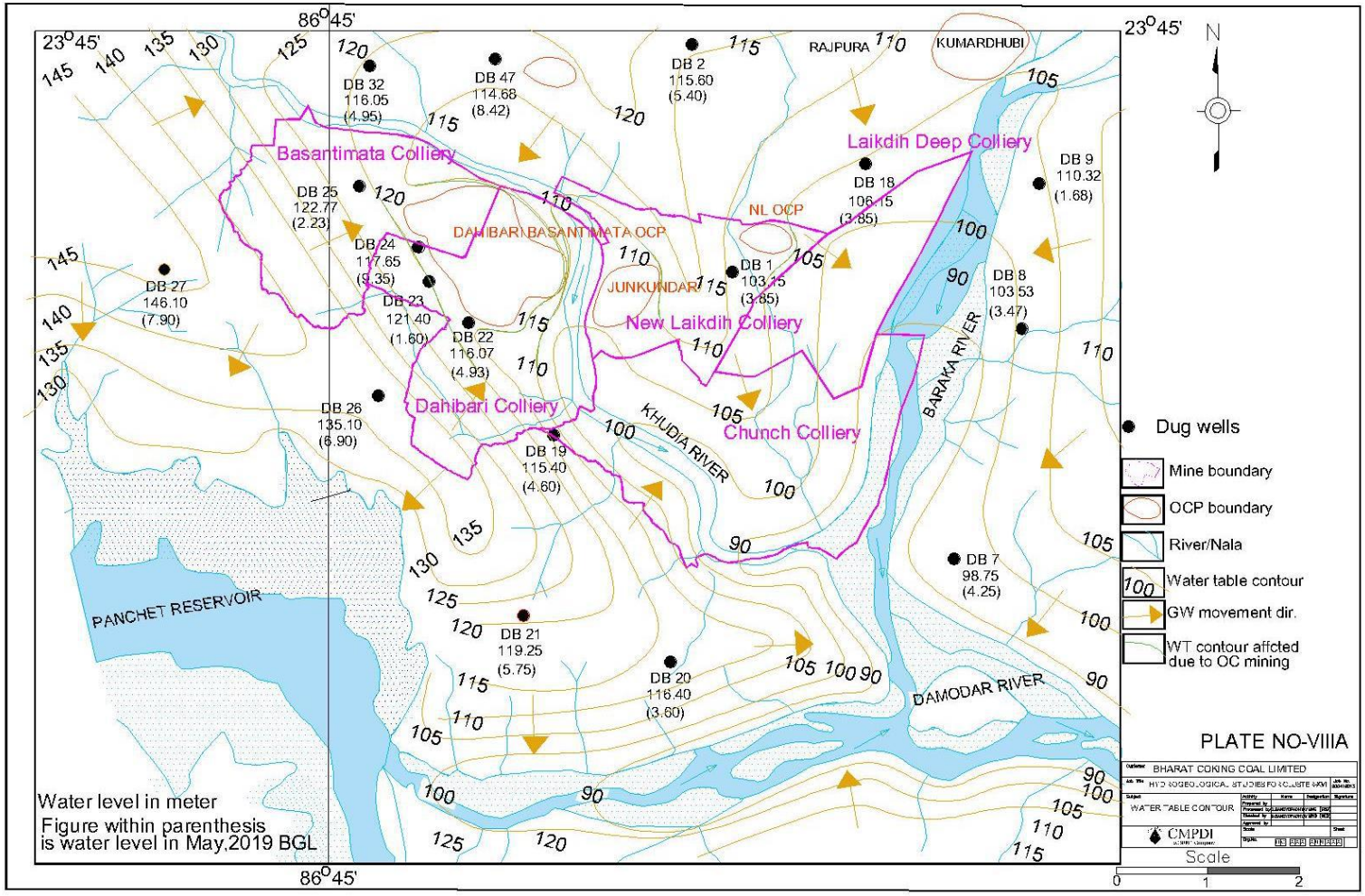
The Pre-monsoon (May'2019) and Post-monsoon (Dec'2019) water table contour map of the top unconfined aquifer of the study area has been prepared and shown in **Plate No-VIII A & B**. The ground water flow direction is towards major rivers and hydraulic gradient of water table is varying from 3.0 x 10^{-2} to 7.0 x 10^{-3} in average. It may be observed from the water table contour map that water table is a subdued replica of surface topography. It is also observed that the trend of water table contours, its gradient and configuration are mainly controlled by topography, drainage pattern, rainfall, geologic controls and induced flow of ground water towards mine quarries.

Recharge Area: Water table contour maps prepared for May'2019 and Dec'2019 indicates that the recharge zone is the North-East and North-West higher plain along the water divide of the Khudia River, Barakar River and Damodar River. The recharge is mainly from rainfall to the unconfined aquifer. Two big dams in Barakar River (Maithon Dam) & Damodar River (Panchet Dam) are also the source of water.

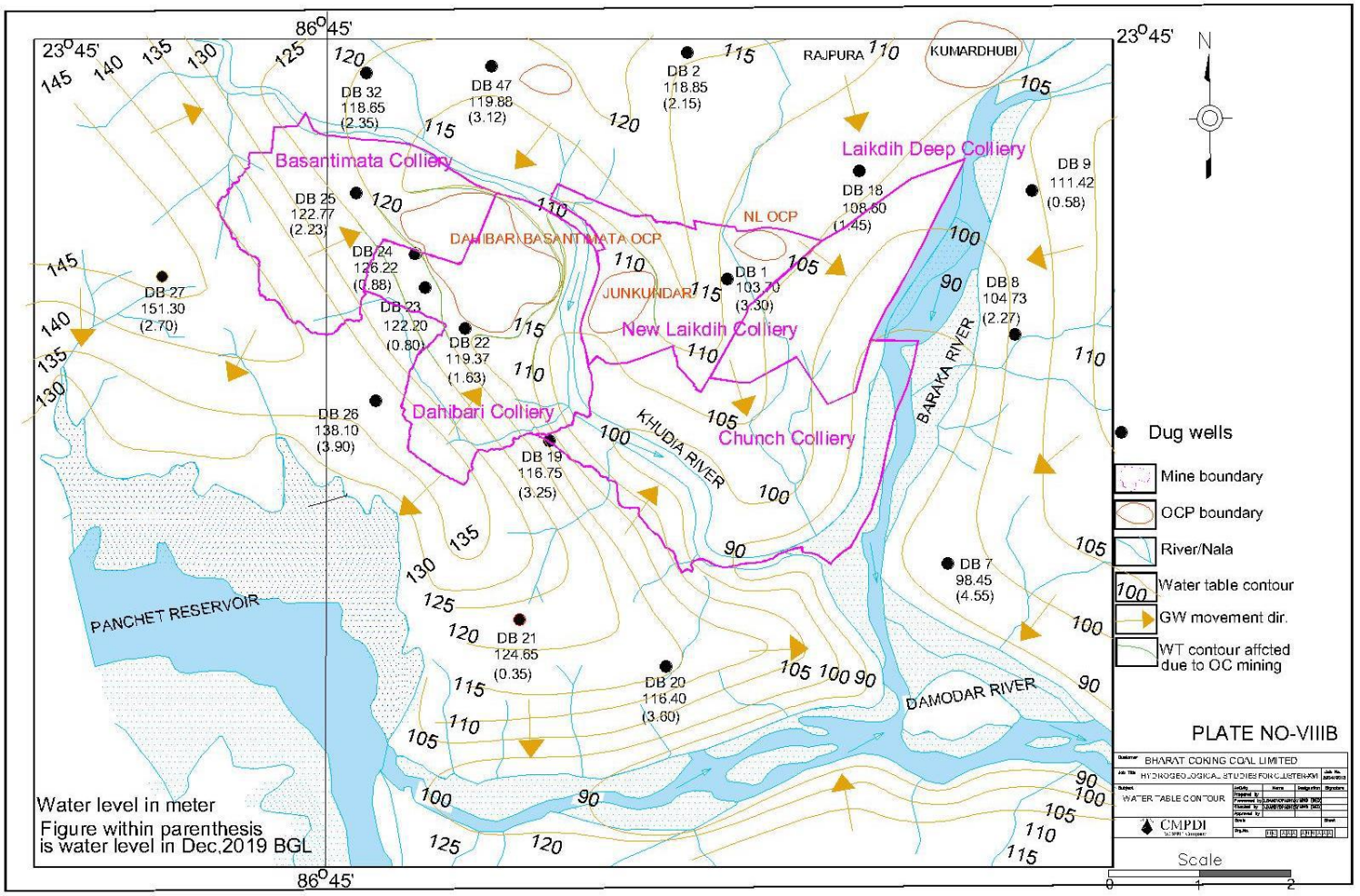
Discharge Area: Water table contour map for May'2019 and Dec'2019 indicates that the discharge area is the low lying flat terrain, streams and master drainage, Damodar River and Barakar River valley area. The open cast mine also acts as local discharge zone for the aquifer.

However, change in natural path and increased hydraulic gradient in the vicinity of the active opencast mining activity has been found in the study area. There is no such affected water table condition in and around the abandoned underground mining areas has been noticed. The affected water tables are shown in the **Plate No-VIII A & B** both during Pre and Post-monsoon season. It is also found that there is no change in natural groundwater flow path in and around the Barakar River and Damodar River watershed regime. **The only change has been found in the Khudia River watershed area adjacent to OC mining activity.**

PRE - MONSOON WATER TABLE CONTOUR MAP



POST - MONSOON WATER TABLE CONTOUR MAP



9.1 Dug well water level

Long term groundwater level trend analysis has been done using hydrographs (**Figure No-1 to 6**) of the CMPDI monitoring wells within the study area. The colliery wise groundwater level conditions are discussed below:

Dahibari-Basantimata Colliery- Total four nos. of hydrographs are analyzed in the area, DB-22, 23, 24, and 25. These monitoring stations are part of the Khudia river watershed and in the close proximity with the DB OCP and abandoned UG mine. Except, DB-22 hydrograph all others are showing upward trends in both pre and post-monsoon season.

Chanch Colliery - Total two nos. of hydrographs are analyzed in the area, DB-01 and 19. These monitoring stations are part of the Khudia river and Barakar river watershed respectively and in the close proximity with the abandoned Chanch UG mine. These hydrographs are showing upward trends both in pre and post-monsoon season.

Laikdih Deep and New Laikdih Colliery - Total two nos. of hydrographs are analyzed in the area DB-01 and 18. These monitoring stations are part of the Barakar river watershed and in the close proximity with the abandoned Laikdih Deep UG mine and New Laikdih OC (closed) and Jhunkundar OC (closed). These hydrographs are showing upward trends both in pre and post-monsoon season.

Year	Pre-monsoon W.L		Post-monsoon W.L		Fluctuation (m)		
	Min	Max	Min	Max	Min	Max	Avg.
2015	2.58	9.52	2.13	8.20	0.02	5.32	1.98
2016	1.60	12.10	0.82	7.53	0.40	9.85	3.08
2017	1.58	6.90	1.33	5.25	0.15	3.67	1.31
2018	1.58	8.32	0.35	4.16	0.30	6.90	2.64
2019	1.60	9.35	0.35	4.55	0.55	8.47	3.09

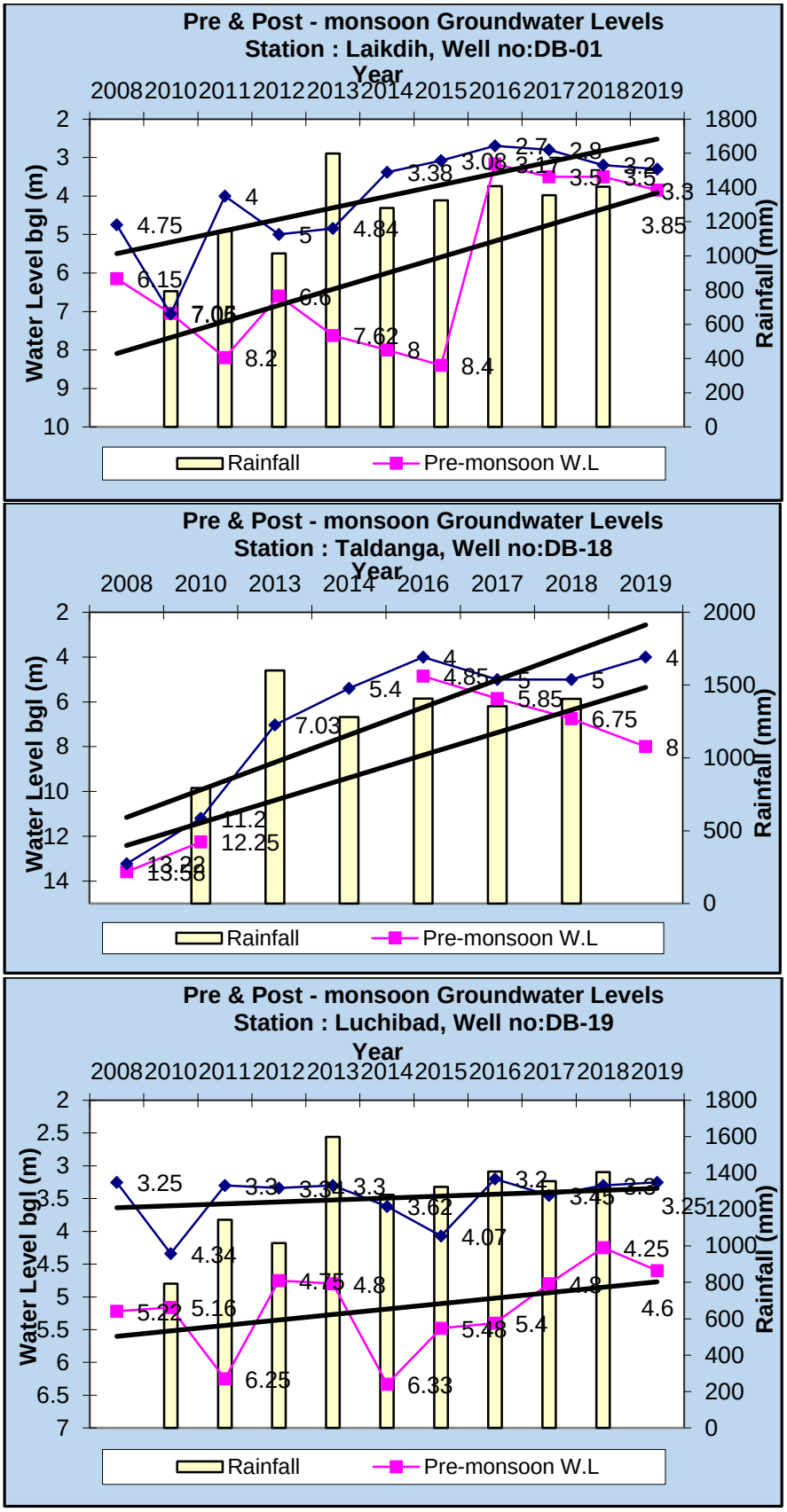


Figure No-1-3: Hydrographs of the monitoring wells in the study area.

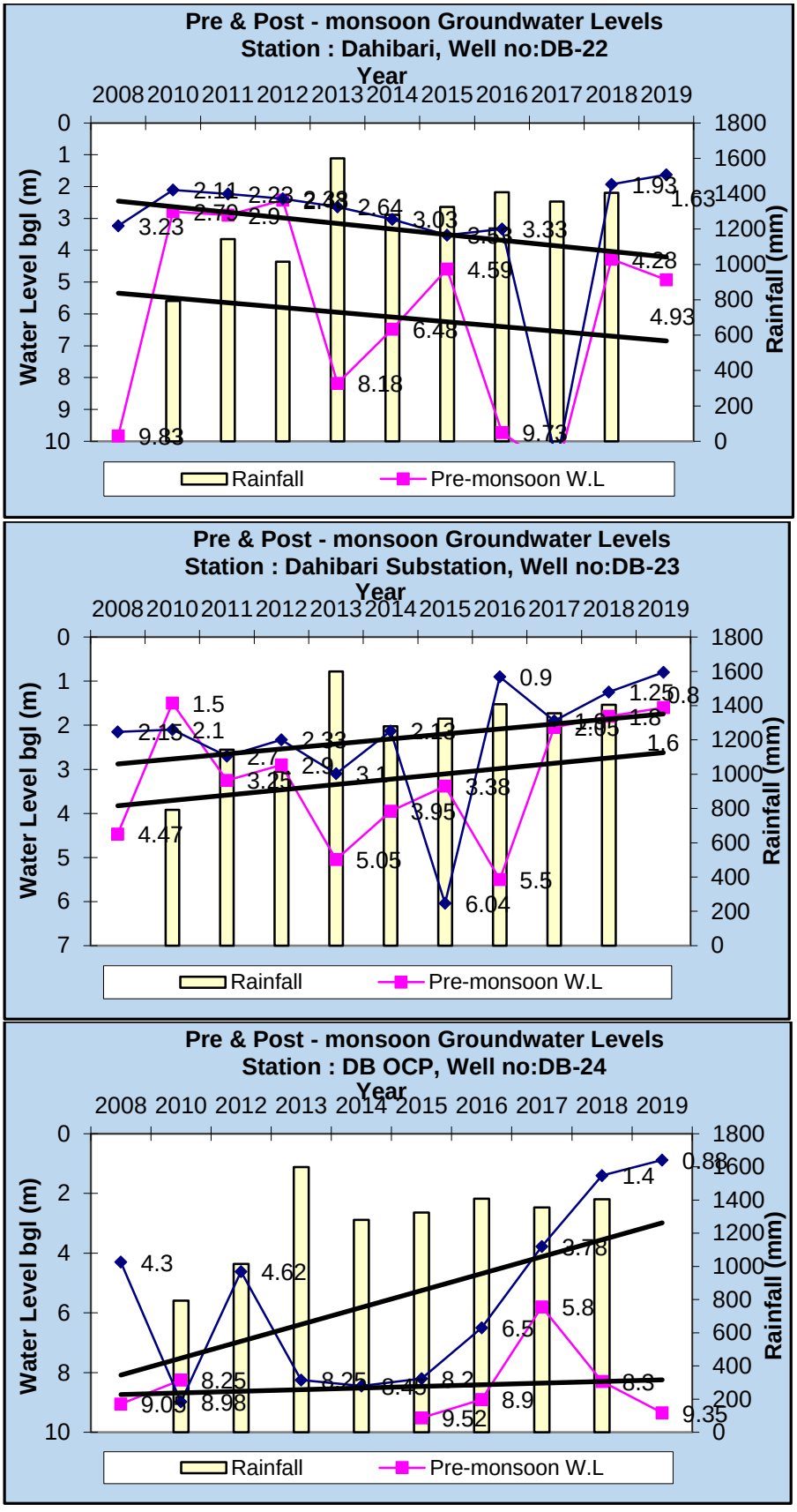


Figure No-3-6: Hydrographs of the monitoring wells in the study area

9.2 Piezometer location and water level

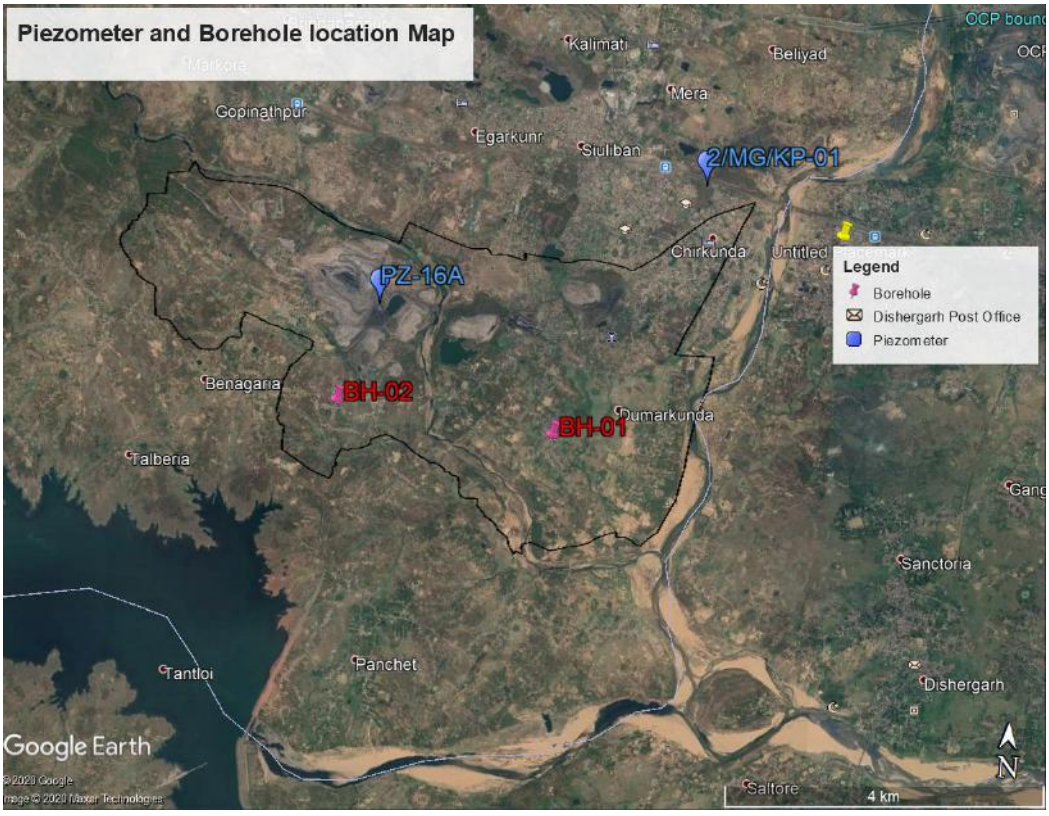
A network of piezometer is useful to monitor the impact of mining activity on deep aquifer groundwater regime. The piezometers were constructed and proposed within coal bearing area where the well should reflect the impact on groundwater regime due to coal mining activity. The locations of piezometers were selected in and around the Cluster-XVI mines, BCCL in RCF (part) are based on followings:

1. The piezometer should tap the aquifers which are expected to be affected due to mine pumping to study the impact on ground water system.
2. Representative lithological/aquifer setup should persist in and around the desired location with permissible structural disturbance.
3. The site should show no influence of any external input such as from canal, tank, river and irrigation return flow, except special cases where interest is to study the influence of these parameters on groundwater system.
4. The site should not fall within the radius of influence of any well, which is under pumping; but it should be capable of recording the effects of the pumping or mine pumping as a regional phenomenon.
5. The location should be hassle free, easily assessable and safe from vandalism (should be in the protected place).
6. The piezometers should be located in the non-mining area so that drilling and construction of piezometer can be done without any difficulties.
7. The locations of piezometer should be nearer to the mine or within the mine influence area so that the impact of mine pumping on the particular aquifer can be assessed.
8. Longevity of piezometers should be maintained as far as possible.
9. The ownership of the site should be clear for drilling the piezometers and for continued monitoring.

Considering the present mining scenario and future strategy, one piezometer well, ***2/MG/KP-01*** is already constructed at Barmuri OCP, Kumardhubi Mine, Mugma area of ECL, located around 200-250 m north-west of the Cluster-XVI boundary. Another well ***PZ-16A*** is proposed at Dahibari-Basantimata OCP, near workshop of Cluster-XVI mines of BCCL.

The location and design of the wells of Cluster-2 of ECL and Cluster-XVI mines of BCCL is given in the location map in **Figure No–7**.

Figure No-7: Location of Piezometers and Boreholes in the study area.

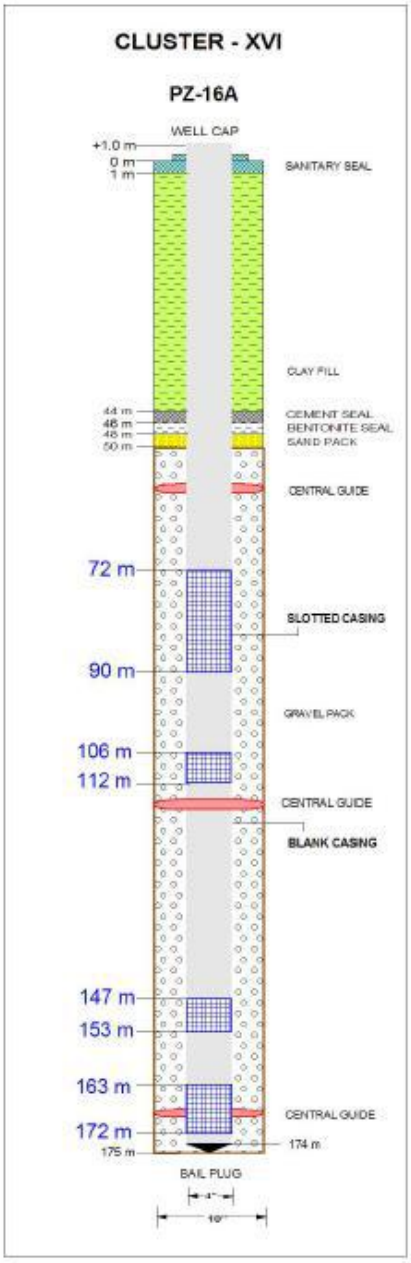


There is no suitable location found within the Cluster-XVI mines area to construct well/piezometer above/adjacent to the old UG workings due to decade old abandoned UG mining activity, water logged goafs, subsided areas and paucity of BCCL land etc. The details of Colliery wise mining plans are shown in **Figure No- VIII A, B and C**. The location and design details of the piezometric wells in the Cluster-XVI mines, BCCL and Cluster-2 of ECL is given in below:

Table No-7: Details of the proposed Piezometric well (PZ-16A).

Name of Cluster	Lat./Lon.	Location of Piezometer	Name of Mines	Depth /R.L (m)	Length & Type of casing	Aquifers Tapped by Piezometer	Aquifer to be monitored
Cluster-XVI MINES, BCCL	23º43'48" N 86º45'36" E	DB OCP near workshop	DB Colliery, CV Area	175 M / 120 M	Blank: 136 m Slotted: 39 m	Aquifer tapped between KHUDIA/PALASIA and KALIMATI	BARAKAR FORMARTION

Figure No-8: Location and Design of the proposed Piezometer at BCCL.



Depth (m)		Blank/ Slot pipe	Design details	Drilling/ Casing Diameter (mm)
From	To			
+1.0	72	Blank	Top sanitary seal: +0.5 to 1 m Clay fill: 1 to 44 m Separator: 44 to 50 m (cement+bentonite +sand pack) Gravel pack: 50 to 175 m (targeted aquifer zone)	250 mm / 100 mm Same as (10 inch / 4 inch)
72	90	Slotted		
90	106	Blank		
106	112	Slotted		
112	147	Blank		
147	153	Slotted		
153	163	Blank		
163	172	Slotted		
172	174	Blank		
174	175	Bail plug		

Proposed Piezometer Design at Dahibari-Basantimata Block of Cluster-XVI mines, BCCL

Table No-8: Details of the Piezometric well (2/MG/KP-01).

Name of Cluster	Lat./Lon.	Location of Piezometer	Name of Mines	Depth /R.L (m)	Length & Type of casing	Aquifers Tapped by Piezometer	Aquifer to be monitored
Cluster -2, ECL	23º44'46" N 86º47'58" E	campus Barmuri OCP office	Kumardhubi Colliery, Mugma	110 M / 125 M	Blank: 80.0 m Slotted : 30 m	Aquifer tapped between SINGPUR and BRINDABANPUR	BARAKAR FORMARTION

Figure No-9: Location and Design of Piezometer at ECL.

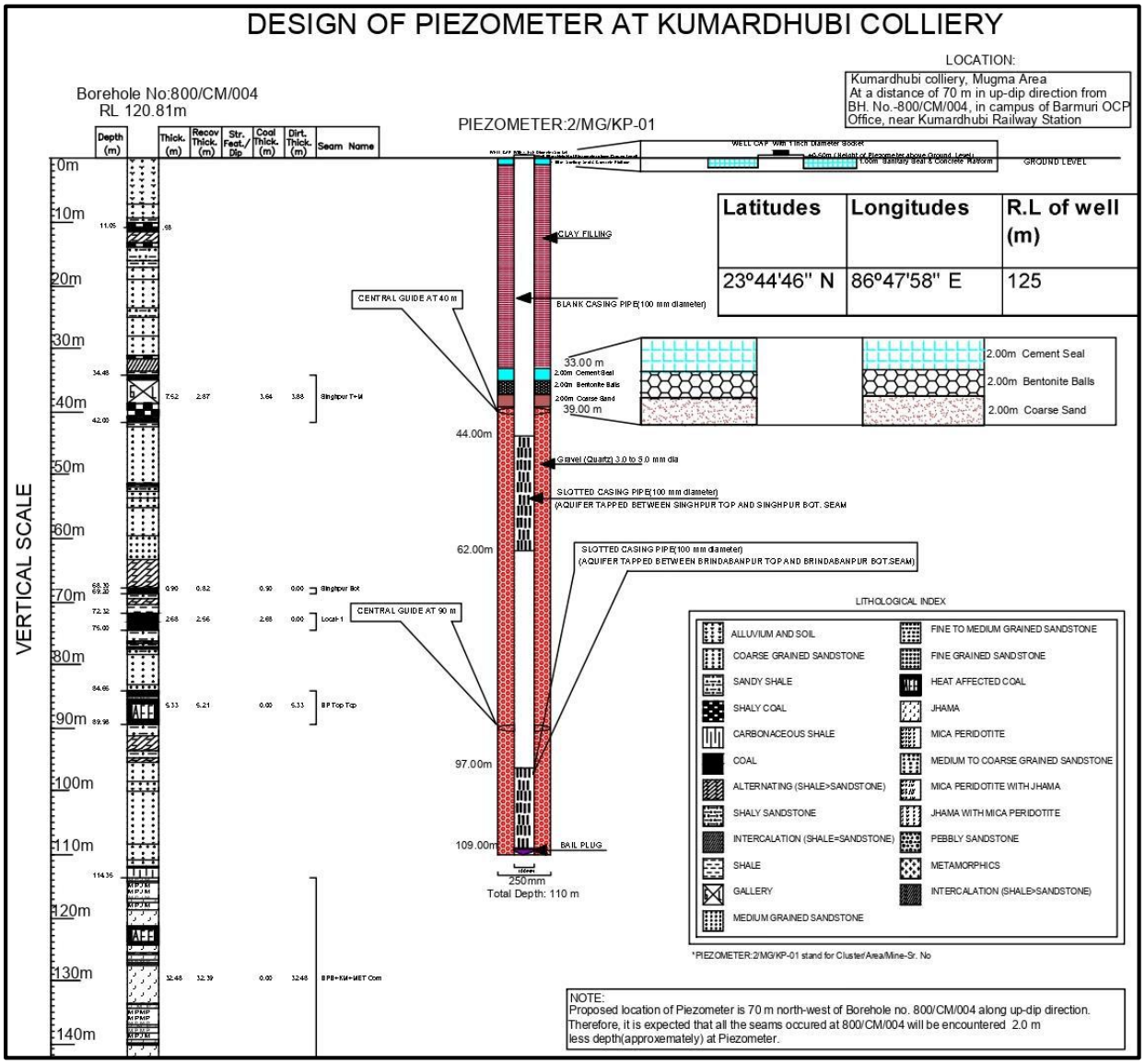
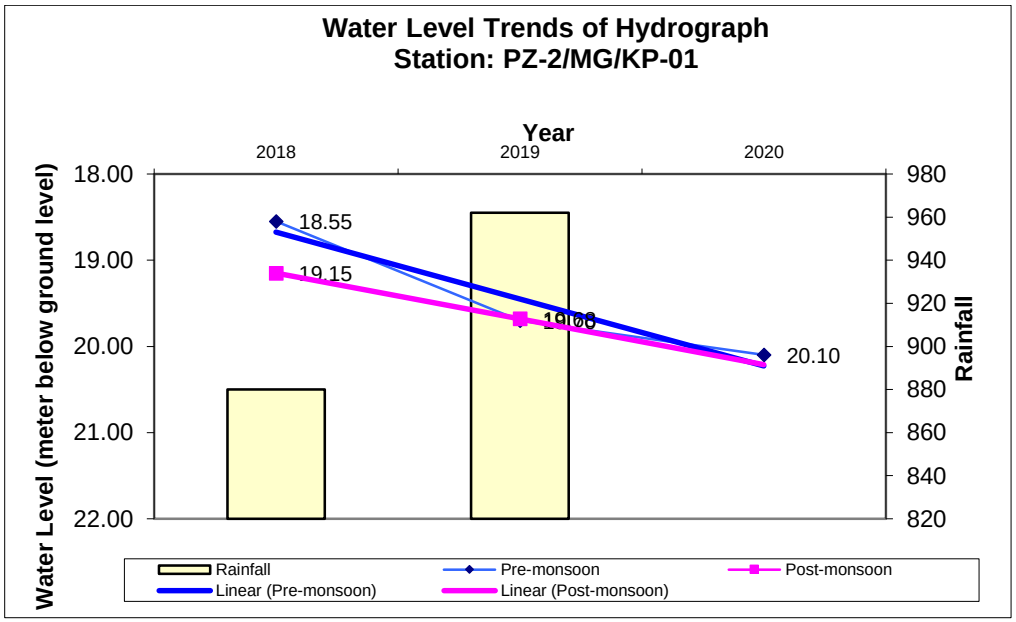


Table No-9: Water level data of the Piezometer (2/MG/KP-01).

Year	Piezometric Head (BGL in meters)				Fluctuation
	Jan	May	Sept	Nov	Avg.
2018	-	-	18.55	19.15	0.60 m
2019	19.35	19.70	19.57	19.68	0.13 m
2020	19.75	20.10	-	-	0.35 m

Figure No-10: Groundwater Level Hydrograph of the Piezometer.



9.3 Borehole Location and water level

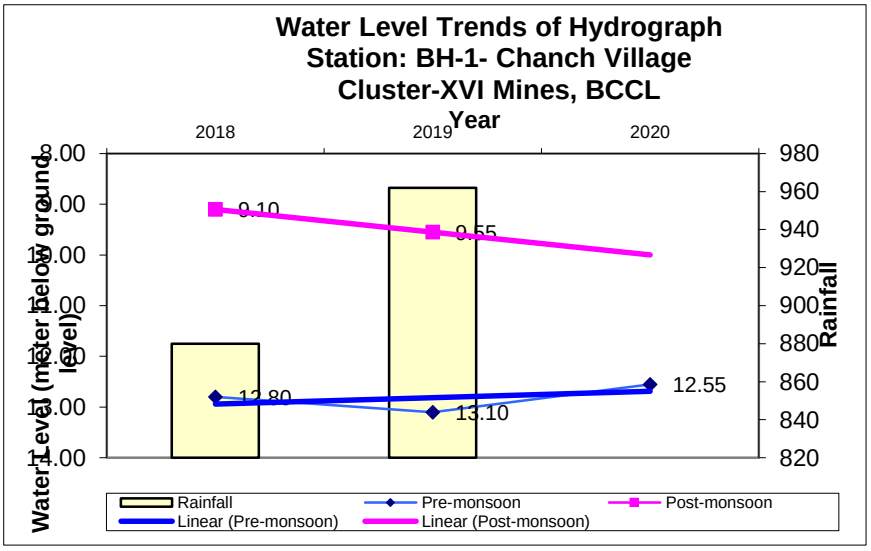
A network of borehole is useful to monitor the impact of mining activity on deep aquifer groundwater regime. There are 02 nos. of boreholes (BH-01 and 02) are identified and quarterly monitored during 2018 to till date for the purpose of the study. The well inventory details are given below:

Well No.	Location	Formation	Owner	Use	M.P (m)	Depth (m)	Dia. (m)	R.L AMSL
BH-01	Chanch	Barakar	Private	Domestic	0.35	65.0	0.15	118.0
BH-02	Patlabari	Metamorphic	Private	Domestic	0.50	85.0	0.15	135.0

Table No-10: Water level data of the Boreholes.

Bore hole	Year	GW level in Borehole (BGL in meters)				Fluctuation
		Jan	May	Aug	Nov	Avg.
BH-01	2018	--	12.80	5.15	9.10	3.70
	2019	10.45	13.10	6.05	9.55	3.55
	2020	10.25	12.55	--	--	--
BH-02	2018	--	9.50	4.10	7.10	2.40
	2019	8.85	10.10	4.70	7.65	2.45
	2020	8.35	9.20	--	--	--

Figure No-11: Groundwater Level Hydrographs of the Borehole.



