भारत कोकिंग कोल लिमिटेड
एक मिनी रत्न कम्पनी
(महारत्न कम्पनी कोल इंडिया का एक उपक्रम)
पंजीकृत कार्यालय : कोयला भवन, कोयला नगर,
धनबाद–826005
सीआइएन : U10101JH1972GOI000918
महाप्रबंधक का कार्यालय
पश्चिमी झरिया क्षेत्र
पो. मुनीडीह, जिलाः धनबाद (झारखण्ड)–828129
फ़ोन नं. 0326 2273483; फ़ेक्स: 0326 2273445, ई-मेल: gmwj.bccl@coalindia.in

Bharat Coking Coal Limited
A Mini Ratna Company
(A Subsidiary of Coal India Limited: A Maharatna Company)
Regd. Off. : Koyla Bhawan, Koyla Nagar
Dhanbad - 826005
CIN : U10101JH1972GOI000918
OFFICE OF THE GENERAL MANAGER
WESTERN JHARIA AREA
PO: MOONIDIH, DISTT: DHANBAD (JHARKHAND) - 828129
PHONE NO: 0326 2273483, FAX NO: 0326 2273445, e-mail : gmwj.bccl@coalindia.in

Ref: - BCCL/WJA/ENV/2022/ 170(D) **Date:-** 31/05/2022

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

Sub: - Submission of six-monthly reports on compliance of Environment Clearance for the period from **October'2021 to March'2022** in respect **Cluster-XI** group of mines of BCCL.

Ref: EC Order No. – J-11015/77/2011-IA.II (M) Dated: - 26.08.2013.

Dear Sir,

Please find enclosed herewith the six-monthly reports on compliance of Environment Clearances for the period from **October'2021 to March'2022** in respect of **Cluster XI** group of mines of BCCL. We hope you will find in order.

Thanking you,
Encl: - As Above

Yours faithfully,
31.5.2022
General Manager
W.J.Area, BCCL

CC to:-

1. The Director, 1A Monitoring Cell, Paryavaran Bhawan, CGO Complex, New Delhi – 110003.
2. The Member Secretary, Jharkhand State Pollution Control Board, TA – Division Building, Dhruwa– Ranchi – 834004.
3. HoD (Env.), BCCL, Koyla Bhawan Dhanbad.
4. GM, W.J. Area.
5. Nodal Officer (Env.), WJ Area.

"For uploading online on "parivesh portal" of MoEF&CC and send by e-mail"

ENVIRONMENTAL CLEARANCE COMPLIANCE OF CLUSTER-XI (GRANTED VIDE EC No. J-11015/77/2011-IA.IIM Dated 26.08.2013)

(From **Oct'21 - March'22)**

Sl. No.	A. Specific Conditions by MOEF:	Compliance
i.	**No mining shall be undertaken in/under the forestland until prior forestry clearance has been obtained under the provisions of FC Act 1980.**	No mining will be undertaken in/under the forestland until prior forestry clearance has been obtained under the provisions of FC Act 1980. However an application for forest clearance has been submitted online for Moonidih mine with reference number FP/JH/MIN/9699/2015 in Feb'2019, it is presently under process.
ii.	**You will need to seek and obtain approval under the FC Act for diversion of the entire forest land located within the mining lease within a period of two years from 1.2.2013 i.e. date of issue of FC Division's guidelines vide no. 11-362/2012-FC, failing which the mining lease area will be reduced to the non-forest area plus the forest area for which you have been able to obtain the FC at the end of this time period. In the case of reduction in mine lease area, you will need to get a revised mining plan approved from the Competent Authority for reduced area and enter into a new mining lease as per reduced lease area. The EC will be construed to be available for the mining lease area as per the revised mining lease deed.**	Amendment in EC is granted for 1982.90 Ha. Leasehold area of Moonidih UG mine on 26th July 2019 for Cluster XI group of mines.
iii.	**The maximum production in the cluster shall not exceed beyond that for which environmental clearance has been granted for the cluster XI.**	**It is being complied.** The production from the cluster is within the limit for which environmental clearance has been granted. Moonidih washery is operating within the permissible limit of 1.6 MTPA. **Enclosed as ANNEXURE I.**
iv.	**The open cast quarries of the abandoned mines should be backfilled to the ground level and restored with native species.**	**Complied**
v.	**All coal from smaller UG mines should be transported by high capacity and mechanically covered trucks/ tippers.**	Various mechanically covered trucks Manufacturers for the transportation of Coal and OB in India have been contacted and things are under process. At present coal transportation has been done by trucks with tarpaulin cover. Covering of truck has been made mandatory in the transportation contract.
vi.	**Green belts shall be developed on both sides of the roads.**	**Complied.**

		Plantation work on 12 Ha OB dump has been completed with the help of Forest Department (Approx.30000 saplings have been planted) Approximately 1500 flower saplings have been planted on Gopalichuck dump slope.
vii.	**Action plan for quenching of fires and rehabilitation along with the details of master plan be submitted to the MoEF for monitoring purpose.**	**Complied.** Jharia Master Plan is already uploaded on BCCL website and under implementation.
viii.	**Presently coal to Moonidih washery from other mines of the cluster is taking place through NH.** **An alternate route for coal transportation may be explored.**	Coal from P.B. Area is direct feed coal and hence washing is not required. Presently coal (wet enough due to sprinkling at loading and unloading point) from Moonidih mine transported to Moonidih washery through conveyor belt and coal dispatched from Moonidih washery through rail transport.  (Coal transport from Moonidih Mine to Washery through Conveyor belt)  (Coal transport in tarpaulin covered Truck)
ix.	**For understanding the composition of emissions from coal mine fires, BCCL may**	Agreed.
x.	**Initiate action as proposed in the visit report of the EAC to Dhanbad.**	Action as proposed in the visit report of EAC has been initiated.
xi.	**The approved mining plan be submitted to the MoEF.**	Mining Plan of Gopalichuk OC and Kendwadih OC is submitted and Feasibility report of other mines is also submitted. Revised Mining plan along with Mine closure plan of Moonidih colliery of Cluster XI was approved by the 348th Board empowered sub-committee meeting of BCCL held on 29.01.2019.

xii.	**The measure to identify in the Environmental Plan for Cluster- XI groups of mine and the conditions given in this environmental clearance letter shall be dovetailed to the implementation of the Jharia Action Plan.**	Environmental plan for Custer XI group of mines and the condition given on the environment clearance has been dovetailed. **As per Table 1 of Jharia Action Plan** Pootkee XV Seam & Moonidih XVIIT seam fire status – Extinguished. Kendwadih XIII, XIV seam & kachhi Balihari XV seam fire status – Dormant.
xiii.	**The proponent shall prepare time -series maps of the Jharia Coalfields through NRSC 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 II shall be undertaken. Expertise available internationally could also be utilized for control of fire in Jharia Coalfields and for their reclamation and to further minimize time for fire and subsidence control. Isothermal mapping using thermal imaging has been got done by NRSC. Measures would be taken to prevent ingress of air (ventilation) in such areas, which may re-start fresh fires.**	**It has been complied.** NRSC was engaged for preparation of time series maps to monitor and prevent fire problems of Jharia Coalfield by Isothermal mapping/imaging and monitoring temperatures of the coal seams and NRSC has submitted their final report in January 2018 in which the area of fire has been reduced from 9.00 Km^2 to 3.28 km^2. NRSC report is enclosed as **ANNEXURE II.**
xiv.	**The embankment constructed along the river boundary shall be of suitable dimensions and critical patches shall be strengthened by stone pitching on the river front side and stabilized with plantation so as to withstand the peak water flow and prevent mine inundation.**	Not applicable. BCCl submission for Non Applicability enclosed in **ANNEXURE III.**
xv.	**No mining shall be undertaken where underground fires continue. Measure shall be taken to prevent/check such fire including in old OB dump areas where the fire could start due to presence of coal/shale with sufficient carbon content.**	It is being complied
xvi.	**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.**	Complied as per statute.

xvii.	**Thick green belt shall be developed along undisturbed areas, mine boundary and in mine reclamation. A total area of 254.67 ha shall be reclaimed and afforested.**	Plantation work on 12 Ha OB dump has been completed with the help of Forest Department (Approx.30000 saplings have been planted) Approximately 1500 flower saplings have been planted on Gopalichuck dump slope. 400 bamboo saplings planted along the boundary of Gopalichuck OC mine. 300 sapling are planted at various location at Moonidih mine.
xviii	**Details of transportation, CSR, R&R and implementation of environmental action plan for the clusters-XI should be brought out in a booklet form within a year and regularly updated.**	**Complied. Enclosed as Annexure IV**
xix.	**Specific mitigative measures identified for the Jharia Coalfields in the Environmental Action Plan prepared for Dhanbad as a critically polluted area and relevant for Cluster XI shall be implemented.**	**It is being complied** in the name of Dhanbad Action Plan. It has been prepared in consultation with Jharkhand Pollution Control Board for entire BCCL and not on cluster basis. It is being implemented comprehensively for all the mines of BCCL. Online PM10 Analyzer has been installed at Moonidih to Check the Ambient air quality continuously. Some of the salient actions of this cluster are as under: **Enclosed as Annexure V**
xx.	**The locations of monitoring stations in the Jharia Coalfields should be finalized in consultation with the Jharkhand State Pollution Control Board. The Committee stated that smoke/dust emission vary from source to source (fuel wood, coal, fly ash from TPPs, silica from natural dust, etc.) and a 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.**	**It is being complied.** Establishment of ambient environment quality monitoring stations has been finalized with the consultation of Jharkhand State Pollution Control Board. Draft Final Report of Source Apportionment Study has been submitted by NEERI, Nagpur and under examination at BCCL for final comments. Progress report of Source Apportionment study is **Enclosed as Annexure VI**
xxi.	**The proponent will continue the existing Road-Rail transport network system in view of the implementation of the Master Plan (for 10 years) and another 5 years, gestation period after the completion of Master Plan for consolidation of the backfilled dug out fire areas and unstable areas is required. All mitigation measures (like covered trucks, green belting on either sides of the roads, enhanced water sprinkling, strengthening and maintaining the roads etc.) shall be adopted up**	Action has been taken for conveyor-cum-rail transport system. Meanwhile transportation is being done by covering vehicle with tarpaulin cover. Coal from P.B. Area is direct feed coal and hence washing is not required. Presently coal (wet enough due to sprinkling at loading and unloading point) from Moonidih mine transported to Moonidih washery through conveyor belt. **Enclosed as Annexure VII**

	to 15 years (Phase-I) with the existing road-rail transport system. In phase-II, BCCL shall implement conveyor-cum-rail transport to avoid movement of trucks within the cluster for coal transportation in Phase-II which shall start after 15 years. Transportation of coal shall be by Rail and Conveyor belt, minimizing the existing road transport system in all the mines of the cluster and shall continue after 15 years. Loading of coal by pay loaders shall be discontinued. Adequate number of suitably designed off-take points shall be provided.	 (Coal transportation through conveyor belt)  (Coal transportation from tarpaulin covered Truck)  (Water Sprinkling from Mobile Tanker)
xxii.	**16944 nos of PAFs should be rehabilitated at cost of Rs 53776.60 Lakhs as per the approved Jharia Action Plan.**	Implementation of master plan has already been started through Jharia Rehabilitation and Development Authority (JRDA), Dhanbad.
xxiii	**Regular monitoring of subsidence movement on the surface over and around the working area and impact on natural drainage pattern, water bodies, vegetation, structure, roads, and surroundings shall be continued till movement ceases completely. In case of observation of any high rate of subsidence movement, appropriate effective corrective measures shall be taken to avoid loss of life and material. Cracks shall be effectively plugged with ballast and clayey soil/suitable material.**	It is being complied and will be implemented as the case may be. Regular subsidence monitoring is done at underground mines. **Enclosed as ANNEXURE - VIII**
xxiv	**Coal Extraction shall also be optimized in areas where agricultural production is continuing. Some pillars shall be left below the agricultural land. No depillaring & coal extraction should be carried out below habitation, H.T. Lines & beneath road, water bodies.**	It is being complied. Being implemented as per statute.
xxv.	**Subsidence shall be monitored closely and if subsidence is found exceeding the permitted limits, then the landowners shall be adequately compensated with mutual agreement with the landowners.**	It is being complied. **Enclosed as ANNEXURE - VIII**

xxvi.	**3-tier plantation should be developed 2 km stretch of road from the mine using native species.**	**It is being complied.** Plantation is being done on roadside in non-coal bearing areas and colonies.
xxvii.	**Water sprinkling system shall be provided to check fugitive emissions from loading operations, conveyor system, haulage roads, transfer points, etc. Major approach roads shall be black topped and properly maintained.**	**It is being complied.** Mobile water tankers are used for spraying water. Sprinkler arrangement provided in respect of Moonidih washery and Moonidih mine. Water sprinkler are provided at Moonidih Underground at transfer and coal cutting points to reduce coal dust.At Moonidh washery some new sprinkler arrangement near loading point and washery gate to VIP office is provided for dust suppression. **Enclosed as Annexure VII**  (Water Sprinkling from Mobile Tanker)
xxviii	**A progressive afforestation plan shall be prepared and implemented over the mine lease area acquired and shall include areas under green belt development, areas along roads, infrastructure, along ML boundary and township etc., by planting native species in consultation with the local DFO/Agriculture Department.**	**It is being complied.** **1.** 400 saplings planted around mine boundary. **2.** 600 around weigh bridge and area office boundary. **3.** 20 Ha site is given to forest department for plantation work in FY 2020-21. **4.** 200 saplings are planted at XV seam mine boundary, shaft shrinking and 500 at Dhobni Plantation Site of Moonidih mine in FY 2020-21. **5.** 600 Sapling distributed to local public and employees in FY 2020-21 by WJA. **6.** Plantation work on 12 Ha OB dump has been completed with the help of Forest Department (Approx.30000 saplings have been planted). **7.** 1500 Flowering saplings planted on slope of OB Dump **Enclosed as Annexure IX**
xxix.	**Acid Water Treatment Plant, volume of water to be treated and disposal of brine should be provided.**	Presently there is no acid water mines in Cluster-XI.
xxx.	**Mine discharge water outside the ML shall be monitored, particularly for TDS and treated to conform to prescribed levels before discharge into the natural environment.**	**It is being complied.** Being monitored. Moonidih washery is operating under closed water circuit system. Pilot scale Mine Water Treatment Plant is installed at P.B. Area to convert mine water into drinking water. 1 No Pressure Filter is installed near P.B. Project and 2 nos. of pressure filters are installed at Moonidih mine to supply clean water.