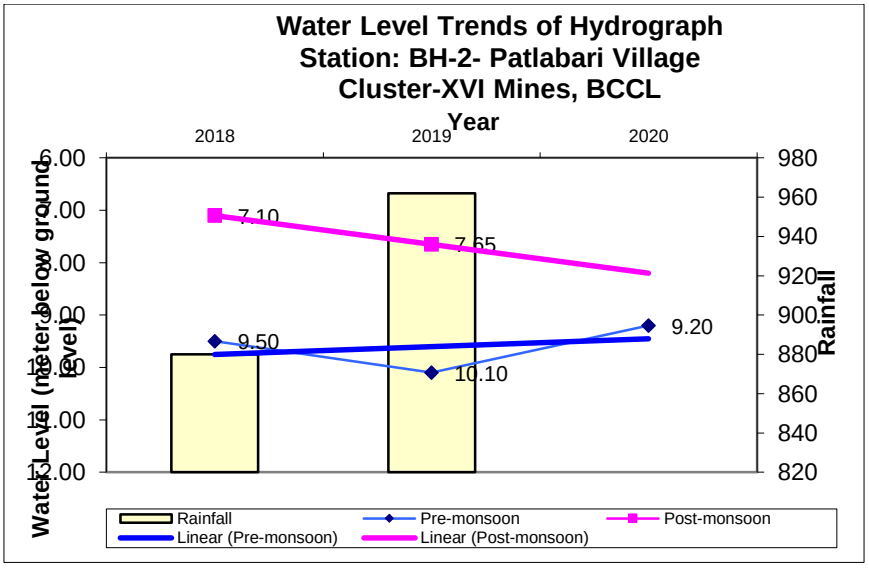
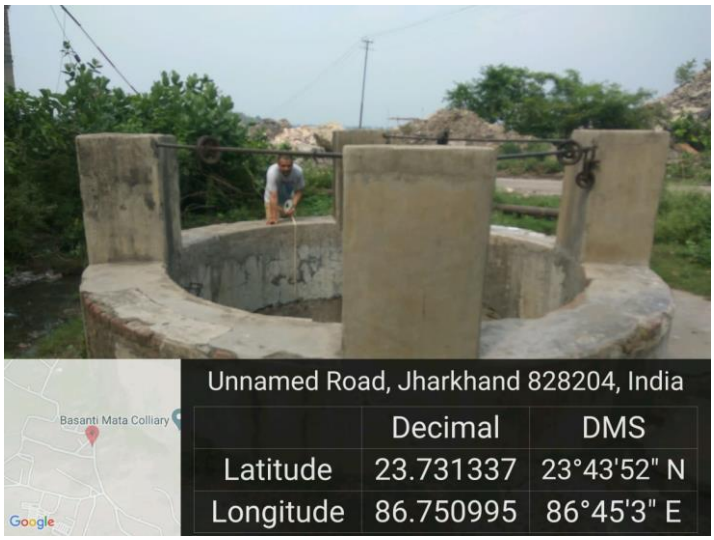


Figure No-12: Field photographs of Dug well, Piezometer construction and Borewell.



Dug well DB-22, Dahibari-Basantimata OCP

Piezometer construction site,

2/MG/KP-01 at Kumardhubi, ECL

Bore well at Patlabari village

Bore well at Chanch Village

9.4 Hydraulic property of the Aquifers

There are total four types of different aquifer system prevails in the study area with critical interaction with each other. These aquifers are, top unconfined aquifer, soft rock/sedimentary aquifer (Talchir, Barakar & Barren Measure Formations), hard rock/metamorphic aquifer and river bed/unconsolidated loose sand aquifer. The disposition of these aquifers are shown in **Plate No-VI** in context with present mining activity (both opencast and underground mining) of the study area. However, the aquifer system of the study area can be broadly classified into two types:

1. Consolidated aquifers (Unconfined, sedimentary and hard rock aquifer).
2. Unconsolidated aquifer (river bed loose sand aquifer).

Unconfined aquifer: The aquifer in the top alluvial soil/detrital mantle and sandy soil is under unconfined state and is extending down to a maximum depth of about 50.0 m. Site specific aquifer parameters of the unconfined aquifer has not been determined in the study area. However, aquifer performance test was carried out at New Ghusik Block, Cluster-5 of ECL at Raniganj CF and Sitanala Block of Cluster-X mines of BCCL in Jharia Coalfield. The hydraulic conductivity of the unconfined aquifer is determined in the order of 0.002 m/day to 0.42 m/day at New Ghusik Block, whereas, hydraulic conductivity of the unconfined aquifer is determined in the order of 0.0006 m/day to 1.22 m/day in Sitanala Block**.** Geologically Sitanala Block has more resemblance with the present study area of Cluster-XVI mines as both are situated in the Barakar formation of the Gondwana Basin adjacent to Damodar River. Therefore, the hydraulic conductivity of the unconfined aquifer is considered as **0.0006 m/day to 1.22 m/day** in the study area**.**

Table No-11: Hydraulic properties of the unconfined aquifer

Permeability (k):	0.0006 – 1.22 m/d
Transmissivity:	0.10 – 8.06 m^2 /day
Specific Yield (S_y):	4.0% - 8.0% (GEC-2015 Norms)

Sedimentary aquifer/soft rock formation: Below the unconfined aquifer (top aquifer) lies within the sandstone partings in-between impervious layers of shale and coal seams and is designated as semi-confined / confined aquifers. The sandstones (Barakar formation) in these aquifers are fine to coarse grained with less porosity. Mostly groundwater occurs in this formation in the weak zones formed due to weathering, fracture, faults, which creates the secondary porosity. **Sandstone of Talchir formation and Barren Measure formation are of very low potential due to their very low porosity and low capacity to transmit/yield**. Aquifer Performance Test (APT) has been carried out to determine hydraulic property of the Barakar formation sandstone aquifer in the Cluster-2 of ECL located in the north of the study area. The bore well construction and the test has been performed on July'2018 at the Cluster-2 of ECL (conducted by Hydrogeologist of CMPDI). The transmissivity and permeability of the target aquifer, i.e., Barakar formation has been evaluated using ***Aquifer Test Pro software (Annexure-III)*** and the results are summarized in **Figure No-13** and **Table No-12**. Therefore, the hydraulic conductivity of the sedimentary aquifer of Barakar formation is considered as **0.441 m/day** in the study area**.**

Table No-12: Hydraulic properties of the sedimentary aquifer (Barakar formation)

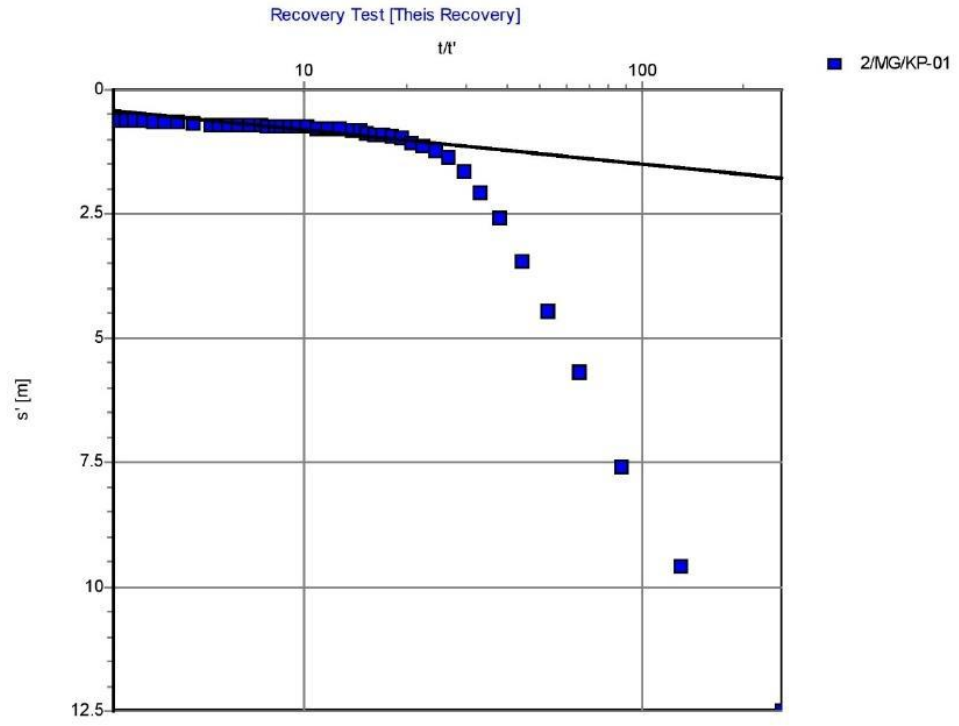
Permeability (k):	0.441 m/d
Transmissivity:	23.40 m^2/day
Specific Yield (S_y):	1.0% - 5.0% (GEC-2015 Norms)

However, piezometric well is also proposed (design in **Figure No-8**) in the Cluster-XVI mines at DB Block where aquifer performance test will also be proposed to carrying out at the time of well construction by BCCL. Hence, aquifer parameters of Barakar formation which will be determined from the proposed well will add the information in the study area about deeper aquifers.

Figure No-13: Aquifer Pumping test analysis of Piezometer at ECL.

Pumping Test Analysis result

Waterloo Hydrogeologic, Inc. 460 Philip Street - Suite 101 Waterloo, Ontario, Canada Phone: +1 519 746 1798	**Pumping Test Analysis Report** Project: Kumardhubi Piezometer (Cluster-2) Number: 2/MG/KP-01 Client: ECL



Pumping Test:	**Recovery Test**			
Analysis Method:	**Theis Recovery**			
Analysis Results:	Transmissivity:	2.34E+1 [m²/d]	Conductivity:	4.41E-1 [m/d]
Test parameters:	Pumping Well:	2/MG/KP-01	Aquifer Thickness:	53 [m]
	Casing radius:	0.05 [m]	Confined Aquifer	
	Screen length:	30 [m]		
	Boring radius:	0.125 [m]		
	Discharge Rate:	86.4 [m³/d]		
	Pumping Time	129 [min]		

Comments: Aquifer Performance Test was conducted on date 25.07.2018 for piezometer 2/MG/KP-01 by running air compressor for 129 min. The piezometer is located within premises of Barmuri OC office, Mugma Area, Jharkhand.

Evaluated by: CMPDI

Evaluation Date: 07-09-2018

Metamorphic aquifer/ hard rock formation: Hard rock or metamorphic aquifer is located outside of the coal bearing Gondwana basin area separated by boundary faults. This formation is constituting of weathered metamorphic rocks including granite gneiss, hornblende gneiss, schist and pegmatite etc. also constitute unconfined aquifer. The thickness of the unconfined aquifer within hard rock area is varies up to 14.45 m in the area. However, groundwater movement is only restricted to fracture zones at particular depths within hard rock aquifer area. No aquifer pumping test data has been available by any agency to determine the hydraulic property of the deeper hard rock aquifers in the study area. Therefore, the **GEC-2015 (Groundwater Estimation Committee)** recommended value suitable in the study area has been considered given in **Table No-13**.

Table No-13: Hydraulic properties of the hard rock aquifer

Permeability (k):	0.0006 – 1.22 m/d (Unconfined aquifer)
Specific Yield (S_y):	1.0% - 2.0% (GEC-2015 Norms) (Confined fracture aquifer)

Unconsolidated alluvial aquifer/ river bed loose sand formation: The unconsolidated quaternary river borne loose sand / sediments comprising recent alluvium, older alluvium along with Khudia river, Barkar river and Damodar river course is the most potential but limited extent aquifer zone in the study area. The Barkar River and Damodar River basin have distinctive hydrogeological environment and potential. However, no hydrogeological test has been carried out to determine the hydraulic property of the aquifer. Therefore, the **GEC-2015** recommended value suitable in the study area has been considered given in **Table No-14**.

Table No-14: Hydraulic properties of the river bed loose sand aquifer

Permeability (k):	No pumping Test data
Specific Yield (S_y):	6.0% - 12.0% (GEC-2015 Norms)

10.0 Groundwater Resource Estimation (as per GEC-2015 methodology)

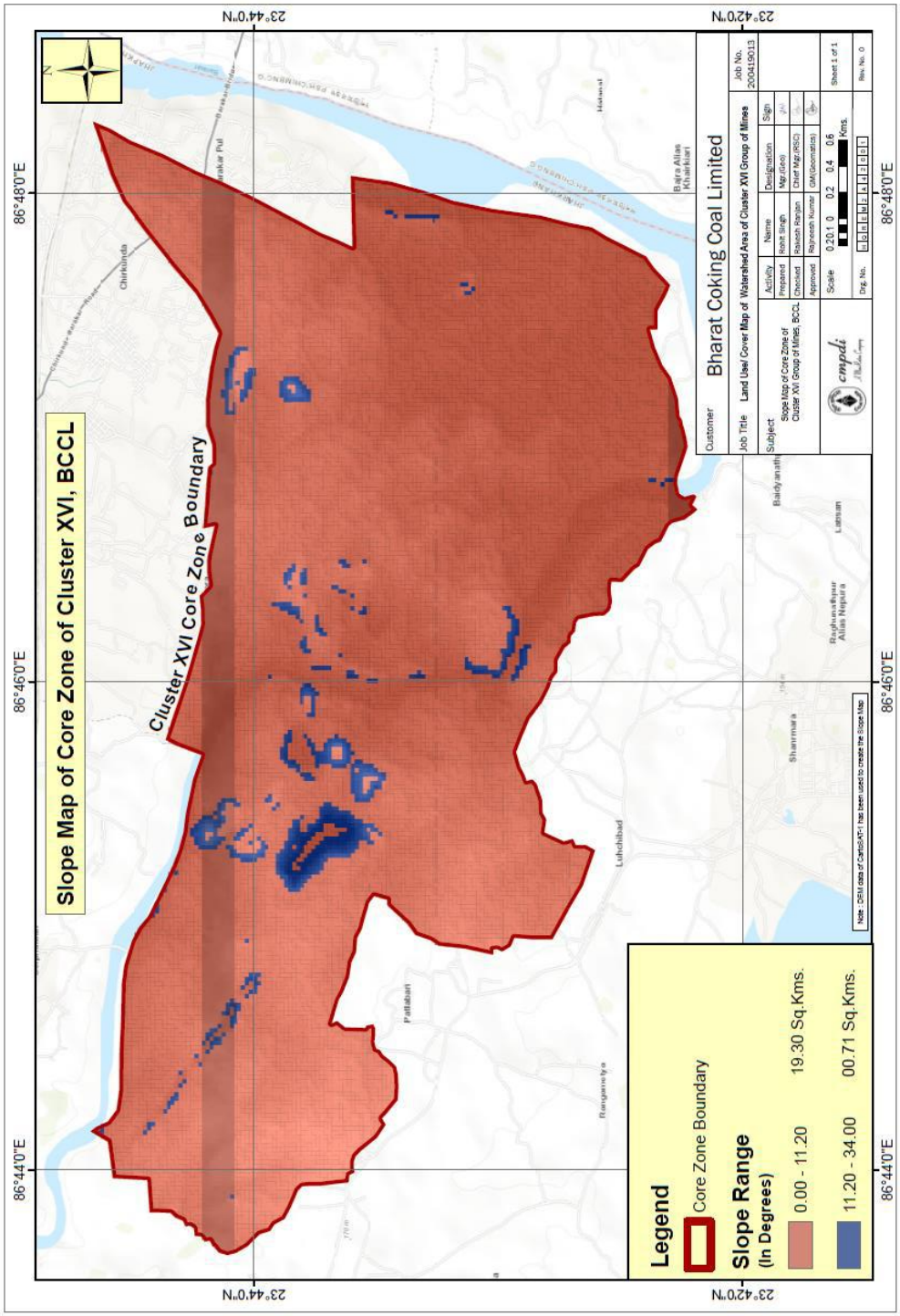
Rainfall is the major recharge source of groundwater in the study area. The area (Jharkhand Dist.) experiences a rainfall of 962 mm (reported by IMD, Rainfall Statistics of India, 2018). The land use pattern of the Cluster-XVI mines area depicts that industrial (coal mining) along with agriculture activity and domestic use are the major source of draft. The study area is located within the lower part (discharge area) of the Micro-watershed of Khudia River. It is also receiving significant recharge from the upper and middle part of the Khudia River watershed. The mine water discharge into local drainage with 20% return flow and irrigation water with 25% return flow also augments the ground water recharge.

The groundwater recharge potential in the study area is estimated by both ***Rainfall infiltration method (RFIM)*** and ***Water table fluctuation method (WTFM)***. As per GEC-2015 methodology, aquifer wise GW Resource Estimation has been performed. Rainfall infiltration factor of 12% for sandstone and 7% for hard rock are considered for the study area. The specific yield for sandstone is 3% and 2% for hard rock is considered.

10.1 Groundwater recharge estimation

The total leasehold area of the Cluster-XVI mines, BCCL is 20.1821 sq.km. The Slope map (hilly area with >20% or 11.20^0 slope, i.e., 0.71 sq.km.) has been prepared using SRTM-DEM data (***Plate No-IX***). In addition to that, the area of 1.84 sq.km. under Urban & Industrial settlement and surface waterbody has been excluded. Therefore, the total effective area for recharge estimation is 17.6321 sq.km., out of which, 2.70 sq. km. in hard rocks (metamorphic) and 14.9321 sq. km. is sedimentary rocks respectively. The recharge from rainfall in the study area has been computed using ***RFIM method*** (Eq-1) and ***WTFM method*** (Eq-2):

Plate No-IX: Slope map of the Cluster-XVI mines, BCCL



Eq-1:

Rainfall Recharge $_{(RFIM)}$ = (Rainfall – Minimum threshold) * RFIF * Area

Eq-2:

Rainfall Recharge $_{(WTFM)}$ = (Area* S_y* h) + GE - R_{GWI} - R_{TP} - R_{WCS} - R_{mine}

Where, ***S_y=*** Specific Yield, ***h***= water table fluctuation, GE= Groundwater extraction during monsoon season, ***R_{GWI}***= Return from groundwater irrigation, ***R_{TP}***= Recharge from tank/ponds, ***R_{WCS}***= Recharge from water conservation structure, ***R_{mine}***= Return from net mine discharge water on surface

Table No - 15: Groundwater Recharge Estimation (As Per GEC-2015 Methodology)

i) Rainfall Recharge by Rainfall Infiltration Method.

	Description of items	***GEC-2015 methodology***		
		Monsoon	***Non-monsoon***	***Total***
1	Annual Rainfall 2019	861.50 mm	100.50 mm	962.0 mm
2	Min. threshold value	96.20 mm	96.20 mm	96.20 mm
3	Effective Rainfall	765.30 mm	4.30 mm	-
4	Recharge (12%) Sedimentary area	Area:14.9321 km^2 1.3713 MCM	0.007 MCM	1.3783 MCM
5	Recharge (7%) Hard rock area	Area: 2.70 km^2 0.1446 MCM	0.0008 MCM	0.1454 MCM
6	***Total***	***1.5159 Mm^3***	***0.0078 Mm^3***	***1.5237 Mm^3***

*Average rainfall value of C.V Area, DB OCP Station has been considered.

ii) Water Level Fluctuation Method during monsoon season

	Description of items	***GEC-2015 methodology***		
		Sedimentary	***Hard rock***	***Total***
1	Area	14.9321 km^2	2.70 Km^2	17.6321 km^2
2	Specific Yield	03%	02%	-
3	Water Table Fluctuation	2.53 m	2.72 m	-
4	Change in Storage	1.1333 Mm^3	0.14688 Mm^3	1.28018 Mm^3
5	Gross GW Extraction of all uses during Monsoon season	Domestic- 0.0805 Mm^3 Irrigation – NIL Industrial – 0.1369 Mm^3		0.2174 Mm^3
6	Recharge from Other Sources during Monsoon season	Irrigation return flow- 0.0121 MCM Mine water return flow- 0.0434 MCM		0.0555 MCM
7	Gross Rainfall Recharge	**(4 + 5 - 6)**		1.44208 Mm^3
8	Normalized Monsoon season Rainfall Recharge	RF in 2019 Monsoon- 861.50 mm Avg. RF in last 3 yrs. Monsoon- 900.70 mm		***1.5077 Mm^3***

iii) Rainfall Recharge (PD method during monsoon season)

	Description of items	***GEC-2015 norms***
1	WTF method (Normalized)	1.5077 Mm^3
2	RFIF method	1.5159 Mm^3
3	PD = [(1-2)/2] * 100	(-) 0.55%
4	WTF method during Monsoon season	1.5077 Mm^3

iv) Summary of Recharge from Other Sources

	Recharge from Other Sources	***GEC-2015 methodology***		
		Monsoon MCM	***Non-monsoon MCM***	***Total MCM***
1	Irrigation Return flow	NIL	0.0484@25%= 0.0121	0.0121
2	Return flow from excess mine discharge	NIL	0.2171@20%= 0.0434	0.0434
3	Recharge from water bodies	NIL	NIL	NIL
4	***Total***	NIL	***0.0555***	***0.0555***

Recharge from other sources: Return flow from irrigation and mine water discharge has been considered for recharge from other sources. Around **0.0555 MCM/annum** will be the probable quantum of recharge from other sources in the study area in calculated in **Table No-iv**.

10.2 Groundwater Draft

The total groundwater extraction or draft composed of irrigation draft, community draft and industrial draft (due to coal mining activity) in the study area. These three draft component are calculated as per GEC-2015 norms described below:

a. Irrigation draft: The land use pattern map shows that the total agricultural land in the study area is around 4.02 sq. km. Based on the groundwater draft assessment for irrigation by CGWB (Dynamic Groundwater Resources of Jharkhand state, 2013) prepared for Govindpur Block, the irrigation draft for the proportional area is estimated as ***0.0484 MCM***.

b. Community draft: Groundwater extraction for community use has been calculated based on the water demand by various projects (industrial & domestic) in the study area. The domestic demand (1590 cum/day) of the area is fulfilling from mine water from Laikdih Deep Colliery abandoned UG

mine/goaf and river bed (Barakar River) intake well in Sundar nagar (Laikdih Deep Colliery) is estimated as 0.58035 MCM. Out of which, **0.1934 MCM** from groundwater and rest is from surface water source (***Table no-16***).

Table No - 16: Mine water pumping details and utilization.

Sl	Colliery	Pump Capacity (GMP)	Running hours/day		Utilization (cum/day)		Excess water (cum/day)		Discharge point
			Monsoon	Non-monsoon	Domestic	Industrial	Monsoon	Non-monsoon	
1	DB OC & UG	1000	10.0	6.0	NIL	900	595	NIL	Khudia River
2	Chanch	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
3	Laikdih Deep	500	6.0	6.0	530.0	NIL	NIL	NIL	UG Shaft
4		500	12.0	12.0	1060.0	NIL	NIL	NIL	Barakar River bed intake well
5	New Laikdih	NIL	N.A	N.A	NIL	NIL	NIL	NIL	NIL

Efficiency of the pumps has been considered as 65% @ 365 days/year.

c. Industrial draft: Industry (coal mine) requires water for different activates like, fire-fighting, dust suppression, HEMM washing, workshop, CHP, green belt development, coal Washery etc. The peak industrial water demand for DB OCP (the only operating mine) is projected as 900 cum/day source from mine water. Thus the industrial draft will be ***0.3285 MCM*** (**Table No-16**).

Table No-17: Gross Annual Groundwater Draft for 'All uses'

	Groundwater Extraction/ Draft	**GEC-2015 methodology**		
		Monsoon MCM	***Non-monsoon MCM***	***Total MCM***
1	***Domestic Draft***	***0.0805***	***0.1129***	***0.1934***
2	***Irrigation Draft***	***-***	***0.0484***	***0.0484***
	(Draft from Govindpur Block, Jharkhand, CGWB assessment 2013)			
3	***Industrial Draft***	***0.1369***	***0.1916***	***0.3285***
	Mine water pumping from all Collieries of Cluster-XVI mines of BCCL			
4	***Total Draft***	***0.2174***	***0.3529***	***0.5703***

10.3 Stage of Groundwater Extraction (SoGWE)

The net annual groundwater availability is 1.49245 MCM. The gross groundwater draft for all uses in the study area was projected as 0.5703 MCM. Thus, the balance available annual groundwater resource is projected as 0.92215 MCM. The Stage of Groundwater Extraction computed as per GEC-2015 methodology in the study area is **38.21%** (**Table No-18**). The GW budgeting exercise carried out in the study area is acceptable (**Table No-19 and Annexure-IV**).

Table No-18: Net Annual Groundwater Availability in Buffer Zone

	Description of items	***GEC-2015 methodology***
1	Rainfall Recharge	
	a. Monsoon season	1.5077 Mm^3
	b. Non-monsoon season	0.0078 Mm^3
2	Recharge from Other Sources	
	a. During Non-monsoon & Monsoon	0.0555 Mm^3
3	Environmental Flow assessed	NO
4	Gross Annual GW Recharge	1.5710 Mm^3
5	Environmental Flow Losses @ 5%	0.07855 Mm^3
6	Net Annual GW Availability	1.49245 Mm^3
7	Annual GW Draft for All Uses	0.5703 Mm^3
8	Annual GW Balance Availability	0.92215 Mm^3
9	***Stage of GW Extraction***	***38.21% (Safe)***
10	Quality tag (if any)	Potable

Table No-19: Validation of Stage of Groundwater Extraction.

Well ID	**Nos. of GW years**	**GW Level trend (cm/year)**		**SoGWE**	**Category**	**Validation**
		Pre	**Post**			
Cluster-XVI DB-01, 19, 22, 23	11 years (2008-19)	(-) 17.27	(-) 13.35	***38.21%***	***Safe***	**Acceptable** (since both the Pre & Post-monsoon trends are increasing)

11.0 Water budgeting of the Khudia River Micro-watershed

Under natural conditions, the hydrologic system is in long-term equilibrium state. Averaged over a long period of time, the amount of water entering the system is approximately equal to the amount of water leaving the system. The main objective of conducting this study is to estimate the recharge and draft component of the water budget/cycle of the **Khudia River micro watershed**.

The methodology mainly involves collection of data/information *viz.,* map of the micro-watershed area: Geological map (**Plate No-IV**), land use map (**Plate No-X**), meteorological data such as rainfall & evapotranspiration, estimation of recharge & draft components, analysis of water yield of catchment area and outflow/run-off from the catchment area etc., based on the data available, the water balance components were worked out.

An equation that describes the annual water budget of a natural system states that, water input (I) equals discharge (D) plus or minus changes in water in storage (ΔS): **I (water entering system) = D (water leaving system) ± ΔS.**

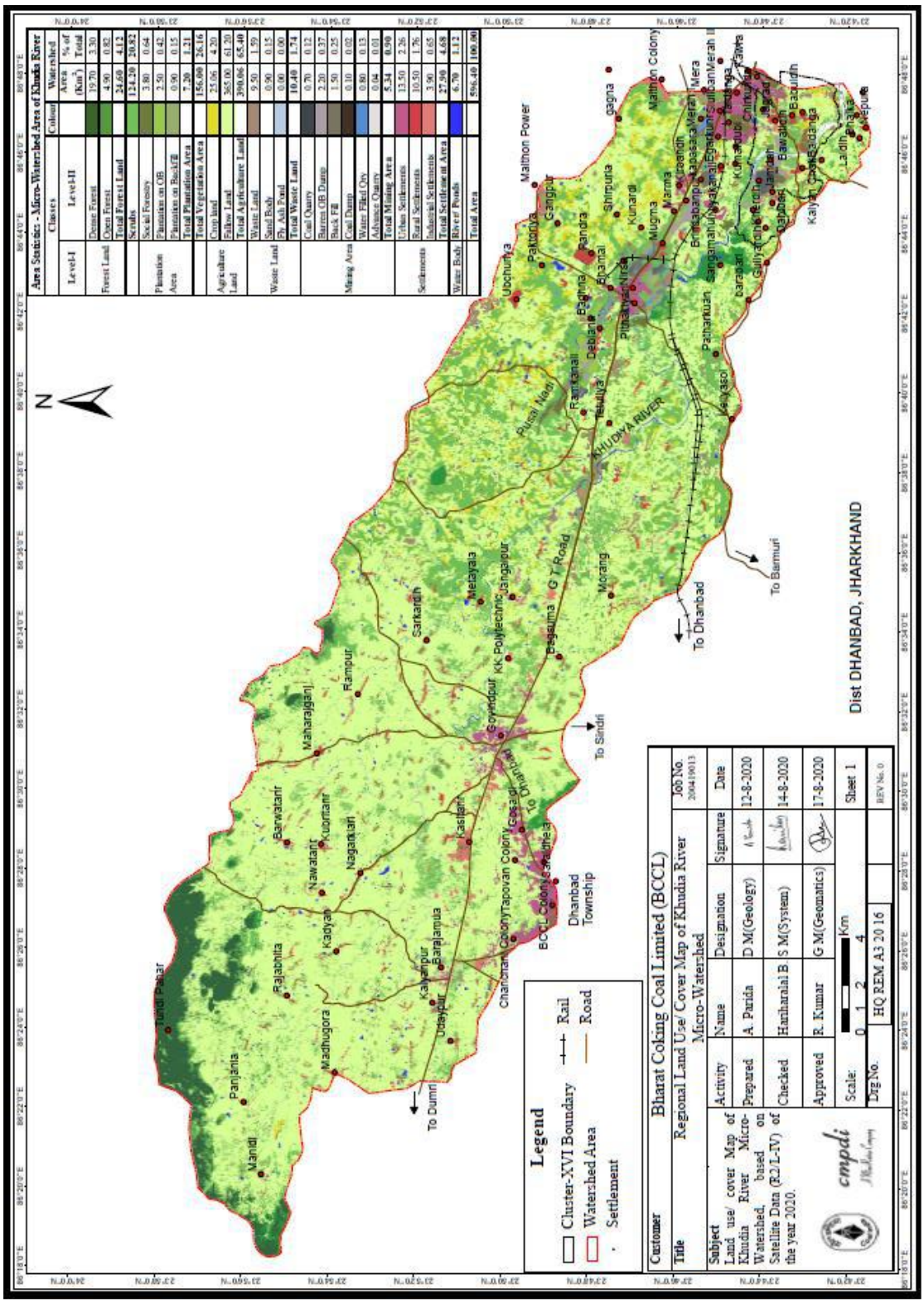
In natural systems, water enters the system as precipitation/rainfall (RF) and leaves the system as stream flow (SF) (surface runoff plus groundwater discharge to streams), Change in storage/draft (ΔS) and evapotranspiration (ET).

RF = SF ± ΔS + ET

Monthly precipitation, evapotranspiration, infiltration, draft and surface run-off has been considered for effective mass balance equation of the **Khudia River Micro-watershed area**.

Area X (Rainfall – Evapotranspiration) = (Area X Infiltration) ± Draft + Surface run-off

Plate No-X: Regional Land use/Land cover map of the Khudia River Micro-watershed area.



11.1 Morphometric analysis of the watershed

Khudia River is a tributary of Barakar River which further joins the master drainage of the area, Damodar River. The distance and direction of flow of those rivers are shown in **Plate No-II**. The study area comes under the micro-watershed of Khudia River; it is a part of lower stage of Barakar River watershed which is part of the middle stage of Damodar River sub-basin. Basic river catchment/watershed morphometry in the study area are described below in a tabular format.

Table No-20: River catchment/watershed characteristics.

Sl.	**Parameters**	Khudia River Micro-watershed	Barakar River Watershed (Lower part)*
1	Watershed/basin area (km^2)	596.40	3162.0
2	Basin perimeter (km)	132.60	264.0
3	Watershed/basin length (km)	56.50	100.0
4	Drainage density	0.50	0.36
5	Stream frequency	0.15	0.09
6	Bifurcation Ratio	0.40	0.30

*Barakar River Watershed data sourced from the article “Morphometry of Barakar River Basin”.

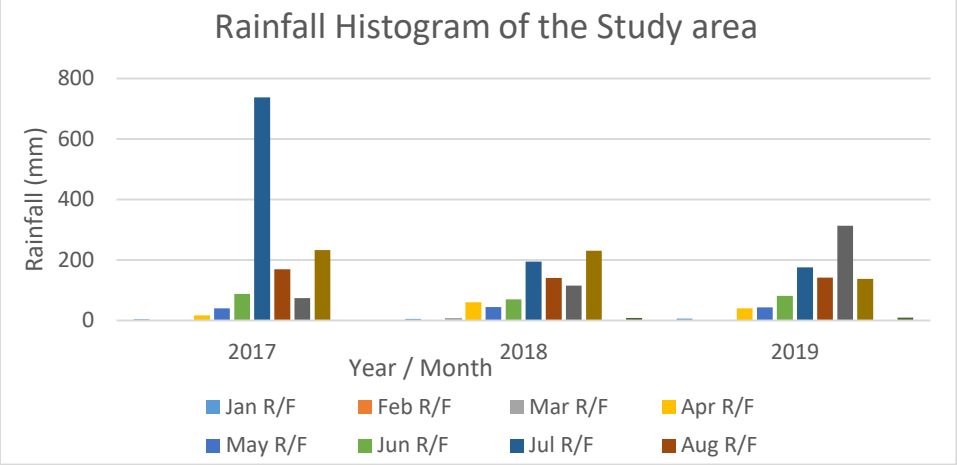
11.2 Rainfall, Evapotranspiration and Infiltration factor

The rainfall data has been taken from the monthly rainfall recorded in Rain gauge station by BCCL at Dahibari-Basantimata mine, CV area, Dhanbad Dist. (2017 to 2019).

Table No–21: Rainfall (mm) statistic of the study area.

District /Station	**Year**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
	R/F	**R/F**	**R/F**	**R/F**	**R/F**	**R/F**	**R/F**	**R/F**	**R/F**	**R/F**	**R/F**	**R/F**	**R/F**
DB mine/ CV Area	**2017**	4.5	0.0	0.0	17.6	40.5	88.0	737.0	169.5	74.50	232.5	0.0	0.0
	2018	5.5	0.0	8.5	60.5	45.0	70.5	194.9	141.4	115.5	230.4	0.0	8.5
	2019	6.5	10.0	0.0	40.5	43.5	82.0	175.8	141.6	313.8	138.0	0.0	10.0

Figure No-14: Historical rainfall distribution in the study area.



Potential Evapotranspiration data is considered using FAO-PPP-17 Penman (Frere and Popov, 1979) made for Indian continent. Ref. Potential Evapotranspiration estimation for India condition, Central Research Institute for Dryland Agriculture, Hyderabad. Nearest station Ranchi, Jharkhand has been considered for calculations, i.e., 1.78 mm/day during NE Monsson, 5.56 mm/day during summer season and 2.92 mm/day during winter season (**Annexure-I**).

Table No–22: Effective Rainfall (ERF) during 2019 in mm.

Items	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
Rainfall	6.5	0.0	0.0	40.5	43.5	82.0	175.8	141.6	313.8	138.0	0.0	10.0
PET	87.6	87.6	166.8	166.8	166.8	53.4	53.4	53.4	53.4	87.6	87.6	87.6
ERF	0	0	0	0	0	28.6	122.4	88.2	260.4	50.40	0	0

As per GEC-2015 norms, infiltration factor of 12% for sedimentary formations and 07% for metamorphic or hard rock formation and Specific yield value of 03% for sedimentary formations and 02% for metamorphic or hard rock formation has been considered (**Plate No-IV**).

Table No–23: Infiltration factor and Specific Yield.

Formations	Area (sq.km.)	Infiltration factor	Specific Yield	Norms
Sedimentary	93.57	12%	03%	As per GEC-2015
Metamorphic	502.83	07%	02%	

11.3 Draft components

The total groundwater extraction or draft composed of irrigation, community and industrial draft (due to coal mining activity) in the Khudia River micro-watershed area are calculated and described below:

Irrigation and Community draft: Based on the groundwater draft assessment for irrigation and community by CGWB (Dynamic Groundwater Resources of Jharkhand state, 2013) prepared for Govindpur Block, the irrigation draft for the proportional area of 390.06 sq.km. is estimated as *3.8119 MCM* and community draft as 8.1872 MCM. Out of which 25% is considered as irrigation return flow. i.e., actual irrigation draft is in the tune of **2.8589 MCM**. Around 25% of total community draft is actually consumed rest is discharged into natural system, i.e., actual domestic draft is around **2.0468 MCM**.

Industrial draft: There are total 13 nos. of Colliery/Mines of ECL and BCCL within micro-watershed area. Industry (coal mine) requires water for different activates like, dust suppression, HEMM washing, workshop, CHP, green belt development, fire-fighting, coal Washery etc. The peak industrial water demand is projected as 4713.50 cum/day. Thus the industrial draft from top aquifer (base flow abstraction) will be ***1.72 MCM.***

Table No–24: Industrial draft in terms of mine discharge (cum/day).

Cluster	Mine	Avg. Mine Pumping	Utilization	Excess	Effective draft*
Cluster-1 ECL	Chapapur-II, UG	2200	1600	600	800
	Badjna UG	1300	450	850	225
	Hariazam UG	2500	2350	150	1175
	Shampur'B' mixed	1080	700	380	350
	Khoodia UG	800	120	680	60
	Mandman UG	820	410	410	205
	Gopinathpur mixed	450	230	220	115
	Lakhimata UG	239	220	19	110
Cluster-2 ECL	Rajpura UG & OC	1500	615	885	307.50
	Barmuri OC	600	120	480	60
	Kumardhubi UG	2000	1200	800	600
Cluster-XVI BCCL	DB OCP	900	900	0	450
	Laikdih Deep UG	530	530	0	256
Total Industrial draft from top aquifer only					4713.50

*Effective draft = 50% of (Avg. mine pumping – excess water) is considered.

11.4 Base Flow calculation of Khudia River:

Rainfall runoff process is an important part of land phase of hydrological cycle. Runoff is defined as the portion of the precipitation flowing off from catchment through surface channels as surface or sub surface flow.

A stream hydrograph is the time-series record of stream conditions (such as water level or flow) at a gauging site. The hydrograph represents the aggregate of the different water sources that contribute to stream flow. These components can be subdivided into:

1. Storm flow – the direct response to a rainfall event including overland flow (runoff), lateral movement in the soil profile (interflow) and direct rainfall onto the stream surface (direct precipitation).
2. Base flow – the longer-term discharge derived from natural storages.

The relative contributions of storm flow and base flow components changes through the stream hydrographic record.

A. Data generation / Stream Gauging

Field survey was executed during 2019 and 2020 for data generation regarding river cross-section, river water level / velocity, groundwater level and mine pumping capacity etc. **The Maithon dam controls the discharge of the Barakar River and the Panchet dam controls the discharge of Damodar River, i.e., natural river flow system in those rivers are not existed in the study area.** However, Khudia river profiling and water level / velocity data was generated to calculate the river discharge.