xxxi.	**The Company shall put up artificial groundwater recharge measures for augmentation of groundwater resource, in case water table shows a declining trend. The project authorities shall meet water requirement of nearby village(s) in case the village wells go dry due to dewatering of mine.**	**It is being complied.** Mine water is being used for the industrial as well as domestic non drinking purpose. Mine water is also utilized for the community and irrigation purposes. Artificial Rainwater Harvesting Structure is constructed and fully functional near Area office of WJ Area. **Enclosed as Annexure X**  (Artificial Rain water Harvesting Structure)
xxxii.	**Besides carrying out regular periodic health checkup of their workers, 10% of the workers identified from workforce engaged in active mining operations shall be subjected to health checkup for occupational diseases and hearing impairment, if any, through an agency such as NIOH, Ahmadabad within a period of one year and the results reported to this Ministry and to DGMS.**	**It is being complied.** Draft report submitted by NIOH has been scrutinized by Medical department, BCCL. NIOH have been requested to arrange a final closure presentation at BCCL and to submit the final report as well. NIOH also done an Awareness workshop on occupational disease. **Enclosed as** Annexure XI
xxxiii.	**The mining in the existing mines would be phased out after expiry of the current mining lease and after reclamation of mined over area. The operating mines may be analyzed and monitored for compliance of conditions, having bearing with movement of wild life until such time they are closed/phased out.**	**Complied**
xxxiv.	**Sufficient coal pillars shall be left unextracted around the air shaft (within the subsidence influence area) to protect from any damage from subsidence, if any.**	Complied in respect of all mines of Cluster XI.
xxxv.	**High root density tree species shall be selected and planted over areas likely to be affected by subsidence.**	Plantation in BCCL is being done on 3-tier basis, in which both, Monocotyledonae (Monocots) such as grasses, bamboo etc and Dicotyledonae (Dicots) such as sheesham, mango etc are being planted for developing an extensive root system. The Monocots having fibrous root system. The Monocots having fibrous root system helps in developing roots density at the topsoil level while, Diocots having the tap root system have a distributed root density topsoil, subsoil and regolith layer of soil. These two root system together forms the high root density system. **Enclosed as** Annexure XII
xxxvi.	**Depression due to subsidence resulting in water accumulating within the low lying areas shall be filled up or drained out by cutting drains.**	**Complied**

xxxviii.	**Solid barriers shall be left below the roads falling within the blocks to avoid any damage to the roads.**	**Being Complied.**
xxxviii.	**The CSR Action Plan shall consist of need-based CSR Action Plan, CSR Auditing and monitoring mechanism etc. The proponent will spend 5 % of the retained earnings of the previous year subject to a minimum of Rs. 5/- per ton of coal production which should be adjusted as per the annual inflation The progress made thereon shall be uploaded on the company annually on the company website. Monitoring of the impacts of activities under CSR shall be carried out periodically.**	**Complied.** CSR work is handled at Headquarter level and every area is assigned work. enclosed as **Annexure –IV**
xxxix.	**Third party evaluation shall be got carried out regularly for the proper implementation of activities undertaken in the project area under CSR. Issue raised in the Public Hearing shall also be integrated with activities being taken up under CSR. The details of CSR undertaken along with budgetary provisions for the village-wise various activities and expenditure thereon shall be uploaded on the company website every year. The company must give priority to capacity building both within the company and to the local youth, who are motivated to carry out the work in future. The gap/space available between the entire mine area should be suitably planted with native species. Plantation should also be made in vacant area and along the road side so as to reduce dust pollution**.	**It is being complied.**
xl.	**Central recreation park with herbal garden should be developed for use of all inhabitants.**	Sneh-Smriti Upvan is constructed at P.B. Area Office consisting of flowering, fruit, medicinal and ornamental saplings.
xli.	**The mine water should be treated properly before supply to the villager.**	**It is being complied.** An action plan for the utilization and treatment of surplus Mine Water has been prepared by Environment, Civil and CSR department conjointly. In this regard, 26 Mines have been identified for the implementation of scheme in the Phase-I. A pilot scale mine water treatment plant in collaboration with CSIR, CIMFR is installed at P.B. Area office to convert mine water into drinking water. 2 number of pressure filter (1500 gph each capacity) are installed for treating mine water. Two number of pressure

		filters are also installed in Moonidih mine for mine water treatment.
xlii	**Mine discharge water shall be treated to meet standards 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.**	**Complied.** Mine discharge water is being allowed to settle down in the mine sumps before passing through sedimentation tank. The monitoring of water quality parameters is being carried out by CMPDIL. **Enclosed as** Annexure XIII
xliii	**The void shall be converted into a water reservoir of a maximum depth of 15-20 m and shall be gently sloped and the upper benches of the reservoir shall be stabilized with plantation and the periphery of the reservoir fenced. The abandoned pits and voids should be backfilled with OB and reclaimed with plantation and or may be used for pisciculture.**	As working in P.B. Area does not approached combined seam therefore water reservoir cannot be formed. In due course we will be able to comply this point in future.
xliv	**Regular monitoring of groundwater level and quality of the study area shall be carried out by establishing a network of existing wells and construction of new piezometers. The monitoring for quantity shall be done four times a year in pre-monsoon (May), monsoon (August), post-monsoon (November) and winter (January) seasons and for quality including Arsenic and Fluoride during the month of May. Data thus collected shall be submitted to the Ministry of Environment & Forest and to the Central Pollution Control Board/SPCB quarterly within one month of monitoring. Rainwater harvesting measures shall be undertaken in case monitoring of water table indicates a declining trend.**	**Complied.** CMPDI RI-II has prepared a report for Location and design of Piezometers. Groundwater monitoring data has been enclosed as **Annexure XIV**
xlv	**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.**	There is no CHP under of Cluster XI. Effluents from mine is treated before discharge. ETP is provided at compressor house. Effluent treated is not discharged into the natural water course rather sent to washery for further usage.
xlvi	**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 Ranchi.**	**Complied.** Presently a time series map of vegetation cover in the Jharia Coal Field is being carried out through CMPDI, Ranchi using satellite imagery. Further CMPDI has been requested to prepare "Time series of land use maps based on satellite imagery of the core zone and buffer zone.

xlvii.	**A Final Mine Closure Plan along with details of Corpus Fund shall be submitted to the Ministry of Environment & Forests five year before mine closure for approval. Habitat Restoration Plan of the mine area shall be carried out using a mix of native species found in the original ecosystem, which were conserved in-situ and ex-situ in an identified area within the lease for reintroduction in the mine during mine reclamation and at the post mining stage for habitat restoration. the mining plan and post- mining plan, closure plan should be prepared and submitted to the Ministry;**	**It shall be complied.** It will be complied when mine life will reach its final phase.
xlviii.	**A separate management structure for implementing environment policy and socio-economic issues and the capacity building required in this regard.**	Agreed
xlix.	**The raw coal, washed coal and coal wastes (rejects) shall be stacked properly at earmarked**	Agreed. Being Complied.
l	**Site(s) within stockyards fitted with wind breakers/shields. Adequate measures shall be taken to ensure that the stored minerals do not catch fire.**	Complied. Coal is directly feed to Moonidih washery by conveyor belt by proper sprinkling at discharge point from Moonidih Colliery. Coal is stocked in silos of Moonidih Washery in which ample amount of water is sprinkled on regular basis.
li.	**Hoppers of the coal crushing unit and washery unit shall be fitted with high efficiency bag filters and mist spray water sprinkling system shall be installed and operated effectively at all times of operation to check fugitive emissions from crushing operations, transfer points of closed belt conveyor systems and from transportation roads.**	Being Complied. Some more water sprinkler have been added nearby Hopper of Coal Crushing unit and loading points for water spraying and also mobile water tanker are used for spraying and also mobile water tanker are used for spraying water spraying water in transportation road.
li.	**All approach roads shall be black topped and internal roads shall be concreted. The roads shall be regularly cleaned with mechanical sweepers.**	**Compliance under process.**. Presently cleaning of roads done manually.

lii.	**Green belt of 3 ha shall be developed all along the periphery of the site, along the areas such as the washery unit, crushing unit, and stockyard.** **A 3-tier avenue plantation would be developed along vacant areas, near washery, storage yards, loading points and transfer points and along internal roads and main approach roads and on the road upto the railway siding and at the siding. The road between the coal washery and the main -road shall be black topped and thick 3-tier vegetation between the washery and villages/habitations shall be developed. In addition, a 10m thick green avenue plantation in the transportation route from washery to Majhri Railway Siding (of WCL) shall be provided in consultation with and approval of WCL under CSR.**	**Under Compliance.** There is no Majhri Railway siding (of WCL). Plantation work has been done along mine boundaries, overburden dump, weighbridge and along roads.
liii.	**Trucks engaged for mineral transportation outside the washery up to the railway siding shall be optimally loaded. The trucks shall be properly maintained and emissions shall be below notified limits. Facilities for parking of trucks carrying raw coal from the linked coalmines shall be created within the Unit.**	**Complied.** Certificate of Vehicle Fitness (Form 38) under Motor Vehicle Rules 1989 issued by DTO, Dhanbad.
liv.	**Records of quantum of coal (in TPD) and ash content of raw coal being washed, clean coal and coal rejects produced from every batch of washing shall be maintained and details thereof uploaded on the company website.**	Records of Coal fines/Slurry are Maintained and are regularly updated in the Website.
lv.	**The washery unit shall be a zero-discharge facility and no wastewater shall be discharged from the washery into the drains/natural watercourses. Recycled water shall be used for development and maintenance of green belt and in the Plant Operations.**	There is a Zero discharge from the washery and the water are recycled for the plant operations and for the development of the Green belts, inside the Washery premises.
lvi.	**Coal fines shall be recovered from the coal slurry, washery discharge and used in power generation and records of quantum of coal fines collected and used shall be properly maintained.**	Stock of slurry is maintained, Records of Coal Fines are Maintained.
lvii.	**No additional groundwater shall be used for the Plant Operations. Any additional water requirement envisaged shall be obtained by recycle/reuse to the maximum extent and from rainwater harvesting measures.**	**Complied.**
lviii	**Heavy metal content in raw coal, and washed coal shall be analyzed once in a year and records maintained thereof.**	Agreed. Coal Sample has been sent to IIT(ISM), Dhanbad for analysis, Result awaited.

lix	**Corporate Environment Responsibility:**	**Enclosed as Annexure-XV**
a	**The Company shall have a well laid down Environment Policy approved by the Board of Directors.**	Agreed
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.**	Agreed
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.**	Agreed
d	**To have proper checks and balances, the company shall have a well laid down system of reporting of non-compliances/violations of environmental norms to the Board of Directors of the company and/or shareholders or stakeholders at large.**	Agreed
Sl.No	**B. General Conditions by MOEF:**	**Compliance**
i.	**No change in mining technology and scope of working shall be made without prior approval of the Ministry of Environment and Forests.**	**Complied**
ii.	**No change in the calendar plan of production for quantum of mineral coal shall be made.**	**Being Followed.**
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 NO_x monitoring.**	The fixing up of locations of monitoring stations in the Jharia Coalfields has been taken up with the Jharkhand State Pollution Control Board. **Enclosed as Annexure XVI**

		The work of monitoring of ambient environment has been done through CMPDI, Regional Institute Dhanbad having laboratory recognized under EPA Rules.
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 Ranchi 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.**	**Complied.** Monitoring for the same is done by CMPDI having own laboratory recognized under EPA Rules. Monitoring data is **Enclosed as Annexure XVI**
v.	**Adequate measures shall be taken for control of noise levels below 85 dBA in the work environment. Workers engaged in blasting and drilling operations, operation of HEMM, etc. shall be provided with ear plugs/muffs.**	**Being Complied.**
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.**	CMPDI Dhanbad is carrying out monitoring of environment quality work. There is arrangement for treatment of effluent discharge to prescribed standards.
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.**	**Complied.** Vehicles used for transportation are covered with tarpaulin covers.
viii.	**Monitoring of environmental quality parameters shall be carried out through establishment of adequate number and type of pollution monitoring and analysis equipment in consultation with the State Pollution Control Board and data got analyzed through a laboratory recognized under EPA Rules, Monitoring of environmental quality parameters shall be carried out through establishment of adequate number and type of pollution monitoring and analysis equipment in consultation with the State Pollution Control Board and data got analyzed through a laboratory recognized under EPA Rules, 1986.**	Presently, CMPDI Dhanbad is carrying out regular monitoring of environmental quality work.
	Personnel working in dusty areas shall wear protective respiratory devices and they shall also be provided with adequate training and	**Complied.** Vocational training Centers under

ix.	**information on safety and health aspects.**	Separate Human Resource Development Dept. is Conducting regular training program on these issues. Due to COVID-19 pandemics VTC under separate HRD deptt. is NOT conducting regular training programme on these issues till date. VTC training details is enclosed as **Annexure XVII**
x.	**Occupational health surveillance Programme of the workers shall be undertaken periodically to observe any contractions due to exposure to dust and to take corrective measures, if needed and records maintained thereof. The quality of environment due to outsourcing and the health and safety issues of the outsourced manpower should be addressed by the company while outsourcing**.	IME (Initial Medical Examination) & PME (Periodic Medical Examination) of the workers is undertaken in initial phase and periodic wise respectively. The records are maintained properly. Details of IME and PME Enclosed as **Annexure XVII**
xi.	**A separate environmental management cell with suitable qualified personnel shall be set up under the control of a Senior Executive, who will report directly to the Head of the company.**	A full-fledged Environment Department, headed by a HOD (Environment) along with a suitable qualified multidisciplinary team of executives which includes Environment, Mining, Excavation, Civil, Survey, Electrical & mechanical, Forestry disciplines executives and technicians (4 nos.) has been established in Headquarters. They are also trained in ecological restoration, sustainable development, rainwater harvesting methods etc. At the project level, on Executive in each area has also been nominated as Project Nodal Officer (Environment) and is also entrusted with the responsibility of compliance and observance of the environmental Acts/ Laws including environment protection measures. The activities are monitored on regular basis at Area and at Headquarters levels. GM (Environment) at head quarter level, co-ordinates with all the Areas and reports to the Director (Technical) and in turn he reports to the CMD of the company. The team is multidisciplinary and very much motivated under the guidance of company's Director (Technical) and CMD. Further capacity building at both corporate and operating level is being done.
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 Ranchi.**	It is being complied. Agreed to report the same.

xiii.	**The Project authorities shall advertise at least in two local newspapers widely circulated around the project, one of which shall be in the vernacular language of the locality concerned within seven days of the clearance letter informing that the project has been accorded environmental clearance and a copy of the clearance letter is available with the State Pollution control Board and may also be seen at the website of the ministry of Environment & Forests at http://envfor.nic.in.**	**Complied.**
xiv.	**A copy of the environmental clearance letter shall be marked to concern Panchayat/Zila Parishad, Municipal Corporation or Urban local body and local NGO, if any, from whom any suggestion/representation has been received while processing the proposal. A copy of the clearance letter shall also be displayed on company's website.**	**Complied.**
xv.	**A copy of the environmental clearance letter shall also be displayed on the website of the concerned State Pollution Control Board. The EC letter shall also be displayed at the Regional Office, District Industry Sector and Collector's Office/Tehsildar's Office for 30 days.**	**Complied.**
xvi.	**The clearance letter shall be uploaded on the company's website. The compliance status of the stipulated environmental clearance conditions shall also be uploaded by the project authorities on their website and updated at least once every six months so as to bring the same in public domain.** **The monitoring data of environmental quality parameter (air, water, noise and soil) and critical pollutant. Such as PM_{10}, $PM_{2.5}$, SO_2 and NOx (ambient) and critical sectoral parameters shall also be displayed at the entrance of the project premises and mine office and in corporate office and on company's website.**	**Complied.**
xvii.	**The project proponent shall submit six monthly compliance reports on status of compliance of the stipulated environmental clearance conditions (both in hard copy and in e-mail) to the respective Regional Office of the Ministry, respective Zonal Office (s) of CPCB and the SPCB.**	**Complied.** **Last Environmental Compliance for the period of April'2021 to Sept'2021** **Ref No. BCCL/WJA/ENV/2021/112** **dated 30.11.2021**

xviii.	The Regional Office of this Ministry located at Ranchi 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.	Complied.
xix.	The Environmental statement for each financial year ending 31 March in Form –V is mandated to be submitted by the project proponent to 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&CC by e-mail.	Complied. Environment statement is sent to The Member Secretary, JSPCB, Ranchi. Moonidih Mine Environmental Statement for April'2020 – March'2021 Ref. No. MND/PO/Env/28/2021/677 dated : 05/08/2021 Moonidih Washery Environmental Statement for April'2020 – March'2021 Ref. No. BCCL/MND/MCW/PO/ENV/2021/E-995 dated 13.09.2020

Additional General Manager
P.B.Area

Additional General Manager
POOTKEE BALIHARI AREA
B.C.C.L. DHANBAD

31/5/22

Project Officer
Moonidih Washery

PROJECT OFFICER
MOONIDIH WASHERY

31.05.22

Project Officer
Moonidih Colliery

PROJECT OFFICER/AGENT
MOONIDIH COLLIERY
B.C.C.L. LTD

ANNEXURE – I

EC grant for Cluster XI is 6.474 MTPA . The production from Cluster-XI is only 0.82 MT for the period of April'2021 to March'2022, which is well within the limits.

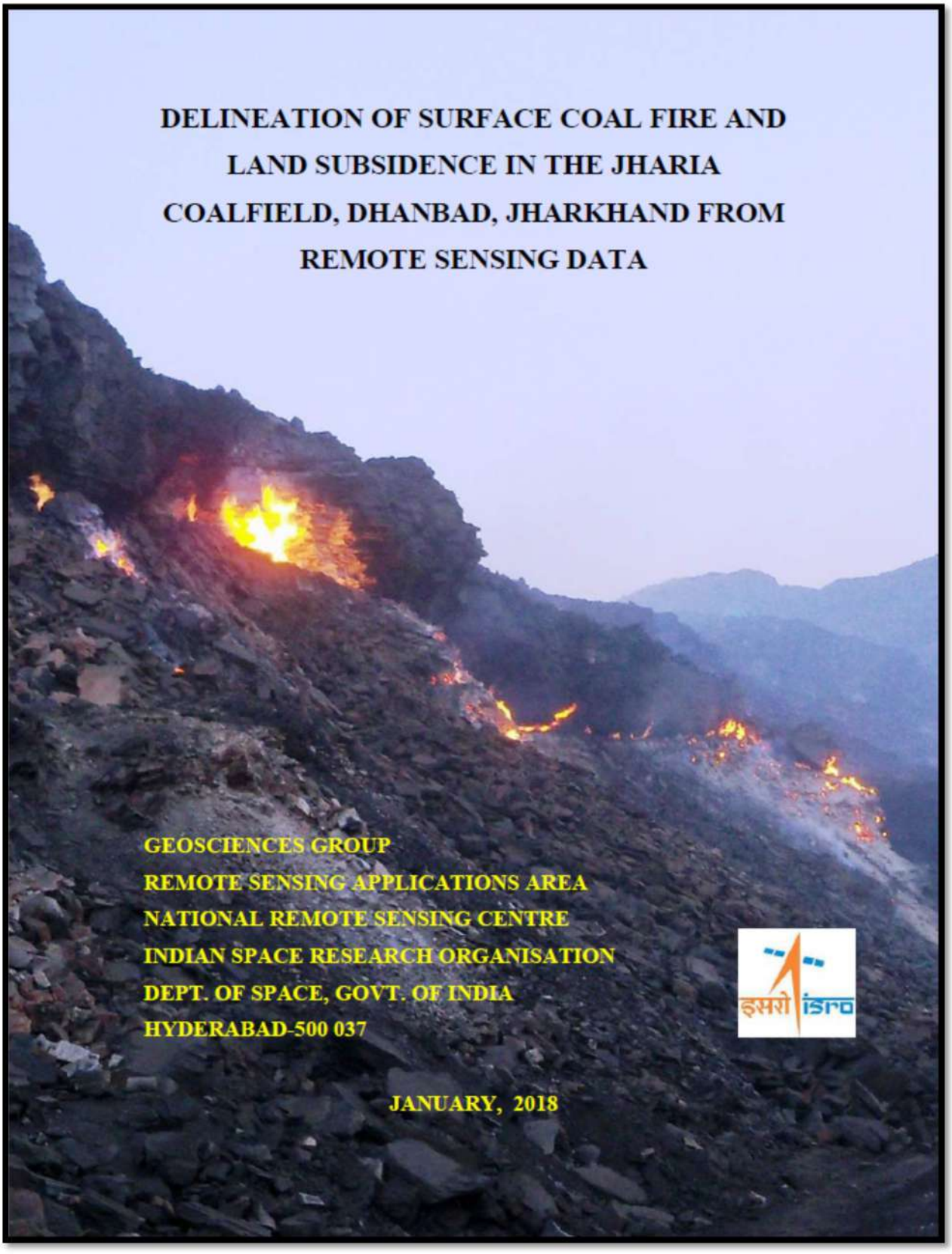
Production from **April'2021** to **Sept'2021 (Tonne)**	
Colliery	**Production (Tonne)**
Moonidih Colliery	3,19,571
Other Mines	90,660
Total Production from Cluster from April'2021 to Sept'2021	4,10,231 Tonne = .41 MT

Production from **Oct'2021** to **March'2022 (Tonne)**	
Colliery	**Production (Tonne)**
Moonidih Colliery	2,74,070
Other Mines	1,43,580
Total Production from Cluster for Oct'2021 to March'2022	4,17,650 Tonne = .41 MT

Production from **April'2021** to **March'2022 (Tonne)**	
Colliery	**Production (Tonne)**
April'2021 – Sept'2021	4,10,231
Oct'2021 – March'2022	4,17,650
Total Production from Cluster for April'2021 to March'2022	8,27,881 Tonne = .82 MT

ANNEXURE-II

As per specific condition no xiii. 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.



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

Report for

BHARAT COKING COAL LIMITED (BCCL)

(A SUBSIDIARY OF COAL INDIA LTD.)

ENVIRONMENT DEPARTMENT, KOYLA BHAWAN

KOYLA NAGAR, DHANBAD – 826 005, JHARKHAND

GEOSCIENCES GROUP

REMOTE SENSING APPLICATIONS AREA

NATIONAL REMOTE SENSING CENTRE

INDIAN SPACE RESEARCH ORGANISATION

DEPT. OF SPACE, GOVT. OF INDIA

HYDERABAD-500 037

JANUARY, 2018

PROJECT TEAM

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

CONTENTS

ACKNOWLEDGEMENTS

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

EXECUTIVE SUMMARY

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

LIST OF FIGURES AND TABLES

Field Photographs

List of Tables

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.

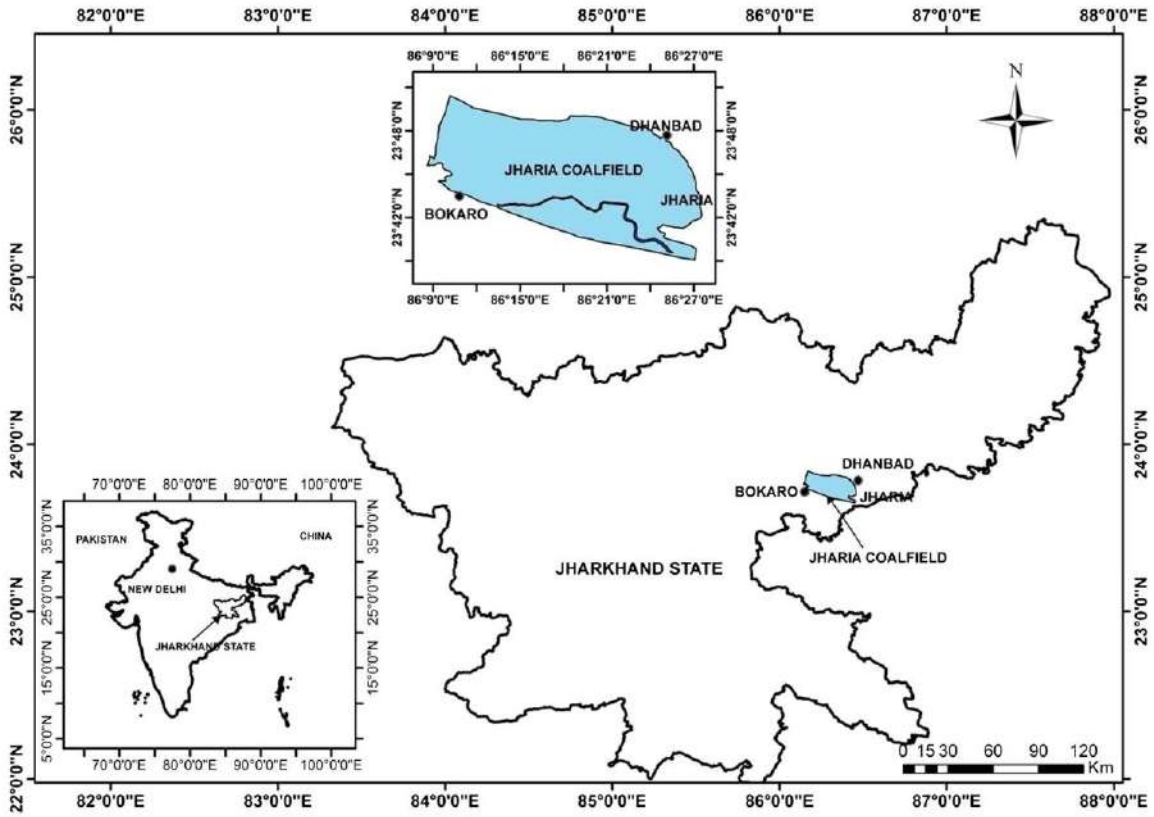


Figure 1: Study area map of Jharia Coalfied, Jharkhand

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.

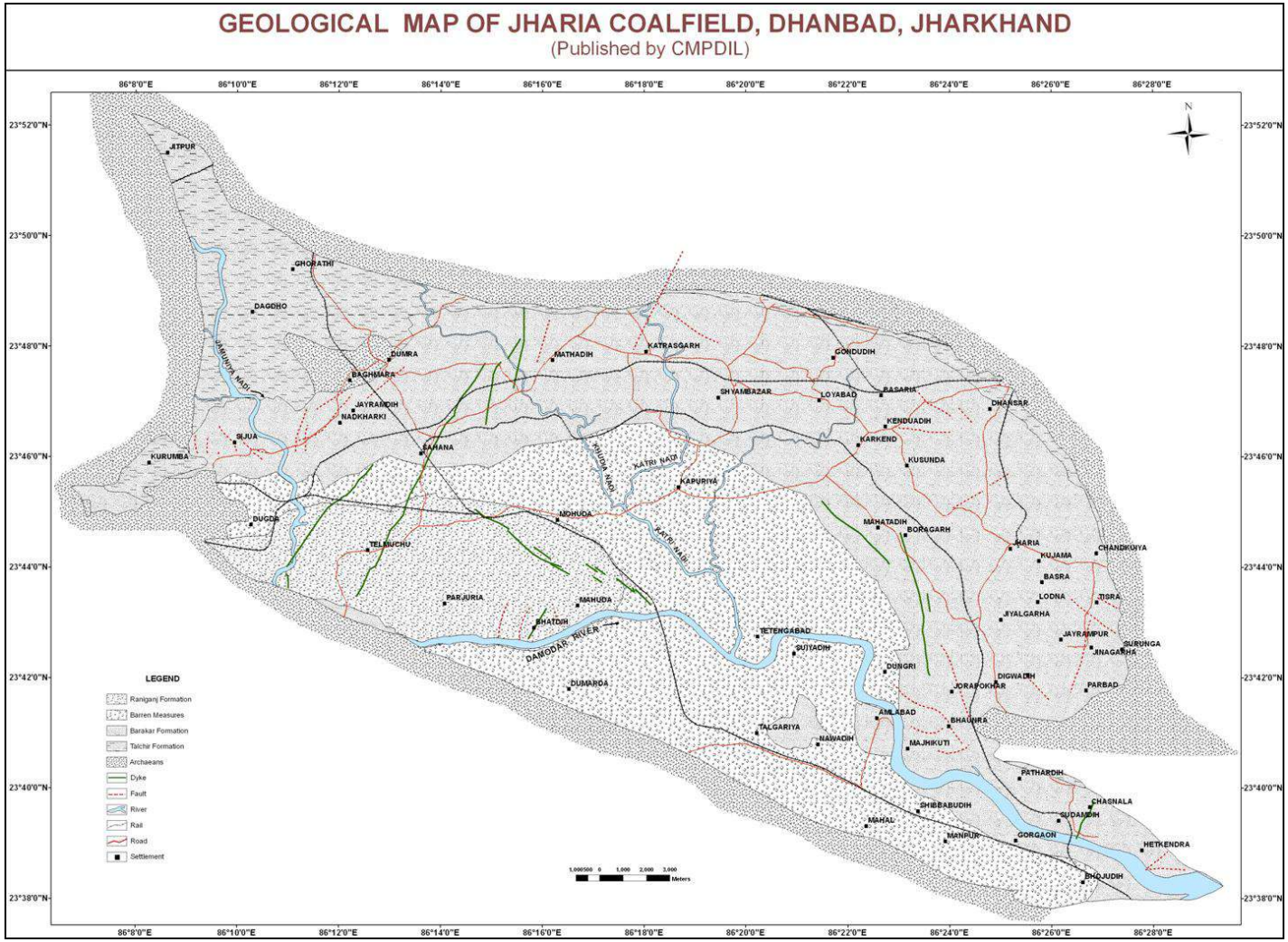


Figure 2 : Geological map of Jharia coal field, Dhanbad, Jharkhand (published by CMPIDL)

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).

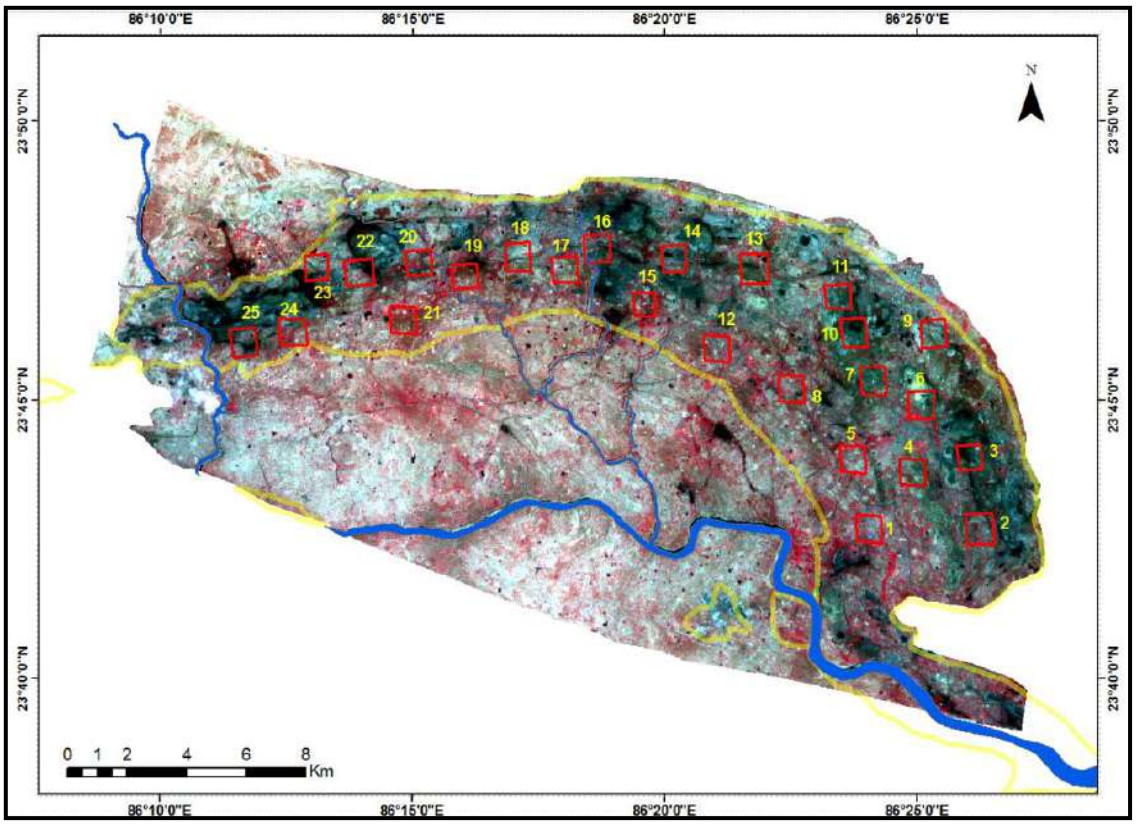


Figure 3. False colour composite image of Jharia Coalfield, with subset blocks (in red boxes) to obtain temperature values (from radiant temperature image) within the Barakar formation across the Jharia coalfield.

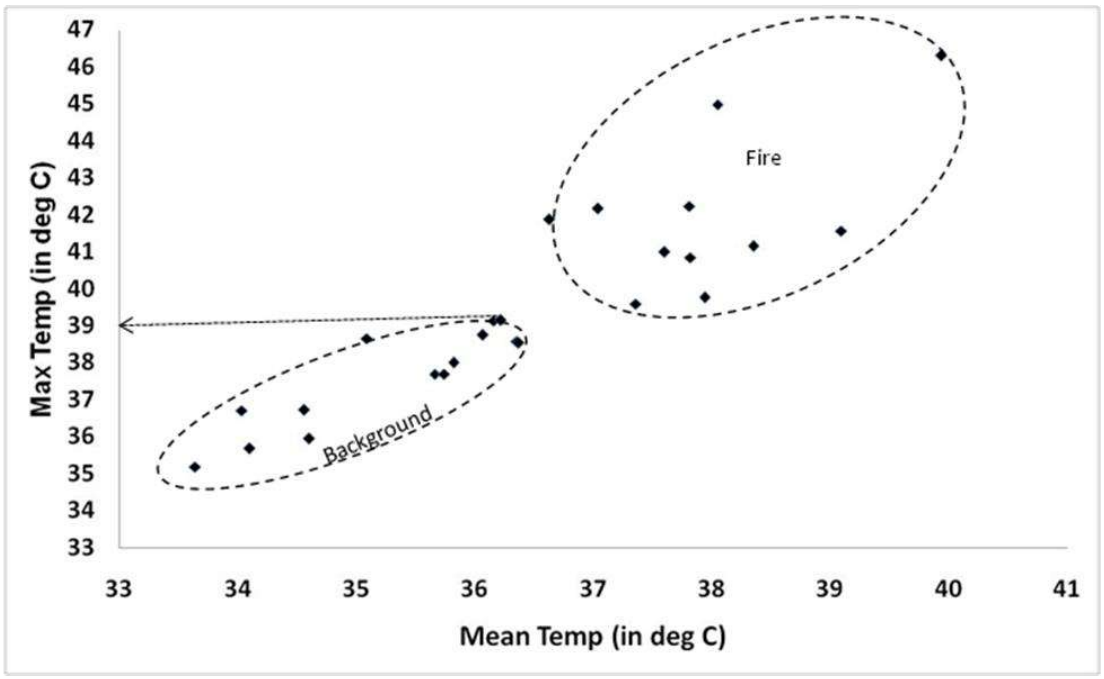


Figure 4. Maximum temperature plotted against mean temperature for various locations; cluster separation observed around 39 °C (marked with arrow)