Total three nos. of locations have been considered to assess the minimum River discharge at U/S, M/S and D/S of Khudia River (**Figure No-11**, 03 nos. location) based on the **Area-Velocity Method**. The wetted area of the river has been measured using meter tape and the water velocity at those sections has been assessed using floaters. Accordingly, the **lowest discharge / base flow** of Khudia River has been calculated.

Figure No-15A: Khudia River gauging stations U/S (Up Stream).

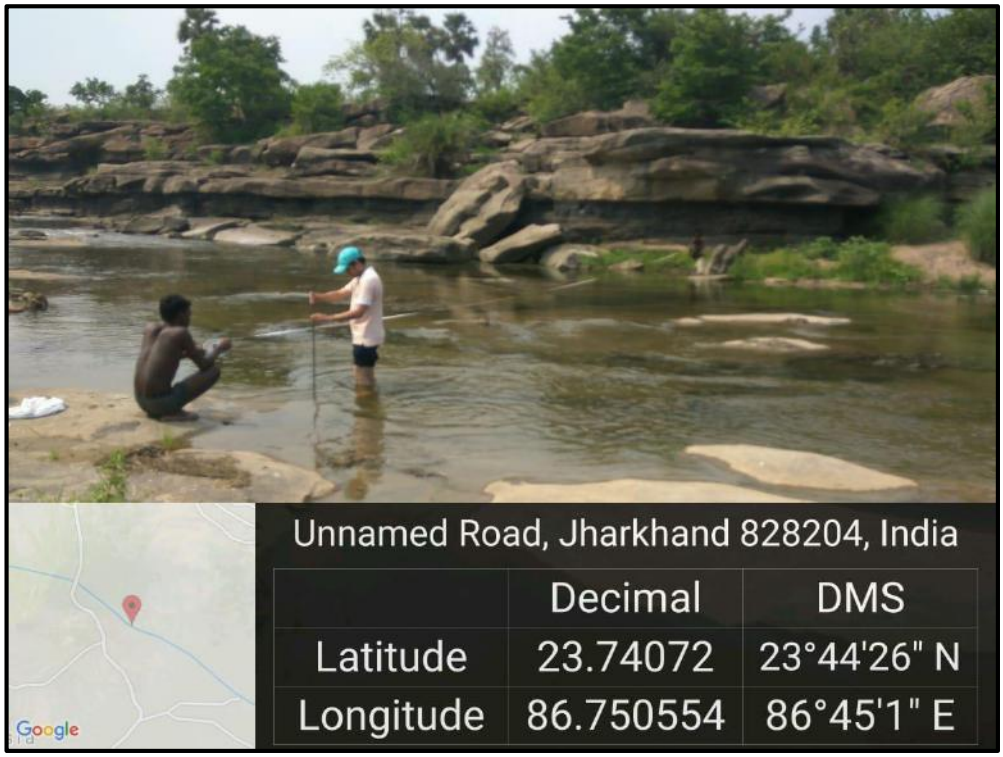


Figure No-15 (B): Khudia River gauging station M/S (Middle Stream).

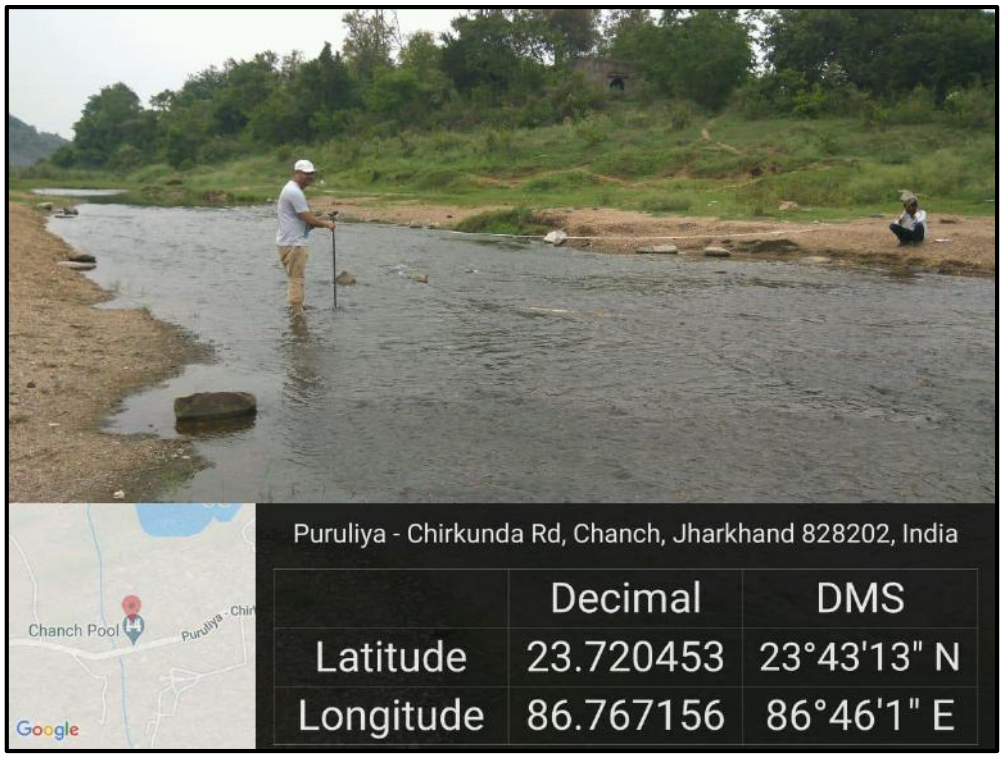


Figure No-15(C): Khudia River gauging stations D/S (Down Stream).

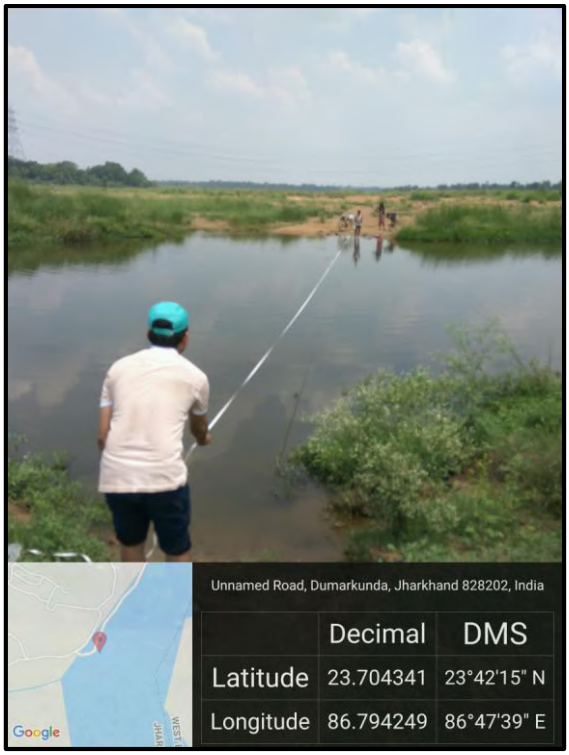
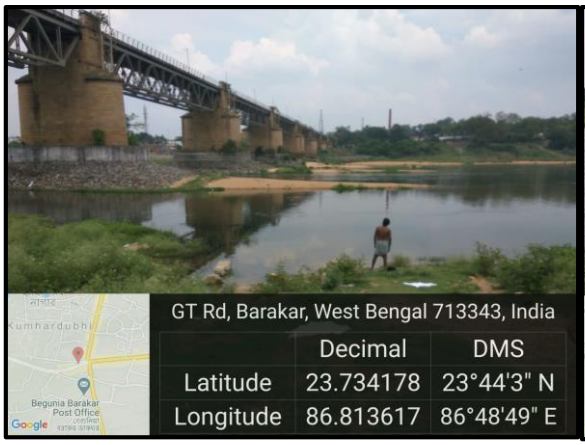


Figure No-16: Barakar River, Cluster-XVI Mines, BCCL.



Barakar River U/S location.

Barakar River D/S location

B. Khudia River Discharge / Base flow calculation

Khudia River is an un-notified and ungauged river in the study area. River gauging has been conducted to determine the base flow of the Khudia River in the desired locations. The locations of the stream gauging have been determined considering the coal mining activity in the area. The U/S location situated NW of the DB OCP where Khudia River starts flowing into the study area. M/S location situated in the middle of the Cluster-XVI mines separating OC and UG mining activity. D/S location situated near the confluence of the Khudia River and Damodar River, SE corner of the study area.

Table No–25: Estimation of River Base Flow using Area-Velocity method.

Item	River Bed width		River Bed Profiling intervals (in meters)									Floater Velocity (m/sec)	Water level (m)	Discharge (MCM/ Month)
	Active channel	Total river bed	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18		Min	Base Flow
U/S	14.0	25.0	0.3	0.05	0.3	0.48	0.3	0.3	0.3	-	-	0.30	0.23	2.503872
M/S	16.0	55.0	0.15	0.35	0.35	0.35	0.35	0.25	0.2	0.15	-	0.255	0.25	2.64384
D/S	18.0	70.0	0.3	0.45	0.5	0.5	0.5	0.45	0.2	0.15	0.3	0.16	0.37	2.762035

- Location details of the U/S, M/S and D/S has already been shown in geo-tag image of the field photos (**Figure No-11**).

The Base Flow calculation using Area-Velocity method is shown in **Table No-25**. Therefore, Khudia River base flow of 2.503872 MCM/month (34.287 Cusec) has been estimated before the river entering into Cluster-XVI mine area. 2.64384 MCM/month or 36.029 Cusec of river base flow is estimated in the M/S, i.e., after crossing the DB OCP and UG mining area. 2.762035 MCM/month or 37.866 Cusec of river base flow is estimated after crossing the Chanch UG and Laikdih Deep UG mine area. After that the Khudia River meets to Barakar River.

C. Water Budgeting of the Khudia River Micro-watershed

The water budget components (inputs and outputs) of the Khudia River Micro-watershed has been estimated using rainfall / evapotranspiration data, Land use / Land cover data, Geology / Hydrogeological units, aquifer hydraulic parameters, recharge component, draft components and base flow measurement data. The basic input parameters are summarized below:

Table No–26: Land use / Land Cover of Khudia River Micro-watershed

Sl. No.	Items / Parameters	Area (sq.km.)	% of total area
1	Watershed area	596.40	100%
2	Forest & Plantation	156.00	26.16%
3	Agriculture Land	390.06	65.40
4	Waste Land	10.40	1.74%
5	OC Mining area	5.34	0.90
6	Settlement area	27.90	4.68
7	River / Ponds	6.70	1.12

As per the land use / land cover map data, 91.56% of the total Micro-watershed area is covered by Forest, Plantation and agricultural activity. Around 93.57 sq.km is sedimentary formation and 502.83 sq.km. is metamorphics / hard rock formation. The area of Open cast mining activity is <1.0 % of the total Micro-watershed area. Considering the above mentioned land use pattern the total rainwater availability, Groundwater recharge, draft from all uses and predicted river discharge are estimated using mass balance of the Khudia River Micro-watershed area.

Table No–27: Water Budgeting of Khudia River Micro-watershed.

Yr. 2019	Area (sq.km.)		ERF (mm)	Total water availability (MCM)	GW Recharge (MCM)	Unit Draft (MCM)			Net GW Storage (MCM)	Estimated Surface Runoff (MCM)
	Sedimentary	Hard rock				Irrigation	Community	Industrial		
Jan	93.57	502.83	0.0	0.0	0.271595025	0.4084	0.1707	0.1965	-0.504005	--
Feb	93.57	502.83	0.0	0.0	0.4178385	0.4084	0.1707	0.1965	-0.3577615	--
Mar	93.57	502.83	0.0	0.0	0.0	0.4084	0.1707	0.1965	-0.7756	--
Apr	93.57	502.83	0.0	0.0	1.692245925	0.4084	0.1707	0.1965	0.9166459	Base flow
May	93.57	502.83	0.0	0.0	1.817597475	0.4084	0.1707	0.1965	1.0419975	Base flow
Jun	93.57	502.83	28.6	17.05704	3.4262757	NIL	0.1707	0.0688	3.1867757	13.8702643
Jul	93.57	502.83	122.4	72.99936	7.34560083	NIL	0.1707	0.0688	7.1061008	65.89325917
Aug	93.57	502.83	88.2	52.60248	5.91659316	NIL	0.1707	0.0688	5.6770932	46.92538684
Sep	93.57	502.83	260.4	155.3025	13.11177213	NIL	0.1707	0.0688	12.872272	142.4302879
Oct	93.57	502.83	50.4	30.05856	5.7661713	NIL	0.1707	0.0688	5.5266713	24.5318887
Nov	93.57	502.83	0.0	0.0	0.0	0.4084	0.1707	0.1965	-0.7756	--
Dec	93.57	502.83	0.0	0.0	0.4178385	0.4084	0.1707	0.1965	-0.3577615	--

Figure No-17: Khudia River Micro-watershed Strom Flow Vs Base Flow.

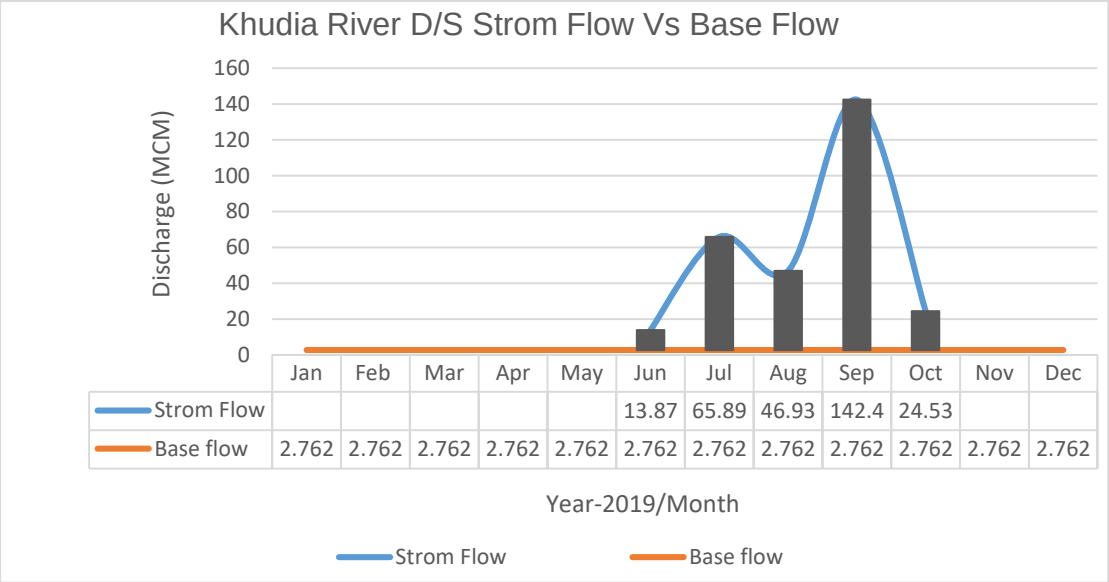


Figure No-18: Base Flow comparisons at different stages of Khudia River.

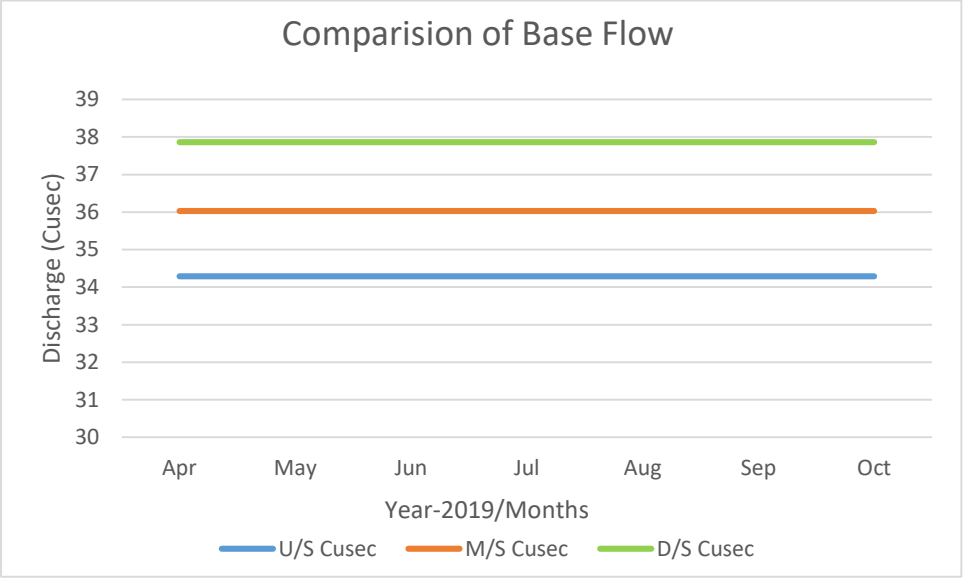


Table No–28: Base Flow comparisons at different stages of Khudia River.

Assessment Year-2019	U/S (Cusec)	M/S (Cusec)	Loss/Gain (%)	D/S (Cusec)	Loss/Gain (%)
Base Flow	34.30	36.029	(+) 5.04 %	37.866	(+) 5.10 %

The Khudia River base flow measurement and water budgeting of the micro-watershed analysis shown that, the **Khudia River base flow is not affected in the down-stream region due to mining activity**. The comparative U/S, M/S and D/S river Base flow diagram depicts that, around 5.0% gain in base flow in every stage instead of flowing within Coal mining areas. **Mine seepage is only 1.62% of the avg. Base flow of the Khudia River (36.0 Cusec).**

12.0 Water Quality data analysis

Water quality monitoring has been carried out in the study area by sampling of surface water, groundwater and mine effluent water. The water quality sampling stations is shown in **Plate No-XI**. There are 4 nos. of surface water quality monitoring stations in the upstream and downstream of Khudia river (SW-1 & SW-2) and Barakar river (SW-3 & SW-4), 02 nos. of groundwater quality monitoring stations at Dhaibari village (GW-1) & Patlabari village (GW-2) and 01 no. of mine effluent water quality monitoring station at Dahibari UG (MW-1). Therefore, total 07 nos. of monitoring stations with the objective to generate the baseline data on water quality (as per BIS standards of IS:2288-1982 Class-C) which can be used to predict the impact due to project on water regime.

With no processing activity involved, the mine water is free from any contamination. In underground mining operation, except for suspended solids, the mine water is free from any serious pollutants. As part of the present study, the surface water, ground water and mine water quality of Cluster-XVI mines of BCCL are analysed during 2018-19 and 2019-20 (**Env. Lab of CMPDI/RI-II/Dhanbad**) and the water quality reports are enclosed as **Annexure-V (A, B, and C)**.

12.1 Surface water quality

The water samples collected from the up-stream and down-stream on Khudia River and Barakar River within the Cluster-XVI area has been analyzed to find out if there is any contamination from mine discharge. The properties of surface water sample of Cluster-XVI area are shown in **Annexure-VA**.

It can be seen that the pH of the water is varies from 7.48 to **9.62** and slightly above the prescribed standard. Chloride concentrations of water collected from stream are varies from 12 mg/L to 44 mg/L respectively, which are well within

the prescribed standard (600 mg/L). Heavy metal analysis of surface water body demonstrates that the elements such as lead, zinc, copper, iron and chromium are below detection limit.

Dissolved oxygen is found exceed (3.60 mg/L and 8.10 mg/L) the prescribed limits (4 mg/L). BOD concentration (2.80 mg/L) it is within the prescribed limit. The TDS concentration of surface water is maximum upto 716 mg/L are well within the limit (1500 mg/L). Several other parameters such as, nitrate, sulphate, fluoride are also well within the prescribed standards.

The analysis of the water quality in comparison with the standards indicates that the surface water body, i.e., Khudia river and Barakar river fit for its designated use. Dissolved oxygen is in healthy concentration for sustaining the aquatic life.

12.2 Groundwater quality

To assess the status of groundwater water quality of Cluster-XVI area, water sample from dug well of Dahibari village (GW-1) and Patlabari village (GW-2) are collected and analyzed for various water quality parameters. The properties of ground water sample of Cluster-XVI area are shown in **Annexure-VB**.

It can be seen that the pH of the drinking water collected from the location is 7.14 to 8.20 and it is well within the prescribed standards. Turbidity of the water sample is 1 - 4 (NTU) and it is within the prescribed limit (5 NTU). Total hardness of drinking water found to be 118 - 584 mg/L, just above the standard limit (300 mg/L). Though the calcium concentration (34 - 115 mg/L) is just above the limit (75 mg/L).

The TDS concentration in drinking water found 344 to 802 mg/L which is in the permissible drinking water standard. The other parameters such as chloride, fluoride, nitrate, sulphate are well within the permissible drinking water

standards. The heavy metal analysis of the drinking water sample indicates that all heavy metals, i.e., Iron, arsenic, copper, lead, mercury, chromium, manganese, boron are well within the detection limit.

12.3 Mine effluent water quality

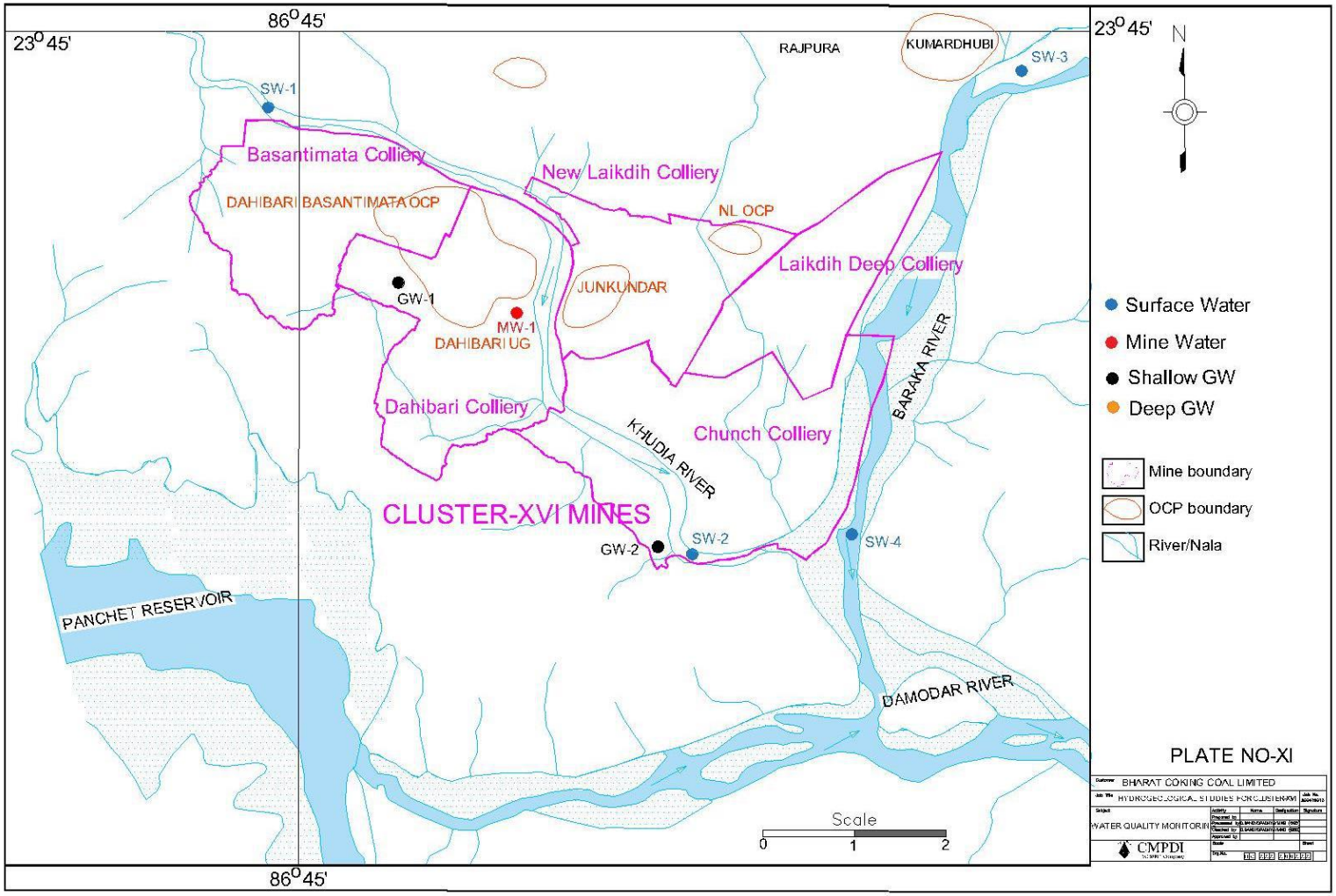
Mine water from Dahibari UG mine (MW-1) of Cluster-XVI has been analyzed during 2018-19 and 2019-20 to assess mine effluent water quality. The properties of ground water sample of Cluster-XVI area are shown in **Annexure-VC**.

It can be seen that the pH of the mine water varies from 7.95 to 8.03 which is within the permissible range. The TSS concentration in mine water is 28 mg/l to 40 mg/l well within the standard limits (100 mg/l). The B.O.D (<2.0 mg/L) and C.O.D (40 - 56 mg/L) is also found within the permissible limit.

Fluoride and phenolic compounds are in concentration of 0.17 to 0.48 mg/L and <0.002 mg/L respectively, which is much below the permissible standards.

Heavy metal analysis of drinking water samples indicates that all heavy metals. i.e., Iron, lead, mercury, selenium, zinc, nickel, arsenic, chromium, manganese etc. are well below the detection limit.

LOCATION MAP OF WATER QUALITY MONITORING STATION



13.0 Observations

The observations of this hydrogeological study are summarized below-

i. The study area is located at the western part of the Raniganj Coalfield in Chanch-Victoria Area of BCCL. Various types of rock belong to Quaternary age (top soil, alluvium, sandy soil), Gondwana age (Barakar Formation, Barren Measure Formation, Talchir Formation) and Archean metamorphic basement has been found in the Cluster-XVI and Khudia River Micro-watershed area.

ii. The study area is located in the discharge zone of Khudia River, Barakar River watershed. It is part of middle stage Damodar River Sub-basin. The area is also potential in terms of groundwater and surface water resources (Maithon dam on Barakar River and Panchet dam on Damodar River) with fair to moderate rainfall received throughout the year.

iii. There are various aquifer systems found in the area, i.e., unconfined aquifers (top alluvium, soil and river bed loose sand), semi-confined aquifers (Barakar Formation sandstones) and confined aquifers (Archean Metamorphic rocks). Those semi-confined aquifers can be called **multi-aquifer system**.

iv. At present New Laikdih, Laikdih Deep, Chanch and Dahibari-Basantimata UG Collieries are closed for coal production. Only operating coal mine in the Cluster is Dahibari-Basantimata OCP. Mine water pumping is being done from Dahibari-Basantimata OCP (industrial use of the mine) and Laikdih Deep Colliery (domestic water supply). In addition to that, intake well at Barakar River bed, Sundar Nagar/ Laikdih Deep Colliery (drinking water supply) is also operative in the area.

v. Groundwater level monitoring of the 17 nos. of Dug wells (unconfined aquifer), 01 no. of Piezometer (Barakar Formation/Semi-confined aquifer) and 02 nos. of bore wells (Semi-confined and confined aquifer) has been conducted in the study area.

vi. There is no suitable location found within the Cluster-XVI mines area to construct additional well/piezometer above/adjacent to the old UG workings

due to decade old abandoned UG mining activity, water logged goafs, subsided areas and paucity of BCCL land etc.

vii. The Groundwater level and fluctuations (upto 2019-20) are given below:

   a. Unconfined aquifer: 0.35 m to 12.10 m (BGL) [Dug wells]

   b. Semi-confined aquifer: 18.55 m to 21.10 m (BGL) [Piezometer]

   c. Confined aquifer: 4.10 m to 13.10 m (BGL) [Borehole]

   The historical groundwater level trends of the monitoring stations are showing upward in both pre and post-monsoon season (except well no DB-22 at Dahibari village near to DB OCP).

viii. The Water Table Contour map of both pre and post-monsoon during 2019 shows shallow water table with flow of groundwater towards major drainage system, i.e., Barakar River and Damodar River in the area. **A water divide in between Khudia River and Damodar River has been observed**.

ix. **Aquifer Performance Test (APT)** results of the Piezometric well (near to Barakar River) in Barakar Formation shows low permeability (K= 0.441 m/day and T= 23.40 m^2/day) of the semi-confined to confined aquifer in the study area. Aquifer property of the unconfined shows moderate permeability (K=1.22 m/day).

x. **Groundwater Resource Estimation using GEC-2015 Methodology** shows **Stage of Groundwater Extraction is 38.21%** with groundwater level trend analysis during pre-monsoon is (-) 17.27 cm/year and post-monsoon is (-) 13.35 cm/year in the Cluster-XVI mine area, which is acceptable (Validation).

xi. **Khudia River base flow** of 34.287 Cusec has been estimated before the river entering into Cluster-XVI mine area. 36.029 Cusec of river base flow is estimated in the M/S, i.e., after crossing the DB OCP and UG mining area. 37.866 Cusec of river base flow is estimated after crossing the Chanch UG and Laikdih Deep UG mine area. After that the Khudia River meets to Barakar River.

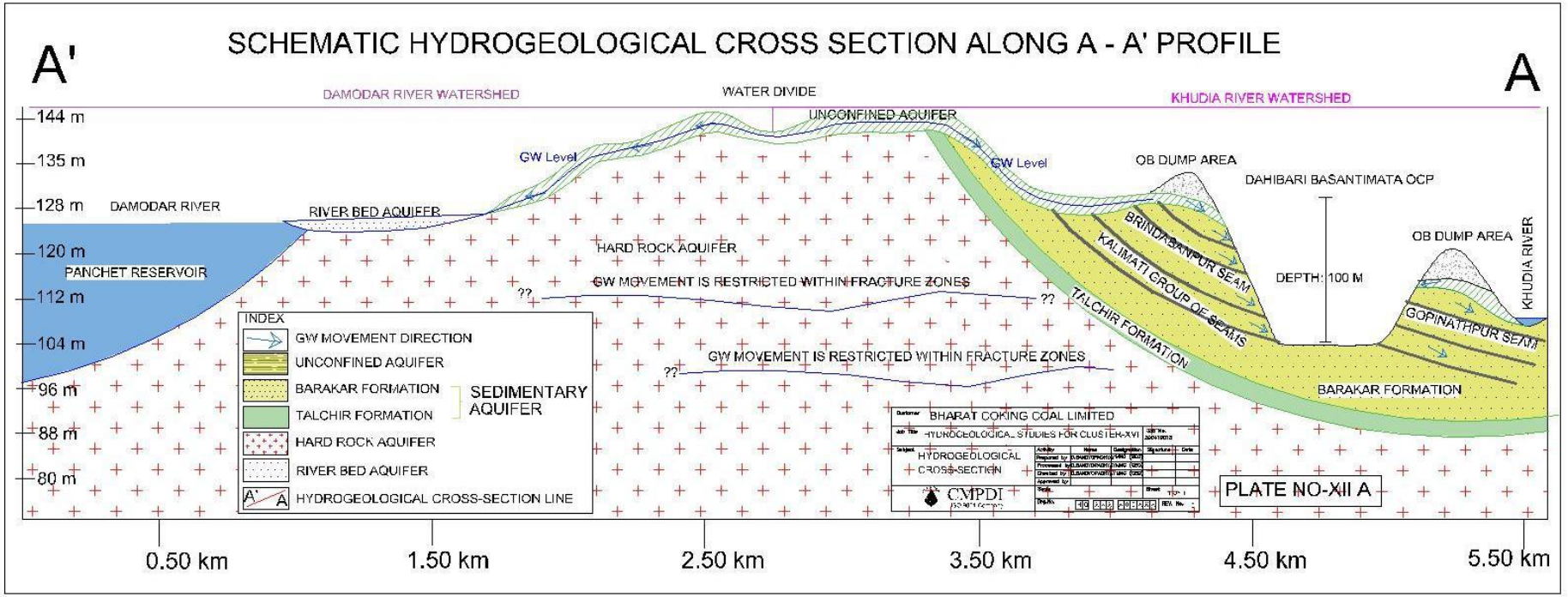
xii. **Water Budgeting of the Khudia River Micro-Watershed** using Mass balance equation gives the Maximum (Strom flow), Minimum and average discharge during monsoon season at U/S, M/S and D/S.

Assessment Year-2019		Strom Flow D/S (MCM/Month)	Base Flow (MCM/month)
Discharge	**Max.**	142.4302879	2.762035
	Min.	13.8702643	2.503872
	Avg.	58.73021738	2.6329535

xiii. Surface water, groundwater and mine water quality data analysis revels that the quality is accepted as per BIS standards and the groundwater quality is portable.

xiv. In the A-A' cross-section line it is evident that, there may be no connection in between Damodar River/Panchet dam and DB OCP mine pit through shallow or deep aquifers. Damodar River flowing within hard rock area whereas the coal mining activity is within sedimentary basin. Therefore, the Damodar River and DB OCP mine pit are belongs to different hydraulic and groundwater regime where movement of water within each other is barely possible (**Plate No – XII A)**. However, there is a possibility of connection of Khudia River and DB OCP mine pit due to reversal of groundwater gradient as an impact of mining activity through deeper aquifers (sedimentary Formation).

xv. In the B-B' cross-section line it is evident that there may be connection in between Barkar River, OC mine pit of Dahibari-Basantimata Colliery and abandoned UG mine voids of Chanch Colliery, New Laikdih Colliery, Laikdih Deep Colliery through shallow or deep aquifers. The Barakar River and Coal mines are part of a same sedimentary basin but the Barakar River is flowing within Barren Measure Formation and the coal mining activity is in Barakar Formation. Therefore, the Barakar River and both OC & UG coal mining activities are belonging to different hydraulic and groundwater regime where movement of water within each other is barely possible (**Plate No – XII B)**. Connections if any, may be concluded using R.L. of aquifer wise groundwater level and river water level. However, there is a possibility of connection of Khudia River and DB OCP mine pit due to reversal of groundwater gradient as an impact of mining activity through deeper aquifers (sedimentary Formation).


A'
SCHEMATIC HYDROGEOLOGICAL CROSS SECTION ALONG A - A' PROFILE
A
DAMODAR RIVER WATERSHED
WATER DIVIDE
KHUDIA RIVER WATERSHED
144 m
135 m
128 m
120 m
112 m
104 m
96 m
88 m
80 m
DAMODAR RIVER
PANCHET RESERVOIR
RIVER BED AQUIFER
GW Level
UNCONFINED AQUIFER
GW Level
OB DUMP AREA
DAHIBARI BASANTIMATA OCP
BRINDABANPUR SEAM
KALIMATI GROUP OF SEAMS
TALCHIR FORMATION
DEPTH: 100 M
OB DUMP AREA
KHUDIA RIVER
GOPINATHPUR SEAM
BARAKAR FORMATION
HARD ROCK AQUIFER
GW MOVEMENT IS RESTRICTED WITHIN FRACTURE ZONES
??
??
GW MOVEMENT IS RESTRICTED WITHIN FRACTURE ZONES
??
INDEX
GW MOVEMENT DIRECTION
UNCONFINED AQUIFER
BARAKAR FORMATION
TALCHIR FORMATION
SEDIMENTARY AQUIFER
HARD ROCK AQUIFER
RIVER BED AQUIFER
A' A
HYDROGEOLOGICAL CROSS-SECTION LINE
BHARAT COKING COAL LIMITED
HYDROGEOLOGICAL CROSS-SECTION
CMPDI
PLATE NO-XII A
0.50 km
1.50 km
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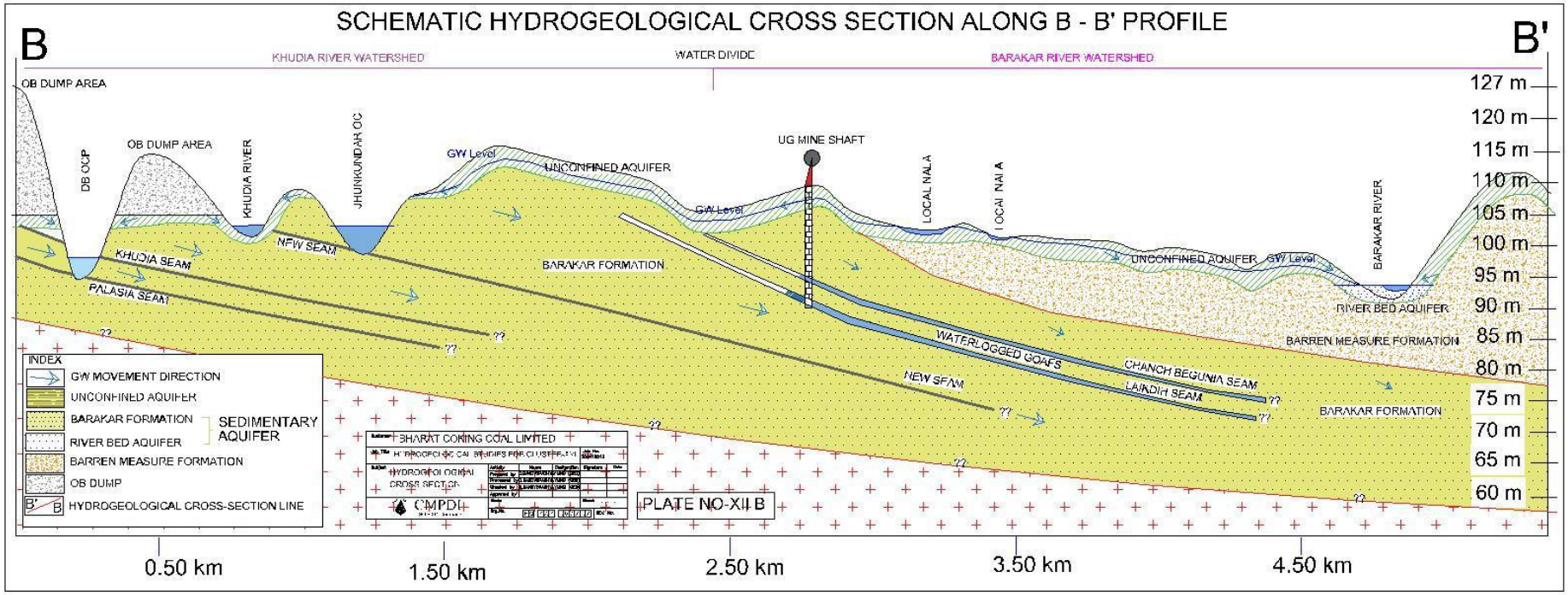
3.50 km
4.50 km
5.50 km


SCHEMATIC HYDROGEOLOGICAL CROSS SECTION ALONG B - B' PROFILE
B
B'
KHUDIA RIVER WATERSHED
WATER DIVIDE
BARAKAR RIVER WATERSHED
OB DUMP AREA
DB OCP
OB DUMP AREA
KHUDIA RIVER
JHURKUNDAH OC
GW Level
UNCONFINED AQUIFER
UG MINE SHAFT
LOCAL NALA
LOCAL NALA
BARAKAR RIVER
GW Level
UNCONFINED AQUIFER
GW Level
KHUDIA SEAM
NEW SEAM
PALASIA SEAM
BARAKAR FORMATION
WATERLOGGED GOAFS
CHANCH BEGUNIA SEAM
LAIKDIH SEAM
NEW SEAM
RIVER BED AQUIFER
BARREN MEASURE FORMATION
BARAKAR FORMATION
127 m
120 m
115 m
110 m
105 m
100 m
95 m
90 m
85 m
80 m
75 m
70 m
65 m
60 m
INDEX
GW MOVEMENT DIRECTION
UNCONFINED AQUIFER
BARAKAR FORMATION
RIVER BED AQUIFER
SEDIMENTARY AQUIFER
BARREN MEASURE FORMATION
OB DUMP
HYDROGEOLOGICAL CROSS-SECTION LINE
B' B
BHARAT COKING COAL LIMITED
HYDROGEOLOGICAL CROSS SECTION
CMPDI
PLATE NO-XII B
0.50 km
1.50 km
2.50 km
3.50 km
4.50 km

14.0 Summary and Conclusions

The objective of the study is to monitoring of wells (dug well / bore well / Piezometer) for permeability and seepage of water from River (Damodar River, Barakar River and Khudia River / adjacent aquifers) into coal mine voids/pits of Cluster-XVI mines, BCCL.