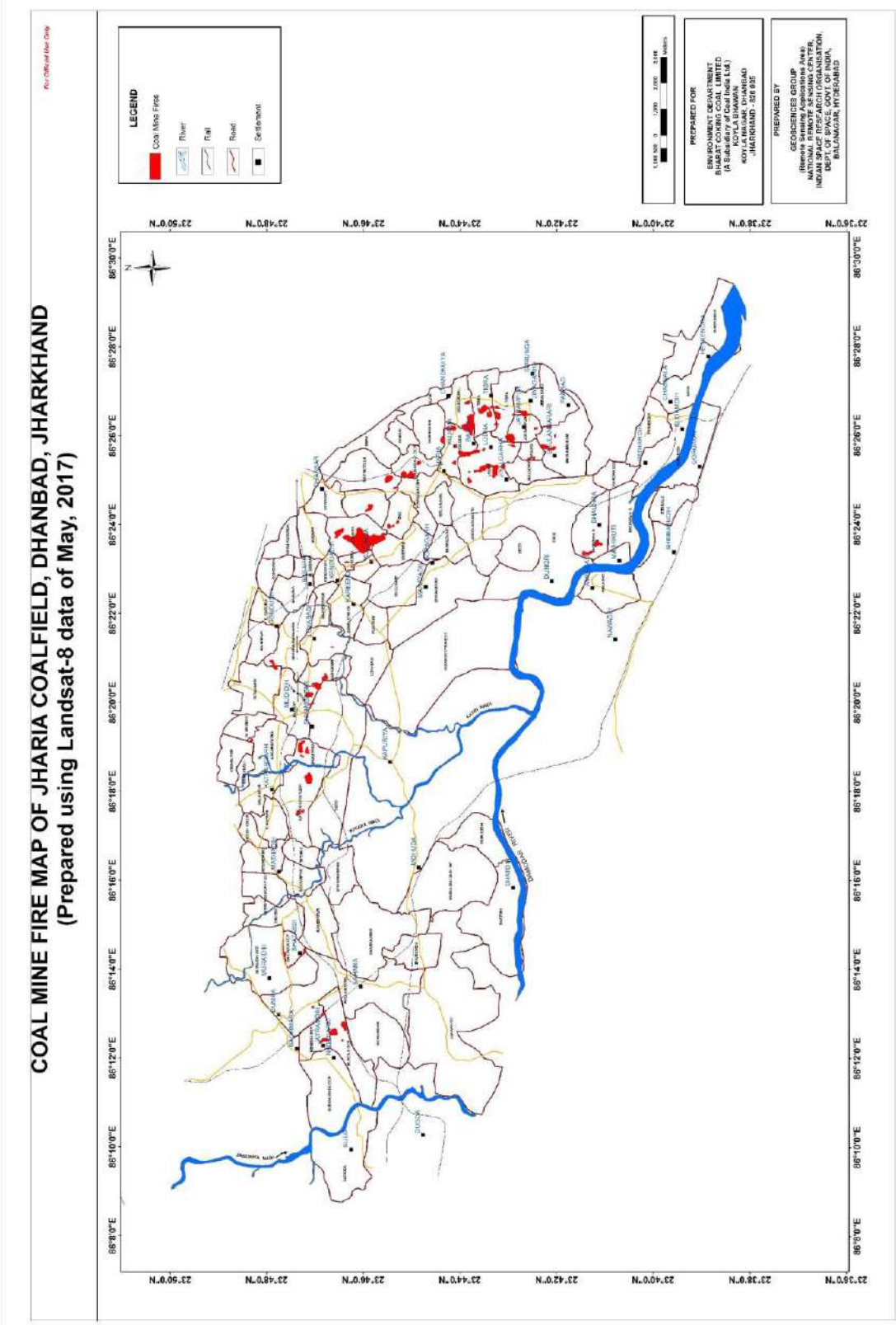


Figure 5: Coal mine fire map (May, 2017) of Jharia coal field, Dhanbad. The fire areas shown in this map have been verified in the field as per field points in figure 13.

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).

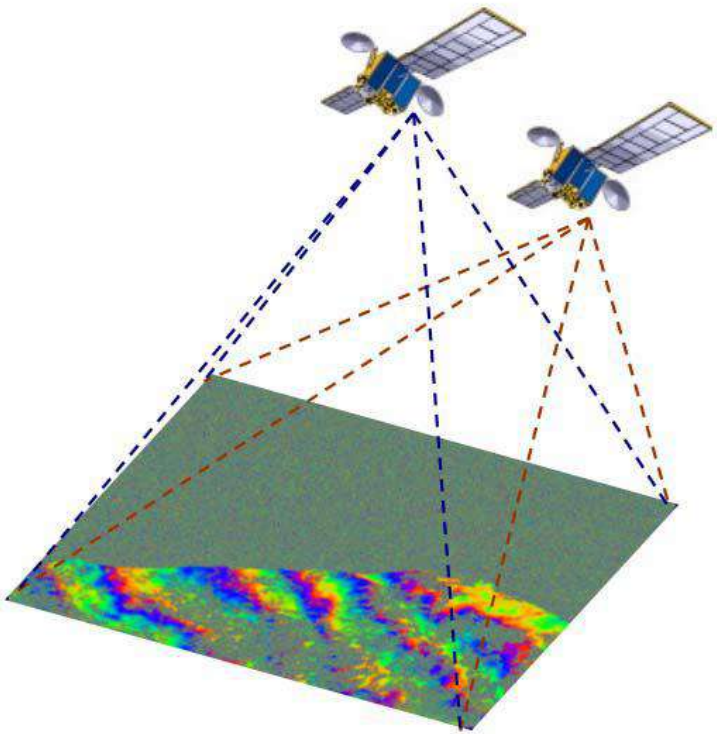


Figure 6. DInSAR acquisition scheme.

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.

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

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

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

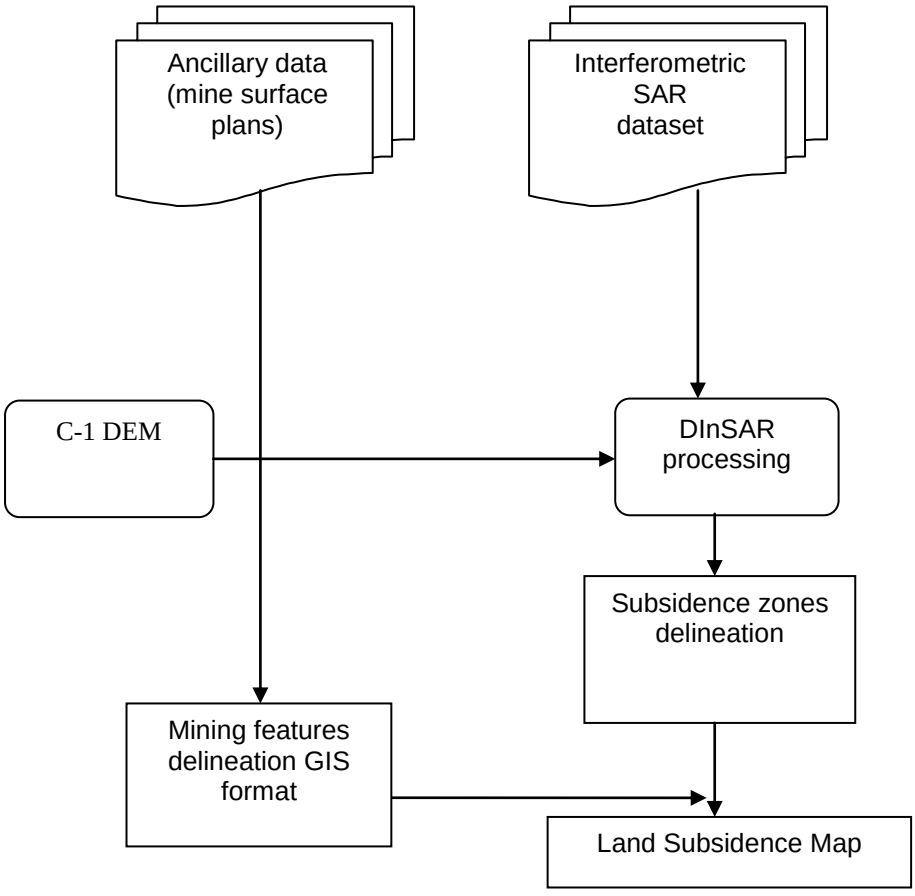


Figure 7. Work flow diagram for generating land subsidence map using DInSAR technique.

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

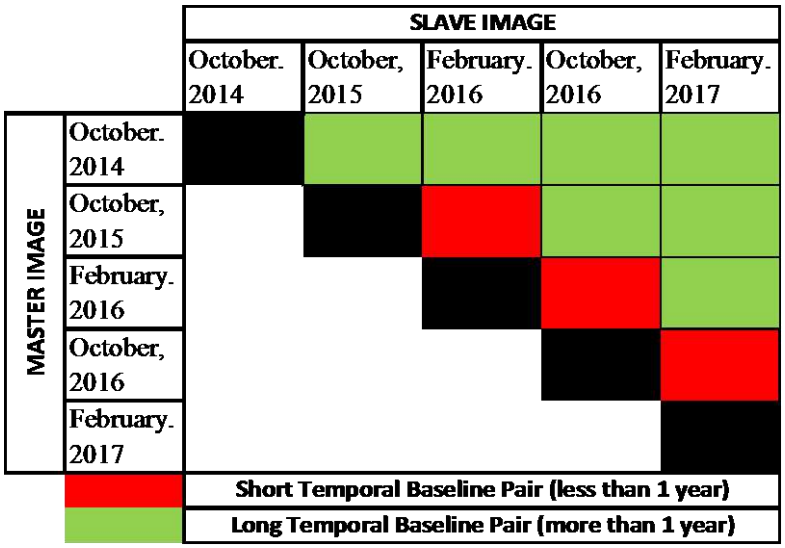


Figure 8. ALOS-PALSAR - 2 Master-Slave pairs for short and long temporal base line processing

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

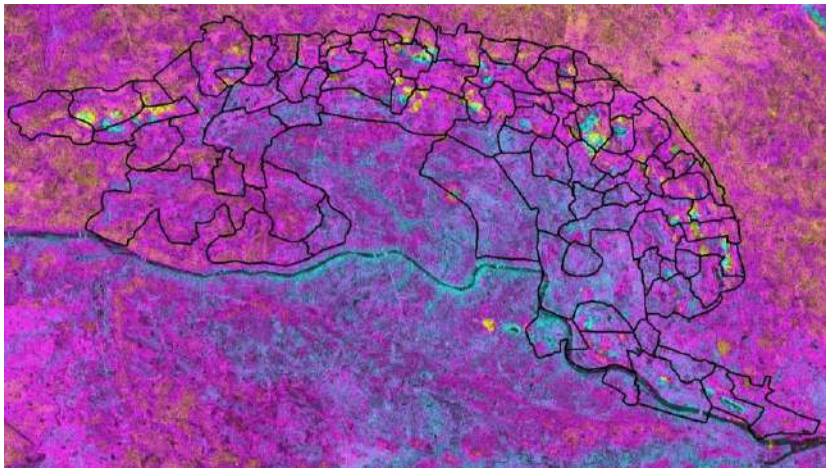


Figure 9. Fringe patterns generated from short baseline processing (e.g. Master: Oct, 16, Slave: Feb, 17).

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

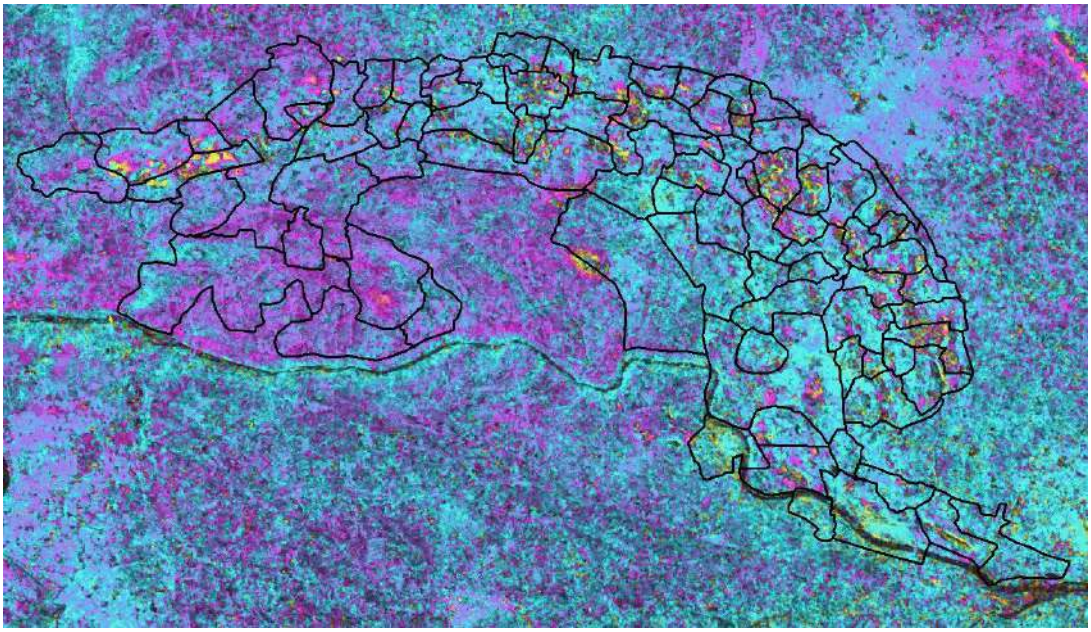


Figure 10. Fringe patterns generated from long baseline processing (e.g. Master: Oct, 15, Slave: Feb, 17).

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

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

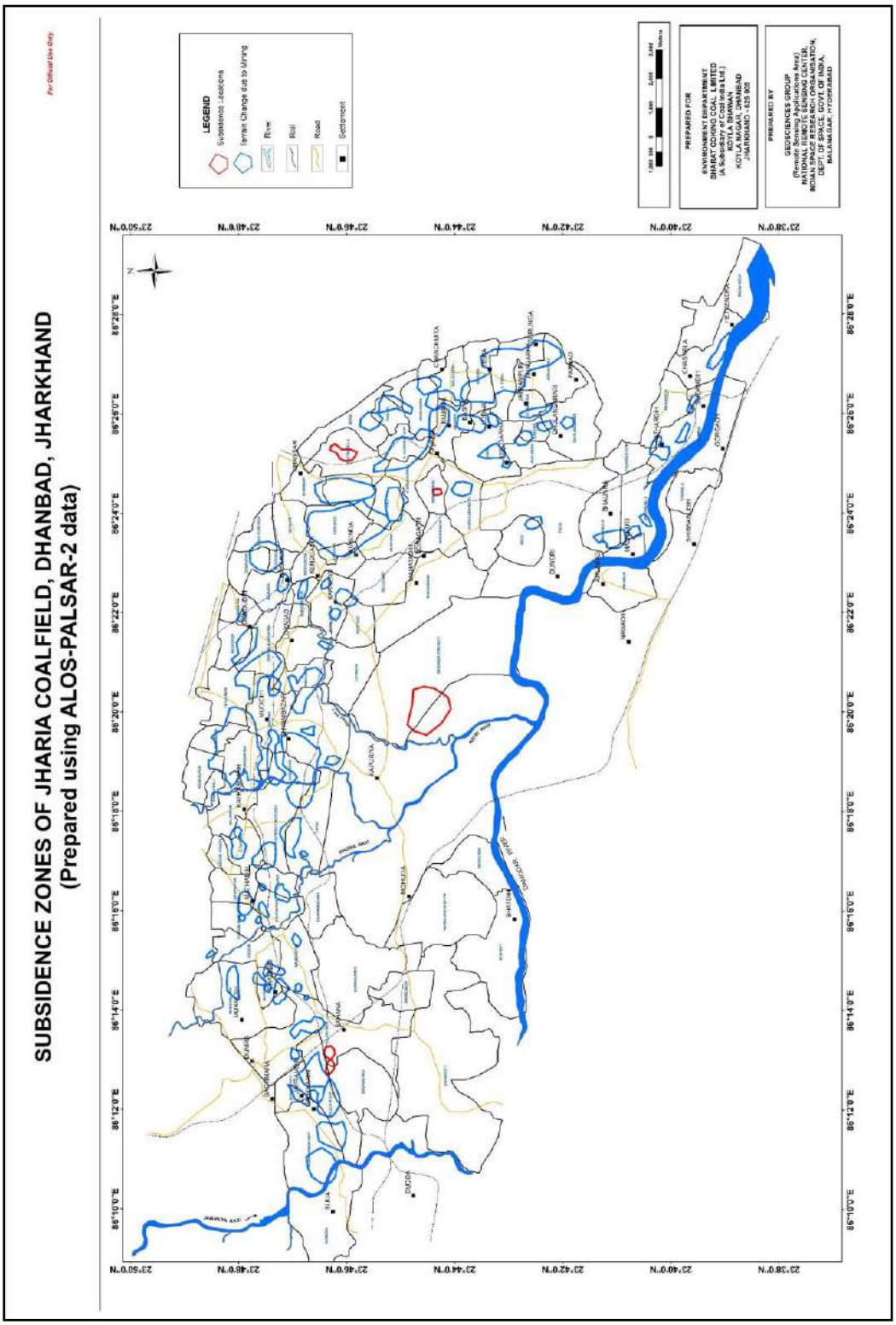


Figure 11: Subsidence map of Jharia coal field, Dhanbad.