Long term historical groundwater level trends (2008-2019) of the monitoring stations within the Cluster-XVI mines area showing that, both pre and post-monsoon water level trends are increasing at a rate of 17.27 cm/yr. and 13.35 cm/yr. **The study area in located in Salanpur Block of West Bengal State which is marked as a "Safe" as per CGWB-2017 assessment**. Therefore, it may be concluding that there is no impact on local groundwater level in the study area. However, DB-22 located adjacent to the DB OCP showing down ward water level trends in both pre and post-monsoon season may be due to impact of Radius of Mine Influence zone.

The permeability & seepage (Hydraulic property) from the aquifers has been determined using Aquifer Pump test in and around the study area.

Hydraulic properties of the sedimentary aquifer (Barakar formation)

Permeability (k):	0.441 m/d
Transmissivity:	23.40 m^2 /day

Hydraulic properties of the unconfined aquifer

Permeability (k):	0.0006 – 1.22 m/d
Transmissivity:	0.10 – 8.06 m^2 /day

In the A-A' cross-section line (**Plate No – XII A)** it is evident that, there is no connection in between Damodar River/Panchet dam and DB OCP mine pit through shallow or deep aquifers. Damodar River flowing within hard rock area whereas the coal mining activity is within sedimentary basin. Therefore, the Damodar River and DB OCP mine pit are belongs to different hydraulic and groundwater regime where movement of water within each other is barely

possible. However, there is a possibility of connection of Khudia River and DB OCP mine pit due to reversal of groundwater table gradient (**Plate No – VIII A & B)** as an impact of mining activity, i.e., within Radius of Mine Influence zone.

In the B-B' cross-section line (**Plate No – XII B)** it is evident that there may be connection in between Barkar River, OC mine pit of Dahibari-Basantimata Colliery and abandoned UG mine voids of Chanch Colliery, New Laikdih Colliery, Laikdih Deep Colliery through shallow or deep aquifers. The Barakar River and Coal mines are part of a same sedimentary basin. However, the Barakar River is flowing within Barren Measure Formation and the coal mining activity is in Barakar Formation. However, there is also a possibility of connection of Khudia River and abandoned UG mine voids through interconnected shallow and deep aquifers in the region. ***Connections if any, may be concluded using Stable isotope / Major ion chemistry of major geochemical facies in the study area.***

Therefore, the Damodar River and both OC & UG coal mining activities are belonging to different hydraulic and groundwater regime where movement of water is barely possible. However, there is a possibility of connection in between Barakar River, Khudia River and mining activity in the study area.

The Khudia River base flow measurement in the mining area and water budgeting of the micro-watershed analysis shown that, the **Khudia River base flow is not affected in the down-stream region**, the comparative river Base flow diagram (Fig No-18). Around 5.0% gain in base flow in every stage instead of flowing within Coal mining areas and **mine seepage is only 1.62% of the avg. Base flow of the Khudia River (36.0 Cusec).**

Assessment Year-2019	U/S (Cusec)	M/S (Cusec)	Loss/Gain (%)	D/S (Cusec)	Loss/Gain (%)
Base Flow	34.30	36.029	(+) 5.04 %	37.866	(+) 5.10 %

Therefore, in the conclusion of the study, it is evident that the-

- Damodar River is a part of different water regime than the Cluster-XVI mine area of BCCL.
- The mine seepage 1430 cum/day is connected with unconfined aquifer and exposed portion of the semi-confined aquifers of Barakar sandstone in the study area. These aquifers are also contributing to the Khudia River and Barakar River Base flow. The cumulative potential of these two aquifers is enough to sustain the withdrawal quantity in terms of mine seepage.
- The Stage of Groundwater Extraction, historical groundwater level trends and river base flow estimation also support the fact of potential aquifer in the study area.
- The mine seepage quantity is very negligible in terms of the base flow quantity of Khudia River or Barakar River or Damodar River system in the study area. Hence, it may be concluding that, ***there is no impact on Khudia River, Barakar River and Damodar River permeability and seepage in Cluster-XVI mines area in terms of quantity and quality***.

15.0 Recommendations

To establish the connection and source of mine seepage water in Cluster-XVI mines of BCCL with river system, stable isotope systematics coupled with hydro-geochemical assessment will be very useful. Stable isotopes ($\delta^{18}O$ and $\delta^{2}H$) with conventional hydro-geochemical parameters (Cations: calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), potassium (K^{+}) and Anions: chlorine (Cl^{-}), nitrate (NO_3^{-}), sulphate (SO_4^{2-}), carbonate (CO_3^{2-}) bicarbonate (HCO_3^{-}), fluorine (F^{-}) analysis of groundwater, surface water and rainwater will help to conclude the study more scientifically.

Potential Evapotranspiration rates

Station: Ranchi, Jharkhand.

Location: latitude $23^0$17'00" N and longitudes $85^0$19'00" E.

Seasons wise PET rates	Evaluation Methods/Equations								
	FAO	Open Pan	Penman	Hargr-eaves	Turc	Thornth-waite	Baney-Criddle	Christian-sen Pan	PET Open pan
Mean Daily	3.85	5.43	3.99	4.40	11.96	9.42	6.14	4.05	3.75
Southwest Monsoon	3.86	4.86	4.66	4.39	12.79	11.13	10.89	4.09	3.55
Northeast Monsoon	1.78	2.16	2.15	2.95	10.88	8.30	3.44	1.80	1.64
Summer season	5.56	8.70	5.29	6.11	12.77	10.93	5.01	5.81	5.61
Winter season	2.92	4.24	2.84	3.45	10.46	6.08	3.10	3.09	2.95
Mean Bias Error (MBE) *	--	1.67	0.32	1.04	8.42	5.66	3.94	0.79	0.35
Root Mean Square Error (RMSE) *	--	2.09	0.40	1.25	8.46	5.79	6.13	1.29	1.00

Daily Evapotranspiration rates in mm. * Errors on Annual Basis.

Reference: Potential Evapotranspiration estimation for India condition, Central Research Institute for Dryland Agriculture, Hyderabad.

Groundwater Monitoring Well Field Inventory

Well No.	Location	Formation	Owner	Use	M.P (m)	Depth (m)	Dia. (m)	R.L AMSL
Dug Well								
DB-1	Laikadih	Barakar	BCCL	Domestic	1.00	14.96	2.55	107.0
DB-2	Sulibari	Barakar	Govt	Domestic	0.73	21.20	1.80	121.0
DB-2A	Sulibari	Barakar	Govt	Domestic	0.60	13.88	1.80	121.0
DB-7	Hatinal	Raniganj	R.Mandol	Domestic	0.75	10.30	1.75	103.0
DB-8	Chungei	BM	Govt	Domestic	0.73	6.45	1.80	107.0
DB-9	Barakar	Barakar	Govt	Domestic	0.42	9.63	1.80	112.0
DB-18	Taldanga	Barakar	Govt	Domestic	0.65	16.30	3.00	
DB-19	Luchibad	Barakar	DVC	Domestic	0.70	9.80	4.00	120.0
DB-20	Napura	Alluvium	Govt	Domestic	0.40	7.10	3.00	121.0
DB-21	Panchet	Metamorphic	Govt	Domestic	0.25	8.95	1.50	125.0
DB-22	Dahibari	Barakar	Govt	Domestic	0.67	10.65	2.40	121.0
DB-23	Substation	Barakar	BCCL	Domestic	0.70	8.00	2.30	123.0
DB-24	Dahibari	Barakar	BCCL	Domestic	0.60	13.70	3.60	127.0
DB-25	Palasya	Barakar	Govt	Domestic	0.37	5.25	1.55	125.0
DB-26	Patlabari	Metamorphic	Govt	Domestic	0.60	11.00	3.10	145.0
DB-27	Ledaharia	Metamorphic	Govt	Domestic	0.60	8.84	1.20	154.0
DB-32	Bhalsudha	Barakar	Govt	Domestic	0.65	6.77	1.80	121.0
DB-47	Mugma	Barakar	Govt	Domestic	0.68	19.25	3.00	123.0
Piezometer								
PZ-2/MG/KP-01	Kumardubi	Barakar	ECL	Piezometer	0.50	102.0	0.15	125.0
PZ-16A	DB OCP Workshop	Barakar	BCCL	Piezometer	Proposed			
Borehole								
BH-01	Chanch	Barakar	Private	Domestic	0.35	45.0	0.15	118.0
BH-02	Patlabari	Metamorphic	Private	Domestic	0.30	75.0	0.15	135.0

M.P-measuring point, R.L-Relative level, Dia-Diameter of well. All values in meters.

Water level data of the Boreholes.

Bore hole	Year	GW level in Borehole (BGL in meters)				Fluctuation
		Jan	May	Aug	Nov	Avg.
BH-01	2018	12.65	15.15	11.10	12.25	4.05
	2019	13.75	15.25	11.21	13.50	4.04
	2020	13.55	16.05	-	-	-
BH-02	2018	18.72	20.40	16.15	18.22	4.25
	2019	18.75	19.54	16.00	18.03	3.54
	2020	17.43	20.10	-	-	-

Historical Groundwater level data.

WELL NO.		Water level Below Ground Level (in meters)										
	YR.	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
DB-1	May	6.15	7.05	8.20	6.60	7.62	8.00	8.40	3.17	3.50	3.5	3.85
	Nov	4.75	7.06	4.00	5.00	4.84	3.38	3.08	2.70	2.80	3.2	3.3
DB-2	May	18.07	4.46	-	-	-	-	-	2.97	2.82	1.87	4.77
	Nov	3.24	2.42	-	-	-	-	-	1.67	3.37	3.77	3.27
DB-2A	May	11.55	8.51	3.50	6.15	3.55	5.41	5.08	-	-	5.20	5.40
	Nov	3.47	2.54	3.00	3.29	2.42	1.97	2.57	0.82	2.12	1.92	0.97
DB-7	May	4.35	5.29	9.25	5.85	7.03	5.73	7.26	1.60	3.28	4.10	4.25
	Nov	2.05	8.17	4.17	2.27	5.45	6.27	4.37	2.45	1.80	3.60	4.55
DB-8	May	3.62	4.28	3.97	-	4.53	5.27	4.53	1.77	3.37	3.37	3.47
	Nov	1.57	3.00	2.12	2.52	3.27	2.74	3.29	1.22	1.33	2.09	2.27
DB-9	May	4.05	4.78	2.18	1.88	2.93	2.13	2.58	2.91	1.58	1.58	1.68
	Nov	0.93	0.93	0.95	0.98	1.08	1.13	2.13	1.58	1.58	0.68	0.58
DB-18	May	13.58	12.25	-	-	-	-	-	1.85	1.85	3.75	3.85
	Nov	13.22	11.20	-	-	7.03	5.40	-	1.45	1.55	1.33	1.40
DB-19	May	5.22	5.16	6.25	4.75	4.80	6.33	5.48	5.40	4.80	4.25	4.60
	Nov	3.25	4.34	3.30	3.34	3.30	3.62	4.07	3.20	3.45	3.3	3.25
DB-20	May	6.38	6.70	6.20	6.20	6.45	5.33	5.60	5.65	3.80	3.45	3.60
	Nov	3.25	5.41	2.90	2.80	1.94	3.60	3.24	2.10	4.00	-	-
DB-21	May	8.05	3.45	4.76	8.50	8.45	6.33	6.81	5.31	1.75	5.6	5.75
	Nov	5.35	7.85	0.30	6.25	4.05	5.35	6.55	7.53	5.25	0.35	0.35
DB-22	May	9.83	2.79	2.90	2.43	8.18	6.48	4.59	9.73	1.93	4.28	4.93
	Nov	3.23	2.11	2.23	2.38	2.64	3.03	3.53	3.33	1.63	1.93	1.63
DB-23	May	4.47	1.50	3.25	2.90	5.05	3.95	3.38	5.50	2.05	1.8	1.60
	Nov	2.15	2.10	2.70	2.33	3.10	2.13	6.04	0.90	1.90	1.25	0.80
DB-24	May	9.05	8.25	-	-	-	-	9.52	8.90	5.80	8.3	9.35
	Nov	4.30	8.98	-	4.62	8.25	8.45	8.20	6.50	3.78	1.4	0.88
DB-25	May	4.65	4.09	4.03	3.96	1.33	3.27	3.83	3.08	3.23	2.03	2.23
	Nov	2.83	2.99	2.13	1.18	2.53	2.73	2.68	1.98	2.58	-	-
DB-26	May	8.20	8.32	10.10	7.00	7.70	5.94	6.42	8.44	6.90	6.6	6.90
	Nov	3.77	7.37	4.00	4.10	4.10	4.90	4.32	2.83	3.82	4.16	3.90
DB-27	May	7.10	7.30	8.20	6.50	6.30	6.89	7.24	12.10	6.35	7.3	7.90
	Nov	3.42	6.35	3.10	3.45	2.96	3.80	3.18	2.25	2.68	3.02	2.70
DB-32	May	2.90	3.41	3.25	3.10	2.45	3.37	2.92	2.27	1.95	4.85	4.95
	Nov	1.40	2.47	3.35	1.45	1.35	1.65	2.90	1.35	1.35	2.2	2.35
DB-47	May	17.62	17.92	8.16	-	3.00	5.07	8.77	8.12	5.12	8.32	8.42
	Nov	3.02	15.17	7.72	3.32	2.58	2.28	5.76	2.62	2.97	2.98	3.12

Water level data of the Piezometer (2/MG/KP-01).

Year	Piezometric Head (BGL in meters)				Fluctuation
	Jan	May	Sept	Nov	Avg.
2018	-	-	18.55	19.15	0.60 m
2019	19.35	19.70	19.57	19.68	0.13 m
2020	19.75	20.10	-	-	0.35 m

Aquifer Pumping Test Data (Recovery Period) (On date 25.07.2018)

Location	**Barmuri Manager office, Mugma Area, ECL ,Dhanbad, Jharkhand**		**Project**	**Kumardhubi Colliery, ECL**	
Well No	2/MG/KP-01		**Pumped well discharge**	1.0 lps (2.125 inch)	
Pre-test water level (BGL)	19.3		**MP (m)**	0.7	
Pre-test water level (MP)	20		**Pumping started at**	1.06 pm	
water level measurement	AWL Sounder		**Depth of bore hole (m)**	102	
Aquifer tapped	Seam B-V & Seam B-III (T3)		**Aquifer Thickness (m)**	53	
Pumping stopped at	3.15 pm		**Duration of pumping (min)**	129	

S. No	Time since pumping stopped (t') (min)	Time since pumping started (t) (min)	t/t'	Water level measured (m)	Residual drawdown
1	0.5	129.5	259	32.5	12.5
2	1	130	130	29.6	9.6
3	1.5	130.5	87	27.6	7.6
4	2	131	65.5	25.7	5.7
5	2.5	131.5	52.6	24.45	4.45
6	3	132	44	23.45	3.45
7	3.5	132.5	37.85714286	22.6	2.6
8	4	133	33.25	22.07	2.07
9	4.5	133.5	29.66666667	21.65	1.65
10	5	134	26.8	21.35	1.35
11	5.5	134.5	24.45454545	21.23	1.23
12	6	135	22.5	21.13	1.13
13	6.5	135.5	20.84615385	21.06	1.06
14	7	136	19.42857143	20.96	0.96
15	7.5	136.5	18.2	20.93	0.93
16	8	137	17.125	20.9	0.9
17	8.5	137.5	16.17647059	20.89	0.89
18	9	138	15.33333333	20.86	0.86
19	9.5	138.5	14.57894737	20.8	0.8

S. No	Time since pumping stopped (t') (min)	Time since pumping started (t) (min)	t/t'	Water level measured (m)	Residual drawdown
20	10	139	13.9	20.8	0.8
21	11	140	12.72727273	20.78	0.78
22	12	141	11.75	20.77	0.77
23	13	142	10.92307692	20.76	0.76
24	14	143	10.21428571	20.755	0.755
25	15	144	9.6	20.755	0.755
26	16	145	9.0625	20.74	0.74
27	17	146	8.588235294	20.735	0.735
28	18	147	8.166666667	20.73	0.73
29	19	148	7.789473684	20.73	0.73
30	20	149	7.45	20.725	0.725
31	22	151	6.863636364	20.72	0.72
32	24	153	6.375	20.71	0.71
33	26	155	5.961538462	20.71	0.71
34	28	157	5.607142857	20.705	0.705
35	30	159	5.3	20.7	0.7
36	35	164	4.685714286	20.68	0.68
37	40	169	4.225	20.66	0.66
38	45	174	3.866666667	20.65	0.65
39	50	179	3.58	20.63	0.63
40	55	184	3.345454545	20.62	0.62
41	60	189	3.15	20.61	0.61
42	65	194	2.984615385	20.615	0.615
43	70	199	2.842857143	20.6	0.6
44	75	204	2.72	20.6	0.6

Groundwater Level Trend analysis - Validation of SoGWE

As per GEC-2015 Methodology

DB-01							
Sr. no	**GW year**	**Year (x.i)**	**Pre (y.i)**	**post (y.i)**	**$(x.i)^2$**	**Pre (x.i * y.i)**	**Post (x.i * y.i)**
1	2008	1	6.15	4.75	1	6.15	4.75
2	2010	2	7.05	7.06	4	14.1	14.12
3	2011	3	8.2	4	9	24.6	12
4	2012	4	6.6	5	16	26.4	20
5	2013	5	7.62	4.84	25	38.1	24.2
6	2014	6	8	3.38	36	48	20.28
7	2015	7	8.4	3.08	49	58.8	21.56
8	2016	8	3.17	2.7	64	25.36	21.6
9	2017	9	3.5	2.8	81	31.5	25.2
10	2018	10	3.5	3.2	100	35	32
11	2019	11	3.85	3.3	121	42.35	36.3
	11	66	66.04	44.11	506	350.36	232.01
	N	S1	S2 Pre	S2 Post	S3	S4 Pre	S4 Post

3853.96	2552.11	4358.64	2911.26	5566	4356
N*S4 Pre	**N*S4 Post**	**S1 * S2 Pre**	**S1 * S2 Post**	**N * S3**	**$S1^2$**

GW Level Trend (a)	**Pre-monsoon**	(-) 0.41709	(-) 41.709	Cm/Year
	Post-monsoon	(-) 0.29682	(-) 29.682	Cm/Year

$$a = (N^*S_4 - S_1 \cdot S_2 / N^*S_3 - S_1^2) \times 100$$

Where

N = Number of pairs of data considered (Groundwater years)

S1 = Monitoring years (X_i)

S2 = Depth to water level below ground level in m during single season [Y_i]

S3 = X_i^2

S4 = $X_i * Y_i$

Groundwater Level Trend analysis - Validation of SoGWE

As per GEC-2015 Methodology

DB-19							
Sr. no	**GW year**	**Year (x.i)**	**Pre (y.i)**	**post (y.i)**	**$(x.i)^2$**	**Pre (x.i * y.i)**	**Post (x.i * y.i)**
1	2008	1	5.22	3.25	1	5.22	3.25
2	2010	2	5.16	4.34	4	10.32	8.68
3	2011	3	6.25	3.3	9	18.75	9.9
4	2012	4	4.75	3.34	16	19	13.36
5	2013	5	4.8	3.3	25	24	16.5
6	2014	6	6.33	3.62	36	37.98	21.72
7	2015	7	5.48	4.07	49	38.36	28.49
8	2016	8	5.4	3.2	64	43.2	25.6
9	2017	9	4.8	3.45	81	43.2	31.05
10	2018	10	4.25	3.3	100	42.5	33
11	2019	11	4.6	3.25	121	50.6	35.75
	11	66	57.04	38.42	506	333.13	227.3
	N	S1	S2 Pre	S2 Post	S3	S4 Pre	S4 Post

3664.43	2500.3	3764.64	2535.72	5566	4356
N*S4 Pre	**N*S4 Post**	**S1 * S2 Pre**	**S1 * S2 Post**	**N * S3**	**$S1^2$**

GW Level Trend (a)	**Pre-monsoon**	(-) 0.08282	(-) 8.282	Cm/Year
	Post-monsoon	(-) 0.02927	(-) 2.927	Cm/Year

$$a = (N^*S_4 - S_1 \cdot S_2 / N^*S_3 - S_1^2) \times 100$$

Where

N = Number of pairs of data considered (Groundwater years)

S1 = Monitoring years (X_i)

S2 = Depth to water level below ground level in m during single season [Y_i]

$S3 = X_i^2$

$S4 = X_i * Y_i$

Groundwater Level Trend analysis - Validation of SoGWE

As per GEC-2015 Methodology

DB-22							
Sr. no	**GW year**	**Year (x.i)**	**Pre (y.i)**	**post (y.i)**	**$(x.i)^2$**	**Pre (x.i * y.i)**	**Post (x.i * y.i)**
1	2008	1	9.83	3.23	1	9.83	3.23
2	2010	2	2.79	2.11	4	5.58	4.22
3	2011	3	2.9	2.23	9	8.7	6.69
4	2012	4	2.43	2.38	16	9.72	9.52
5	2013	5	8.18	2.64	25	40.9	13.2
6	2014	6	6.48	3.03	36	38.88	18.18
7	2015	7	4.59	3.53	49	32.13	24.71
8	2016	8	9.73	3.33	64	77.84	26.64
9	2017	9	1.93	1.63	81	17.37	14.67
10	2018	10	4.28	1.93	100	42.8	19.3
11	2019	11	4.93	1.63	121	54.23	17.93
	11	66	58.07	27.67	506	337.98	158.29
	N	**S1**	**S2 Pre**	**S2 Post**	**S3**	**S4 Pre**	**S4 Post**

3717.78	1741.19	3832.62	1826.22	5566	4356
N*S4 Pre	**N*S4 Post**	**S1 * S2 Pre**	**S1 * S2 Post**	**N * S3**	**$S1^2$**

GW Level Trend (a)	**Pre-monsoon**	(-) 0.09491	(-) 9.491	Cm/Year
	Post-monsoon	(-) 0.07027	(-) 7.027	Cm/Year

$$a = (N^*S_4 - S_1 \cdot S_2 / N^*S_3 - S_1^2) \times 100$$

Where

N = Number of pairs of data considered (Groundwater years)

S1 = Monitoring years (X_i)

S2 = Depth to water level below ground level in m during single season [Y_i]

S3 = X_i^2

S4 = $X_i * Y_i$

Groundwater Level Trend analysis - Validation of SoGWE

As per GEC-2015 Methodology

DB-23							
Sr. no	**GW year**	**Year (x.i)**	**Pre (y.i)**	**post (y.i)**	**$(x.i)^2$**	**Pre (x.i * y.i)**	**Post (x.i * y.i)**
1	2008	1	4.47	2.15	1	4.47	2.15
2	2010	2	1.5	2.1	4	3	4.2
3	2011	3	3.25	2.7	9	9.75	8.1
4	2012	4	2.9	2.33	16	11.6	9.32
5	2013	5	5.05	3.1	25	25.25	15.5
6	2014	6	3.95	2.13	36	23.7	12.78
7	2015	7	6.04	3.38	49	42.28	23.66
8	2016	8	5.5	0.9	64	44	7.2
9	2017	9	2.05	1.9	81	18.45	17.1
10	2018	10	1.8	1.25	100	18	12.5
11	2019	11	1.6	0.8	121	17.6	8.8
	11	66	38.11	22.74	506	218.1	121.31
	N	**S1**	**S2 Pre**	**S2 Post**	**S3**	**S4 Pre**	**S4 Post**

2399.1	1334.41	2515.26	1500.84	5566	4356
N*S4 Pre	**N*S4 Post**	**S1 * S2 Pre**	**S1 * S2 Post**	**N * S3**	**$S1^2$**

GW Level Trend (a)	**Pre-monsoon**	(-) 0.096	(-) 9.6	Cm/Year
	Post-monsoon	(-) 0.13755	(-) 13.755	Cm/Year

$$a = (N*S_4 - S_1*S_2 / N*S_3 - S_1^2) \times 100$$

Where

N = Number of pairs of data considered (Groundwater years)

S1 = Monitoring years (X_i)

S2 = Depth to water level below ground level in m during single season [Y_i]

$S3 = X_i^2$

$S4 = X_i * Y_i$

SURFACE WATER QUALITY — Annexure-VA

Name of the Company: Bharat Coking Coal ltd. Year: 2017-18
Name of the project: Cluster-XVI Mines Period: March'18

Sampling Stations:
1.Upstream of Khudia River SW-1 Date: NA
2.Downstream of Khudia River SW-2 Date: NA
3.Upstream of Barakar River SW-3 Date: 17.03.18
4.Downstream of Barakar River SW-4 Date: 17.03.18

Sl.	Parameter	Sampling Stations				Detection Limit	IS:2296-1982 Class-C	BIS Std. & Method
		SW-1	SW-2	SW-3	SW-4			
1	Arsenic (as As), mg/l	--	--	<0.002	<0.002	0.002	0.2	IS 3025/37:1988 R : 2003, AAS-VGA
2	BOD (3 days 27oC), mg/l,	--	--	2.0	2.2	2.00	300	IS 3025 /44: 1993, R:2003 3 day incubation at 27°C
3	Colour (Hazen Unit)	--	--	Clourless	Clourless	Qualitative	300	Physical/Qualitative
4	Chlorides (as Cl), mg/l, Max	--	--	41	47	2.00	600	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	--	--	<0.03	<0.03	0.001	1.5	IS 3025 /42 : 1992 R : 2009, AAS-Flame
6	Disolved Oxygen, min.	--	--	3.6	3.6	0.10	4	IS 3025/381989, R : 2003, Winkler Azide
7	Fluoride (as F) mg/l, Max	--	--	0.28	0.32	0.02	1.5	APHA, 22nd Edition SPADNS
8	Hexavalent Chromium, mg/l, Max	--	--	0.033	0.035	0.01	0.05	APHA, 22nd Edition, 1,5 - Diphenylcarbohydrazide
9	Iron (as Fe), mg/l, Max	--	--	<0.06	<0.06	0.06	50	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
10	Lead (as Pb), mg/l, Max	--	--	<0.005	<0.005	0.005	0.1	APHA, 22nd Edition AAS-GTA
11	Nitrate (as NO3), mg/l, Max	--	--	5.75	6.88	0.50	50	APHA, 22nd Edition, UV-Spectrphotometric
12	pH value	--	--	8.22	7.96	2.5	6.5-8.5	IS-3025/11:1983, R-1996, Electrometric
13	Phenolic compounds (as C6H5OH), mg/l, Max	--	--	<0.002	<0.002	0.002	5.0	APHA, 22nd Edition 4-Amino Antipyrine
14	Selenium (as Se), mg/l, Max	--	--	<0.002	<0.002	0.002	0.05	IS 3025/56: 2003, AAS-VGA
15	Sulphate (as SO4) mg/l, Max	--	--	150	220	2.00	400	APHA, 22nd Edition Turbidity
16	Total Dissolved Solids, mg/l, Max	--	--	268	372	25.00	1500	IS 3025 /16:1984 R : 2006, Gravimetric
17	Zinc (as Zn), mg/l, Max	--	--	<0.01	<0.01	0.01	15.0	IS 3025 /49 : 1994, R : 2009, AAS-Flame

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SURFACE WATER QUALITY — Annexure-VA

Name of the Company: Bharat Coking Coal ltd. Year: 2018-19
Name of the project: Cluster-XVI Mines Period: June'18

Sampling Stations:
1.Upstream of Khudia River SW-1 Date: 07.06.18
2.Downstream of Khudia River SW-2 Date: 07.06.18
3.Upstream of Barakar River SW-3 Date: 07.06.18
4.Downstream of Barakar River SW-4 Date: 07.06.18

Sl.	Parameter	Sampling Stations				Detection Limit	IS:2296-1982 Class-C	BIS Std. & Method
		SW-1	SW-2	SW-3	SW-4			
1	Arsenic (as As), mg/l	0.002	0.003	<0.002	<0.002	0.002	0.2	IS 3025/37:1988 R : 2003, AAS-VGA
2	BOD (3 days 27oC), mg/l,	2.0	2.4	2.2	2.4	2.00	300	IS 3025 /44: 1993, R : 2003 3 day incubation at 27°C
3	Colour (Hazen Unit)	Clourless	Clourless	Clourless	Clourless	Qualitative	300	Physical/Qualitative
4	Chlorides (as Cl), mg/l, Max	32	40	38	44	2.00	600	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	<0.03	0.001	1.5	IS 3025 /42 : 1992 R : 2009, AAS-Flame
6	Disolved Oxygen, min.	4.0	3.8	4.0	3.8	0.10	4	IS 3025/381989, R : 2003, Winkler Azide
7	Fluoride (as F) mg/l, Max	0.49	0.56	0.51	0.058	0.02	1.5	APHA, 22nd Edition SPADNS
8	Hexavalent Chromium, mg/l, Max	0.014	0.017	0.016	0.019	0.01	0.05	APHA, 22nd Edition, 1,5 - Diphenylcarbohydrazide
9	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	<0.06	0.06	50	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
10	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	<0.005	0.005	0.1	APHA, 22nd Edition AAS-GTA
11	Nitrate (as NO3), mg/l, Max	10.51	12.09	10.85	11.72	0.50	50	APHA, 22nd Edition, UV-Spectrphotometric
12	pH value	7.70	7.48	7.84	7.65	2.5	6.5-8.5	IS-3025/11:1983, R-1996, Electrometric
13	Phenolic compounds (as C6H5OH), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.002	5.0	APHA, 22nd Edition 4-Amino Antipyrine
14	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.002	0.05	IS 3025/56: 2003, AAS-VGA
15	Sulphate (as SO4) mg/l, Max	78	98	84	104	2.00	400	APHA, 22nd Edition Turbidity
16	Total Dissolved Solids, mg/l, Max	632	664	682	702	25.00	1500	IS 3025 /16:1984 R : 2006, Gravimetric
17	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	<0.01	0.01	15.0	IS 3025 /49 : 1994, R : 2009, AAS-Flame

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SURFACE WATER QUALITY — Annexure-VA

Name of the Company: Bharat Coking Coal ltd. Year: 2018-19
Name of the project: Cluster-XVI Mines Period: Sept'18

Sampling Stations:
1.Upstream of Khudia River SW-1 Date: 05.09.18
2.Downstream of Khudia River SW-2 Date: 05.09.18
3.Upstream of Barakar River SW-3 Date: 05.09.18
4.Downstream of Barakar River SW-4 Date: 05.09.18

Sl.	Parameter	Sampling Stations				Detection Limit	IS:2296-1982 Class-C	BIS Std. & Method
		SW-1	SW-2	SW-3	SW-4			
1	Arsenic (as As), mg/l	0.002	0.003	<0.002	<0.002	0.002	0.2	IS 3025/37:1988 R : 2003, AAS-VGA
2	BOD (3 days 27oC), mg/l,	2.2	2.0	2.4	2.8	2.00	300	IS 3025 /44: 1993, R : 2003 3 day incubation at 27°C
3	Colour (Hazen Unit)	Clourless	Clourless	Clourless	Clourless	Qualitative	300	Physical/Qualitative
4	Chlorides (as Cl), mg/l, Max	28	24	16	20	2.00	600	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	<0.001	<0.001	0.001	1.5	IS 3025 /42 : 1992 R : 2009, AAS-Flame
6	Disolved Oxygen, min.	3.6	3.8	4.0	3.8	0.10	4	IS 3025/381989, R : 2003, Winkler Azide
7	Fluoride (as F) mg/l, Max	0.50	0.32	0.21	0.26	0.02	1.5	APHA, 22nd Edition SPADNS
8	Hexavalent Chromium, mg/l, Max	0.016	0.019	0.017	0.018	0.01	0.05	APHA, 22nd Edition, 1,5 - Diphenylcarbohydrazide
9	Iron (as Fe), mg/l, Max	0.19	0.22	0.19	0.19	0.06	50	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
10	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	<0.005	0.005	0.1	APHA, 22nd Edition AAS-GTA
11	Nitrate (as NO3), mg/l, Max	1.76	2.01	4.55	3.22	0.50	50	APHA, 22nd Edition, UV-Spectrphotometric
12	pH value	8.35	8.39	9.62	9.09	2.5	6.5-8.5	IS-3025/11:1983, R-1996, Electrometric
13	Phenolic compounds (as C6H5OH), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.002	5.0	APHA, 22nd Edition 4-Amino Antipyrine
14	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.002	0.05	IS 3025/56: 2003, AAS-VGA
15	Sulphate (as SO4) mg/l, Max	34	34	35	33	2.00	400	APHA, 22nd Edition Turbidity
16	Total Dissolved Solids, mg/l, Max	112	128	88	82	25.00	1500	IS 3025 /16:1984 R : 2006, Gravimetric
17	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	<0.01	0.01	15.0	IS 3025 /49 : 1994, R : 2009, AAS-Flame

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SURFACE WATER QUALITY — Annexure-VA

Name of the Company: Bharat Coking Coal ltd. Year: 2017-18
Name of the project: Cluster-XVI Mines Period: Dec'18

Sampling Stations:
1.Upstream of Khudia River SW-1 Date: 04.12.18
2.Downstream of Khudia River SW-2 Date: 04.12.18
3.Upstream of Barakar River SW-3 Date: 04.12.18
4.Downstream of Barakar River SW-4 Date: 04.12.18

Sl.	Parameter	Sampling Stations				Detection Limit	IS:2296-1982 Class-C	BIS Std. & Method
		SW-1	SW-2	SW-3	SW-4			
1	Arsenic (as As), mg/l	0.002	0.003	0.002	0.003	0.002	0.2	IS 3025/37:1988 R : 2003, AAS-VGA
2	BOD (3 days 27oC), mg/l,	2.2	2.6	2.2	2.0	2.00	300	IS 3025 /44: 1993, R:2003 3 day incubation at 27°C
3	Colour (Hazen Unit)	Clourless	Clourless	Clourless	Clourless	Qualitative	300	Physical/Qualitative
4	Chlorides (as Cl), mg/l, Max	16	18	16	20	2.00	600	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	<0.03	0.001	1.5	IS 3025 /42 : 1992 R : 2009, AAS-Flame
6	Disolved Oxygen, min.	4.0	3.8	3.6	3.8	0.10	4	IS 3025/381989, R : 2003, Winkler Azide
7	Fluoride (as F) mg/l, Max	0.41	0.36	0.38	0.42	0.02	1.5	APHA, 22nd Edition SPADNS
8	Hexavalent Chromium, mg/l, Max	0.018	0.014	0.015	0.017	0.01	0.05	APHA, 22nd Edition, 1,5 - Diphenylcarbohydrazide
9	Iron (as Fe), mg/l, Max	0.121	<0.06	0.271	<0.06	0.06	50	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
10	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	<0.005	0.005	0.1	APHA, 22nd Edition AAS-GTA
11	Nitrate (as NO3), mg/l, Max	10.58	10.63	11.03	11.25	0.50	50	APHA, 22nd Edition, UV-Spectrphotometric
12	pH value	8.25	8.23	8.48	8.46	2.5	6.5-8.5	IS-3025/11:1983, R-1996, Electrometric
13	Phenolic compounds (as C6H5OH), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.002	5.0	APHA, 22nd Edition 4-Amino Antipyrine
14	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.002	0.05	IS 3025/56: 2003, AAS-VGA
15	Sulphate (as SO4) mg/l, Max	32	28	34	37	2.00	400	APHA, 22nd Edition Turbidity
16	Total Dissolved Solids, mg/l, Max	106	132	102	140	25.00	1500	IS 3025 /16:1984 R : 2006, Gravimetric
17	Zinc (as Zn), mg/l, Max	1.039	0.059	<0.01	<0.01	0.01	15.0	IS 3025 /49 : 1994, R : 2009, AAS-Flame