CHAPTER V

FIELD WORK

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

The salient overview of the field observations are as follows:

Coal-fire observations:

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

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

Subsidence location observations:

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

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

CHAPTER VI

POST FIELDWORK ANALYSIS

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

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

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

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

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

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.*

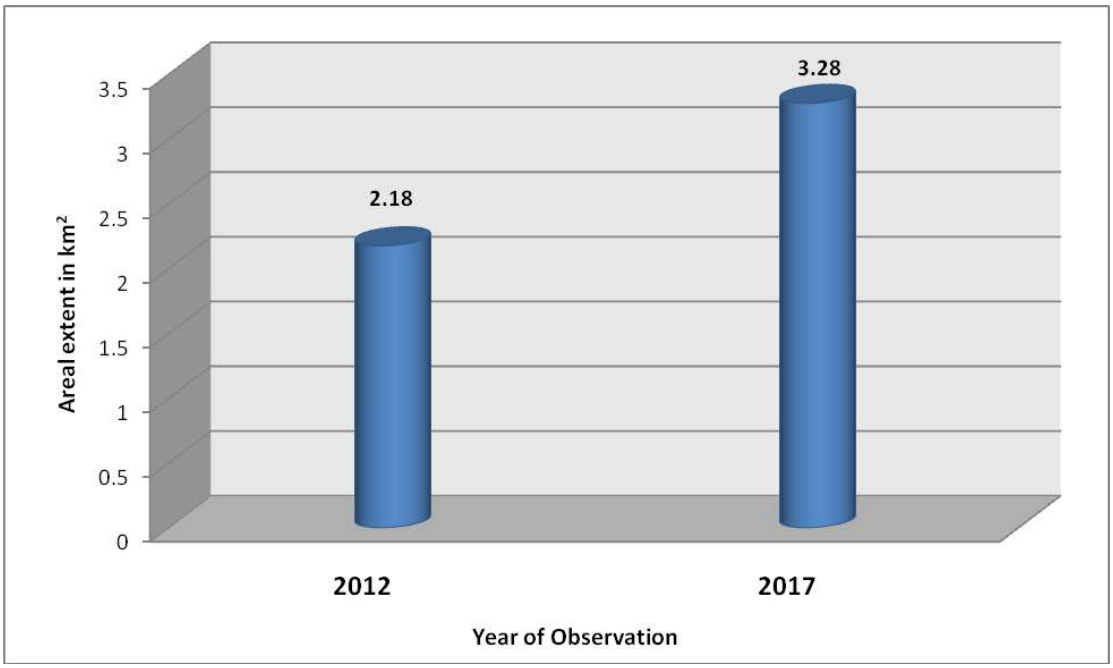


Figure 12: Total fire area statistics

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.

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Annexure –I

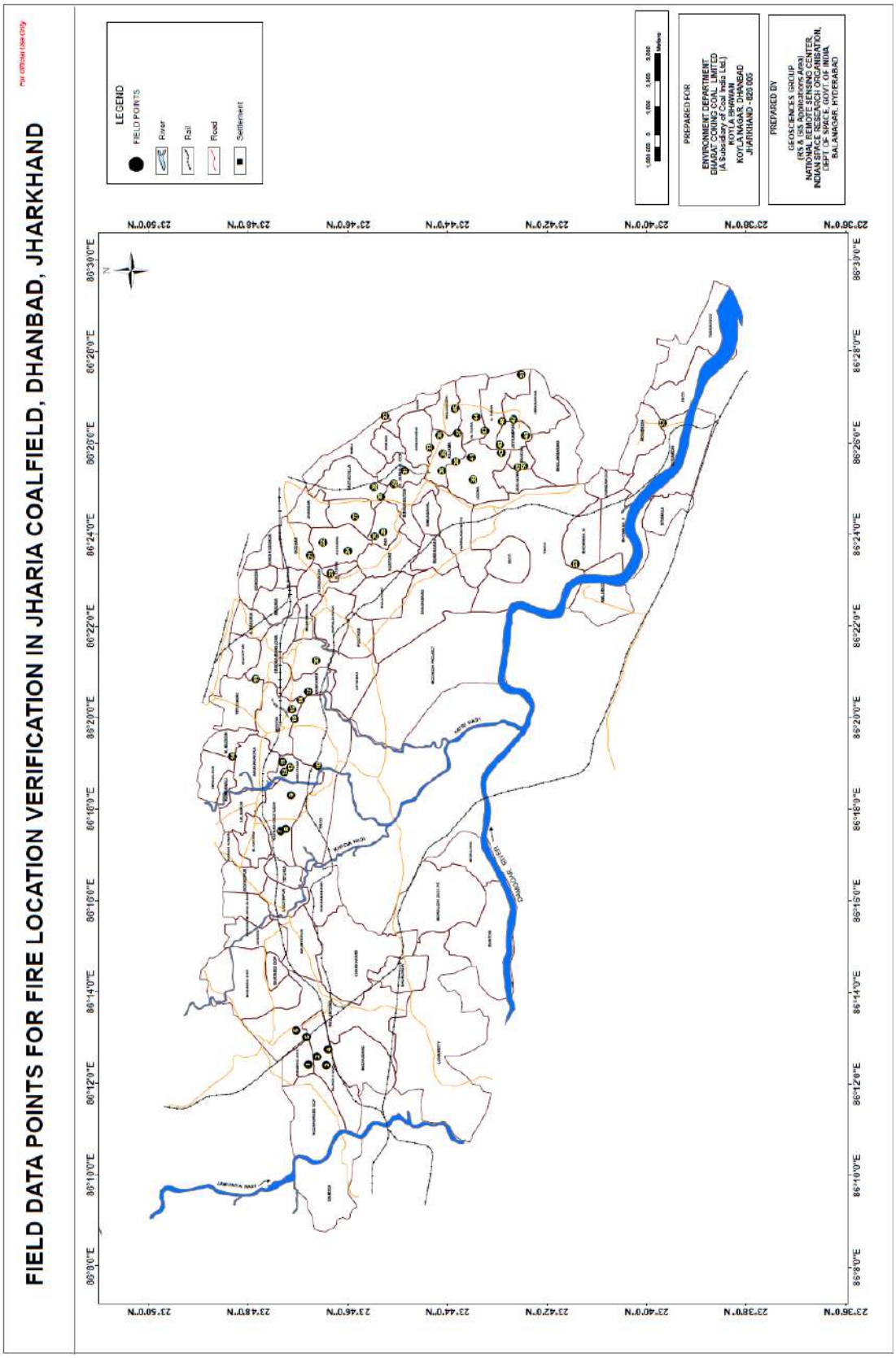


Figure 13. Field data points for coal fire verification

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

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

Annexure –II

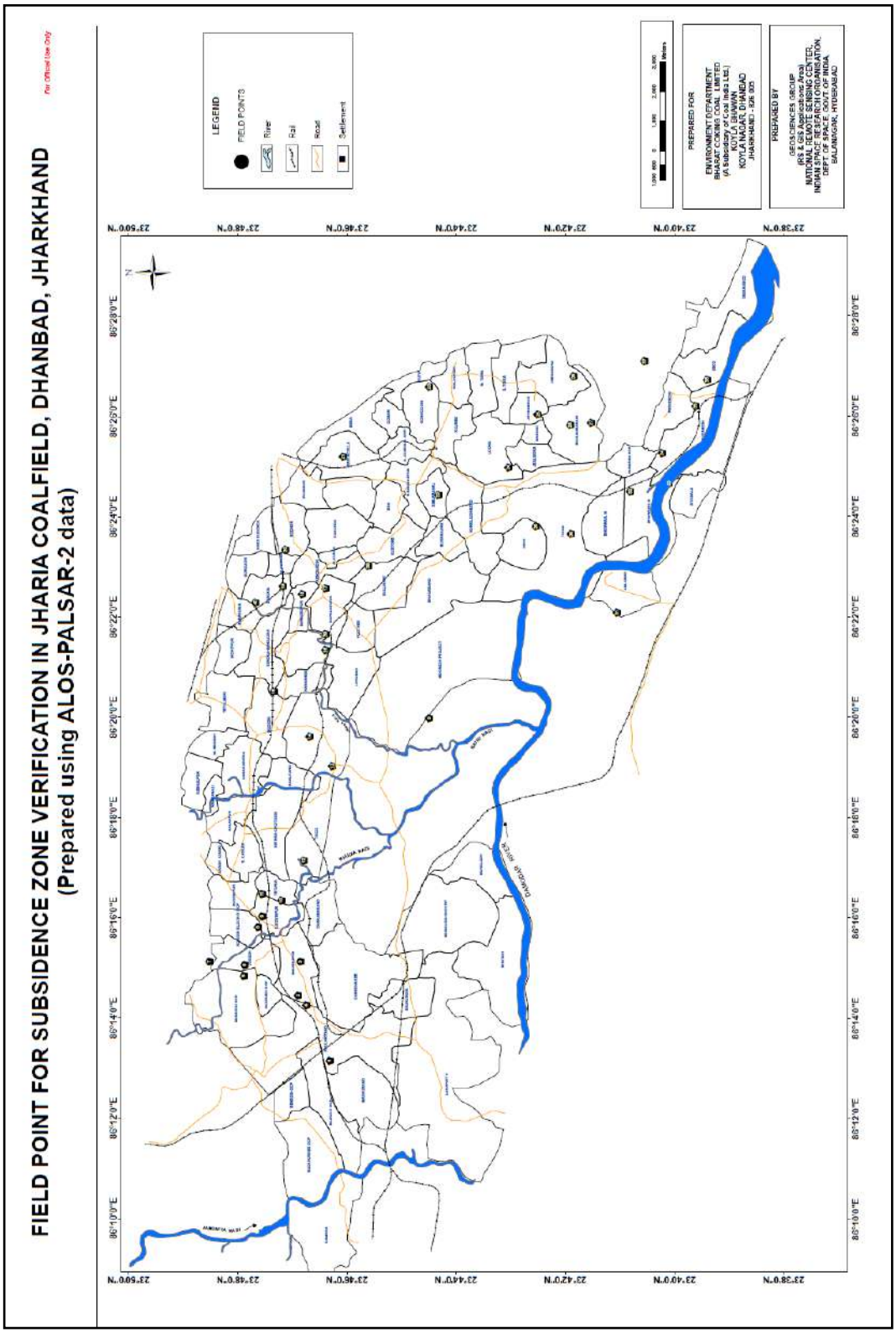


Figure 14. Field data points for subsidence verification

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

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

Annexure –III

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

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

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

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

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

Annexure –IV

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

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

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

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

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

Figure 20: Fume cracks in the Bhulanbarari area.

भारत कोकिंग कोल लिमिटेड
एक मिनी रत्न कम्पनी
(महारत्न कम्पनी कोल इंडिया का एक उपक्रम)
पंजीकृत कार्यालय : कोयला भवन, कोयला नगर
धनबाद–826005
सी आइएन : U10101JH1972GOI000918
महाप्रबंधक का कार्यालय
पश्चिमी झरिया क्षेत्र
पो. मुनीडीह, जिला: धनबाद (झारखण्ड) 828129
फोन नं. 0326 2273483, फेक्स: 0326 2273445 ई-मेल: gmwj.bccl@coalindia.in

Bharat Coking Coal Limited
A Mini Ratna Company
(A Subsidiary of Coal India Limited: A Maharatna Company)
Regd. Off. : Koyla Bhawan, Koyla Nagar
Dhanbad - 826005
CIN : U10101JH1972GO1000918
OFFICE OF THE GENERAL MANAGER
WESTERN JHARIA AREA
PO: MOONIDIH, DISTT: DHANBAD (JHARKHAND) - 828129
PHONE NO: 0326 2273483, FAX NO: 0326 2273445, e-mail : gmwj.bccl@coalindia.in

EC Cluster-XI Specific Condition no. (xiv) by MoEF –

The embankment constructed along the river boundary shall be of suitable dimension and critical patches shall be strengthened by stone pitching on the river front side and stabilized with plantation so as to withstand the peak water flow and prevent mine inundation.

BCCL Submission –

Moonidih Mine of Bharat coking coal limited is an underground mine. The current underground working are situated at a depth of more than 500 m from surface. The mine working have been designed in such a way that there is no effect of subsidence on the surface.

Damodar River is situated in the south edge of the mine leasehold boundary of Moonidih mine. The underground working of Moonidih mine are situated at a horizontal distance of more than 500 m from the river. There is no opencast mine within the leasehold of Moonidih mine. So there is no danger of inundation of the mine from Damadar River hence this condition is presently not applicable.

13/01/21
AGM
W.J.Area

13-1-2021
GM
W.J.Area

ANNEXURE-IV

CSR, R&R and Transportation Plan of Cluster XI

As per EC Condition

(Specific Condition No XVIII)

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 form

Bharat Coking Coal Limited

(A Mini Ratna Company)

P.B Area

Dhanbad

UNDERSTANDING THE SCOPE OF CSR INTERVENTION

(BASELINE STUDY REPORT)

FOR

BHARAT COKING COAL LTD. (BCCL)

DHANBAD

BY-

NATIONAL CORPORATE SOCIAL RESPONSIBILITY HUB

TISS, MUMBAI

25th NOVEMBER 2013

CIL'S POLICY FOR CORPORATE SOCIAL RESPONSIBILITY (CSR)

Introduction

Mining of coal has profound impact on the people living in and around the areas where the mines are established. The obvious impact of the introduction of any production activity in such areas change the traditional lifestyle of the original inhabitants and indigenous communities and also change the socio-economic profile of the Area. Hence, the primary beneficiaries of CSR for the company are:

- Land oustees
- PAPs and
- Those staying within the radius of 25 Kms of the Project.

Poor and needy section of the society living in different parts of India are the second beneficiaries.
In the aforesaid backdrop, policy on Corporate Social Responsibility of CIL has been framed after incorporating the features of the Companies Act 2013 and as per notification issued by Ministry of Corporate Affairs, Govt. of India on 27.02.2014 as well as DPEs guidelines and broadly covers the following: -

a) Welfare measures for the community at large, so as to ensure the poorer section of the Society derived the maximum benefits.
b) Contribution to the society at large by way of social and cultural development, imparting education, training and social awareness especially with regard to the economically backward class for their development and generation of income to avoid any liability of employment.
c) Protection and safeguard of environment and maintaining ecological balance.

Objectives

The main objective of CSR policy is to lay down guidelines for the coal companies to make CSR a key business process for sustainable development for the society. It aims at supplementing the role of the Govt. in enhancing welfare measures of the society based on the immediate and long term social and environmental consequences of their activities. CIL will act as a good Corporate Citizen, subscribing to the principles of Global Compact for implementation.

Areas Covered under CSR

- The poor and needy Section of the Society living in different parts of India are covered.
- The CSR Programme also covers the existing components of Special Component Plan (SCP) and Tribal Sub Plan (TSP) for development of the SC and ST population besides development components for the entire population.

80% of the budgeted amount is spent within the radius of 25 Km of the Project Site/Mines/Area HQ/Company HQ and 20% of the budget is spent within the State.