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SURFACE WATER QUALITY — Annexure-VA

Name of the Company: Bharat Coking Coal ltd. Year: 2018-19
Name of the project: Cluster-XVI Mines Period: March'19

Sampling Stations:
1.Upstream of Khudia River SW-1 Date: 25.03.19
2.Downstream of Khudia River SW-2 Date: 25.03.19
3.Upstream of Barakar River SW-3 Date: 11.03.19
4.Downstream of Barakar River SW-4 Date: 11.03.19

Sl.	Parameter	Sampling Stations				Detection Limit	IS:2296-1982 Class-C	BIS Std. & Method
		SW-1	SW-2	SW-3	SW-4			
1	Arsenic (as As), mg/l	<0.002	<0.002	<0.002	<0.002	0.002	0.2	IS 3025/37:1988 R : 2003, AAS-VGA
2	BOD (3 days 27oC), mg/l,	2.0	2.4	2.0	2.0	2.00	300	IS 3025 /44: 1993, R : 2003 3 day incubation at 27°C
3	Colour (Hazen Unit)	Colourless	Colourless	Clourless	Clourless	Qualitative	300	Physical/Qualitative
4	Chlorides (as Cl), mg/l, Max	22	28	42	24	2.00	600	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	<0.03	0.001	1.5	IS 3025 /42 : 1992 R : 2009, AAS-Flame
6	Disolved Oxygen, min.	4.0	3.8	3.8	3.4	0.10	4	IS 3025/381989, R : 2003, Winkler Azide
7	Fluoride (as F) mg/l, Max	0.44	0.42	0.35	0.38	0.02	1.5	APHA, 22nd Edition SPADNS
8	Hexavalent Chromium, mg/l, Max	0.024	0.020	0.016	0.022	0.01	0.05	APHA, 22nd Edition, 1,5 - Diphenylcarbohydrazide
9	Iron (as Fe), mg/l, Max	0.504	0.530	0.27	0.14	0.06	50	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
10	Lead (as Pb), mg/l, Max	0.066	0.006	0.01	0.006	0.005	0.1	APHA, 22nd Edition AAS-GTA
11	Nitrate (as NO3), mg/l, Max	13.97	12.19	12.06	8.96	0.50	50	APHA, 22nd Edition, UV-Spectrphotometric
12	pH value	8.24	8.22	8.14	8.19	2.5	6.5-8.5	IS-3025/11:1983, R-1996, Electrometric
13	Phenolic compounds (as C6H5OH), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.002	5.0	APHA, 22nd Edition 4-Amino Antipyrine
14	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.002	0.05	IS 3025/56: 2003, AAS-VGA
15	Sulphate (as SO4) mg/l, Max	64	46	81	72	2.00	400	APHA, 22nd Edition Turbidity
16	Total Dissolved Solids, mg/l, Max	318	300	404	296	25.00	1500	IS 3025 /16:1984 R : 2006, Gravimetric
17	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	<0.01	0.01	15.0	IS 3025 /49 : 1994, R : 2009, AAS-Flame

[1] **Authorised for release by HOD (Env), CMPDI, RI-2, DHANBAD,** 21/9/19 **Dated 13.09.19**

SURFACE WATER QUALITY — Annexure-VA

Name of the Company: Bharat Coking Coal ltd. Year: 2019-20
Name of the project: Cluster-XVI Mines Period: June'19

Sampling Stations:
1.Upstream of Khudia River SW-1 Date: 11.06.19
2.Downstream of Khudia River SW-2 Date: 11.06.19
3.Upstream of Barakar River SW-3 Date: 11.06.19
4.Downstream of Barakar River SW-4 Date: 11.06.19

Sl.	Parameter	Sampling Stations				Detection Limit	IS:2296-1982 Class-C	BIS Std. & Method
		SW-1	SW-2	SW-3	SW-4			
1	Arsenic (as As), mg/l	<0.002	<0.002	<0.002	<0.002	0.002	0.2	IS 3025/37:1988 R : 2003, AAS-VGA
2	BOD (3 days 27oC), mg/l,	2.2	2.4	2.0	2.2	2.00	300	IS 3025 /44: 1993, R : 2003 3 day incubation at 27°C
3	Colour (Hazen Unit)	Colourless	Colourless	Clourless	Clourless	Qualitative	300	Physical/Qualitative
4	Chlorides (as Cl), mg/l, Max	30	32	32	38	2.00	600	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	<0.03	0.001	1.5	IS 3025 /42 : 1992 R : 2009, AAS-Flame
6	Disolved Oxygen, min.	3.8	3.6	4.0	3.6	0.10	4	IS 3025/381989, R : 2003, Winkler Azide
7	Fluoride (as F) mg/l, Max	1.0	0.88	0.63	0.59	0.02	1.5	APHA, 22nd Edition SPADNS
8	Hexavalent Chromium, mg/l, Max	0.025	0.016	0.032	0.038	0.01	0.05	APHA, 22nd Edition, 1,5 - Diphenylcarbohydrazide
9	Iron (as Fe), mg/l, Max	0.130	0.170	0.22	0.06	0.06	50	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
10	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	<0.005	0.005	0.1	APHA, 22nd Edition AAS-GTA
11	Nitrate (as NO3), mg/l, Max	17.40	15.60	14.23	15.33	0.50	50	APHA, 22nd Edition, UV-Spectrphotometric
12	pH value	8.10	8.18	7.83	7.77	2.5	6.5-8.5	IS-3025/11:1983, R-1996, Electrometric
13	Phenolic compounds (as C6H5OH), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.002	5.0	APHA, 22nd Edition 4-Amino Antipyrine
14	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.002	0.05	IS 3025/56: 2003, AAS-VGA
15	Sulphate (as SO4) mg/l, Max	238	194	64	78	2.00	400	APHA, 22nd Edition Turbidity
16	Total Dissolved Solids, mg/l, Max	716	632	548	602	25.00	1500	IS 3025 /16:1984 R : 2006, Gravimetric
17	Zinc (as Zn), mg/l, Max	0.10	0.06	<0.01	<0.01	0.01	15.0	IS 3025 /49 : 1994, R : 2009, AAS-Flame

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SURFACE WATER QUALITY — Annexure-VA

Name of the Company: Bharat Coking Coal ltd. Year: 2019-20
Name of the project: Cluster-XVI Mines Period: Sept'19

Sampling Stations:
1.Upstream of Khudia River SW-1 Date: 23.09.19
2.Downstream of Khudia River SW-2 Date: 23.09.19
3.Upstream of Barakar River SW-3 Date: 23.09.19
4.Downstream of Barakar River SW-4 Date: 23.09.19

Sl.	Parameter	Sampling Stations				Detection Limit	IS:2296-1982 Class-C	BIS Std. & Method
		SW-1	SW-2	SW-3	SW-4			
1	Manganese (as Mn), mg/l	<0.20	<0.20	<0.2	<0.2	0.20	0.50	IS 3025/ 37:1988 R : 2003, APHA, 23rd Edition AAS-VGA
2	BOD (3 days 27oC), mg/l,	2.1	<2.0	<2.0	<2.0	2.00	300	IS 3025 /44: 1993, R : 2003 3 day incubation at 27°C
3	Colour (Hazen Unit)	Colourless	Colourless	Clourless	Clourless	Qualitative	300	Physical/Qualitative
4	Chlorides (as Cl), mg/l, Max	24	32	18	38	2.00	600	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.20	<0.20	<0.20	<0.20	0.001	1.5	IS 3025 /42 : 1992 R : 2009, AAS-Flame
6	Dissolved Oxygen, min.	8.0	7.90	7.80	8.10	0.10	4	IS 3025/381989, R : 2003, Winkler Azide
7	Fluoride (as F) mg/l, Max	0.59	0.56	0.38	0.56	0.02	1.5	APHA, 22nd Edition SPADNS
8	Hexavalent Chromium, mg/l, Max	<0.01	<0.01	<0.01	<0.01	0.01	0.05	APHA, 22nd Edition, 1,5 - Diphenylcarbohydrazide
9	Iron (as Fe), mg/l, Max	<0.20	<0.20	<0.52	<0.20	0.06	50	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
10	Lead (as Pb), mg/l, Max	0.007	0.005	0.008	<0.005	0.005	0.1	APHA, 22nd Edition AAS-GTA
11	Nitrate (as NO3), mg/l, Max	1.43	2.32	0.94	5.73	0.50	50	APHA, 22nd Edition, UV-Spectrphotometric
12	pH value	7.93	7.95	8.36	8.28	2.5	6.5-8.5	IS-3025/11:1983, R-1996, Electrometric
13	Phenolic compounds (as C6H5OH), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.002	5.0	APHA, 22nd Edition 4-Amino Antipyrine
14	Total Chromium (as Cr), mg/l, Max	<0.10	<0.10	<0.10	<0.10	0.10	2.0	IS 3025/ 56:2003, R:2019 AAS-VGA
15	Sulphate (as SO4) mg/l, Max	24	47	15	44	2.00	400	APHA, 22nd Edition Turbidity
16	Total Dissolved Solids, mg/l, Max	95	134	106	106	25.00	1500	IS 3025 /16:1984 R : 2006, Gravimetric
17	Zinc (as Zn), mg/l, Max	<0.10	<0.10	<0.01	<0.01	0.01	15.0	IS 3025 /49 : 1994, R : 2009, AAS-Flame

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SURFACE WATER QUALITY — Annexure-VA

Name of the Company: Bharat Coking Coal ltd. Year: 2019-20
Name of the project: Cluster-XVI Mines Period: Dec'19

Sampling Stations:
1.Upstream of Khudia River SW-1 Date: 03.12.19
2.Downstream of Khudia River SW-2 Date: 03.12.19
3.Upstream of Barakar River SW-3 Date: 05.12.19
4.Downstream of Barakar River SW-4 Date: 05.12.19

Sl.	Parameter	Sampling Stations				Detection Limit	IS:2296-1982 Class-C	BIS Std. & Method
		SW-1	SW-2	SW-3	SW-4			
1	Manganese (as Mn), mg/l	<0.20	<0.20	<0.2	<0.2	0.20	0.50	IS 3025/ 37:1988 R : 2003, APHA, 23rd Edition AAS-VGA
2	BOD (3 days 27oC), mg/l,	<2.0	<2.0	<2.0	<2.0	2.00	300	IS 3025 /44: 1993, R : 2003 3 day incubation at 27°C
3	Colour (Hazen Unit)	Colourless	Colourless	Clourless	Clourless	Qualitative	300	Physical/Qualitative
4	Chlorides (as Cl), mg/l, Max	30	30	12	18	2.00	600	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.20	<0.20	<0.20	<0.20	0.001	1.5	IS 3025 /42 : 1992 R : 2009, AAS-Flame
6	Dissolved Oxygen, min.	7.20	7.0	7.40	7.30	0.10	4	IS 3025/381989, R : 2003, Winkler Azide
7	Fluoride (as F) mg/l, Max	0.60	0.57	0.29	0.48	0.02	1.5	APHA, 22nd Edition SPADNS
8	Hexavalent Chromium, mg/l, Max	<0.01	<0.01	<0.01	<0.01	0.01	0.05	APHA, 22nd Edition, 1,5 - Diphenylcarbohydrazide
9	Iron (as Fe), mg/l, Max	<0.20	<0.20	0.43	<0.20	0.06	50	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
10	Lead (as Pb), mg/l, Max	0.005	<0.005	0.006	<0.005	0.005	0.1	APHA, 22nd Edition AAS-GTA
11	Nitrate (as NO3), mg/l, Max	1.41	<0.50	0.68	5.90	0.50	50	APHA, 22nd Edition, UV-Spectrphotometric
12	pH value	8.12	8.03	8.43	8.15	2.5	6.5-8.5	IS-3025/11:1983, R-1996, Electrometric
13	Phenolic compounds (as C6H5OH), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.002	5.0	APHA, 22nd Edition 4-Amino Antipyrine
14	Total Chromium (as Cr), mg/l, Max	<0.10	<0.10	<0.10	<0.10	0.10	2.0	IS 3025/ 56:2003, R:2019 AAS-VGA
15	Sulphate (as SO4) mg/l, Max	77	77	15	202	2.00	400	APHA, 22nd Edition Turbidity
16	Total Dissolved Solids, mg/l, Max	284	224	102	402	25.00	1500	IS 3025 /16:1984 R : 2006, Gravimetric
17	Zinc (as Zn), mg/l, Max	<0.10	<0.10	<0.01	<0.01	0.01	15.0	IS 3025 /49 : 1994, R : 2009, AAS-Flame

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RI-2, CMPDI, Dhanbad

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HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

GROUNDWATER QUALITY — Annexure-VB

Name of the Company: Bharat Coking Coal ltd. Year: 2018-19
Name of the project: Cluster-XVI Mines Period: March'18

Sampling Stations: 1.Dahibari Village GW-1 Date: 07.03.18
2.Patlabari Village GW-2 Date: NA

Sl. No	Parameter	Sampling Stations		Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW-1	GW-2			
1	Boron (as B), mg/l, Max	<0.20	--	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	05	--	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	34	--	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	32	--	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	--	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.26	--	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	--	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.08	--	0.06	0.3	IS 3025 /53 : 2003,R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	--	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	--	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	19.70	--	0.5	45	APHA, 22nd Edition,UV-Spectrphotometric
12	Odour	Agreeable	--	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.80	--	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	--	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	--	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	96	--	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	--	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	132	--	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	--	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	--	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	434	--	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	196	--	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	1.0	--	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	--	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	--	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

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JSA/SA/SSA

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Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(Mining/Environment)
RI-2, CMPDI, Dhanbad

GROUNDWATER QUALITY — Annexure-VB

Name of the Company: Bharat Coking Coal ltd. Year: 2018-19
Name of the project: Cluster-XVI Mines Period: May'18

Sampling Stations: 1.Dahibari Village GW-1 Date: 30.05.18
2.Patlabari Village GW-2 Date: 07.06.18

Sl. No	Parameter	Sampling Stations		Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW-1	GW-2			
1	Boron (as B), mg/l, Max	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	05	03	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	34	38.6	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	32	26	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.26	0.51	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.08	<0.06	0.06	0.3	IS 3025 /53 : 2003,R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	19.7	28.6	0.5	45	APHA, 22nd Edition,UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.80	7.38	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	96	112	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	132	126	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	434	344	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	196	118	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	3.0	02	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

[1] **Authorised for release by HOD (Env), CMPDI, RI-2, DHANBAD,** 21/09/19 **Dated 13.09.19**

GROUNDWATER QUALITY — Annexure-VB

Name of the Company: Bharat Coking Coal ltd. Year: 2018-19
Name of the project: Cluster-XVI Mines Period: August'18
Sampling Stations: 1.Dahibari Village GW-1 Date: 16.08.18
2.Patlabari Village GW-2 Date: 28.08.18

Sl. No	Parameter	Sampling Stations		Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW-1	GW-2			
1	Boron (as B), mg/l, Max	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	4	5	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	115.2	91.2	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	64	36	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	0.005	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.44	0.37	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.08	0.12	0.06	0.3	IS 3025 /53 : 2003,R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	0.01	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	0.94	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	43.57	42.33	0.5	45	APHA, 22nd Edition,UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.06	8.20	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	0.002	0.012	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	144	93	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	112	138	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	0.1	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	552	494	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	584	292	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	<1	2	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	1.88	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

Analysed By JSA/SA/SSA | Checked By Lab In Charge RI-2, CMPDI, Dhanbad | Approved By HOD(In-charge) Environment RI-2, CMPDI, Dhanbad

GROUNDWATER QUALITY — Annexure-VB

Name of the Company: Bharat Coking Coal ltd. Year: 2018-19
Name of the project: Cluster-XVI Mines Period: Dec'18
Sampling Stations: 1.Dahibari Village GW-1 Date: 10.12.18
2.Patlabari Village GW-2 Date: 05.12.18

Sl. No	Parameter	Sampling Stations		Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW-1	GW-2			
1	Boron (as B), mg/l, Max	<0.2	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	3	3	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	12	56	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	30	24	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	0.04	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.43	0.71	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	0.38	0.06	0.3	IS 3025 /53 : 2003,R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	0.03	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	0.14	0.03	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	11.4	10.92	0.5	45	APHA, 22nd Edition,UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.14	7.86	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	65	88	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity ($c_ac_{o_3}$),, mg/l, Max	196	68	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	0.13	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	802	428	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness ($c_ac_{o_3}$), mg/l, Max	556	304	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	4	3	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	0.43	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

Analysed By JSA/SA/SSA

Checked By Lab In Charge RI-2, CMPDI, Dhanbad

Approved By HOD(In-charge) Environment RI-2, CMPDI, Dhanbad

GROUNDWATER QUALITY **Annexure-VB**

Name of the Company: Bharat Coking Coal ltd. Year: 2019-20
Name of the project: Cluster-XVI Mines Period: May'19
Sampling Stations: 1.Dahibari Village GW-1 Date: 28.05.19
2.Patlabari Village GW-2 Date: 14.03.19

Sl. No	Parameter	Sampling Stations		Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW-1	GW-2			
1	Boron (as B), mg/l, Max	<0.2	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	1	5	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	28	100	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	18	36	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.51	0.59	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.15	0.097	0.06	0.3	IS 3025 /53 : 2003,R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	1.223	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	10.97	10.22	0.5	45	APHA, 22nd Edition,UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.04	8.20	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	112	54	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	76	112	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	398	592	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	170	360	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	1	1	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.03	0.104	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.01	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

Analysed By
JSA/SA/SSA

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Approved By
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

GROUNDWATER QUALITY Annexure-VB

Name of the Company: Bharat Coking Coal ltd. Year: 2019-20
Name of the project: Cluster-XVI Mines, Period: June/Sept./Dec'19
Sampling Stations: 1. Patlabari Village GW-2, Date: 12.06.19/26.09.19/03.12.19

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW-2 12.6.19	GW-2 26.9.19	GW-2 3.12.19			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	2	2	1	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	96	82	50	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	34	72	68	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.72	0.61	0.63	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.04	<0.04	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.19	0.21	0.17	0.06	0.3	IS 3025 /53 : 2003,R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	0.82	0.08	0.48	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	39.79	42.64	43.15	0.5	45	APHA, 22nd Edition,UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.14	7.95	7.96	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.0005	<0.00 05	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	115	129	118	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	104	80	84	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.0005	<0.00 05	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	718	396	499	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	344	224	220	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2	1	1	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.18	0.02	0.09	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.01	0.01	0.05	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

Analysed By JSA/SA/SSA

Checked By Lab In Charge RI-2, CMPDI, Dhanbad

Approved By HOD(In-charge) Environment RI-2, CMPDI, Dhanbad

MINE EFFLUENT WATER QUALITY **Annexure-VC**

Name of the Company: Bharat Coking Coal ltd. Year: 2018-19
Name of the project: Cluster-XVI Mines, Period: June'18

Sampling Stations: 1. Dahibari UGP MW-1, Date: 20.06.2018

Sl. No	Parameter	MW-1	Detection Limit	MoEF-SCH- VI Stnd. Class-A	BIS Standard / Test Method
1	Ammonical Nitrogen, mg/l, Max	0.04	0.02	50.0	IS 3025/34:1988, R : 2009, Nessler's
2	Arsenic (as As), mg/l, *Max*	<0.002	0.002	0.2	IS 3025/37:1988 R : 2003, 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	colourless	Qualitative	Qualitative	Physical/Qualitative
5	C.O.D, mg/l, Max	56	4.00	250.0	APHA, 22nd Edition, Closed Reflux, Titrimetric
6	Copper (as Cu), mg/l, *Max*	<0.03	0.03	3.0	IS 3025/42: 1992 R : 2009, AAS-Flame
7	Dissolved Phosphate, mg/l, Max	0.70	0.30	5.0	APHA, 22nd Edition Molybdovanadate
8	Fluoride (as F) mg/l, *Max*	0.21	0.02	2.0	APHA, 22nd Edition, SPADNS
9	Free Ammonia, mg/l, Max	<0.01	0.01	5.0	IS:3025/34:1988, Nesseler's
10	Hexavalent Chromium, mg/l, Max	0.026	0.01	0.1	APHA, 22nd Edition, Diphenylcarbohydrazide
11	Iron (as Fe), mg/l, *Max*	0.42	0.06	3.0	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
12	Lead (as Pb), mg/l, *Max*	<0.005	0.005	0.1	APHA, 22nd Edition, AAS-GTA
13	Manganese(as Mn), mg/l, Max	<0.02	0.02	2.0	IS-3025/59:2006, AAS-Flame
14	Nickel (as Ni), mg/l, *Max*	<0.005	0.005	3.0	IS-3025/54:2003, AAS-Flame
15	Nitrate Nitrogen, mg/l, *Max*	1.10	0.50	10.0	APHA, 22nd Edition, UV-Spectrphotometric
16	Oil & Grease, mg/l, Max	<2.0	2.00	10.0	IS 3025/39:1991, R : 2003, Partition Gravimetric
17	pH value	7.95	2.5	5.5 to 9.0	IS-3025/11:1983, R-1996, Electrometric
18	Phenolic compounds (as C6H5OH),mg/l, *Max*	<0.002	0.002	1.0	APHA, 22nd Edition 4-Amino Antipyrine
19	Selenium (as Se), mg/l, *Max*	<0.002	0.002	0.05	APHA, 22nd Edition, AAS-GTA
20	Sulphide (as SO3), mg/l, Max	<0.005	0.005	2.0	APHA, 22nd Edition Methylene Blue
21	Temperature (o C)	31.60	Shall not exceed 50 C above the receiving temp.		IS-3025/09:1984, Thermometeric
22	Total Chromium (as Cr), mg/l, Max	<0.06	0.04	2.0	IS-3025/52:2003, 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	<0.02	0.02	1.0	APHA, 22nd Edition, DPD
25	Total Suspended Solids, mg/l, Max	40	10.00	100.0	IS 3025/17:1984, R :1996, Gravimetric
26	Zinc (as Zn), mg/l, *Max*	<0.01	0.01	5.0	IS 3025 /49 : 1994, R : 2009, AAS-Flame
27	Odour	Agreeable	Agreeable	Qualitative	Is-3015/5:1983/R:2012/Qualitative

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(Mining/Environment)
RI-2, CMPDI, Dhanbad

MINE EFFLUENT WATER QUALITY — Annexure-VC

Name of the Company: Bharat Coking Coal ltd. Year: 2018-19
Name of the project: Cluster-XVI Mines, Period: Dec'18

Sampling Stations: 1. Dahibari UGP MW-1, Date: 18.12.2018

Sl. No	Parameter	MW-1	Detection Limit	MoEF-SCH- VI Stnd. Class-A	BIS Standard / Test Method
1	Ammonical Nitrogen, mg/l, Max	0.04	0.02	50.0	IS 3025/34:1988, R : 2009, Nessler's
2	Arsenic (as As), mg/l, *Max*	<0.002	0.002	0.2	IS 3025/37:1988 R : 2003, 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	colourless	Qualitative	Qualitative	Physical/Qualitative
5	COD, mg/l, Max	40	4.00	250.0	APHA, 22nd Edition, Closed Reflux, Titrimetric
6	Copper (as Cu), mg/l, *Max*	<0.03	0.03	3.0	IS 3025/42: 1992 R : 2009, AAS-Flame
7	Dissolved Phosphate, mg/l, Max	0.50	0.30	5.0	APHA, 22nd Edition Molybdovanadate
8	Fluoride (as F) mg/l, *Max*	0.48	0.02	2.0	APHA, 22nd Edition, SPADNS
9	Free Ammonia, mg/l, Max	<0.01	0.01	5.0	IS:3025/34:1988, Nesseler's
10	Hexavalent Chromium, mg/l, Max	0.028	0.01	0.1	APHA, 22nd Edition, Diphenylcarbohydrazide
11	Iron (as Fe), mg/l, *Max*	0.272	0.06	3.0	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
12	Lead (as Pb), mg/l, *Max*	<0.005	0.005	0.1	APHA, 22nd Edition, AAS-GTA
13	Manganese(as Mn), mg/l, Max	0.112	0.02	2.0	IS-3025/59:2006, AAS-Flame
14	Nickel (as Ni), mg/l, *Max*	<0.10	0.005	3.0	IS-3025/54:2003, AAS-Flame
15	Nitrate Nitrogen, mg/l, *Max*	2.30	0.50	10.0	APHA, 22nd Edition, UV-Spectrphotometric
16	Oil & Grease, mg/l, Max	<2.0	2.00	10.0	IS 3025/39:1991, R : 2003, Partition Gravimetric
17	pH value	7.98	2.5	5.5 to 9.0	IS-3025/11:1983, R-1996, Electrometric
18	Phenolic compounds (as C6H5OH),mg/l, *Max*	<0.002	0.002	1.0	APHA, 22nd Edition 4-Amino Antipyrine
19	Selenium (as Se), mg/l, *Max*	<0.002	0.002	0.05	APHA, 22nd Edition, AAS-GTA
20	Sulphide (as SO3), mg/l, Max	0.024	0.005	2.0	APHA, 22nd Edition Methylene Blue
21	Temperature (o C)	27.0	Shall not exceed 50 C above the receiving temp.		IS-3025/09:1984, Thermometeric
22	Total Chromium (as Cr), mg/l, Max	0.210	0.04	2.0	IS-3025/52:2003, AAS-Flame
23	Total Kjeldahl Nitrogen, mg/l, Max	1.8	1.00	100.0	IS:3025/34:1988, Nesseler's
24	Total Residual Chlorine, mg/l, Max	<0.02	0.02	1.0	APHA, 22nd Edition, DPD
25	Total Suspended Solids, mg/l, Max	28	10.00	100.0	IS 3025/17:1984, R :1996, Gravimetric
26	Zinc (as Zn), mg/l, *Max*	<0.01	0.01	5.0	IS 3025 /49 : 1994, R : 2009, AAS-Flame
27	Odour	Agreeable	Agreeable	Qualitative	Is-3015/5:1983/R:2012/Qualitative

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(Mining/Environment)
RI-2, CMPDI, Dhanbad

MINE EFFLUENT WATER QUALITY — Annexure-VC

Name of the Company: Bharat Coking Coal ltd. Year: 2019-20
Name of the project: Cluster-XVI Mines, Period: Dec'19

Sampling Stations: 1. Dahibari UGP MW-1, Date: 27.12.19

Sl. No	Parameter	MW-1	Detection Limit	MoEF-SCH- VI Stnd. Class-A	BIS Standard / Test Method
1	Ammonical Nitrogen, mg/l, Max	0.20	0.02	50.0	IS 3025/34:1988, R : 2009, Nessler's
2	Mercury (as Hg), mg/l, *Max*	<0.0005	0.0005	0.01	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	colourless	Qualitative	Qualitative	Physical/Qualitative
5	COD, mg/l, Max	40	4.00	250.0	APHA, 22nd Edition, Closed Reflux, Titrimetric
6	Copper (as Cu), mg/l, *Max*	<0.20	0.03	3.0	IS 3025/42: 1992 R : 2009, AAS-Flame
7	Dissolved Phosphate, mg/l, Max	0.50	0.30	5.0	APHA, 22nd Edition Molybdovanadate
8	Fluoride (as F) mg/l, *Max*	0.17	0.02	2.0	APHA, 22nd Edition, SPADNS
9	Free Ammonia, mg/l, Max	<0.01	0.01	5.0	IS:3025/34:1988, Nesseler's
10	Hexavalent Chromium, mg/l, Max	0.019	0.01	0.1	APHA, 22nd Edition, Diphenylcarbohydrazide
11	Iron (as Fe), mg/l, *Max*	0.20	0.06	3.0	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
12	Lead (as Pb), mg/l, *Max*	<0.005	0.005	0.1	APHA, 22nd Edition, AAS-GTA
13	Manganese(as Mn), mg/l, Max	<0.20	0.02	2.0	IS-3025/59:2006, AAS-Flame
14	Nickel (as Ni), mg/l, *Max*	<0.10	0.005	3.0	IS-3025/54:2003, AAS-Flame
15	Nitrate Nitrogen, mg/l, *Max*	3.27	0.50	10.0	APHA, 22nd Edition, UV-Spectrphotometric
16	Oil & Grease, mg/l, Max	<2.0	2.00	10.0	IS 3025/39:1991, R : 2003, Partition Gravimetric
17	pH value	8.03	2.5	5.5 to 9.0	IS-3025/11:1983, R-1996, Electrometric
18	Phenolic compounds (as C6H5OH),mg/l, *Max*	<0.002	0.002	1.0	APHA, 22nd Edition 4-Amino Antipyrine
19	Selenium (as Se), mg/l, *Max*	<0.005	0.002	0.05	APHA, 22nd Edition, AAS-GTA
20	Sulphide (as SO3), mg/l, Max	<0.005	0.005	2.0	APHA, 22nd Edition Methylene Blue
21	Temperature (o C)	17.0	Shall not exceed 50 C above the receiving temp.		IS-3025/09:1984, Thermometeric
22	Total Chromium (as Cr), mg/l, Max	<0.10	0.04	2.0	IS-3025/52:2003, AAS-Flame
23	Total Kjeldahl Nitrogen, mg/l, Max	1.40	1.00	100.0	IS:3025/34:1988, Nesseler's
24	Total Residual Chlorine, mg/l, Max	<0.04	0.02	1.0	APHA, 22nd Edition, DPD
25	Total Suspended Solids, mg/l, Max	31	10.00	100.0	IS 3025/17:1984, R :1996, Gravimetric
26	Zinc (as Zn), mg/l, *Max*	0.16	0.01	5.0	IS 3025 /49 : 1994, R : 2009, AAS-Flame
27	Odour	Agreeable	Agreeable	Qualitative	Is-3015/5:1983/R:2012/Qualitative

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
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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
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Bhubneswar - 751 001
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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

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TABLE -- 8.1.(b)
CALENDER PLAN

(VARIANT - II)

YEARS	DAHIBARI QUARRY					BASANTIMATA QUARRY					TOTAL QUARRY				
	COAL +JHAMA (mt)			O.B	S.R	COAL +JHAMA (mt)			O.B	S.R	COAL +JHAMA (mt)			O.B	S.R
	COAL	JHAMA	TOTAL	(mm3)	(m3 / t)	COAL	JHAMA	TOTAL	mm3	(m3 / t)	COAL	JHAMA	TOTAL	(mm3)	(m3 / t)
PC-1	-	-	-	-	-	-	-	-	-	-					
C-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P-1	0.35	-	0.35	1.55	4.43	-	-	-	-	-	-	-	-	-	-
P-2	0.78	0.02	0.80	2.65	3.31	-	-	-	-	-	0.35	0.00	0.35	1.55	4.43
P-3	1.07	0.23	1.30	2.65	2.04	-	-	-	-	-	0.78	0.02	0.80	2.65	3.31
P-4	1.05	0.25	1.30	2.65	2.04	-	-	-	-	-	1.07	0.23	1.30	2.65	2.04
P-5	1.05	0.25	1.30	2.65	2.04	-	-	-	-	-	1.05	0.25	1.30	2.65	2.04
P-6	1.05	0.25	1.30	2.65	2.04	-	-	-	-	-	1.05	0.25	1.30	2.65	2.04
P-7	1.10	0.20	1.30	2.65	2.04	-	-	-	-	-	1.05	0.25	1.30	2.65	2.04
P-8	1.10	0.20	1.30	2.65	2.04	-	-	-	-	-	1.10	0.20	1.30	2.65	2.04
P-9	1.10	0.20	1.30	2.65	2.04	-	-	-	-	-	1.10	0.20	1.30	2.65	2.04
P-10	1.05	0.25	1.30	2.55	1.96	-	-	-	-	-	1.10	0.20	1.30	2.65	2.04
P-11	1.05	0.25	1.30	2.59	1.99	-	-	-	-	-	1.05	0.25	1.30	2.55	1.96
P-12	0.80	0.20	1.00	0.76	0.76	0.30	-	0.30	2.00	6.67	1.05	0.25	1.30	2.59	1.99
P-13	0.47	0.19	0.66	0.53	0.80	0.62	0.02	0.64	2.30	3.59	1.10	0.20	1.30	2.76	2.12
P-14						1.08	0.22	1.30	2.85	2.19	1.09	0.21	1.30	2.83	2.18
P-15						1.08	0.22	1.30	2.85	2.19	1.08	0.22	1.30	2.85	2.19
P-16						1.08	0.22	1.30	2.85	2.19	1.08	0.22	1.30	2.85	2.19
P-17						1.08	0.22	1.30	2.85	2.19	1.08	0.22	1.30	2.85	2.19
P-18						1.10	0.20	1.30	2.85	2.19	1.08	0.22	1.30	2.85	2.19
P-19						1.08	0.22	1.30	2.80	2.15	1.10	0.20	1.30	2.85	2.19
P-20						1.06	0.24	1.30	2.50	1.92	1.08	0.22	1.30	2.80	2.15
P-21						1.06	0.24	1.30	1.72	1.32	1.06	0.24	1.30	2.50	1.92
P-22						0.73	0.17	0.90	0.93	1.03	1.06	0.24	1.30	1.72	1.32
											0.73	0.17	0.90	0.93	1.03
TOTAL	12.02	2.49	14.51	29.18	2.01	10.27	1.97	12.24	26.50	2.17	22.29	4.46	26.75	55.68	2.08

Annexure 11

Annexure 12

DHANBAD ACTION PLAN (2018), CLUSTER XVI, CV AREA, BCCL

SL NO.	Activity	Details	Abatement Type/ Curbing	Initiative type[#]
1.	Tarpaulin covered coal transportation by trucks.	Transportation of coal is being done through tarpaulin covered trucks. Covering of loaded coal for transportation is also mentioned in the transport agreement/contract.	Dust/ Air Pollution	Short/ Medium/ Long Term
2.	Construction of garland drain/retaining wall/toe wall.	Garland drain and toe walls at OB dumps are proposed for construction.	Water Pollution/ Check Surface Run-Off	Short Term
3.	Use of mobile sprinklers/Fixed sprinklers installation and other operations practiced for dust suppression.	6 mobile water sprinklers are in use for spraying at loading points, haul road, coal transportation road, siding etc. for suppression of dust. Proposals for installation of fixed sprinklers at siding are under process. Drill m/c's are having OEM fitted dust extraction system. Water spraying are done through pipeline at feeder breaker, Tipplers, local coal stock yard etc. to suppress dust.	Dust/ Air Pollution	Short/ Medium/ Long Term
4.	Creation of water bodies for accumulation of mine discharge water.	At JOCP & Kalyanchack mine water is already being accumulated at old quarry for the purpose of industrial and community use as well as ground water recharging.	Water Pollution	Short/ Medium/ Long Term
5.	Tree plantation /Eco-Restoration to reclaim biologically OB dumps and mine degraded areas.	By DFO 66000 nos. of saplings has been already planted between years 1986 to 2014 on OB dumps. In 2014-15; 14044 nos. of saplings & in 2015-16; 5000 nos. & in 2016-17 15000 Nos. of saplings has been planted in JOCP Eco-Restoration site and NLOCP Dump eco-restoration sites respectively. Further 10000 Nos. of saplings has been planted in Riverside OB dump of DBOCP mine in 2017-18.	Dust/ Air Pollution; Land Degradation	Medium/ Long Term
6.	Installation of Oil and Grease trap and STP.	Installation of Oil & Grease trap at DBOCP workshop is under process.	Municipal Solid/ Hazardous Waste; Water Pollution	Short Term

[#]*Short Term* – Less than 5 years; Medium Term – 5-10 years; Long Term – 10 years and above

7.	The setting of pipeline in abandoned /inoperative mines for pumping out mine water for its utilization.	Mine water being pumped out from UG mines of Basantimata & Laikdih for common utilization.	Water Pollution	Short Term
8.	Dealing of mine fires.	At DBOCP measures have been taken as per CMR'57 and DGMS guidelines to control UG fire and entrances have been filled/ sealed to stop ingress of air into fire affected area.	Air Pollution; Land Degradation	Short/ Medium Term
9.	All hazardous waste shall be disposed off.	All units have Hazardous waste authorization certificate from JSPCB. Burnt oil is disposed as per rule.	Municipal Solid/ Hazardous Waste	Short/ Medium Term
10.	The removed OBs shall be utilized for low land filling for making roads.	Being implemented as and when opportune conditions arise	Land Degradation	Short/ Medium Term
11.	All drilling to be done with dust containment and suppression system.	Drill machine are having OEM fitted Dust Extraction system and in operation.	Dust/ Air Pollution	Short/ Medium/ Long Term

13/11/18

Add. General Manager
CV Area

General Manager 13/11/18
CV Area

*Short Term – Less than 5 years; Medium Term – 5-10 years; Long Term – 10 years and above

Annexure 13

Progress Report

1st Phase Air Monitoring report for

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

Sponsor

Bharat Coking Coal Limited (BCCL)

CSIR-National Environmental Engineering Research Institute, Nagpur

2019

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1. Introduction

1.1 Project Background

Bharat Coking Coal Limited, a subsidiary of Coal India Limited, has been operating the majority of the coal mines in the Jharia coal field regions since its inception in 1972. Jharia coal mines are special for its low ash content and high calorific value coals. 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 causes lot of fugitive gaseous and PM emissions. Hence, Jharia region has been under scrutiny by various public authorities and 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 dusts, fugitive emissions, fuel oils, household LPGs, etc. The percentage contribution of these factors in the ambient depends exclusively on the economic activities of that particular region. In order to improve the existing ambient air quality, the major sources of PM emissions first need to be identified. Hence, the environmental clearance committee of MoEF 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 Jharia coalfields region in order to quantify the various sources PM emissions and suggest an effective environmental management plan.

1.2 Project objectives

The major objective of the study 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 to include the entire Jharia Coalfield along with area up to 10 Km from the periphery / boundary of BCCL mines.

The detailed objectives are as following:

i. Ambient Air Monitoring

- ✓ Monitoring of ambient air quality at selected receptor locations for pollutants including PM10, PM 2.5(limited), SO2, NOx, PAHs to establish the status of the air quality in Jharia Coalfields along with 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 calibrate dispersion modelling predictions using measured air quality parameters.

- ✓ To draw supportive data through 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 micro meteorological conditions of the Jharia Coalfields.

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

- ✓ 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.

iii. Source apportionment related

- ✓ To identify and apportion the pollution load at receptor level to various sources in the Jharia Coalfields along with 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 period of the day and day-of-the-week.

iv. Any other item in consensus between both BCCL/CIL & NEERI evolved during the study.

2. Field visit

In connection with the above objectives, the NEERI's team and BCCL's team visited BCCL's Jharia coal filed for 3 days from 23 September to 27 September 2018. The team covered the entire Jharia coalfield, which spans roughly 30km in length and 22 km wide in three days with the following purpose.

To identified the location for air monitoring station in entire Jharia Coal Field region.

2.1 Jharia coalfield maps:

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 and details of the visit along with mine cluster names are given in Table 2.1.

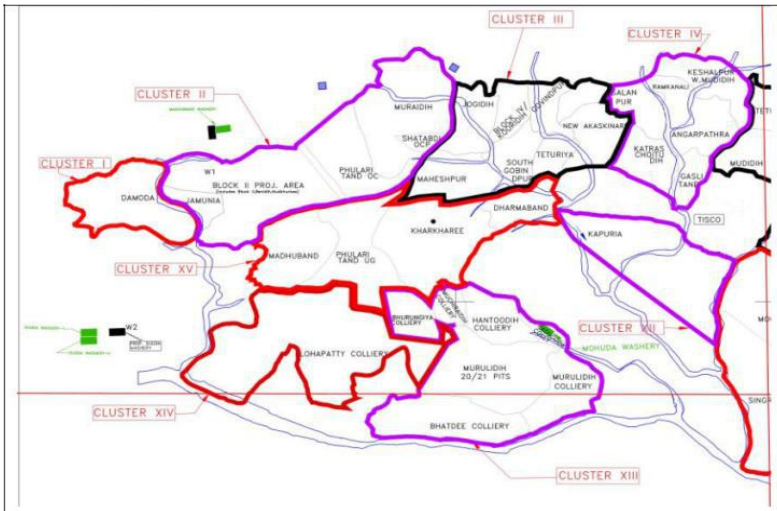
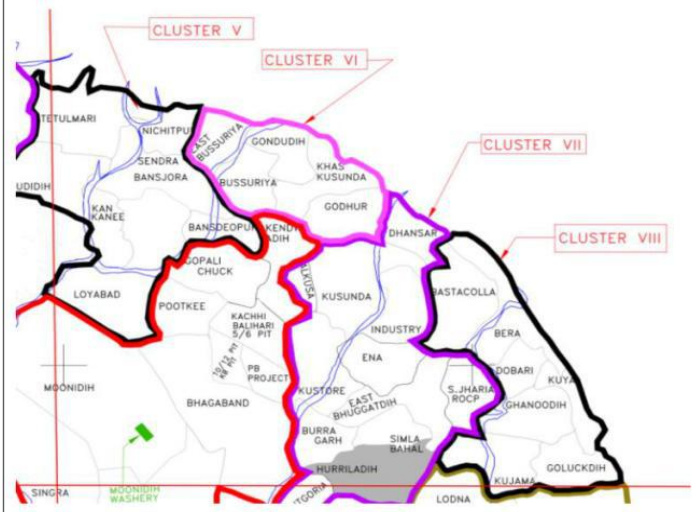
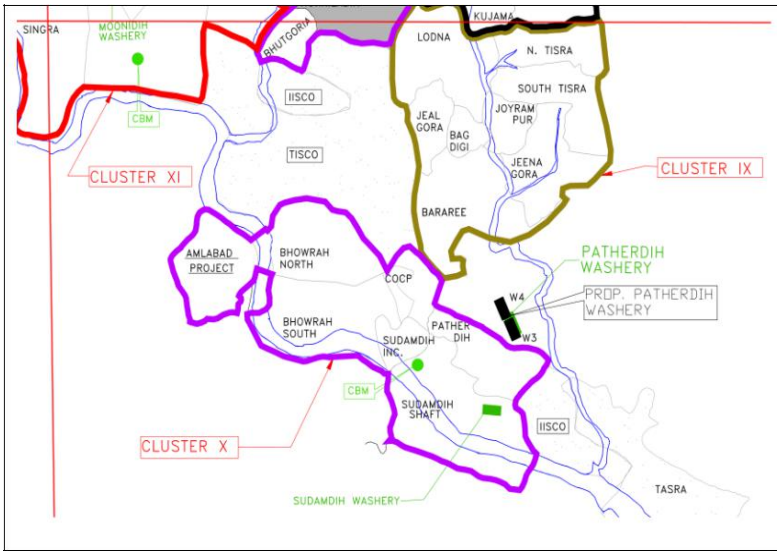
	**Part 1:** Cluster VI, VII, VIII, and X
	**Part 2:** I, II,III, IV, V, XI, XII, XIII, and XV
	**Part 3:** Cluster IX

Table 2.1 Jharia coalfields Site visit on cluster-base

Based on the objectives and outcomes envisaged, the various mine areas were visited to identify sources of emissions such dumpsite emissions, fugitive emissions, blasting emissions. Furthermore, the already existing PM monitoring sites of BCCL were also visited to explore of possibility of installing NEERI's PM monitoring stations.

2.2 Site Identification:

The Entire Jharia Coal Field (JCF) is divided into 16 clusters. Both opencast 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, which have their own 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.

Based on the preliminary field visit by CSIR-NEERI Scientists along with BCCL staffs, the following locations are 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 IV or Cluster V – Banssuriya or Katras
4. Cluster IX (Lodhna)
5. Cluster XI (Moonidih)
6. Cluster X (Patherdih): nearby sources: Coal Mine, Steel Industry
7. Cluster VIII (Bastacola)

Buffer Zone

8. Bank More
9. Harina
10. Bhuli
11. Sindri
12. Parbatpur Electrosteel/ Bhaga

13. Background site (Upwind & away from sources) and also secondary Data from DVC, CCL mines Sail Bokaro and Jharkhand pollution Control Board will be obtained.

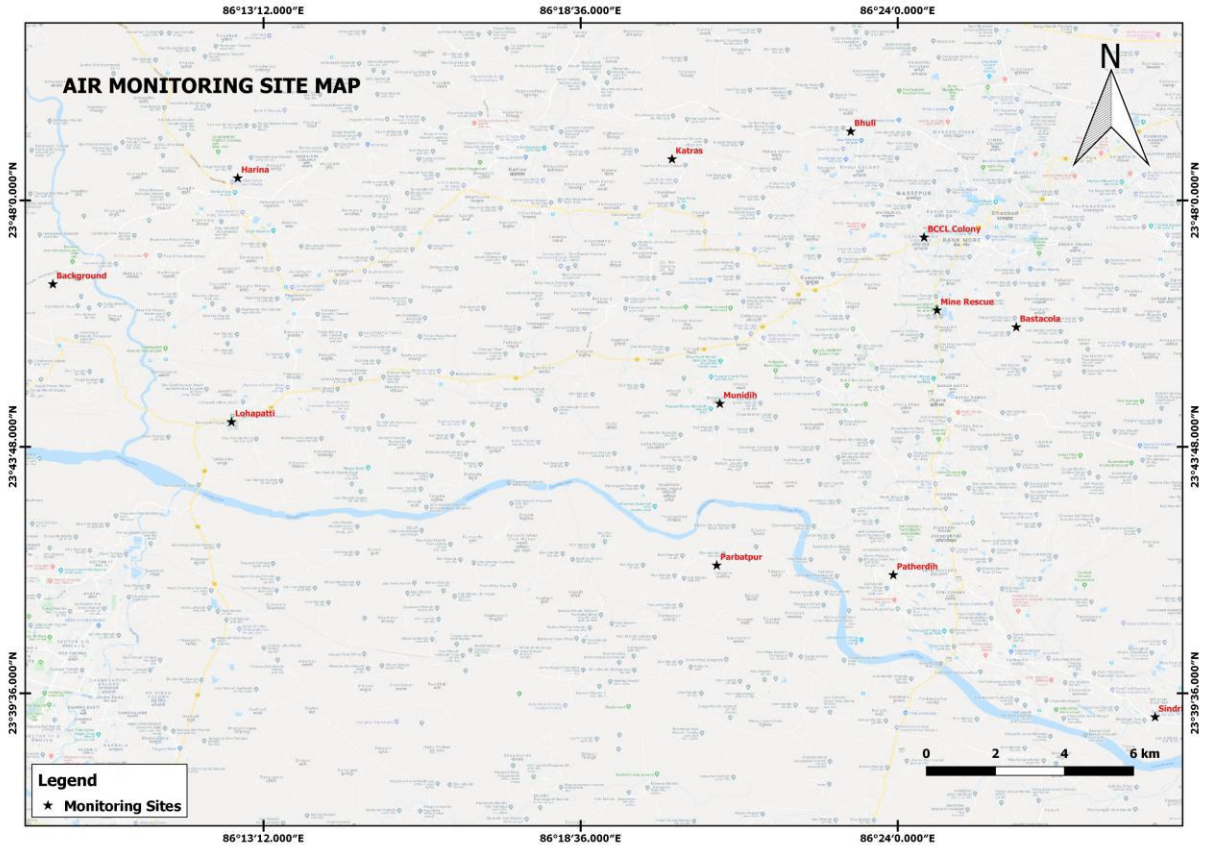


Figure2.1 Identified air monitoring station in Jharia Coalfield

3. Sampler Selection and Procurement

Standard equipment were catered for the parameter required towards ambient air particulate characterization and gaseous sampling in the initial phase of the project.

Table 3.1 Samplers Procured for Monitoring

Sampler	**Brief Description of operating conditions**
Fine Dust Sampler	Sampling Inlets- $PM_{2.5}$, PM_{10} and TSP Flow rate-16.7LPM
FRM Sampler	Versatile inlet configurations for $PM_{2.5}$, PM_{10}, or TSP sampling FRM quality 24-hour sampling at 16.7 LPM
Gaseous Sampler	Sampling Rate-0.5-1.0 LPM Operation time-8 hours

4. Monitoring parameters

Parameters of monitoring were decided based on the objectives of air pollution and source apportionment study. The source apportionment analysis required air monitoring for particulate matter ($PM_{2.5}$ and PM_{10}) and its chemical speciation to develop signature profiles of pollution sources that can be used in chemical mass balance models. The analysis data could also be used to interpret the overall loading of different chemicals contributed varied sources. Monitoring included air quality attributes such as Particulate matter, Sulphur Dioxide (SO_2) and Oxides of Nitrogen as NO_2, to understand not only the regulatory compliance but also their inter-correlations with other species such as Heavy metals, EC, OC etc. Since the objective of source apportionment study is to determine the contributions from various sources such as industries, vehicular and other area sources additional parameters were also monitored such as Polycyclic Aromatic Hydrocarbons (PAHs). List of all parameters, sampling flow rate and analytical methods are provided in Table 4.1

Table 4.1 Ambient Air Quality Sampling/Analysis Methodology for Target Pollutants

Particulars	Parameters			
	PM_{10}	$PM_{2.5}$	NO_2	SO_2
Sampling Instrument	Fine Dust Sampler & FRM Sampler	Fine Dust Sampler & FRM Sampler	APM sampler	APM sampler
Sampling Principle	Cyclonic Flow Technique	Cyclonic Flow Technique/ WINS Impactor	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	10 days continuous, Teflon and quartz on alternate days	10 days continuous, Teflon and quartz on alternate days	10 days continuous	10 days continuous

Analytical Instrument	Electronic Micro Balance	Electronic Micro Balance	Spectrophoto-meter	Spectrophoto-meter
Analytical Method	Gravimetric	Gravimetric	Colorimetric Improved West & Gaeke Method	Colorimetric Improved West & Gaeke Method
Minimum reportable value	5 µg/m^3	5 µg/m^3	9 µg/m^3	4 µg/m^3

4.1 Monitoring Frequency

All pollutants exhibit diurnal and seasonal variations, which have been taken into account while determining the frequency of the sampling. In order to assess the impact of the diurnal variations in source contributions for a given meteorology of the day, 24 hourly monitoring plan was envisaged (8 hourly sampling for gaseous pollutants and 24 hourly sampling for particulate matter). The field study was planned for a period of 10 days at each monitoring site for the season to represent variation in air quality. The sampling frequency details are presented in Table 4.1.

Table 4.1.1 Frequency of Air pollutants sampling in Jharia Coalfield

Parameter	Number of Days	Change of Filter/ absorbing media	Reporting
PM_{10}	10	24 hourly, Teflon: 05 days Quartz: 05 days	24 hourly
$PM_{2.5}$	10	24 hourly Teflon: 05 days Quartz: 05 days	24 hourly
NO_2	10	8 hourly	8 hourly
SO_2	10	8 hourly	8 hourly

The glimpses of air monitoring of some locations are shown in Figure 4.1.

Kataras

Lodhana

Moonidih

Patherdiha

Bastacola

Sindri

Figure 4.1 Glimpses of air monitoring of some locations

4.2 Filter handling and Weighing:

Teflon-membrane and quartz-fibre filter are most commonly used for chemical analysis. Each filter was individually examined prior to labelling for discoloration, pinholes, creases, separation of ring, chaff or flashing, loose material, or other defects.

Gravimetry measured the net mass on a filter by weighing the filter before and after sampling with balance in temperature and relative humidity controlled environment. To minimize particle volatilization and aerosol liquid water bias, $PM_{2.5}$ Filters were equilibrated for 24 hours at a constant (within ±5%) relative humidity between 30% and 40% at a constant (within ±2°C) temperature between 20°C and 23°C. PM_{10} filters were equilibrated at 20% to 45% relative humidity (±5%) and 15°C to 30°C temperature (±3°C).

Methods of Chemical characterization:

Sulphur dioxide (SO_2)	: Modified West and Gaeke method
Nitrogen dioxide (NO_2)	: Sodium Arsenite method
Suspended Particulate Matter (SPM)	: High Volume method (Gravimetric method)
Respirable suspended Particulate Matter (RSPM)	: Gravimetrically with GFA/EPM 2000 filter paper using respirable dust sampler (Cyclonic Flow Technique)

5. Ambient Air Quality Monitoring

Core Zone

Site 1: Cluster XIV (Lohapatty)

The samplers were installed on the roof of area office of Lohapatty (Latitude 23.737066 and Longitude 86.210894). It was located near residential colony. Coal mine was 1 km away from the sampling site. Coal has been transported through railway line which is 1.5 km away on a daily basis and also through trucks. NH-32 construction was going on 500 m away from the site. The major fuel used for cooking is coal in the study area.

Site 2: Cluster VII Mine rescue Station

Monitoring station was positioned in Mine rescue station, Dhansar on the roof of office building (Latitude 23.768746 and Longitude 86.411141). Mine rescue station is next to

the state highway 12 where continuous movement of heavy vehicles takes place. Mining activities were also observed nearby the location.

Site 3: Cluster V Katras

In Katras, samplers were installed at Expert hostel (Latitude 23.811692 and Longitude 86.335910). There was a settlement residential area nearby. Mining activities was in progress within 500m area. Railway track was nearly at 150m distance from the site. Coal was used for cooking. Many other activities were observed during sampling in the nearby area which may contribute. 'Mela' and continuous 'Hawan' were going on within 100m area. Also road construction was in progress near 7km.

Site 4: Cluster IX (Lodhana)

Samplers were installed at office in Lodhna (Latitude 23.721713 and Longitude 86.410260). Near Lodhna, colliery was 2 km away from the site. Nearest Railway track was 1.5 km away. Coal was mostly used for cooling.

Site 5: Cluster XI (Moonidih)

Moonidih mine is one of the underground mine of BCCL. Sampler was stationed in Area office of Moonidih mine (Latitude 23.742228 and Longitude 86.349494). Since monitoring location was 250-300m from the mine, movement of heavy vehicles was continuous. There is washery also at distance of 500m where trucks and conveyor were used for transportation of coal. So the mining activities nearby contributes to particulate matter emission.

Site 6: Cluster X (Patherdih)

Samplers were stationed in guest house of BCCL in Patherdih area (Latitude 23.693577 and Longitude 86.398728). It is situated beside highway where continuous movement of heavy vehicles observed. TATA steel coal mine is situated 1km away from the location where continuous mining activities takes place. Transportation of coal through railway wagons in same area also contributes to particulate matter emission.

Site 7: Cluster VIII (Bastacola)

The samplers were positioned in area office of Bastacola mine (Latitude 23.763966 and Longitude 86.433635). Here also, coal was used as a cooking media. Railway track was

at Jodaphata which was 3-4 km away from the site. Residential area was nearly 0.5-1km. Mine was situated 3km from the site but no Mining activity was observed during monitoring.

Buffer zone

Site 8: Bank More (BCCL Colony)

Sampling station was installed in BCCL colony, Jawahar Nagar on the roof of a resident (Latitude 23.789463 and Longitude 86.407448). No mining activities were observed but the colony was beside the NH 18 highway so it may contribute to particulate matter emission.

Site 9: Harina

At Harina, the site chosen for air sampling was BCCL colony (Latitude 23.806308 and Longitude 86.212641). Since it was BCCL residential area, fuel used for cooking purpose was LPG. Settlement residential area was observed nearby where coal was used as a media for cooking. Colliery and Railway track were 3km and 2 km away from the site respectively. Highway was 1km away from the site and Coal washery at distance of 4.5km.

Site 10: Bhuli

The samplers were installed on the roof of Saraswati Vidya Mandir, Bhuli (Latitude 23.819554 and Longitude 86.386647). The location was in residential area. Mining activity was going at a distance of 8-10km. A closed Brick factory was located in the nearby area. Fuel used for cooking was mostly coal. Railway track used for coal transportation was 4km from the site. Construction of highway was also going on within 1.5km area during the monitoring.

Site 11: Sindri

Air samplers were installed at BIT Sindri college campus (Latitude 23.653214 and Longitude 86.473022). Transportation of coal was done by railway wagons at distance of 2km from monitoring site. LPG was mostly used for cooking rather than coal. A construction activity was going on nearby. The site was near the highway at a distance of <100m.

Site 12: Parbatpur

The sampling station was installed on roof of a house (Latitude 23.696296 and Longitude 86.348609). Mining activity was no longer going nearby. Coal was primarily used for cooking.

Site 13: Background

The air monitoring samplers were installed on roof of resident's house which was near to the highway at a distance of less than 1 km (Latitude 23.776180 Longitude 86.160177). Construction activities were going on nearby the location. Heavy rainfall also occurred during monitoring period. Mine activities were also observed in radius of 2-3km. Settlement resident's uses coal for cooking purposes.

Sample collection Transportation and Preservation

Ambient $PM_{2.5}$ and PM_{10} samples were collected using suitable sampler at a desired flow rate. Filters were wrapped carefully with aluminium foil and stored in re-sealable plastic bags. At sampling site, the filter that collected the particle sample on the previous day was taken out of the filter holder and immediately wrapped with aluminium foil and sealed. The sample filers were transported back to the laboratory in an isolated cooler container with ice and then frozen at -10°C until analysis.

Table 5. 1 Physical and Chemical components for characterization of Particulate matter

Components	**Filter Matrix**	**Analytical Methods**
PM10/ PM2.5	Teflon/Quartz filter paper	Gravimetric
Elements (Na, Mg, Al, Si, P, S, Cl, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Br, Rb, Sr, Y, Zr, Mo, Pd, Ag, Cr, Cd, In, Sn, Sb, Ba, La, Hg, Ti, and Pb)	Teflon/Quartz filter paper	ICP-OES
Ions ($NO2^-$, $NO3^-$, SO_4^{-2}, K+, NH^{4+}, Na^+)	Teflon/Quartz filter paper	Ion chromatography with conductivity detector
Carbon Analysis (OC, EC)	Quartz filter paper	TOR/TOT method
PAHs	Teflon/Quartz filter paper	Extraction followed by GC-MS analysis with and without derivatization

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

(FOR THE Q.E. SEPTEMBER 2020)

E. C. no. J-11015/185/2010-IA.II (M) dated 06.02.2013

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CLUSTER - XVI

(FOR THE Q.E. SEPTEMBER 2020)

CONTENTS

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EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the 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 Raniganj Coalfield (RCF) is a part of Gondwana Coalfields located in Burdwan district of West Bengal, the RCF is bounded by $23^0$42' N to $23^0$75' N latitudes and $86^0$43' E to $86^0$85' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Raniganj Coalfield (RCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Water sampling stations

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

3.0 Methodology of sampling and analysis

3.1 Water quality

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

4.0 Results and interpretations

4.1 Water quality

The test results indicate that the major parameters compared with 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 within permissible limits.

CHAPTER - I

INTRODUCTION

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

Bharat Coking Coal Limited (BCCL), a subsidiary company of Coal India Limited (CIL) is operating UG Mines and Opencast Mines in Raniganj Coalfield (RCF).

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 MoEFCC 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-XVI is in the Western part of the Raniganj coalfield and situated in the C.V. area of BCCL. It includes a group of 5 Mines (viz. Dahibari Basantimata OCP, Basantimata UG, New Laikdih OCP, Laikdih Deep UG & Chanch UG). The Cluster – XVI is situated about 50 - 55 kms from Dhanbad Railway Station. The mines of this Cluster – XVI 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 River & Barakar River.

1.2 The Cluster-XVI is designed to produce 1.51 MTPA (normative) and 1.963 MTPA (peak) capacity of coal.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity 1.51 MTPA (normative) and 1.963 MTPA (peak) capacity of coal production vide letter no. J-11015/185/2010-IA.II (M) dated 06th February, 2013.

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

CHAPTER – II

WATER QUALITY MONITORING

2.1 Location of sampling sites

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

i) Ground Water quality at **Patlabari Village (GW16)**

ii) Surface Water quality at **U/S of Khudia River (SW33)**

iii) Surface Water quality at **D/S of Khudia River (SW34)**

2.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. Effluent samples were analyzed for 25 parameters on quarterly basis and for 27 parameters on half yearly basis. The 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.

2.3 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- 17 PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : 2020-21

Name of the Project : **Cluster - XVI** Period: **Q.E. SEPT 2020**

Stations: 1. Upstream in Khudia River SW-33 14/09/2020

2. Downstream in Khudia River SW-34 14/09/2020

Sl.No	Parameter	Sampling Stations				BIS Standard & Method	Detection Limit	
		SW33	SW34					
1	Arsenic (as As), mg/l, Max	<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°C), mg/l, Max	<2.0	<2.0			3.00	2.00	**IS 3025 (Part 44) : 1993 Reaffirmed 2019 , 3 day incubation at 27°C**
3	Colour	Colourless	Colourless			300	Qualitative	Physical/Qualitative
4	Chlorides (as Cl), mg/l, Max	16	17			600	2.00	IS-3025/32:1988, R-2019 Argentometric
5	Copper (as Cu), mg/l, Max	<0.2	<0.2			1.5	0.2	IS 3025/42 : 1992 R : 2019, AAS-Flame
6	Dissolved Oxygen, min.	5.5	6.5			4	0.10	**IS 3025 (Part 38) : 1989, Reaffirmed 2019 Modified Winkler Azide Method**
7	Fluoride (as F) mg/l, Max	0.98	0.86			1.5	0.02	APHA, 23RD Edition, Page 4-90 to , 4500 –F- D (SPADNS Method)
8	Hexavalent Chromium, mg/l, Max	<0.01	<0.01			0.05	0.01	IS 3025 (Part 52) : 2003,Reaffirmed 2019
9	Iron (as Fe), mg/l, Max	<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			0.1	0.005	APHA, 23rd Edition, AAS-GTA
11	Nitrate (as NO_3), mg/l, Max	1.5	1.38			50	0.50	APHA, 23rd Edition, P-4-127, 4500 - NO_3^- B , UV-Spectrophotometric Screening Method
12	pH value	8.13	8.21			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			0.005	0.002	APHA, 22nd Edition 4-Amino Antipyrine
14	Selenium, mg/l, Max	<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	30	30			400	2.00	APHA –23rd Edition. P-4-199, 4500 SO_4^{2-} E
16	Total Dissolved Solids, mg/l, Max	155	159			1500	25.00	IS 3025, Part 16: 1984 R 2017 Gravimetric method
17	Zinc (as Zn), mg/l, Max	<0.1	<0.1			15	0.1	IS 3025/ 49 : 1994, R : 2019, AAS-Flame

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

WATER QUALITY

(GROUND/DRINKING WATER- 25 PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2020-21**

Name of the Project : **Cluster - XVI** Period: **Q.E. SEPT 2020**

Stations: **Date of Sampling:**

1. Drinking Water from Patlabari village DW-16 10.08.2020

Sl.No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		DW16 10.08.20					
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	54			1.6	75	IS 3025, Part 40: 1991 R 2019 EDTA Method
4	Chloride (as Cl), mg/l, Max	23			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	0.36			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	<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	0.01	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 23rd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02			0.02	0.1	APHA, 23rd Edition, 3111B, Direct Air Acetylene Flame AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	42.48			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	7.13			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	105			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	117			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	308			25	500	IS 3025, Part 16: 1984 R 2017 Gravimetric method
22	Total Hardness (c_aco_3), mg/l, Max	202			4	200	IS 3025, Part 21, 2009 R 2019 EDTA Method
23	Turbidity, NTU, Max	1			1	5	IS 3025, Part 10 : 1984 R 2017 Nephelometric Method
24	Zinc (as Zn), mg/l, Max	<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	0.02	IS 3025 Pat 54 : 2003,R : 2019, AAS-Flame APHA, 23rd Edition, AAS-GTA

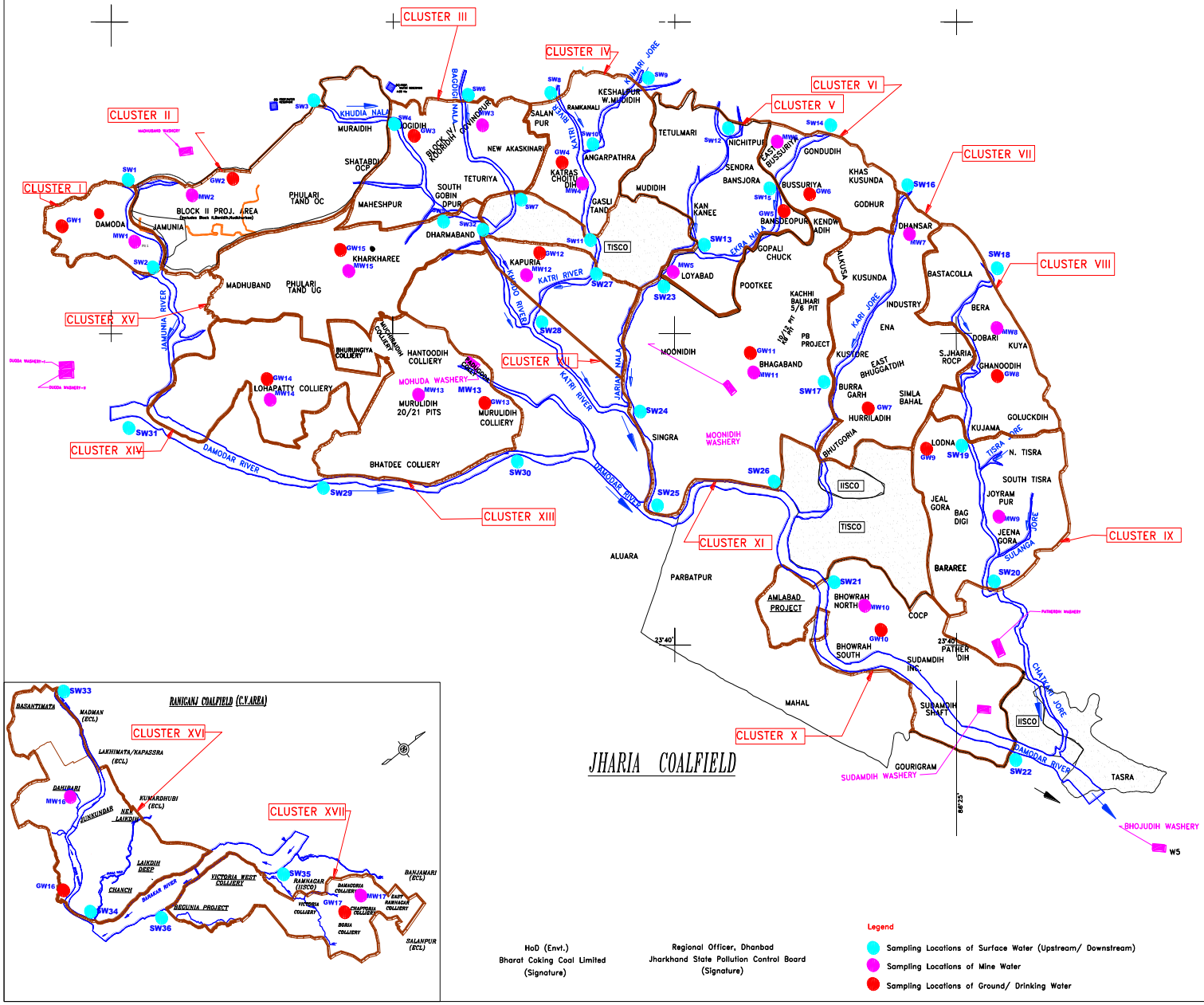
All values are expressed in mg/lit unless specified.

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

Water Sampling Locations in BCCL



INDEX

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

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

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

Legend

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

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

Annexure 15

Annexure 16

Certificate of high root density plant for controlling subsidence

This is to certify that BCCL has been doing plantation/ecological restoration under the guidelines of Forest Research Institute. The various species selected for the restoration are having a tap root system with branches which serve the purpose. These species have high root density and are already being planted at all the ecorestoration/plantation sites of BCCL. The various species having tap root system are given below

S.No.	Species	Common name
1.	*Acacia nilotica*	Kikkar
2.	*Albizia odoratissima*	Kala siris
3.	*Bauhinia variegata*	Kachnar
4.	*Cassia fistula*	Amaltas
5.	*Ficus benghalensis*	Baniyan /bargad
6.	*Ficus racemosa*	Gular
7.	*Ficus religiosa*	Pipal
8.	*Gmelina arborea*	Ghamar
9.	*Lagerstroemea parviflora*	Jarul
10.	*Lannea coromandelica*	Zhingan
11.	*Madhuca latifolia*	Mahua
12.	*Mangifera indica*	Aam
13.	*Morus alba*	Shahtoot
14.	*Phyllanthus emblica*	Aonla
15.	*Pithecellobium dulce*	Jangal jalebi
16.	*Pongamia pinnata*	Karanj
17.	*Tamarindus indica*	Imli
18.	*Trema orientalis*	Tree
19.	*Terminalia arjuna*	Arjun
20.	*Terminalia bellerica*	Bahera
21.	*Dalbergia sissoo*	Shisham
22.	*Syzizum cumini*	Jamun
23.	*Azadirachta indica*	Neem
24.	*Holoptelea integrifolia*	Indian elm
25.	*Butea monosperma*	Palash /dhak

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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.

Study to Analyze the Extent of Reduction of Pollution Load Every Year by reducing Coal Transportation by Road

CLUSTER XVI GROUP OF MINES

(Dahibari Basantimata OCP, Basantimata UG, New Laikdih OCP (Includes prop. Dahibari Washery, Laikdih Deep UG, Chanch UG, Dahibari washery)

Normative Production :1.51 MTPA
Peak Production :1.963 MTPA
Lease Hold Area : 1964.21Ha

Bharat Coking Coal Limited

(March, 2017)

Prepared by

Environment Division

Central Mine Planning & Design Institute Limited

CMPDI (HQ)

Gondwana Place

Kanke Road, Ranchi-834008

CONTENTS

Chapter – I

Introduction

1.1 Genesis:

MOEF provided Environmental Clearance to the various mines of the Cluster vide letter no. J-11015/185/2010-IA.II(M) dated 6 Feb 13 As per the Environmental Clearance Conditions given by the Ministry of Environment & Forest "A study should be initiated to analyse extent of reduction in pollution load every year by reducing road transport of coal". Therefore the present study has been carried out to quantify the pollution load due to coal transportation.

1.2 Methodology:

In order to find out the pollution load due to coal transportation a Questionnaire was developed by the Environment Division of CMPDI Headquarter and Regional Institute –II, Dhanbad. The Questionnaire was circulated to the various mines of BCCL for collection of the requisite inputs for this study. The quantification of pollution load for PM-10 has been carried out on the basis of the field visit, data provided by BCCL officials and interaction with them.

1.3 General Information about the Cluster:

1.3.1 Brief Description:

Cluster-XVI group of mines of BCCL is a group of five mines consisting of opencast and underground mines and one proposed washery (Dahibari Washery) in the Chanch-Victoria Area in Raniganj Coalfield of the Bharat Coking Coal Limited in the Dhanbad District of Jharkhand state. BCCL is the proponent of the cluster and it is under the administrative control of Coal India Limited. Coal India Limited is a Public Sector Undertaking of Government of India and functioning under the Ministry of Coal, Govt. of India.

BCCL is the proponent of the cluster and it is under the administrative control of Coal India Limited.

1.3.2 Nature and Size of the Cluster:

Cluster-XVI group of mines of BCCL is a group of five mines consisting of opencast and underground mines and one proposed washery (Dahibari Washery) in the Chanch-Victoria Area in Raniganj Coalfield of the Bharat Coking Coal Limited in the Dhanbad District of Jharkhand state.

The details of the mines showing normative/ peak productions, lease hold areas and life are given in Table no. 1.1.

Table 1.1: Details of the Mines of Cluster

Sl No	Name of Mines	Production Capacity (MTY)		Lease Hold Area (Ha)
		Normative	Peak	
1	Dahibari Basantimata OCP	1.30	1.69	385.68
2	Basantimata UG	0.21	0.273	417.00
3	New Laikdih OCP (Includes prop. Dahibari Washery)	0.00	0.00	305.1
4	Laikdih Deep UG	0.00	0.00	281.00
5	Chanch UG	0.00	0.00	575.43
	Total	1.51	1.963	1964.21
	Proposed Washery	Capacity	Lease Hold Area (Ha)	
	Dahibari washery	1.6 MTPA	12 (Within New Laikdih lease hold)	

1.3.3 Impact of Fire Control on Ambient Air Quality:

Mining in Raniganj coalfield was started more than 200 years back and most of the mines were opencast with manual excavations. Gradually underground mines were started at shallow depth and the mining was done by the private mine operators. Due to complex geo-mining conditions, the private mine operators abandoned the mines without taking care of the safety, conservation of the post mining situations. The unscientific mining has created many small surface craters or unsafe goaf in the Raniganj Coalfield area.Out of 595 unstable sites identified in the Master Plan , 13 sites consisting of 1193 no. of houses/families are affected due to instability. The affected families will be rehabilitated in adjacent non coal bearing area at a cost of Rs. 10171 lakhs.

1.3.4 Impact of Resettlement on Ambient Air Quality:

As per Jharia Action Plan (JAP) household will be shifted for implementation of master plan. The reduction in number of households within the leasehold area of Cluster will lead to reduction in generation of air pollutants due to reduction in movement of man & materials apart from decrease in consumption of coal as a domestic fuel. As per Jharia Action Plan (JAP) household will be shifted as per for implementation.

1.4 Meteorological Data

A meteorological data generated during 1st January 16 to 31st March 2016 has been presented in this report .The micro meteorological set up was established at the roof of BCCL Dugda Guest house and parameters like temperature, relative humidity, wind speed and directions, cloud cover and rainfall were recorded. The data were collected on hourly basis during the entire study period.

Generally, moderate winds prevailed throughout the study period. The wind velocity ranged between ≤ 0.5 m/s to 13.2 m/s. The seasonal average wind speed was observed to be 0.69 m/s. Wind-roses were made by using latest WRPLOT View of Lakes Environmental Software.

The analysis of wind pattern during the season showed that the predominant wind directions were from North-West & West followed by North-East having frequencies 15.71%, 11.45% & 4.67% respectively.The receptors located in the Downwind directions i.e. SE and East from the dust generating sources are likely to be affected. The dispersion of air borne dust during calm period (45% of time) will be very poor and buildup of pollutant concentration during this period will occur.

The maximum temperature recorded was 39.3^0C and the minimum was 6.2^0C. The daily average relative humidity values were in the range of 32.2 to 65.0%. The sky was mostly clear during the study period. The average atmospheric pressure value has been found to be around 732.3 mm Hg. Total 94.5mm rainfall was recorded

during the study period. The average rainfall during the season was found to be 1.04 mm.