Allocation of Fund

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

Scope

As per Schedule VII of New Companies Act 2013, the following are 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 centers 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;

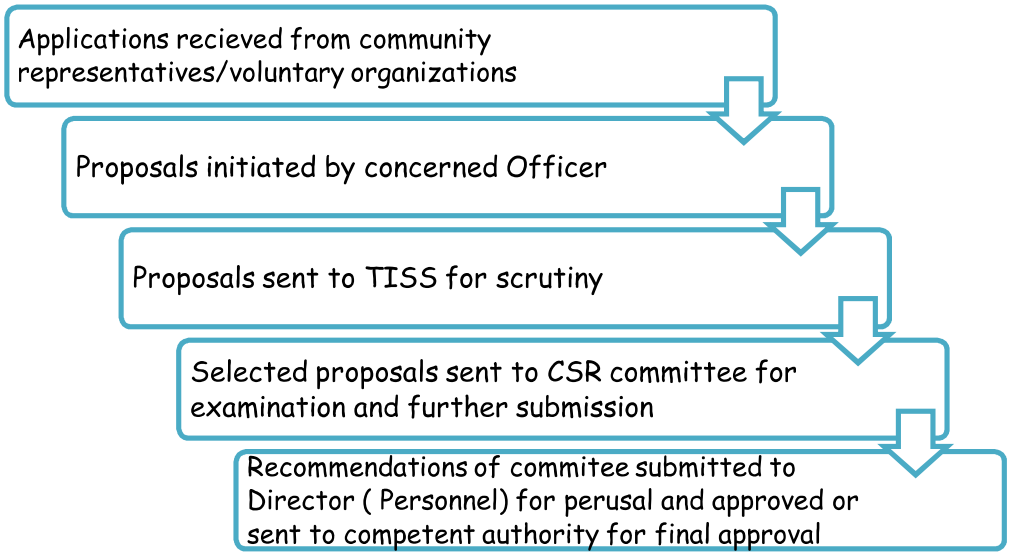
ix) Contributions or funds provided to technology incubators located within academic institutions which are approved by the Central Government;

x) Rural development projects

Implementation

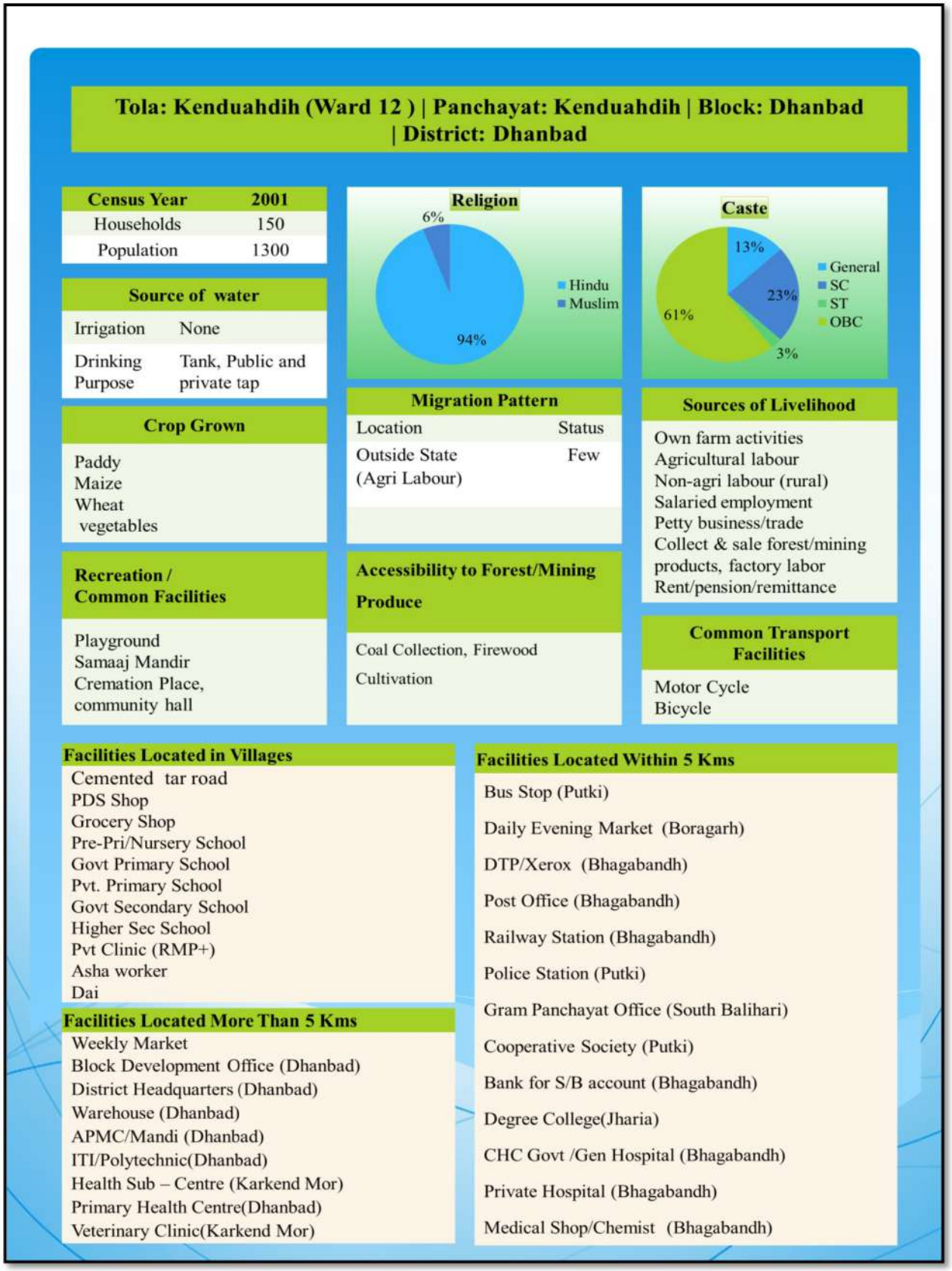
- The investment in CSR is project based and for every project time framed periodic mile stones should be finalized at the outset.
- Project activities identified under CSR are implemented by Specialized Agencies. Specialized Agencies are made to work singly or in tandem with other agencies. Specialized agencies that are included presently for implementation of CSR projects in Cluster VII are through Contracted agencies for civil works.

Institutional Arrangement



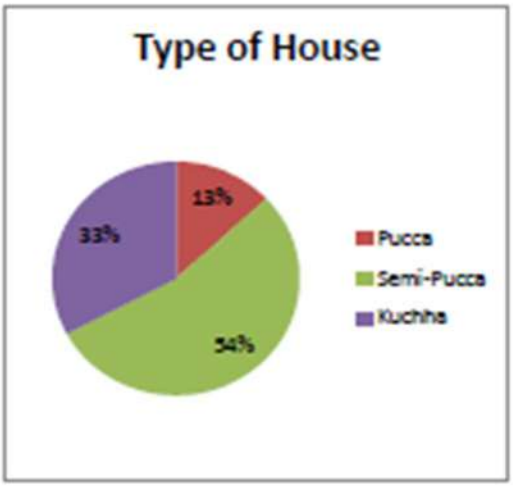
Baseline study done by TISS (Putki Balihari Area)

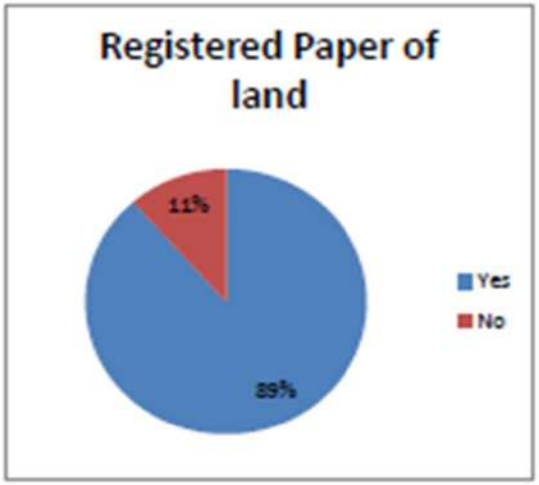
KENDUAHDIH



HOUSEHOLD STATUS

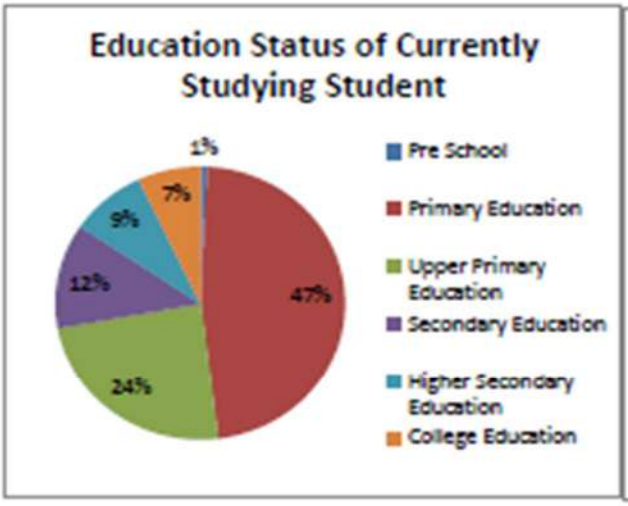
4.10.1.1 HOUSEHOLD STATUS

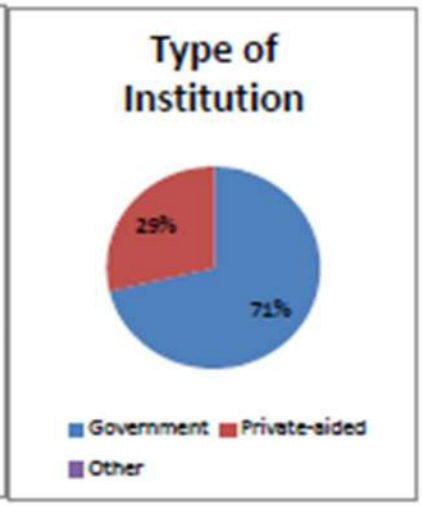




In Kenduahdih Basti, 40% of the households are found to be Semi- Pucca while 48% are Kuchha and 12% are Pucca. 95% of the houses are registered while only 5% was found to be non-registered. Nearly 85% of the houses in this village are electrified.

4.10.1.2 EDUCATION





In Kenduahdih Basti, it has been found that 35% of the students are enrolled in Primary education followed by 28% in Upper primary, 10% in secondary education, and 5% in higher secondary, 3% in college. Education after 12th standard is found comparatively less with any

Major Problems and Recomendations

AREA	MAJOR PROBLEMS AND RECOMMENDATIONS
Education	There is no road which can join schools to main working road
	No electricity and in-house circuiting of lights and fans in the class room of primary school
	Shakti Nath Mehto School needs school boundary and toilet in school premises
Water Supply	Pipeline already exists in this village. More number of pipelines are required in Harijan Basti of Kenduahdih
Health Care	Mobile medical Van should treat children every month in primary school
	Maternity health camp should be initiated through MMV
Social Empowerment	Nearly 5-6 SHG has been identified in this village. SHG *(Ma Saraswati Mahila Samuh)* already exist in the village. They need are trained in agriculture. They need support of land to start collective farming of horticultural crops. They are also trained in preparation *Agarbatti* and bangles made from lac.
	Vocational training school for girls and boys is needed in this village. School building of Shakti Nath Mehto School can be used for providing vocation al training center in the weekends or after the school hours with prior permission of the school administration. Not only that the training center for women to start small enterprise can be establish in the same school premises.
Sanitation	No toilets in any of the households. Toilets is needed to construct
Infrastructural Development	There *Kuccha* road in the village which creates problem during rainy season
	On hand pump/tap point is needed in ICDC
	One kitchen room is required in primary school
	Playground boundary in needed with gate in primary school

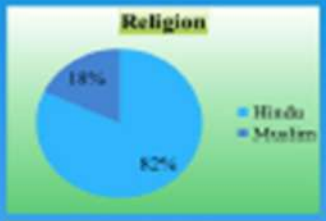
Bhagabandh

4.10.2 BHAGABANDH

Tola: Bhagabandh(Ward 12) | Panchayat:Bhagabandh| Block: Dhanbad | District: Dhanbad

Census Year	2001
Households	720
Population	4409

Religion



Caste

Source of water

Irrigation	None
Drinking Purpose	Tank, public and private tap

Migration Pattern

Location	Status
Outside State (Agri Labour)	Rarely

Sources of Livelihood

Own farm activities
Cattle rearing
Non-agri labour (rural)
Salaried employment
Petty business/trade
Collect & sale forest/mining products, factory labor
Rent/pension/remittance

Crop grown

Paddy
Maize
Vegetables

Accessibility to Forest/Mining Produce

Coal Collection, fire wood
Cultivation

Recreation / Common Facilities

Playground
Sarnaj Mandir
Cremation Place

Common Transport Facilities

Moter Cycle, Share Auto
Bicycle

Facilities Located Within the village

Cemented tar road
Grocery Shop
DTP/Aanik
PDS Shop
Post Office
Bank for S/B account
Pre-Pri/Nursery School
Govt Primary School
Govt Secondary School
Pvt. Secondary School
CHC Govt /Gen Hospital
Pvt Clinic (MBBS/BAMS+)
Medical Shop/Chemist
Asha worker
Dai(Trained/Untrained)
Pvt Clinic (RMP+)

Facilities Located with 5 kms

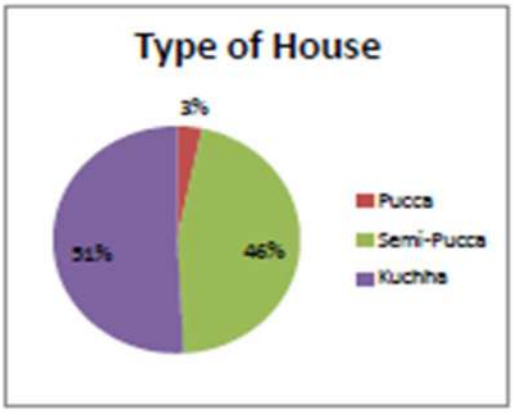
Bus Stop (Putki)
Daily Evening Market (Putki)
Weekly Market (Putki)
Police Station (Putki)
Veterinary Clinic (Putki)
Health Sub – Centre (Putki)

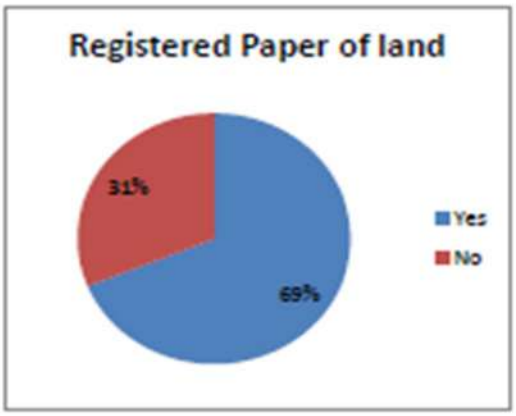
Facilities Located more than 5 kms

Railway Station (Dhanabd)
Block Development Office (Dhanabd)
District Headquarters (Dhanabd)
Warehouse (Dhanabd)
APMC/Mandi (Dhanabd)
Degree College (Dhanabd)
Primary Health Centre (Dhanabd)

Household Status

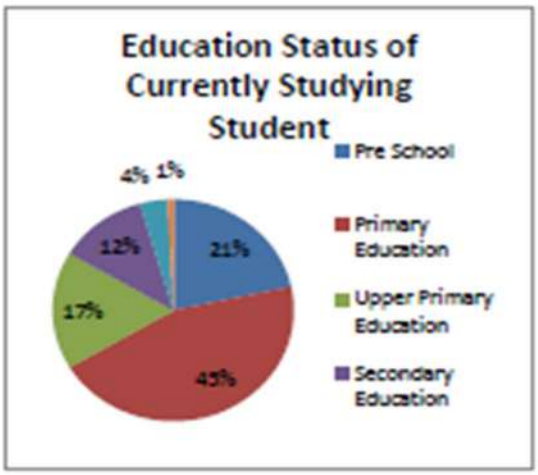
4.10.2.1 HOUSEHOLD STATUS

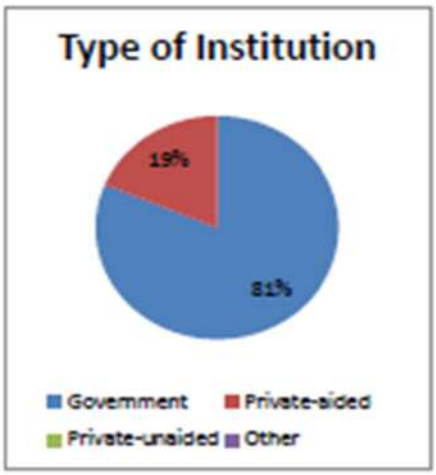




In Bhagabandh Village, 3% of the sample is living in pucca house and 51% were having kuccha house while 46% were having semi -pucca house. Among the sample 69% of the people have registered paper of land while 31% of them do not have registered paper of land. 94% of the sample is living in electrified.

4.10.2.2 EDUCATION





In Bhagabandh Village, status of education does not seem positive as far as college education is considered, only 1% of the children among sample households are found at the time of data collection enrolled in higher education. Among the students of sample households who are currently studying, 45% are currently studying in primary school, 17% are in upper primary school, 12% in secondary school and another 4% is studying in

295

Major Problems and Recommendations

AREA	MAJOR PROBLEMS AND RECOMMENDATIONS
Education	There should scholarship for the children belongin to underprivileged section of the society who is going for education after matriculation to schools of Dhanbad by BCCL
	Library is required in this village
	Evening school has been requested by the people
Water Supply	More number of tap points are required in Manjhi Tola of Bhagabandh Basti
Health Care	Maternity health ccmpa
	Regular check-up of primary school children
Rural Electrification	School should have in-house electric fitting of fans and light
Sports & Culture	Sports equipment should be provided to the sports club
Sanitation	No toilets in houses.
	There should be provision for garbage disposal By BCCL at regular interval along with fumigation
	Ponds should be cleaned with involving community by providing them daily wage as followed in MNREGS
Social Empowerment	SHG for women and men should be formed to start Income Generation activity
	Group activity on Piggery and poultry has been requested by the people. But for that a formal group has to be formed who have to register in the local bank
	Women who are not getting widow pension should be supported with livestock's like poultry, duckery and goatry
Infrastructural Development	Playground for children with boundary
	Repair of damage road should be done so that medical vans or ambulance should reach at the door step for pregnant women
	Playground with boundary should be constructed
	There is requirement of High school covering students from nearby villages like Bhagabandh. It can be done constructing additional school building in government secondary school in the village itself

CSR Activities (April'21 to September'21)

Relief work during Lockdown:

P.B Area through its CSR initiative carried out relief work within peripheral villages/wards in the form of distribution of dry ration and hygiene kits since phase one of Coronavirus induced lockdown.

The kits were distributed to the poor needy families of the community affected due to Covid-19 lockdown. Both ration kit and hygiene kit consisted of basic items; while ration kit had Sattu, Chana, Gur, Chura and Biscuits, hygiene kit included mask and soap. Covid-19 awareness sessions were also organized on social distancing, hand washing techniques and wearing mask in crowded places. Total 1000 ration kits distributed among needy families and 500 hygiene kits distributed among communities residing nearby villages of P.B Area office and Collieries.

Expenditure incurred in distribution of Ration Packet, Face Mask & Soap under CSR:

Sl. No.	Item	No. of Units Distributed	Expenditure (in Rs.)	Sanctioned Amount from HQ	Remarks
1.	**Ration Packet**	**1000**	**1,99,500**	**2,00,000**	
2.	**Face Mask**	**500**	**11,025**	**15,000**	**Remaining amount returned to HQ CSR Fund**
3.	**Soap**	**500**	**12,375**	**34,840**	

Details of ward/ panchayat wise No. of Beneficiaries covered for Food Packets

Area of BCCL	Name of Panchayat/Ward No.	Name of Village/ward	No. of Beneficiaries covered for Food Packet (APPROX.)
P.B Area	Aralgaria	Aralgaria	40
P.B Area	Ward No. 10	Bhagabandh	73
P.B Area	Ward No. 10	Kenduadih Basti	47
P.B Area	Ward No. 12	Kendua Bazar	58
P.B Area	Ward No. 09	Kerkend	33
P.B Area	Ward No. 35	Burragarh	25
P.B Area	Ward No. 35	Surrendranagar	45
P.B Area	Ward No. 11	Khaira	54
P.B Area	Ward No. 11	Kenduadih	68
P.B Area	Ward No. 09	Gopalichak	30
P.B Area	Aralgaria	Bauri Basti	70
P.B Area	Ward No. 12	Kendua Bazar/EB Section	100
P.B Area	Ward No. 10	South Balihari	50
P.B Area	Ward No. 10	Khapra Dhowra	28
P.B Area	Ward No. 10	Tina Dhowra	25
P.B Area	Ward No. 11	BNR Kustore	27
P.B Area	Aralgaria	Singh Tola	20
P.B Area	Pandarkanali	Dhobni, Parasia, Pandarkanali	77
P.B Area	Sialgudri	Sialgudri	80
P.B Area	Ward No. 12	Kendua No. 4	50
Total			**1000**

Details of ward/ panchayat wise No. of Beneficiaries covered for Face mask & Hand Wash/Soap				
Area of BCCL	**Name of Panchayat/Ward No.**	**Name of Village/ward**	**No. of Beneficiaries for face masks**	**No. of Beneficiaries for Dettol soap**
P.B Area	Aralgaria	Aralgaria	47	47
P.B Area	Ward No. 10	Bhagabandh, Kenduadih basti & Station Dhawra	100	100
P.B Area	Ward No. 10	Bihibari & Orao Patti	46	46
P.B Area	Ward No. 12	Kendua Bazar & EB Section	65	65
P.B Area	Ward No. 11	Khaira & Kenduadih	82	82
P.B Area	Pandarkanali	Dhobni, Parasia & Pandarkanali	85	85
P.B Area	Sialgudri	Sialgudri	75	75
Total			**500**	**500**

Transportation Route

Sl. No.	Mine	Existing siding	Other Transport Sites	Existing Transport distance (in KM)	Avg. Capacity of Dumper (T)
1.	Gopalichuck OC	Burragarh (but at present only Road dispatch is operational)		5.9	25
			Belatand Tata Washery	9-10	28.5
			Jamadobha Tata Washery	9-10	28.5
*It includes departmental and contractual transportation					

Modified CSR Annual Action Plan for FY 2021-22 - BCCL

Sl. No.	CSR Projects/Programmes	Item from the list of the activities in schedule VII of the act	Estimated Budget (rupees in Lakhs)*	Manner of execution	Implementation Schedule	Monitoring and reporting mechanism	Details of need and mpact assessment **, if any
			COVID related proposals				
1	Assistance to Dhanbad District Administration	Eradicating hunger, poverty and malnutrition, promoting preventive health care and sanitation including contribution to the Swachh Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water. Disaster Management, including relief, rehabilitation and reconstruction activities.	100.00	BCCL	FY 2021-22	By BCCL	NA
2	Assistance to Jharkhand State Administration	Eradicating hunger, poverty and malnutrition, promoting preventive health care and sanitation including contribution to the Swachh Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water. Disaster Management, including relief, rehabilitation and reconstruction activities.	25.00	BCCL	FY 2021-22	By BCCL	NA
3	Masks & hand sanitizers	Eradicating hunger, poverty and malnutrition, promoting preventive health care and sanitation including contribution to the Swachh Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water. Disaster Management, including relief, rehabilitation and reconstruction activities.	0.72	BCCL	FY 2021-22	By BCCL	NA

4	Fooding & other miscellaneous heads	Eradicating hunger, poverty and malnutrition, promoting preventive health care and sanitation including contribution to the Swachh Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water. Disaster Management, including relief, rehabilitation and reconstruction activities.	36.45	BCCL	FY 2021-22	By BCCL	NA
5	Boarding and lodging of frontline health workers	Eradicating hunger, poverty and malnutrition, promoting preventive health care and sanitation including contribution to the Swachh Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water. Disaster Management, including relief, rehabilitation and reconstruction activities.	22.62	BCCL	FY 2021-22	By BCCL	NA
6	Sanitization of temporary quarantine centres	Eradicating hunger, poverty and malnutrition, promoting preventive health care and sanitation including contribution to the Swachh Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water. Disaster Management, including relief, rehabilitation and reconstruction activities.	2.15	BCCL	FY 2021-22	By BCCL	NA
Non-COVID related proposals							
7	Training of PAPs at CIPET	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly, and differently abled and livelihood enhancement projects.	28.00	BCCL	FY 2021-22 & FY 2022-23	By BCCL	NA
8	Development of Aanganwadis	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly, and differently abled and livelihood	263.50	BCCL	FY 2021-2022 to FY 2023-2024	By BCCL	NA

		enhancement projects.					
9	Swachh Vidyalaya Abhiyan Survey	Eradicating hunger, poverty and malnutrition, promoting preventive health care and sanitation including contribution to the Swachh Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water.	6.96	BCCL	FY 2021-22	By BCCL	NA
10	Distribution of blankets	Eradicating hunger, poverty and malnutrition, promoting preventive health care and sanitation including contribution to the Swachh Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water.	3.58	BCCL	FY 2021-22	By BCCL	NA
11	Mining sirdarship training for SC/ST candidates. Project closed in FY 2021-22 on submission of bills.	Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly, and differently abled and livelihood enhancement projects.	3.26	BCCL	FY 2021-22	By BCCL	NA
12	COVID quarantine centre. Project closedin FY 2021-22 on submission of bills.	Eradicating hunger, poverty and malnutrition, promoting preventive health care and sanitation including contribution to the Swachh Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water.	3.80	BCCL	FY 2021-22	By BCCL	NA
13	Public toilet at Dhanbad	Eradicating hunger, poverty and malnutrition, promoting preventive health care and sanitation including contribution to the Swachh Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water.	3.15	BCCL	FY 2021-22	By BCCL	NA

14	Gymnasium at Ambedkar Academy, Dhanbad. Project closed in FY 2021-22 on submission of bills.	Eradicating hunger, poverty and malnutrition, promoting preventive health care and sanitation including contribution to the Swachh Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water.	2.35	BCCL	FY 2021-22	By BCCL	NA
15	Reversal of Financial Liability of FY 2020-21 for Medical Camps under CSR	Eradicating hunger, poverty and malnutrition, promoting preventive health care and sanitation including contribution to the Swachh Bharat Kosh set-up by the Central Government for the promotion of sanitation and making available safe drinking water.	-8.52	BCCL	FY 2021-22	By BCCL	NA
	Total		**493.02**				**-**

Note * - Modalities of utilisation of fund- Project wise funds shall be utilised as per project wise budget within the Delegation of Power as per rules of the Company

Note ** - As per the Companies (Corporate Social Responsibility Policy) Amendment Rules, 2021, (a) Every company having average CSR obligation of ten crore rupees or more in pursuance of subsection (5) of section 135 of the Act, in the three immediately preceding financial years, shall undertake impact assessment, through an independent agency, of their CSR projects having outlays of one crore rupees or more, and which have been completed not less than one year before undertaking the impact study.

ANNEXURE-V

COMPLIANCE OF DHANBAD ACTION PLAN

(1) Covering of loaded transport vehicles

It has been complied. The clause of covering of loaded coal transport vehicle has also been incorporated in the transport agreement/ contract.

(2) Coal transport roads shall be made pucca

Coal transport route are made pucca, route around weighbridge has been made pucca and wheel washing arrangement has also been made at coal stock yard.

(3) All drillings to be done with dust containment and suppression systems. Sprinklers will be installed including at all coal stock & sidings

Complied. At present mobile water sprinklers are used.

(4) Mobile Sprinklers

Sl. no.	Mine/Workshop	No. of Fixed Sprinklers	No. of Mobile Sprinklers	Total Capacity(KL)	Trips per day
1	Bhagabandh UG Mine	1 (At coal Unloading Site)	0	N.A	N.A
2	P.B. project Colliery UG Mine	1 (At coal Unloading Site)	1	70	2
3	Central Auto Workshop	Nil	2	8 and 12	2
4	Kendwadih Workshop	Nil	1	45	2

(5) The direction of surface run-off of the premises of collieries shall be diverted to created water bodies.
Creation of water bodies in coal bearing area will pose safety threats to nearby mine and it will be violation of mines act. However, artificial ponds have been created where, there are no chances of future coal extraction.

Pond Constructed for Villagers at KB 10/12 Colliery

Pond Created for Villagers at Kendwadih

(6) Dealing of mine fires

A Master plan for Dealing with fires and subsidence and rehabilitation in the leasehold of BCCL has been approved by Govt. of India vide letter no- 22020/1/2005-CRC dated 12 08 09. In fire patch of V/VI/VII/VIII

seam of Gareria Secn. At East Bassuriya about 1, 70,000 cu.m. mitti and non-combustible material has been filled, rest will be filled by quarry OB.

(7) The waste water shall be passed through oil separator-cum-filtration system

Complied. 1 number of Oil Separator has been constructed at P.B. Project Colliery.

(8) The removed OBs shall be utilized for low land filling or for making roads

It is backfilled and then reclaimed by plantation of native species

(9) Tree plantation on the dumps

Complied.

Plantation work on 12 Ha OB dump has been completed with the help of Forest Department (Approx.30000 saplings have been planted).

Approximately 1500 flower saplings have been planted on Gopalichuck dump slope

(10) **All hazardous wastes shall be disposed off**

Complied.

a. All working units have applied for authorization as per Hazardous Wastes (Management, Handling and Trans boundary Movement) Rules.

b. Burnt/used oil is disposed of as per rule.

c. Disposal of Hazardous waste, burnt Oil / batteries is being done through E-auctioning to authorized recycler/ re-processor having valid authorization from CPCB/ SPCB. Return are also being filed.

(11) Monitoring and Reporting six monthly

Complied. Monitoring work is being done by CMPDI, Dhanbad as per work order issued by BCCL HQ. Six monthly air, water and noise monitoring data is submitted to governing bodies.

(12) Introduction of GIS/ GPS

GPS installed vehicles are used for transportation of coal. CMPDI, HQ has been given the job of satellite surveillance of the Jharia coal field through NRSA Hyderabad and the information is being uploaded in the website.

PM 10 Analyzer installed and working at Moonidih Colliery.

ANNEXURE-VI

(7)

Ph: 0326-2204933

झारखण्ड राज्य प्रदूषण नियंत्रण पर्षद्
Jharkhand State Pollution Control Board
HIG-1, Housing Colony, Dhanbad-826001

Letter No.... 2650 Dated ..... 6/7/13 .....

From,

Regional Officer,
Dhanbad

To,

HOD (Envt.),
M/s. B.C.C.L.,
Koyla Bhawan, Koyla Nagar,
Dhanbad.

Sub: **Fixing up monitoring station/Sampling location of Air, Water & Noise.**

Sir,

With reference to you letter no. GM(Env.)/F-JSPCB/2013/783, dt. 06.07.2013 We have approved Air, Water & Noise monitoring Station/Sampling location after verification and return a copy of the map.

Encl-A/a.

Your's faithfully,

6/7/13

(Dinesh Prasad Singh)
Regional Officer.

Memo..... Dhanbad, dated.....

Copy to: The Member Secretary, Jharkhand State Pollution Control Board for information & enclose a copy of the map for necessary action.

Encl-A/a.

(Dinesh Pd. Singh)
Regional Officer.

Printed by Sandip

(7)