Table 1.2: SEASONAL WIND DISTRIBUTION

Period: 01st JAN.'2016 – 31stMAR.'2016

Wind Direction	Wind Velocity (m/s) & Duration (%)				
	< 0.5	0.6 -1.5	1.6 -3.5	>3.5	Total
N		1.61	0.78	0.00	2.38
NNE		0.83	0.37	0.00	1.19
NE		3.17	1.47	0.05	4.67
ENE		0.41	0.14	0.00	0.55
E		1.10	0.69	0.00	1.79
ESE		0.50	0.37	0.00	0.87
SE		1.28	0.41	0.05	1.74
SSE		0.64	0.18	0.00	0.82
S		0.41	0.09	0.00	0.50
SSW		0.28	0.05	0.00	0.32
SW		2.29	0.60	0.00	2.88
WSW		1.06	0.41	0.00	1.47
W		8.99	2.48	0.00	11.45
WNW		1.24	1.01	0.00	2.24
NW		11.47	4.22	0.05	15.71
NNW		2.11	0.73	0.00	2.84
CALM	48.40	-	-	-	48.40
Total	48.40	37.32	13.97	0.15	100

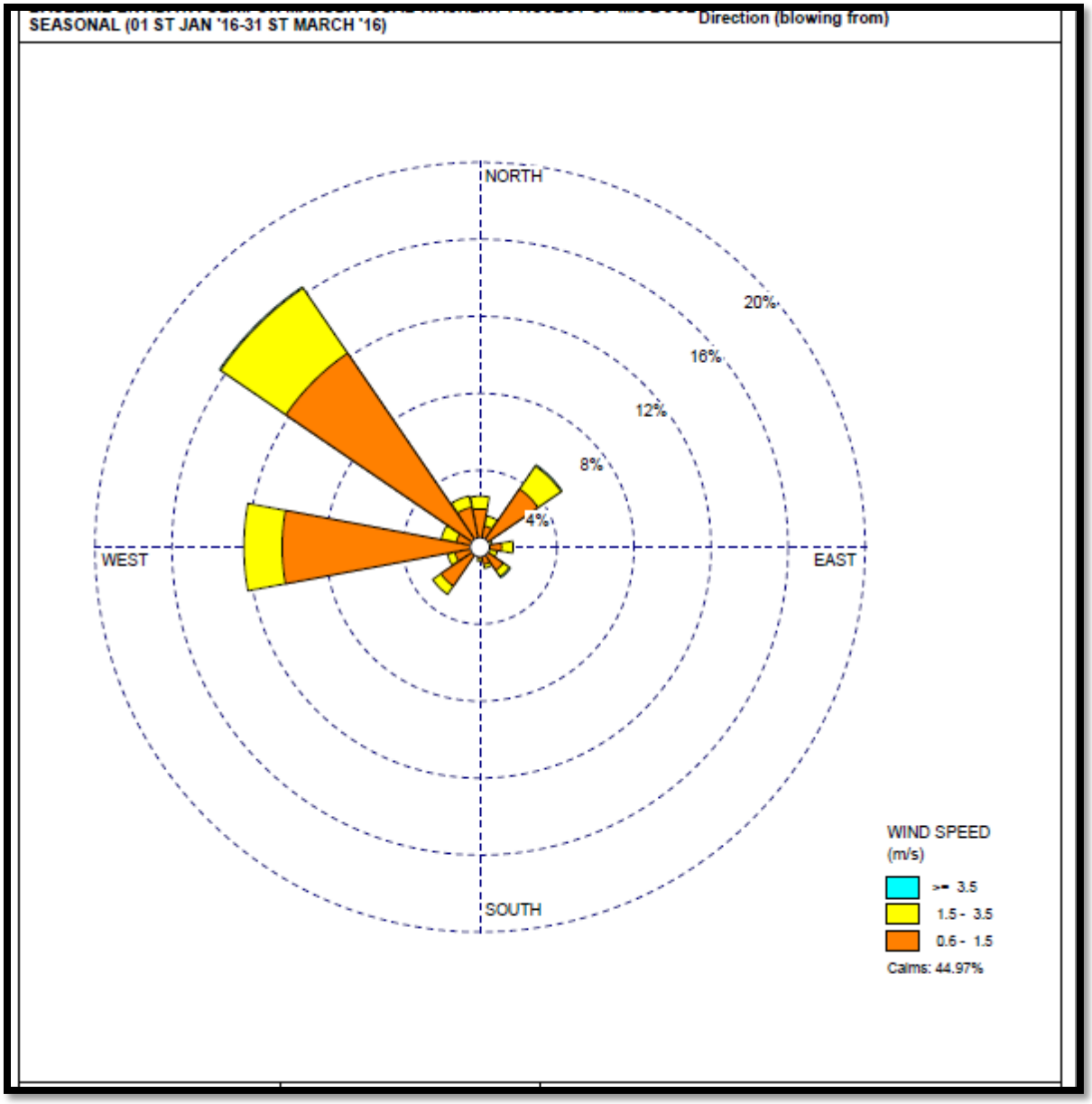


Figure No.-1.1 Wind Rose diagram for the period 1St Jan to 31St March 2016

Chapter – II

Fugitive Dust Generation Due To Movement of Coal

2.1 Introduction

The coal produced moves to the consumers via Road & Rail. Coal from the mine face is brought to the surface dumps and bulk of it goes to the nearby railway sidingsfor further movement to the consumer- end through rail. The journey from the mine face to the railway siding is covered by road. A portion of the coal produced by the mine directly goes to the consumers via road. Transportation of coal by rail is an environmentally better option than the road transportation. Road Transportation results in generation of fugitive dust from road surface apart from other pollutants released due to consumption of Diesel.

The fugitive dust generated due to coal transportation through road depend upon the following factors:

1. Speed and Weight of the moving vehicles.
2. Silt Content of the Road Dust (Particles less than 200 mesh size is considered as silt)
3. Silt loading of the road dust (Kg/m^2).
4. Moisture Content of the dust lying on the road surface.
5. Ambient Temperature, Humidity & wind velocity.

The dust generation will be lower if the quantity of dust (silt loading) lying on the road surface is minimum and the moisture content of the loose material lying on the road surface is high.

2.2 Movement of Coal

Distance travelled by coal and subsequent release of fugitive dust during its journey towards the consumer end has been describedand dust load has been worked out for the year 2013-14, 2014-15 and 2015-16.

2.2.1 Amalgamated Dahibari Basantimata Colliery :

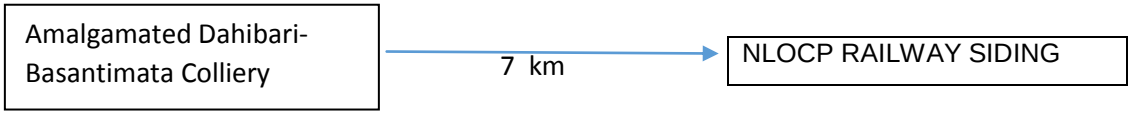


Table: 2.1 Dust Generation (Kg/day)

Name of the Mine	Year	Location	Distance from Face to Siding (Km)	Coal Transferred(Te)	Daily Coal Production (Te/Day)	Capacity of the Dumper	Vehicle Kilometer Travelled	Emission Rate for PM 10 (kg/VKT)	Pollution Load * Dust Generated Per Day (Kg/day)	Dust generated Kg/per tonne
Amalgamated Dahibari-Basantimata Colliery	15-16	NLOCP RAILWAY SIDING	7.00	1084000	3285.00	20.00	2299.50	0.53	1218.735	
		Total for 15-16			**3285.00**				**1218.735**	0.37

* In terms of PM 10 expressed as kg/day, ** Average distance has been considered, *** Capacities of Dumpers used in transportation of coal from face to siding taken as 30Te, to Washery 20Te, and Outside Transport 15 Te. ..## Emission rate for PM_{10} has been taken from the S&T work (funded by MoC) carried out by CMPDI during 2002-2007.

2.3 Optimum Coal Transportation scheme in the Present Scenario:

Phase – I (for 10 + 05 Years)

As suggested by the Environmental Appraisal Committee, it is proposed to continue the existing Road–Rail transport network system in view of the implementation of the Jharia Action Plan(JAP) for 10 years and another 05 years gestation period after the completion of the JAP for consolidation of the backfilled dug out fire areas and unstable areas is required. Thus the period of 15 years, make the Phase – I. All mitigation measures like covered trucks, green belting on either side of the road, enhanced water sprinkling, proper maintenance of roads, removal of spilled materials etc shall be adopted for 15 years with the existing road – rails transport system.

2.4 Conceptual Plan of Proposed Integrated Coal Transportation Network forthe Cluster:

Phase – II (after 15 Years):

As suggested by the EAC Members, BCCL shall implement conveyor –cum-rail transport to avoid movement of trucks within the cluster for coal transportation in Phase –II. Loading of coal by pay–loaders shall be discontinued.

During 2015-16, the combined daily coal production of the Cluster was 1084000 tones resulting in 402164 kg of daily fugitive dust generation. The dust (PM-10) generation rate at present is 0.37 kg/te.

As a result of replacement of existing road transportation of coal by Conveyor to railway siding will result in reduction of fugitive dust generation to the extent of 220689 kg/day for daily coal production of 594848 tonnes (1.963 MTY) during Phase –II.

Table 2.2: Proposed Infrastructure for Coal Transportation (phase – II)

Cluster	Mines in Operation in Phase - II	Production Capacity (MTY)	Proposed Transport Infrastructure in Phase – II
XVI	Amalgamated Dahibari Basantimata **Colliery**	**1.963**	**Coal transport by Conveyor to Railway Siding**
	Total	**1.963 MTY** = **594848** tonnes /Day	

2.5 Conclusion:

On the basis of the study undertaken to assess the impact of coal transportation on pollution load, the followings may be concluded:

Phase – I :(2013-14 to 2028 -29) :

1. During Phase – I, business as usual(BAU) scenario will prevail and the existing road cum rail transport network system will be used for coal dispatch to the consumers. During 2015-16, the combined daily coal production of the Cluster was 1084000 tones resulting in 402164 kg of daily fugitive dust generation. The dust (PM-10) generation rate at present is 0.37 kg/te.
2. The generation of fugitive dust due to transportation of coal by road can be further reduced by enforcing covering of loaded trucks, periodical removal of loose materials lying on the road surface and black topping of coal transportation roads.
3. Avenue plantation, effective wetting of the road surface and proper maintenance of roads will further result in mitigation of the impact of road generated dust on ambient air quality.
4. Better road condition, by the use of Mechanical Sweeper or vacuum cleaner dust generation may be minimized.

Phase – II :(From 2029-30 Onwards):

1. As a result of replacement of existing road transportation of coal by Conveyor to railway siding will result in reduction of fugitive dust generation to the extent of 220689 kg/day for daily coal production of 594848 tonnes (1.963 MTY) during Phase –II.
2. During Phase –II, dust load will further reduce due to quenching of mine fire and domestic coal consumption after resettlement of general population dwelling within the command area of cluster, as a result of implementation of Jharia Action Plan. It will result in significant improvement in ambient air quality.

3. **Coal Production Vs. Dust Generation due to Road Transportation is presented below:**

Table2.3: Coal Production Vs. Dust Generation due to Road Transportation

Year	Coal Production (Te/day)	Dust Generation(Kg/Day)
2015-16 (By Road transportation)	1084000	402164
2029-30 (Considering peak production and all the coal transported through Road)	594848	220689
2029-30(By Conveyor Transportation)	594848	0

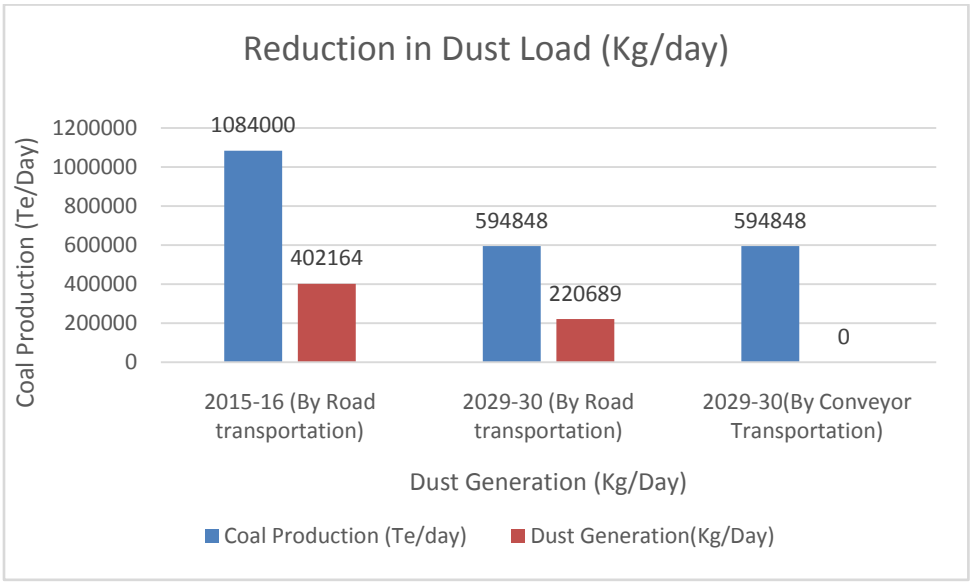


Figure 2.1: Presentation of reduction in dust generation due to replacement of Road transportation by Conveyor system.

Annexure 18

CSR, R&R AND TRANPORTATION PLAN OF

CLUSTER-XVI, BCCL

As per

EC condition (Specific Condition :37) The Details of transportation, CSR, R&R and implementation of environmental action plan for the clusters-XVI should be brought out in a booklet form within a year and regularly updated.

FY 2018-19

INTRODUCTION

Coal India has adopted CSR as a strategic tool for sustainable growth. For Coal India in the present context, CSR means not only investment of funds for Social Activity but also Integration of Business processes with Social processes. Even much before the issue of CSR became global concern; Coal India was aware of its Corporate Social Responsibility and was fulfilling the aspiration of the Society through well-defined "Community Development Policy" within the periphery of 8 Kms. of the Project sites. This has resulted into a harmonious relationship between Coal India and the peripheral Communities.

Coal India has identified land oustees, PAP and those staying within the radius of 25 Kms of the Project as primary beneficiaries. Poor and needy section of the society living in different parts of India are second beneficiaries. For carrying out CSR activities, 80% of the budgeted amount are be spent within the radius of 25 Km of the Project Site/Mines/Area HQ/Company HQ and 20% of the budget to be spent within the States in which operating.

SCOPE

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

i) Eradicating hunger, poverty and malnutrition, promoting healthcare including preventive health care and sanitation and making available safe drinking water.

ii) Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly, and differently abled and livelihood enhancement projects;

iii) Promoting gender equality, empowering women, setting up homes and hostels for women and orphans, setting up old age homes, day care centres and such other facilities for senior citizens and measures for reducing inequalities faced by socially and economically backward groups;

iv) Ensuring environmental sustainability, ecological balance, protection of Flora and Fauna, animal welfare, agro-forestry, conservation of natural resources and maintaining quality of soil, air and water;

v) Protection of national heritage, art and culture including restoration of buildings and sites of historical importance and works of art; setting up public libraries, promotion and development of traditional arts and handicrafts;

vi) Measures for the benefit of armed forces veterans, war widows and their dependents

vii) Training to promote rural sports, nationally recognized sports, Paralympics sports and Olympic sports;

viii) Contribution to the Prime Minister's National Relief Fund or any other fund set up by the Central Government for socio-economic development and relief and welfare of the Scheduled Castes, the Scheduled Tribes, other backward classes, minorities and women;

ix) Contributions or funds provided to technology incubators located within academic institutions which are approved by the Central Government;

x) Rural development projects

SOURCE OF FUND

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

ACTION PLAN FOR CORPORATE SOCIAL RESPONSIBILITY

When the EC was granted, it was estimated as per prevailing policy, 5% of the retained earning of the previous year subject to minimum of Rs. 5 per tonne of coal production of the previous year will be provided for Corporate Social Responsibility (CSR) . Since Normative Capacity of the Cluster XVI is

1.51 MT ,an amount to the tune of Rs. 75,55,000 will be used for the CSR works per year for Cluster-XVI.

The CV Area under the Bharat Coking Coal Limited is committed to good corporate citizenship and makes constant efforts to build and nurture long lasting relationships with members of the society in general and its peripheral communities in Particular.

CSR committee of CV Area

Sr. No.	Name	Designation	Post Hold
1	Sri. A. Banerjee	Addl. General Manager, CV Area	Chairman
2	Sri. B. Saha	Chief Manager (P)/APM, CV Area	Member
3	Sri. Trilok Meena	Area Manager (Civil), CV Area	Member
4	Dr. S. Sinha	MS, CV Area	Member
5	Sri. B. Chakrovorty	Area Manager (Finance), CV Area	Member

The EMP contained the following:

Sl. No.	HEAD OF WORKS	CSR expenditure to be done per year in Rs. lakhs					
		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
1	Education facilities including grant of schools, providing education kits, running of schools etc.	10.00	8.00	12.00	10.00	8.00	8.00
2	Water Supply and rain water harvesting works, wells, ponds, hand pumps and tube wells	20.00	22.00	18.00	20.00	22.00	22.00
3	Health Care and vaccination, awareness camp, mobile medical camp, Immunisation, medicine etc.	7.00	7.00	5.00	5.00	7.00	7.00
4	Environnent Protection i.e plantation etc.	10.00	8.00	10.00	8.00	8.00	8.00
5	Social Empowerment like Community centre, Literacy drive, shopping complex.	5.00	7.00	5.00	5.00	5.00	5.00
6	Infrastructure Development like road, bridge, repairing of school, drains, electric line etc.	10.00	12.00	14.55	15.00	14.00	14.00

7	**Sports Culture like village stadium village stadium, grant to village sports body, organizing sports meet**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
8	**Grant to NGO for community development**	**5.00**	**4.55**	**3.00**	**5.00**	**4.55**	**4.55**
9	**Miscellaneous welfare for adopted villages**	**5.55**	**4.00**	**5.00**	**4.55**	**4.00**	**4.00**
	TOTAL	**75.55**	**75.55**	**75.55**	**75.55**	**75.55**	**75.55**

CURRENT STATUS

Healthcare: Annual CSR (Healthcare) Expenditure for the year 2018-19

I. Mobile Medical Van (MMV):

SN	Month	No. of Mobile Medical Van Camp	Beneficiaries
1	April'16	1	18
2	May'16	1	10
3	June'16	1	14
4	July'16		
5	August'16		
6	September'16		
7	October'16		
8	November'16		
9	December'16		
10.	January'17		
11.	February'17		
12.	March'17		
	Total =	3	42

II. General Medical Camps (2018-19):

SN.	Month	No. of General Medical Camp	Beneficiaries	Amount (in Rs.)
1	April'16	1	36	2000
2	May'16	1	57	2000
3	June'16	3	262	2000
4	July'16	2	193	2000
5	August'16	2	176	2000
6	September'16	1	63	2000
7	October'16	1	63	2000
8	November'16	1	49	2000
9	December'16			
10	January'17	2	123	4000
11	February'17	1	59	2000
12	March'17			
	Total =	**15**	**1081**	**22000**

III. Health Awareness Programmes (2018-19):

SN	Date	Activities	Amount (in Rs.)
1.	1.12.2018	World Aids Day	1,15,000/-
2.	27.02.2019	Blood Donation Camp	9,500/-

IV. CSR Clinics (2018-19):

Sr. No.	Month	No. of Beneficiaries
1	April'18	36
2	May'18	57
3	June'18	262
4	July'18	193
5	August'18	176
6	September'18	63
7	October'18	63
8	November'18	49
9	December'18	
10	January'19	123
11	February'19	86
12	March'19	102

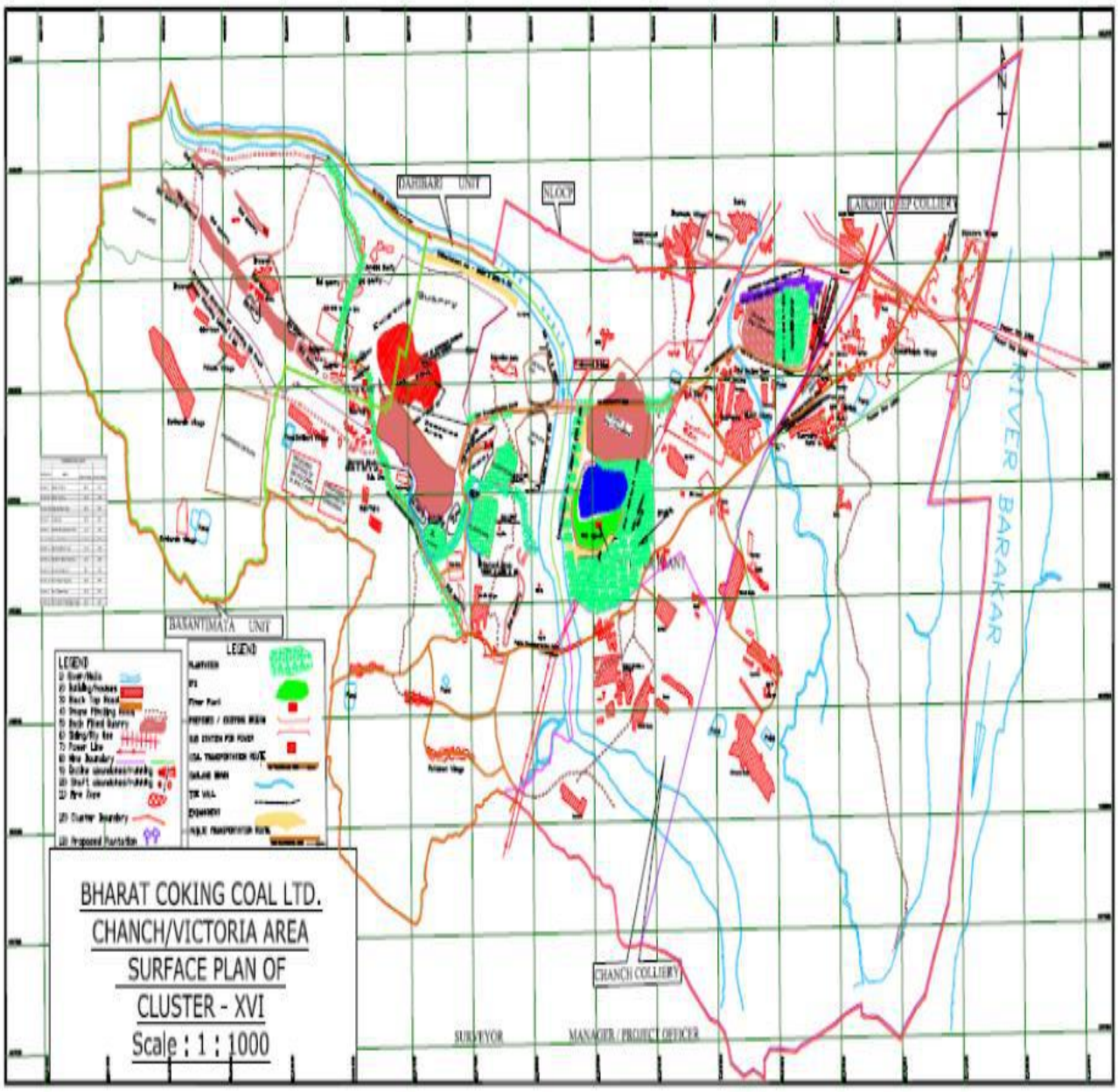
EDUCATION
School Grants (2018-19):

Sr. No.	Name and allocation of Private Committee Managed School	No. of eligible teachers for getting financial assistance	Under Graduate Rs. 5000/- PM/PT	Graduate Rs 5500/- PM/PT	Graduate with BT Rs 6500/- PM/PT	Graduate with B. Ed Rs 7000/- PM/PT	Total amount of financial assistance for 2018-19 (In Rs.)
1	Adarsh Primary School, Dahibari	2	1	1	0	0	126000
2	U.P. School Laikdih, CMWO Colony	3	2	1	0	0	186000
3	U.P. School, Chanch	2	2	0	0	0	120000
4	Prathmik Vidhyalay, Laikdih Deep	2	1	1	0	0	126000
						Total	558000/-

TRANSPORTATION PLAN

Proposed Reduction in Transport-Distance for Phase-I as presented to EAC

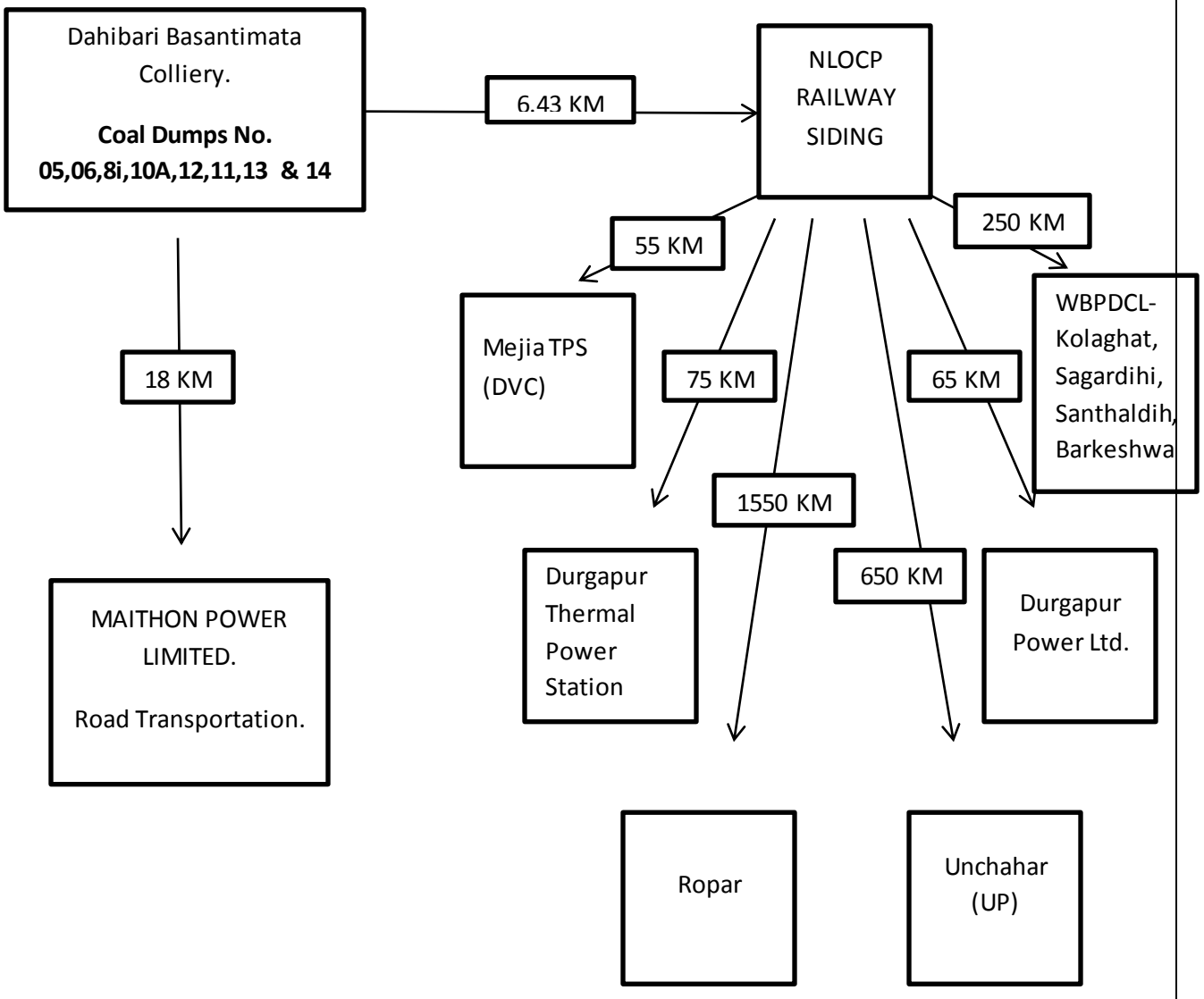
The Phase-I is applicable up to 5years after implementation of Master Plan is completed.



1. Name of the Cluster : CLUSTER XVI
2. Name of the mines of the Cluster: Dahibari-Basantimata Colliery
3. Annual Coal Production : 1.96 MTPA

Name of the Mine	2015-16	2016-17	2017-18	2018-19
Dahibari-Basantimata Colliery	1.185 MT	1.084 MT	1.299 MT	1.527 MT

4. Diagram showing the lead distance from the coal dumps to the railway sidings and other consumers:



5. Coal Dispatch of Cluster-XVI :

Name of the Mine	year	Location	Distance from face to siding (km)	Coal Transferred (in tonnes)	Daily coal Production	Average capacity of the dumpers
Dahibari Basantimata Colliery.	2015-16	NLOCP SIDING	3.5 KM	1279860	2800 Te	30 Te
	2015-16	Road Transport	-----	42583		20 Te
Dahibari Basantimata Colliery.	2016-17	NLOCP SIDING	4.0 KM	947615	3300 Te	30 Te
	2016-17	Road Transport	------	28680		20 Te
Dahibari Basantimata Colliery.	2017-18	NLOCP SIDING	4.0 KM	115520	3500 Te	30 Te
	2017-18	Road Transport	-----	23600		20 Te
Dahibari Basantimata Colliery.	2018-19	NLOCP SIDING	4.0 KM	1482575	4100 Te	30 Te
	2018-19	Road Transport	-----	28600		20 Te

REHABILITATION AND RESETTLEMENT PLAN

The cluster of mines will be dovetailed with the approved Jharia Action Plan for dealing with fire, subsidence and rehabilitation of people. Master Plan for dealing with fire, subsidence and rehabilitation within the leasehold area of BCCL has already been approved by Government of Jharkhand & Government of India. Out of 595 unstable sites identified in the Master Plan, 51 sites consisting of 7012 no. of houses are affected in this cluster. The affected families will be rehabilitated in adjacent non-coal bearing area at a cost of Rs. 26273.69 lakhs.

Requirement of land at Resettlement site:

A) For BCCL houses

The BCCL houses will be resettled in satellite townships with equivalent type of houses in triple storey building. The weighted average plinth area of the houses proposed to be rehabilitated has been estimated at 48.09 sq m /house. Considering the amenities, infrastructure, internal roads etc. to be provided in the township, requirement of land for BCCL houses has been estimated at 34.30 Ha. (@ 160 m^2 /House)

B) For Non BCCL Houses

(i) Private (Authorised)

Head of every family will be provided a plot of land measuring 100 sq.m. Considering the amenities, infrastructure, internal roads etc to be provided in the township, requirement of land for private authorized houses has been estimated at 82.94 Ha. (@ 270 m^2 /house)

(ii) Private Houses (Encroachers)

Encroachers will be provided with a house constructed on about 27 sq.m land in triple storied building in the resettlement site. However provision of 11 sq . m of land has been considered for construction of another room in future . Considering the amenities, infrastructure, internal roads etc to be provided in the township, requirement of land for encroachers has been estimated at 22.74 Ha. (@ 130 m^2/house)

CURRENT STATUS

SHIFTING OF BCCL EMPLOYEES:

A total of 420 No. of houses construction has been completed and BCCL families is being shifted.

REHABILITATION AND RESETTLEMENT

As per the Action plan for rehabilitation , the demographic survey has been conducted by the JHARIA REHABILITATION & DEVELOPMENT AUTHORITY and they have completed the said survey in respect of the following sites:-

Sl.	*Name of the site*	*No. of house surveyed*
1	*Nutungram*	*776*
2	*Jograd Bastee*	*161*
3	*Yadavpur Luchibai*	*362*
4	*Bautdih 2*	*118*
5	*Reliance Factory*	*766*
6	*Dumurkonda Co's quarter*	*210*
7	*Dumurkonda Village*	*1804*
8	*Manjhi Bastee*	*108*

Besides the above the BCCL management is taking action to rehabilitate 5 houses at Kalyanchak Bastee for their rehabilitation at the Non coal bearing area.

23/5/15
Area Manager (Estate)
C V Area, BCCL

Environmental Action Plan

To improve and maintain the environment following action is being taken:-

1. **Air Quality:-**

Drilling operation:-

- All the drills are equipped with well-designed dust extractor arrangement.

Blasting operation

- Controlled blasting is being done in daytime during the shift change over period.

Loading and transport

- Frequent and at regular intervals, water is be sprayed on haul roads, service roads. Mobile water sprinklers of 28 KL capacity have been provided in the project.

- Regular maintenance of HEMM engines to limit emission of harmful exhaust fumes.

- Optimal loading of coal transport vehicle is being ensured.

Coal handling

- Fixed nozzle sprinkler has been installed & maintained for dust suppression at CHP & Mobile Crusher.

Firefighting

- Exposures of coal benches for long time are being avoided.
- Provision of adequate firefighting arrangements including storage of sufficient quantity of water at all critical points is being done.
- Careful removal of all loose coal from the abandoned coal faces is being done.
- Regular supervision is being done.

2. Water Quality

- The mine discharge is being effectively utilized to meet the mine's domestic and industrial needs. The entire industrial and domestic water demand of the Cluster-XVI mines has been met from treated mine water of UGP and OCP.
- The abandoned mine workings behave as water pool and improves the resources availability in the area.
- The construction of surface tanks and de-siltation/deepening of existing ponds in the local villages are being done to enhance the water availability of nearby area.
- Mine water is being utilized for irrigation purposes which will also enhance the groundwater recharge potential through artificial recharge of the area.
- Drinking water is being supplied to nearby villages through pipeline network.
- The discharge mine water has been gainfully utilized for the Industrial and domestic requirement. Thereby the mine water, from existing mines in the area, is a resource for local villages.

-The excess mine water is being discharged to local Nalas to recharge groundwater system.
- Plantation is being done on regular basis.

3. Noise pollution control

- Proper designing of plant & machinery by providing in-built mechanisms like silencers, mufflers and enclosures for noise generating parts and shock absorbing pads at the foundation of vibrating equipment.

- Routine maintenance of equipment.

- Rational deployment of noise generating plant and machinery.

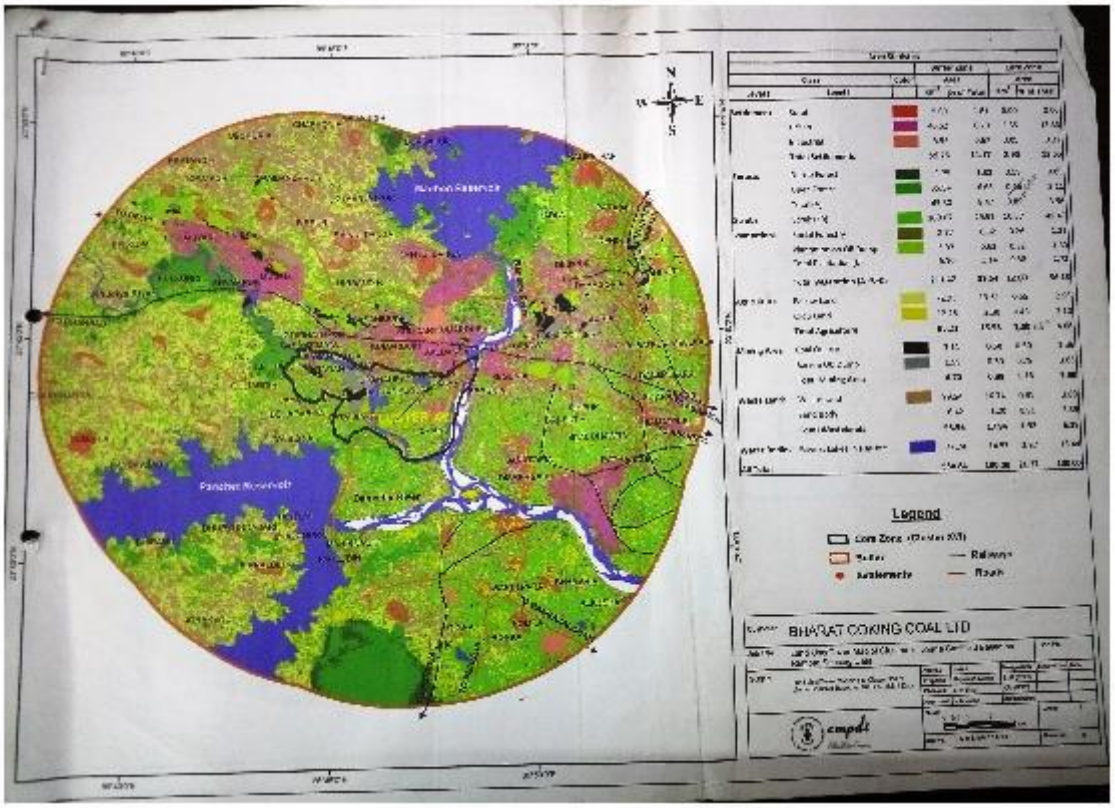
-Greenbelts around the quarry, infrastructure sites and service building area besides avenue plantation on both sides of the roads.

- HEMMs with sound proof cabins.

- Personal protective devices to all the persons working in high noise areas.

- Regular monitoring of noise levels at various points.

Annexure 19



F-20A

Annexure 20

त कोकिंग कोल लिमिटेड
इंडिया लिमिटेड का एक अंग)
कोयला भवन/ कोयला नगर,
धनबाद -826005
ष :0326-2230190/ फ़ेक्स-0326-2230050
ईमेल: cos@bccl.gov.in

Bharat Coking Coal Limited
(A Subsidiary of Coal India Limited)
Koyla Bhawan/ Koyla Nagar
Dhanbad-826005
Phone No. 0326-2230190/Fax-0326-2230050
email ID: cos@bccl.gov.in

बोर्ड सचिवालय /Board Secretariat

Extracts of Minutes of 300th Board Meeting held on 21.09.2013.

300.4N **Approval of Mine Closure Plan.**

Board after deliberation passed the following resolution:

Resolved that the proposal of Mine Closure Plan of the 20(Twenty) mines (as per the enclosed mine closure list vide enclosure 'A') including the total closure cost of ₹ 27980.77 Lakh (Rupees two hundred seventy nine crore eighty lakh and seventy seven thousand only) to be deposited in "Escrow Account" under Revenue head be and is hereby approved.

Further resolved that the said 'Escrow Account' will be opened in accordance with the guidelines issued by D(F),CIL vide letter No.168/96 dated 26.06.2013 and 168/98 dated 28.06.2013 (copy attached vide enclosure-'B') be and is hereby approved.

Certified to be True Copy

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

Board Rs 16/10

भारत कोकिंग कोल लिमिटेड
(कोल इंडिया लिमिटेड की अनुषंगी इकाई)
योजना एवं परियोजना विभाग
कोयला भवन, कोयला नगर, धनबाद
धनबाद– 826005

पत्रांक : बी.सी.सी.एल/ महाप्रबंधक (यो. ए. परि.)/फ-76 /13/ 669 (H) दिनांक :-23.12.2013

सेवा में

महाप्रबंधक

बरोरा, गोविन्दपुर, सिजुआ, कुसुंडा, पी बी, बस्ताकोला, ई जे, सी वी एरिया

बी सी सी एल.

विषय: Implementation of Mine Closure Plan.

महोदय,

The Mine Closure Plan of following mines under the administrative control of your Area has been approved in 300th & 301st BCCL Board held on 21.09.2013 & 30.10.2013. As per the implementation protocol duly approved in the above stated Board as a part of approved Mine Closure Plan of the concerned colliery; the Area CGM/GM has been defined as the implementing authority of the mines for which the Mine Closure Plan has been approved.

Sl.No.	Name of the mine whose Mine Closure Plan has been appropved	Name of the Area	Approved in Board
1	Damoda Group of Mine	Barora	301st BCCL Board
2	Muraidih-Shatabdi Group of Mine	Barora	300th BCCL Board
3	Jogidih Colliery	Govindpur	300th BCCL Board
4	Kharkharee Colliery	Govindpur	300th BCCL Board
5	New Akashkinaree Mine	Govindpur	300th BCCL Board
6	Block-IV/Kooridih Mine	Govindpur	300th BCCL Board
7	Govindpur Colliery	Govindpur	300th BCCL Board
8	Maheshpur Colliery	Govindpur	300th BCCL Board
9	Nichitpur Colliery	Sijua	300th BCCL Board
10	Loyabad Colliery	Sijua	300th BCCL Board
11	Mudidih Colliery	Sijua	300th BCCL Board
12	Sendra Bansjora Mine	Sijua	300th BCCL Board
13	Tetulmari Colliery	Sijua	300th BCCL Board
14	Kusunda OCP	Kusunda	301st BCCL Board
15	Gondudih Khas Kusunda OC	Kusunda	301st BCCL Board
16	East Bassuriya OC	Kusunda	301st BCCL Board
17	Bhutgoria UG	PB	300th BCCL Board
18	Gopalichak UG	PB	300th BCCL Board
19	Hurriladih UG	PB	300th BCCL Board

Sl.No.	Name of the mine whose Mine Closure Plan has been appropved	Name of the Area	Approved in Board
20	Burragarh UG	PB	300th BCCL Board
21	Simlabahal UG	PB	300th BCCL Board
22	Bera Colliery	Bastacolla	301st BCCL Board
23	Kuya Group of Mines	Bastacolla	301st BCCL Board
24	Bastacolla Colliery	Bastacolla	301st BCCL Board
25	Bhowrah North Group of Mine	EJ	301st BCCL Board
26	Patherdih Group of Mine	EJ	301st BCCL Board
27	Sudamdih Incline Mine	EJ	301st BCCL Board
28	Bhowrah South Group of Mines	EJ	300th BCCL Board
29	Basantimata Colliery	CV	300th BCCL Board
30	Dahibari Basantimata OCP	CV	300th BCCL Board

Two copies of Mine Closure Plan of the above listed mines of your Area is sent to you herewith for its implementation as per the procedure mentioned in the book.

भवदीय

संलग्नक: यथोपरि

23/12/13

(टी के बन्दोपाध्याय)
महाप्रबंधक (योजना एवं परियोजना)

Annexure 21

भारत कोकिंग कोल लिमिटेड
एक मिनिरत्न कम्पनी
(कोल इंडिया लिमिटेड का एक अंग)
महाप्रबंधक का कार्यालय,
चॉच विक्टोरिया क्षेत्र
पि. ओ.- बराकर, जिला - पं.बर्धमान (पं. बंगाल)
पिन - 713324, दूरभाष - 0341-2520061/62,
पंजीकृत कार्यालय: कोयला भवन, कोयला नगर,
धनबाद- 826005, (झारखण्ड)
CIN: U10101JH1972GOI000918

Bharat Coking Coal Limited
A MINI RATNA Co.
(A Subsidiary of Coal India Ltd)
Office of the General Manager,
Chanch Victoria Area
P.O.-BARAKAR, DIST-PAS.BARDHAMAN (W.B.)
PIN- 713324, Tel. 0341-2520061/62
Regd.Off. Koyla Bhawan, Koyla Nagar, Dhanbad-826005.
CIN: U10101JH1972GOI000918.

Ref. No.: BCCL/CV/GM/OO/2018/ 191

Date: 27.10.2018

OFFICE ORDER

An Environment Management CELL of Chanch Victoria Area is hereby constituted with following member:

1.	General Manager, CV Area	---- Chairman
2.	Addl. General Manager, CV Area	---- Vice-Chairman
3.	Area Manager (Envt), CV Area	---- Member
4.	Area Manager (Planning), CV Area	---- Member
5.	Area Manager (Finance), CV Area	---- Member
6.	Area Manager (E&M), CV Area	---- Member
7.	Area Manager (Safety), CV Area	---- Member
8.	Area Manager (Survey), CV Area	---- Member
9.	Area Manager (EXCVN), CV Area	---- Member
10.	Area Manager (Civil), CV Area	---- Member

Environment Management Cell will monitor advice and co-ordinate with Project Officers for ensuring the compliances of conditions imposed in Environment Clearance and statuary consents issued by MoEF&CC and State Pollution Boards respectively.

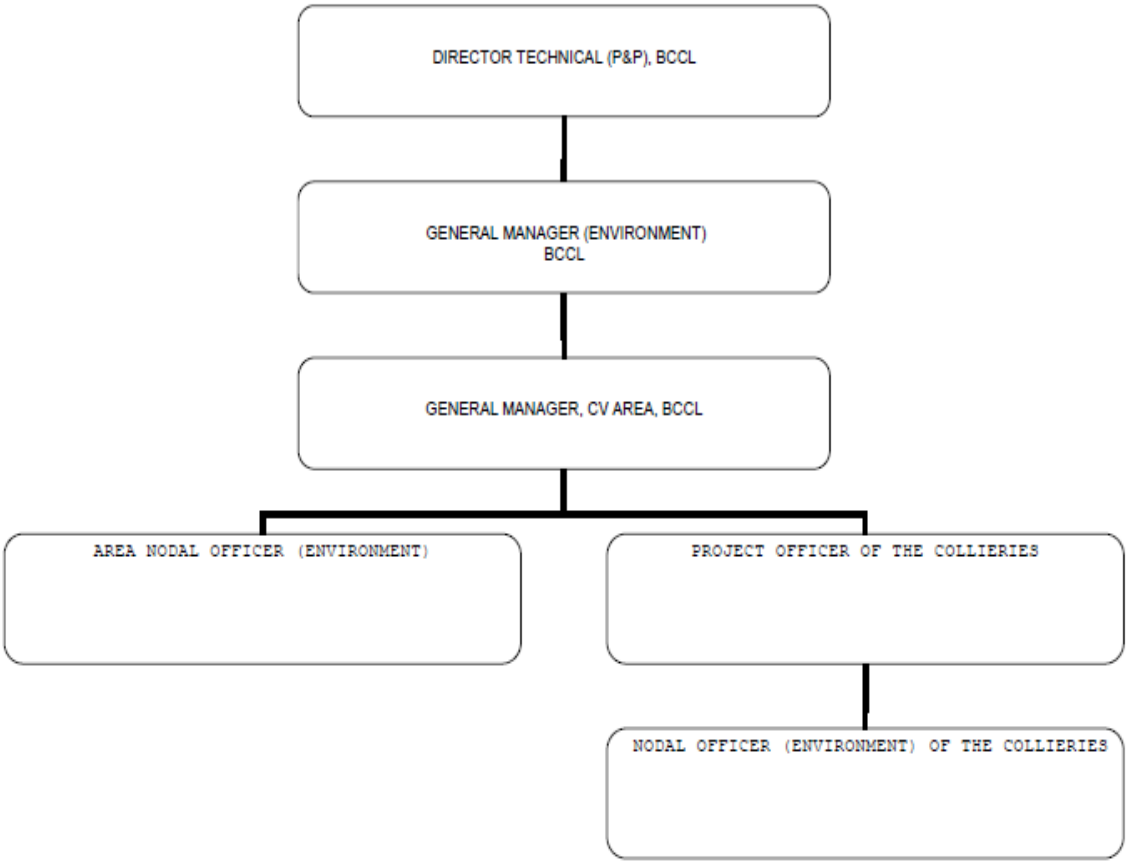
General Manager
CV Area

Distribution:

1. Dy.GM(Env.) BCCL, Koyla Bhavan
2. Project officer, DBOCP/DOCP.
3. Executive Concerned
4. Office Copy.

204
30/10/18

Fig 17 ORGANIZATION CHART



भारत कोकिंग कोल लिमिटेड
(कोल इण्डिया लिमिटेड का एक अंग)
BHARAT COKING COAL LIMITED
(A Subsidiary of Coal India Limited)

टिप्पणी–पत्र
Noting – Sheet

विभाग / Department : Environment
अधिकारी का नाम / Name of Officer :
संदर्भ Ref: BCCL/Dy.GM(Env.)/F-EC/19/ 67/N
दिनांक Date : 08-05-2019

विषय / Subject : **Implementation of internal monitoring mechanism for compliance of environmental conditions.**

In the Workshop held on 03rd April 2019, on the issue related to streamlining of EC/FC pertaining to CIL and its Subsidiaries, Secretary Coal, directed coal companies to have an internal monitoring mechanism also for compliance of environmental conditions which will help in timely grant of clearances.

Copy of Minutes enclosed as Annexure -1

Accordingly a proposal was placed by DT, CIL in 127th meeting of CMDs held on 14.04.2019 at Sl no 15.0. After detailed deliberations, CMDs accorded its approval for implementation of internal Monitoring mechanism at subsidiary & CIL level.

Copy of Minutes along with agenda note is enclosed as Annexure -2

In accordance of approved internal Monitoring mechanism, It is proposed to make following scheme of inspection:

Inspecting Area	Area to be Inspected	Composition of team
Barora Area	Katras Area	1. AM(Environment)-Team leader
Block-II Area	Govindpur Area	2. AM(Planning)-Member
Govindpur Area	Barora Area	3. AM(Civil)- Member
Katras Area	Sijua Area	4. AM(Excavation)- Member
Sijua Area	Block-II Area	5. AM(E&M)- Member
Kusunda Area	Bastacolla Area	6. AM(Pers)- Member
Bastacolla Area	Jodna Area	7. AM(Safety) - Member
Jodna Area	Kusunda Area	
PB Area	CV Area	
WJ Area	PB Area	
CV Area	WJ Area	

The Team will make inspection of all mines of the target Area and submit mine wise report to HoD(Env) within 07 days of inspection.

At Headquarters level, an Advisory Committee to Director (T) is proposed to be constituted in line with the approved mechanism. Proposed constitution of Committee is as under:

1. HoD(Env), BCCL- Team leader
2. GM(P&P) or Representative of senior level -Member
3. GM(Civil) or Representative of senior level -Member
4. GM(Excavation) or Representative of senior level -Member
5. GM(E&M) or Representative of senior level -Member
6. GM(CSR) or Representative of senior level -Member
7. GM(Safety) or Representative of senior level –Member
8. GM(Finance) or Representative of senior level –Member
9. GM(Material Management) or Representative of senior level –Member
10. CMS I/C or Representative of senior level –Member
11. RD-RI II or Representative of senior level –Member

The committee will meet quarterly to review environmental compliance and to make appropriate recommendation to Director Technical, BCCL

Competent authority is requested to approve the implementation scheme as proposed above.

Senior Manager (Min)

HoD/Dy.GM(Env) For kind approval as proposed above. N.

Director (T) P&P

Contd. .....

Annexure 24

COAL PRODUCTION FOR CLUSTER XVI, CV AREA BCCL

SL. No.	Name of mines	Production Capacity (MTPA)		Leasehold area (Ha)	Coal Production in MTe			
		Normative	Peak		2015-16	2016-17	2017-18	2018-19
1	Basantimata UG	0.21	0.273	471.00	0.051	0.044	0.0168	00
2	Dahibari Basantimata OCP	1.30	1.69	385.68	1.032	1.255	1.2583	1.527
3	New Laikdih OCP	00	00	305.10	00	00	00	00
4	Laikdih Deep UG	00	00	281.00	00	00	00	00
5	Chanch UG	00	00	575.73	00	00	00	00
Total Coal Prod. In MTe		**1.51**	**1.963**	**1964.21**	**1.185**	**1.084**	**1.299**	**1.527**

Project officer
DBOCP/NLOCP

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

(FOR THE MONTH OCTOBER, 2020)

E. C. no. J-11015/185/2010-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 noise levels were recorded in mining areas, washery areas and in residential areas.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_X). Respirable Dust Samplers (RDS) 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 optimized to restrict the dust generation.
- Transportation roads should be permanently asphalted free of ruts, potholes etc.
- Water should be sprayed on coal transportation road, service road more frequently and at regular interval.
- Dust from roads should be removed physically or mechanically.
- Greenbelts around industrial sites, service building area besides Avenue plantation along roads should be created.
- Coal dust should be suppressed by using fixed sprinklers.
- Regular maintenance of plant and machinery should be undertaken.

4.2 Water quality

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

4.3 Noise Level

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

INTRODUCTION

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

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

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

1.1 The Cluster-XVI is in the Western part of the Raniganj coalfield and situated in the C.V. area of BCCL. It includes a group of 5 Mines (viz. Dahibari Basantimata OCP, Basantimata UG, New Laikdih OCP, Laikdih Deep UG &Chanch UG). The Cluster – XVI is situated about 50 - 55 kms from Dhanbad Railway Station. The mines of this Cluster – XVI 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 River & Barakar River.

1.2 The Cluster-XVI is designed to produce 1.51 MTPA (normative) and 1.963 MTPA (peak) capacity of coal.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity 1.51 MTPA (normative) and 1.963 MTPA (peak) capacity of coal production vide letter no. J-11015/185/2010-IA.II (M) dated 06th February, 2013.

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

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

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

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

2.1.1 Ambient Air Quality Sampling Locations

I. CORE ZONE Monitoring Location

i) Dahibari OCP (A22): Industrial Area

The location of the sampling station is 23^{o} 43' 43.11''N 86^{o} 45' 5.00'' E. The sampler was placed at a height of 1.5m from above ground level of Substation Office.

ii) **Basantimata Colliery Office (A23): Industrial Area**

The location of the sampling station is 23^{o} 44' 0.24''N 86^{o} 44' 54.71'' E. The sampler was placed at Roof of Project Office.

II. BUFFER ZONE Monitoring Location

i) Gopinathpur village (A24): Residential Area

The location of the sampling station is 23^{o} 44' 57.21''N 86^{o} 44' 39.19'' E. The sampler was placed at a height of 1.5m from above ground level.

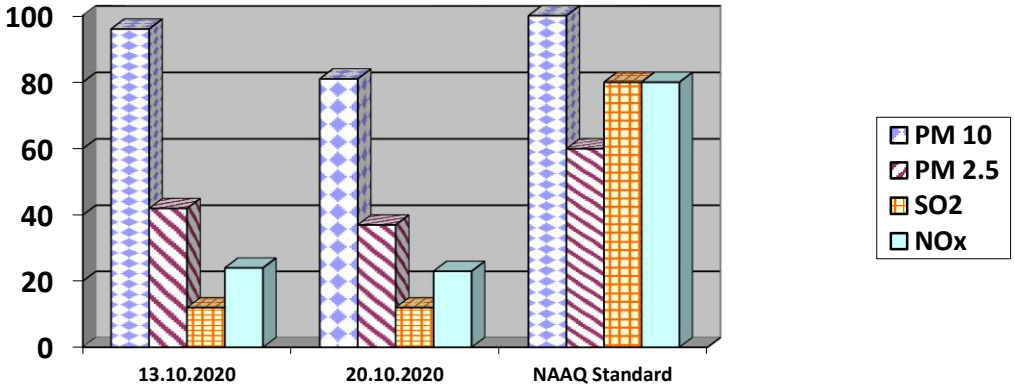
ii) Guliardih Village (A25): Residential Area

The sampler was placed at a height of 1.5m from above ground level.

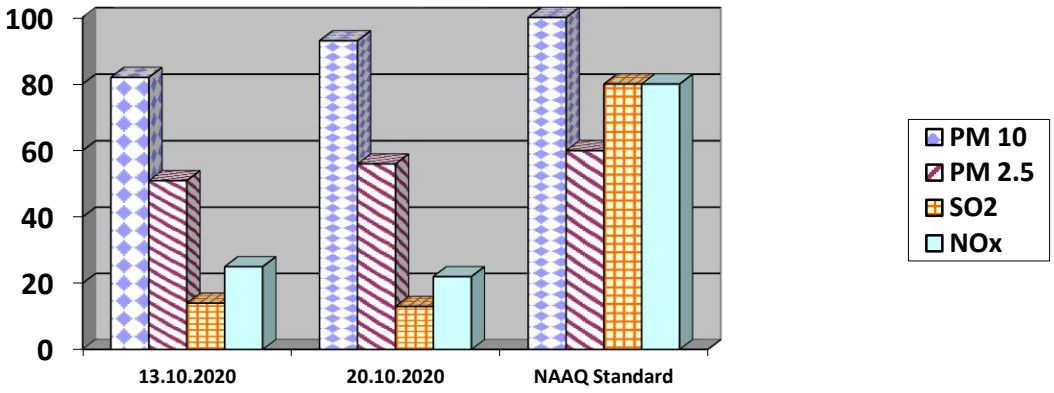
AMBIENT AIR QUALITY DATA

Cluster –XVI, Bharat Coking Coal Ltd Month: **OCT ,2020** Year : **2020-21.**

Station Name:A22, Dahibari OCP		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	13.10.2020	96	42	12	24
2	20.10.2020	81	37	12	23
	NAAQ Standard	100	60	80	80



Station Name: A23, Basantimata Office		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	13.10.2020	82	51	14	25
2	20.10.2020	93	56	13	22
	NAAQ Standard	100	60	80	80

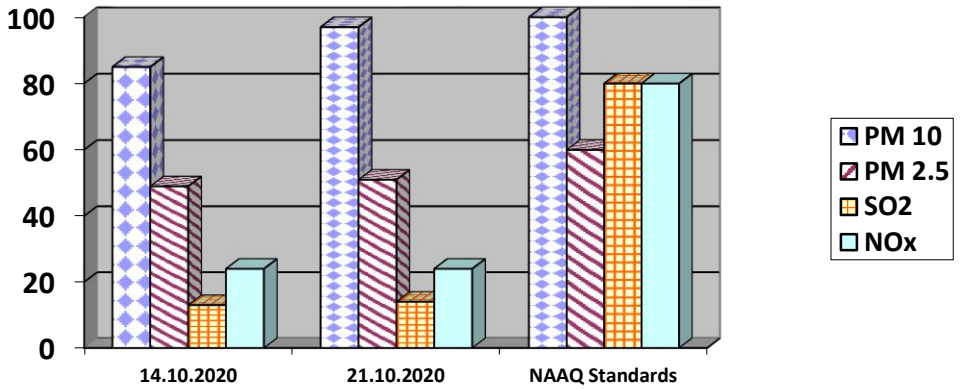


Analysed By
JSA/SA/SSA

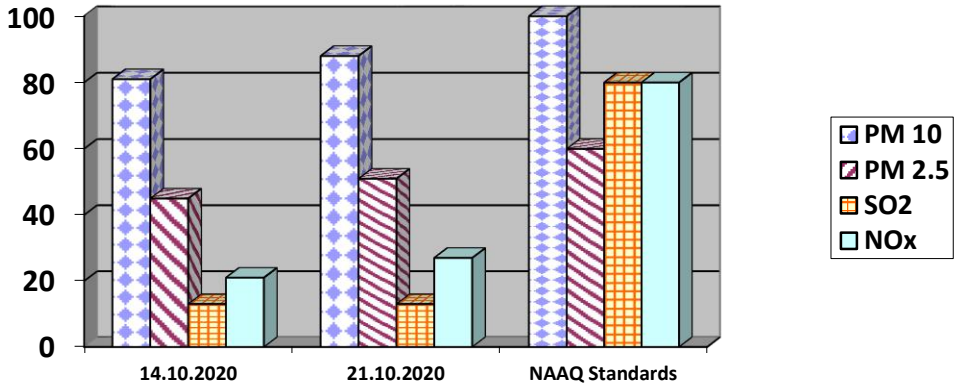
Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(In-charge) Environment
RI-2, CMPDI, Dhanbad

Station Name: A24, Gopinathpur village		Zone: Buffer		Category: Residential	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO2	NOx
1	14.10.2020	85	49	13	24
2	21.10.2020	97	51	14	24
	NAAQ Standards	100	60	80	80



Station Name: A25,Guliardih Village		Zone: Buffer		Category: Residential	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO2	NOx
1	14.10.2020	81	45	13	21
2	21.10.2020	88	51	13	27
	NAAQ Standards	100	60	80	80



- ***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 Dahibari (MW16)**

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

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analyzed 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 -XVI**		Month: **OCT, 2020**	Name of the Station: **Mine Discharge of Dahibari**	
Sl. No.	**Parameters**	**MW16** First Fortnight	**MW16** Second Fortnight	**As per MOEF General Standards for schedule VI**
		12.10.2020	19.10.2020	
1	Total Suspended Solids	35	40	*100 (Max)*
2	pH	7.65	7.55	*5.5 - 9.0*
3	Oil & Grease	<2.0	<2.0	*10 (Max)*
4	COD	32	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) **Dahibari OCP (N22)**
ii) **Basantimata UGP (N23)**
iii) **Gopinathpur village (N24)**
iv) **Guliardih Village (N25)**

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 -XVI**			Month: **OCT, 2020**		
Sl. No.	**Station Name/Code**	**Category of area**	**Date**	**Noise level dB(A)L_{EQ}**	***Permissible Limit of Noise level in dB(A)***
1	Dahibari OCP (N22)	Industrial area	13.10.2020	64.3	*75*
2	Dahibari OCP (N22)	Industrial area	20.10.2020	55.3	**75**
3	Basantimata UGP (N23)	Industrial area	13.10.2020	57.1	*75*
4	Basantimata UGP (N23)	Industrial area	20.10.2020	55.4	*75*
5	Gopinathpur village (N24)	Residential area	14.10.2020	52.7	*55*
6	Gopinathpur village (N24)	Residential area	21.10.2020	51.3	**55**
7	Guliardih Village (N25)	Residential area	14.10.2020	54.3	*55*
8	Guliardih Village (N25)	Residential area	21.10.2020	53.5	*55*

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 m^3
	Respirable Particulate Matter (size less than 10 µm) (RPM)	Annual Average * 24 hours **	250 µg/m^3 300 µg/m^3	Respirable Particulate Matter sampling and analysis
	Sulphur Dioxide (SO_2)	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1.Improvedwest and Gaeke method 2.Ultraviolet fluorescene
	Oxide of Nitrogen as NO_2	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1. Jacob &Hochheiser Modified (Na-Arsenic) Method 2. Gas phase Chemilumine-scence

Note:

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

** 24hourly/8hourlyvaluesshallbemet92%ofthetimeinayear.However,8% of the time it AUGUST exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th FEBRUARY 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 AUGUST 1994 and S.O.935(E), dated 14th October 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

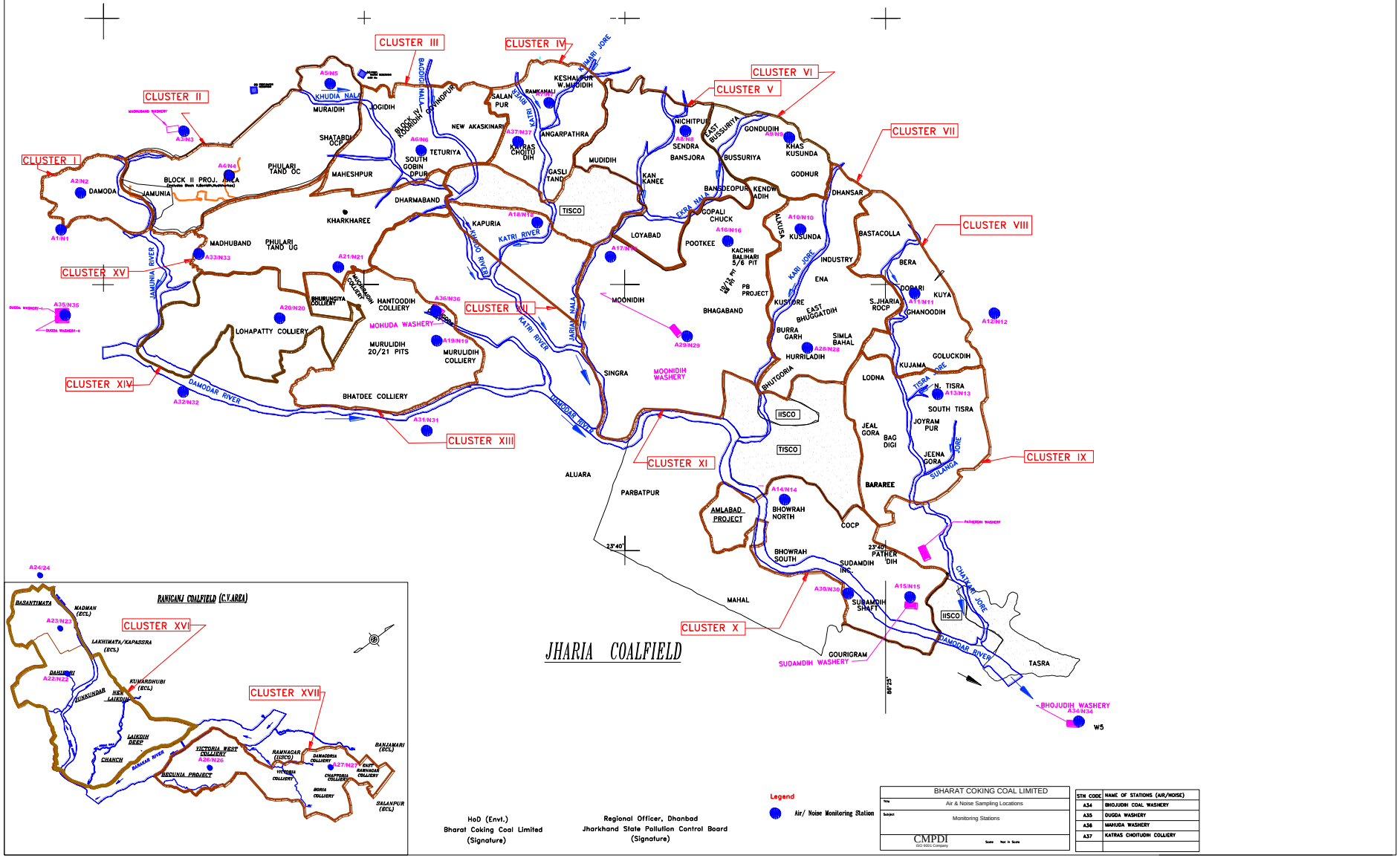
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet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

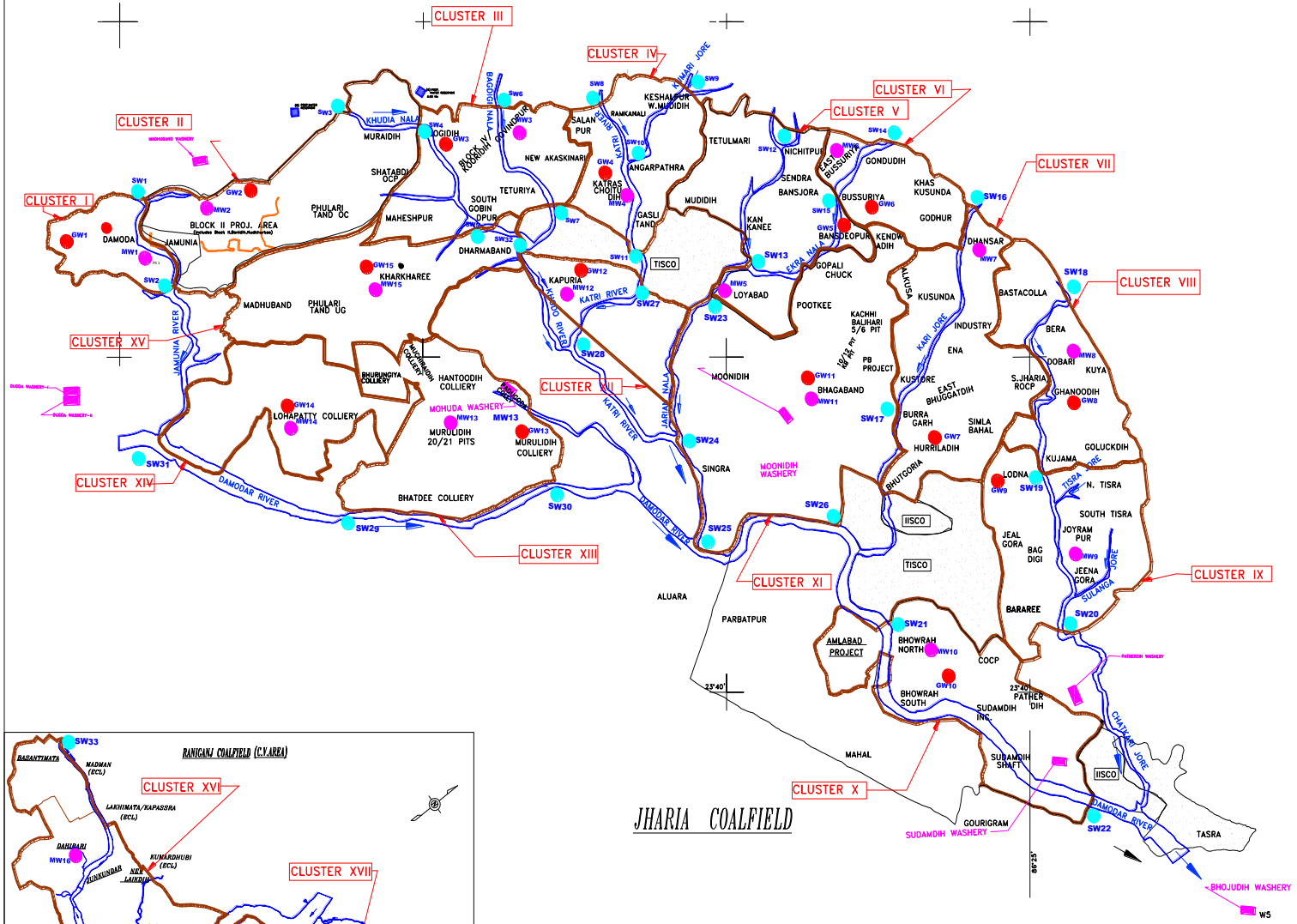
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they AUGUST exceed the limits but not on two consecutive days of monitoring.

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

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

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

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

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

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

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

Annexure 26

भारत कोकिंग कोल लिमिटेड
एक मिनी रत्न कम्पनी
(कोल इंडिया लिमिटेड का एक अंग)
महाप्रबंधक, सी.वि.क्षेत्र-XII का कार्यालय
(उत्खनन विभाग)
बराकर – 713324, पश्चिम बर्धमान, पश्चिम बंगाल
दूरभाष: 0341-2523113

BHARAT COKING COAL LIMITED
A Mini Ratna Company
(A Subsidiary of Coal India Limited)
Office of The General Manager, CV Area-XII
(Excavation Department)
Barakar-713324, Paschim Bardhaman,
West Bengal.
Ph.no.-0341-2523113

DETAILS OF DEPARTMENTAL VEHICLES AT CV AREA

Sl.no.	Vehicle no.	Make	Vehicle type	Road Tax valid upto	Insurance valid upto	Fitness	Remarks	P.C. No.
			Dahibari-Basantimata OCP					
1.	JH 10AN 0578	L&T	Scania tipper	08.12.2019	22.03.2020	Under process	A590/2017029575	
2.	JH 10AN 0471	L&T	Scania tipper	10.12.2019	26.11.2019	Under process	A590/2017029571	
3.	JH 10AN 2322	L&T	Scania tipper	10.12.2019	26.11.2019	Under process		A590/2017029580
4.	JH 10AN 3108	L&T	Scania tipper	29.12.2019	23.03.2020	Under process	A590/2017029572	
5.	JH 10AN 3230	L&T	Scania tipper	08.12.2019	22.03.2020	Under process	A590/2017029577	
6.	JH 10AN 6256	L&T	Scania tipper	28.09.2019	23.03.2020	Under process		A-590/2017029578
7.	JH 10AN 7572	L&T	Scania tipper	10.12.2019	26.11.2019	Under process	A590/2017029576	
8.	JH 10AN 8515	L&T	Scania tipper	07.12.2019	22.03.2020	Under process	A590/2017029579	
9.	JH 10AN 8565	L&T	Scania tipper	07.12.2019	23.03.2020	Under process		~~A590~~ A590/2017029571
10.	JH 10AN 8041	L&T	Scania tipper	29.12.2019	08.08.2020	Under process		A590/2017029574
11.	JH 10AN 5431	L&T	Scania tipper	29.12.2019	26.07.2020	19.07.2021		
12.	JH 10AN 8464	L&T	Scania tipper	29.12.2019	30.03.2020	19.07.2021		
13.	JH 10AN 7479	L&T	Scania tipper	29.09.2019	26.07.2020	Under process	A590/2017029569	
14.	JH 10AN 4355	L&T	Scania tipper	07.12.2019	26.07.2020	Under process	A590/2017029573	
15.	JH 10AN 5503	L&T	Scania tipper	07.12.2019	26.07.2020	Under process	A590/2017029568	
16.	JH 10AN 4863	L&T	Scania tipper	08.12.2019	26.07.2020	Under process	A590/2017029570	
17.	JH 10AE 1631	TATA	Hyva	01.11.2019	29.10.2019	Under process		
18.	JH 10AE 1633	TATA	Hyva	01.11.2019	29.10.2019	Under process		
19.	JH 10AE 1639	TATA	Hyva	01.11.2019	29.10.2019	Under process		

BHARAT COKING COAL LIMITED

(A Mini Ratna Company)

(A Subsidiary of Coal India Limited)

Office Of The Project officer

NLOCP/DBOCP, C/V Area.

P.O. : Chirkunda, Dist : Dhanbad

Environmental Fund Expenditure in 2019-20 (Cluster XVI)

Sl No.	Activity	Expenditure Amount (Rs.) in Lakhs
1	Pollution control (Sprinkling)	56.64
2	Pollution monitoring	8.00
3	Occupational Health	7.00
4	Green belt & biological reclamation (includes Wages of Manpower)	650.00
6	Corpus fund for mine-closure	209.18
7	Water cess and consent to operate	0.00
8	Others (Lumpsum)	5.00
9	Mine Reclaimation	25.00
	Total	960.82

22/02/2021

Project Officer
Basantimata Dahibari Colliery
Cluster XVI, BCCL

Project Officer
LAIKDIH/NLOCP/DBOCP
B. C. C. L./C. V. A.

BHARAT COKING COAL LIMITED
(A Subsidiary of Coal India Limited)
Office of the HOD(Environment)
Koyla Bhawan, Koyla Nagar
Dhanbad

Ref.No.BCCL/HOD(Envt.)/F-EC/13/0-36 Dated 21-02-2013

To,
The CGM- Washeries
GM, C.V. Area
GM-WCD
BCCL.

Sub.: Reg. issue of environmental clearances of Clusters of BCCL mine by MoEF.

Dear Sir,

Find enclosed herewith the environmental clearance of Cluster-XVI approved b MoEF vide letter no. J-11015/185/2010-IA.II(M), dated 06.02.2013. A copy of th environmental clearance has to be given to concerned Panchayat from your end.

This is for your kind information and strict compliance of the conditions a stipulated in the approved environmental clearance by MoEF.

Encl : As above.

Yours faithfully
HOD (Environment

Annexure 29


डिस्प्ले बोर्ड
तिथि
डिस्प्ले बोर्ड
इकाई का नाम तथा पता:- DAHIBARI BASANTI MATA OCP/DAHIBARI COLLIERY, BCCL, MUGMA, DHANBAD, JHARKHAND.
उत्पादन क्षमता
वर्तमान में उत्पादन
संचालन सहमति आदेश की अवधि
उत्पन्न अपशिष्ट की विवरणी
क्र० सं०
प्रकार/नाम
मात्रा
प्रबंधन की व्यवस्था
निपटान/DISPOSAL की विवरणी
विधि
मात्रा
शेष अपशिष्ट की मात्रा
जल गुणवत्ता स्तर की विवरणी
PH
TSS
DO
COD
BOD
OIL & GREASE


Hazardous Waste