Ph: 0326-2204933

झारखण्ड राज्य प्रदूषण नियंत्रण पर्षद्
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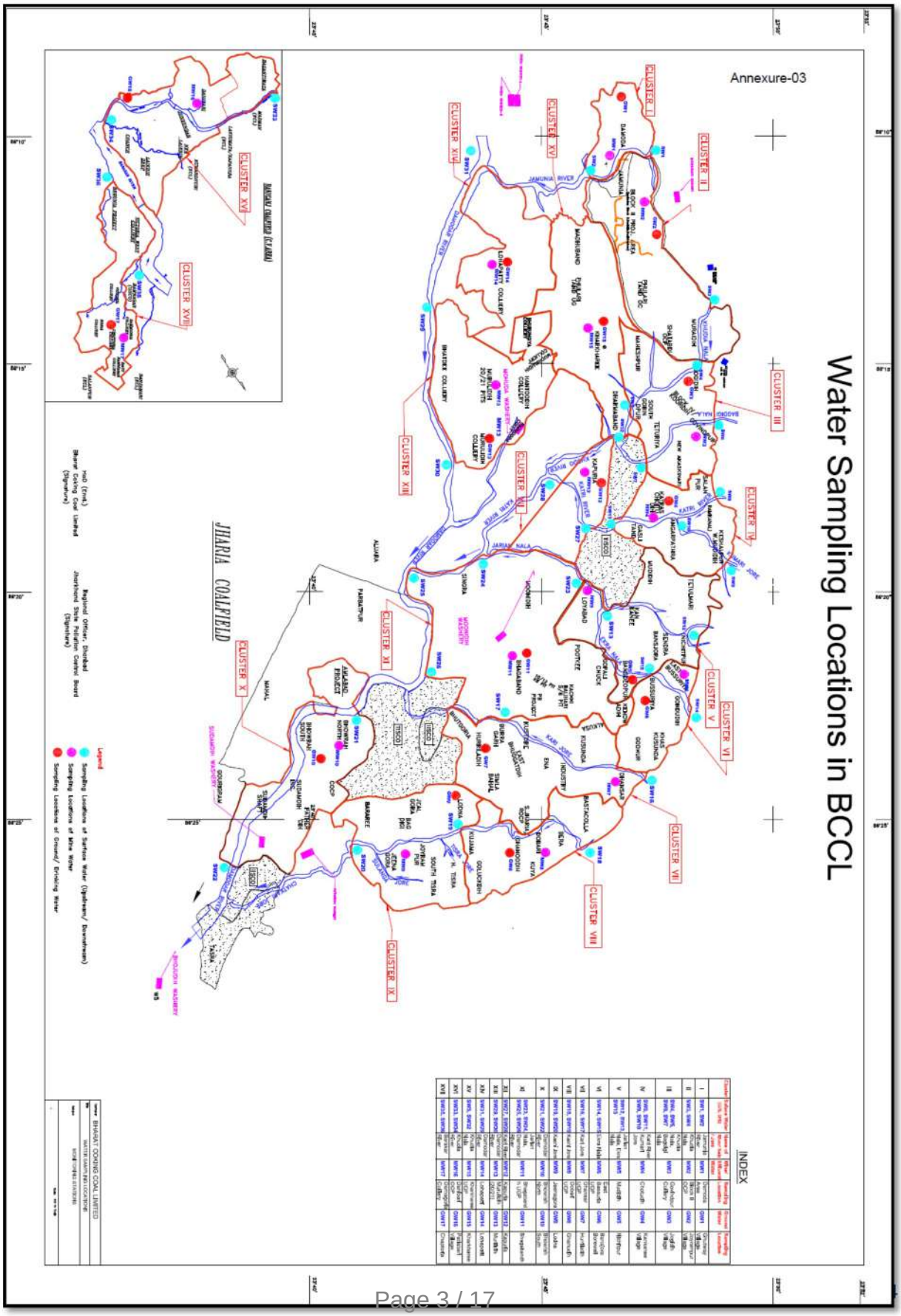
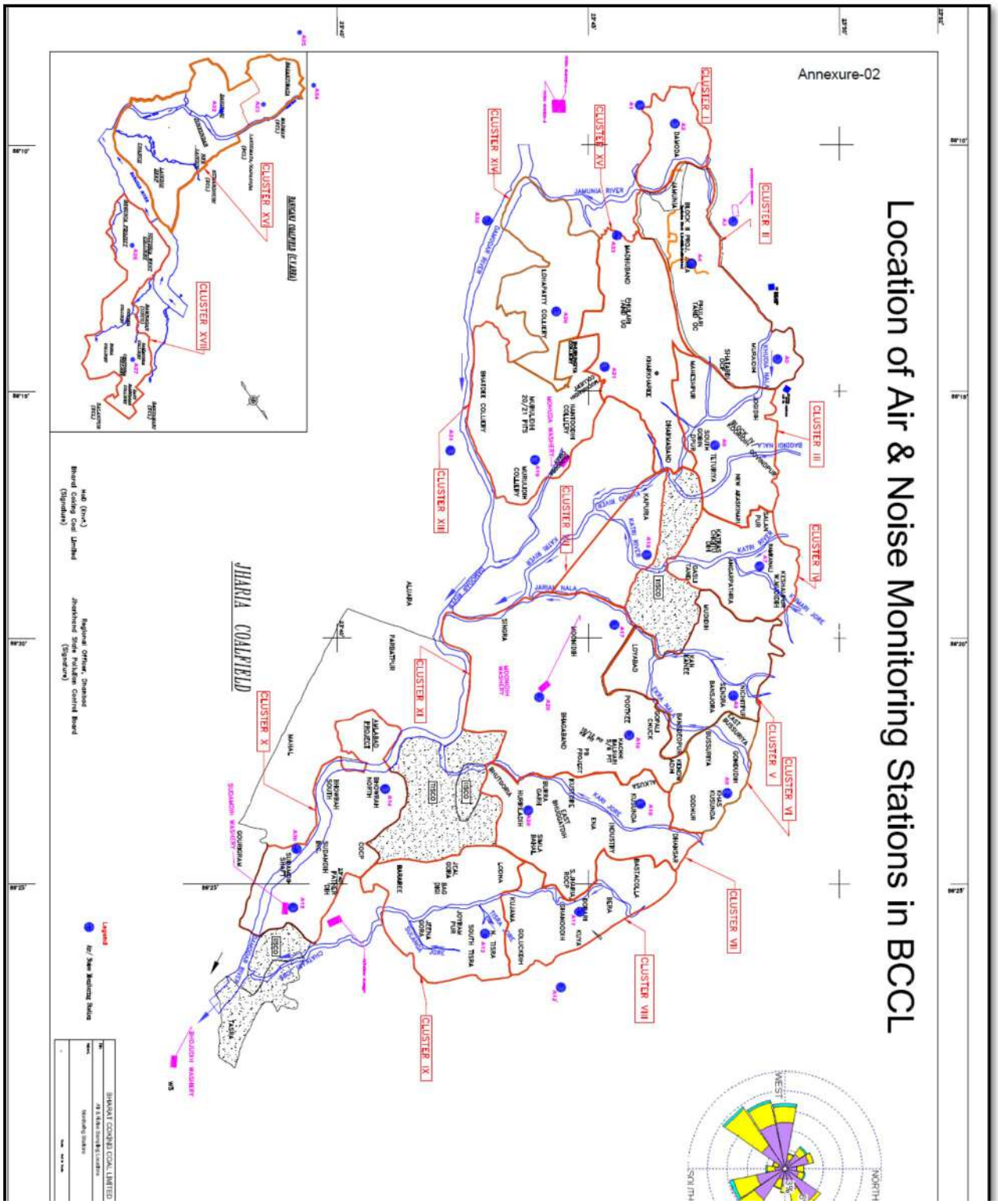
Printed by Sandip


Water Sampling Locations in BCCL
Annexure-03
JHARIA COALFIELD
CLUSTER I
CLUSTER II
CLUSTER III
CLUSTER IV
CLUSTER V
CLUSTER VI
CLUSTER VII
CLUSTER VIII
CLUSTER IX
CLUSTER X
CLUSTER XI
CLUSTER XII
CLUSTER XIII
CLUSTER XIV
CLUSTER XV
CLUSTER XVI
CLUSTER XVII
CLUSTER XVIII
INDEX
Legend
BHARAT COKING COAL LIMITED


Annexure-02
Location of Air & Noise Monitoring Stations in BCCL
JHARIA COALFIELD
BHARAT COKING COAL LIMITED
Legend
Air/ Noise Monitring Station
CLUSTER I
CLUSTER II
CLUSTER III
CLUSTER IV
CLUSTER V
CLUSTER VI
CLUSTER VII
CLUSTER VIII
CLUSTER IX
CLUSTER X
CLUSTER XI
CLUSTER XII
CLUSTER XIII
CLUSTER XIV
CLUSTER XV
CLUSTER XVI
CLUSTER XVII
CLUSTER XVIII
JAMUNIA RIVER
KATRI RIVER
KARI JORE
NORTH
EAST
SOUTH
WEST

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

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.

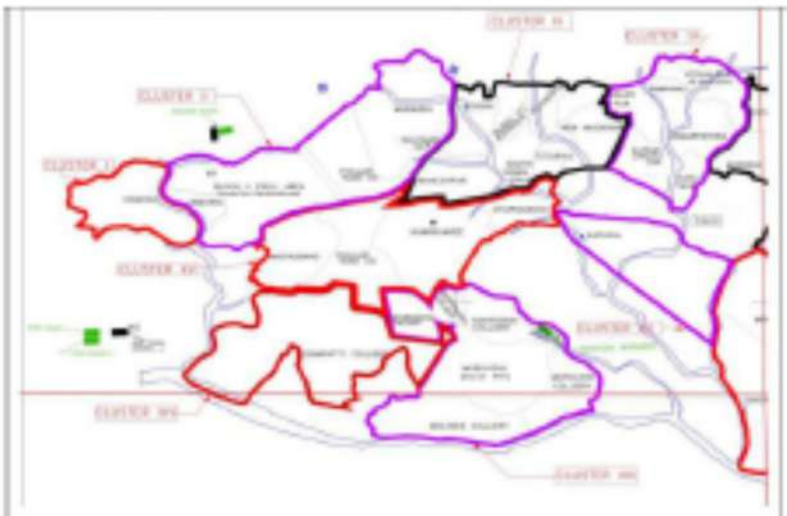
2. Field visit

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.

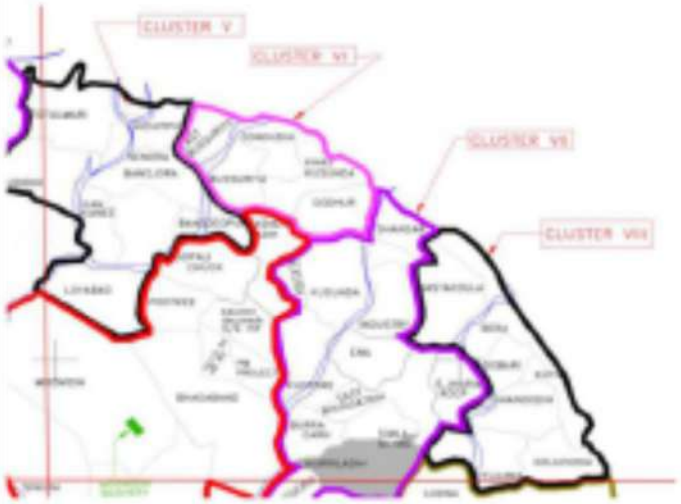
2.1 Jharia coalfield maps:

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.

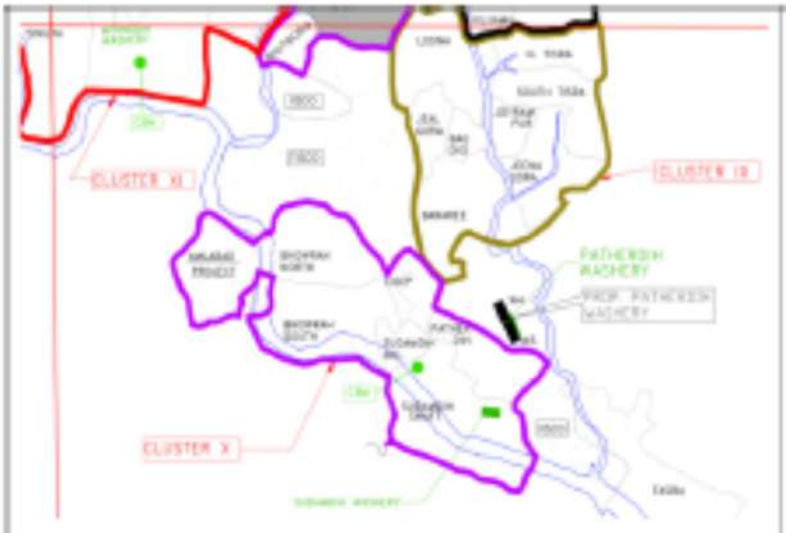


Part 1:

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 $\mu g/m^3$	5 $\mu g/m^3$	9 $\mu g/m^3$	4 $\mu g/m^3$

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

ANNEXURE-VII

Point XVI

सेंट्रल माईन प्लानिंग एण्ड डिज़ाइन इंस्टीच्यूट लिमिटेड
(कोल इंडिया लिमिटेड की अनुषंगी कम्पनी / भारत सरकार की एक लोक उपक्रम)
पंजीकृत कार्यालय : गोन्दवाना प्लेस , कांके रोड , राँची - 834031 (झारखण्ड) भारत
क्षेत्रीय संस्थान-2, पत्रा. बीसीसीएल टाउनशीप, कोयला नगर, धनबाद 826005 (झारखण्ड) भारत
Central Mine Planning & Design Institute Limited
(A Subsidiary of Coal India Limited / Govt. of India Public Sector Undertaking)
Registered Office : Gondwana Place, Kanke Road, Ranchi –834031(Jharkhand)
Regional Institute-II, P.O. BCCL Township, Koylanagar, Dhanbad 826005(Jharkhand) India
Corporate Identity No. U14292JH1975GOI001223

पत्रांकः आर.आई.-2/पर्यावरण/एम-30/ 1150

दिनांकः 20.06.2015

सेवा में,
उप महाप्रबंधक (पर्यावरण)
बी. सी. सी. एल.
कोयला भवन
धनबाद ।

विषयः Study of installation of Rail-cum-Conveyor System in BCCL for transportation of coal.

महोदय,

This has reference to your letter no. BCCL/GM(Env.)/F-EC/13/622, dated 25.05.2013 for conducting the study and preparation of plan for installation of Rail-cum-Conveyor System for coal transportation in BCCL as a part of compliance of environmental clearance (EC) conditions stipulated by MoEF & CC in EC orders of different clusters. In this regard, we would like to inform you the following:

a. As per EC clearance order transportation plan for Rail-cum-Conveyor system should dovetailed with Jharia Action Plan (Master Plan). The system of transportation is required to be installed in 2nd phase of EC implementation i.e. after completion of Master Plan (10 years) and 5 years of gestation period.

b. JRDA has issued direction to RITES for traffic survey and data collection to initiate feasibility study regarding Diversion of Railway lines from fire affected and subsidence prone areas

c. Coal transportation route / conveyor installation layout will be finalized after liquidation of coal mine fire, rehabilitation of 595 unstable sites, road and rail route alignment and location of Rly. Sidings of BCCL.

CMPDI will be able to submit the plan / study for installation of Rail-cum-Conveyor System in BCCL for transportation of coal only after diversions and re-alignments of roads and railway lines and relocation of railway sidings

This is for your kind information.

भवदीय

(वि. कु. सिंह)
क्षेत्रीय निदेशक

Sri Amarkantha Sb.
For compliance pl/pse.
23/6/15

फोन : (+91) 0326-2230850 फैक्स / Fax : (+91) 0326-2230500
वेब साइट / Website : www.cmpdi.co.in
ईमेल / Email : ri2@cmpdi.co.in

ANNEXURE - VIII

सीएसआईआर-केन्द्रीय खनन एवं ईंधन अनुसंधान संस्थान
(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद)
बरवा रोड, धनबाद - 826 015, झारखण्ड, भारत
एक आई एस ओ 9001 प्रमाणित संस्थान

CSIR-Central Institute of Mining and Fuel Research
(Council of Scientific and Industrial Research)
Barwa Road, Dhanbad – 826 015, Jharkhand, India
An ISO 9001 Certified Institute

संदर्भ संख्या/Ref.No.BDIL/PME/CNP/4466/2016-17 / 25 कुर. द्वारा

दिनांक/Dated: 12th मई /May'2017

सेवा में

मेसर्स इंदु - एससीसीएल - सीजीएमइ कंसोर्टियम / M/s INDU-SCCL-CGME Consortium
साईट ऑफिस मुनीडीह - 828129 / Site Office Moonidih - 828129

विषय/Sub:- अनुसंधान एवं विकास परियोजना के संबंध में अन्तिम प्रतिवेदन/Final Report in respect of R&D Project entitled "Advice for finding the effect of subsidence due to coal extraction in XV seam at Moonidih and design the workings in XV(T) & XV(B) sections with no subsidence impact on surface".

आपके संदर्भ संख्या/Your Ref No.: MND/PO/9/2016/180 दिनांक 26/04/2016

प्रिय महाशय/ Dear Sir,

कृपया ध्यान दें, आपके संगठन द्वारा प्रायोजित उपरोक्त अनुसंधान एवं विकास जांच पूरा हो चुकी है और इसकी अन्तिम प्रतिवेदन आपके अवलोकन के लिए संलग्न की जा रही है। मैं प्रतिवेदन के साथ एक फार्मेट संलग्न कर रहा हूँ, आपके द्वारा भरा जाना है (फार्मेट के प्रत्येक पंक्ति के उपयुक्त बॉक्स में टिक निशान लगाए) जो अनिवार्यरूप से ग्राहकों की संतुष्टि के उद्देश्य के साथ अनुसंधान एवं विकास परियोजनाओं के मूल्यांकन के लिए हमारे पैतृक संगठन सीएसआईआर मुख्यालय को अनिवार्य रूप से इसकी आवश्यकता है।

Please note that the above R&D investigation, sponsored by your organization, has been completed and its final report is enclosed for your kind perusal. Along with the report I am enclosing a **format** for getting it filled by you **(tick mark the appropriate box in each row)** which is mandatorily required by CSIR, our parent body, with the purpose of **evaluating customer satisfaction of R&D projects** undertaken by this CSIR Laboratory.

मैं आपका अत्यंत आभारी रहूँगा यदि आप कृपया आगे की कार्रवाई हेतु भरा हुआ फार्मेट हमें भेजने का कष्ट करेंगे। वांछित जानकारी कृपया अधोहस्ताक्षरी को या फैक्स के माध्यम से (0326) 2296025/ 2296021/2296033 भेजें।

It will be highly appreciated if you would kindly extend your co-operation by advising your good office for sending the filled up format to us for taking further action. The desired information may kindly be **sent to the undersigned or fax to (0326) 2296025/2296021/2296033.**

धन्यवाद,

Thanking you,

आपका विश्वासी/Yours faithfully

संलग्न/Encl: रिपोर्ट की दो प्रतियां/two copies of the report,
ग्राहक संतुष्टि फीडबैक फॉर्म/Customer Satisfaction Feedback Form

(तपन कुमार मंडल)
प्रधान तकनीकी अधिकारी/Principal Technical Officer
परियोजना प्रकोष्ठ/Project Cell

प्रतिलिपि/Copy to:- 1) श्रीमान परियोजना अधिकारी (मूनिडीह कोलियरी), परियोजना अधिकारी कार्यालय, मूनिडीह कोलियरी, पोस्टऑफिस: मूनिडीह,डिस्ट्रिक्ट: धनबाद, झारखंड - 828129
2) डॉ. सत्येन्द्र. के. सिंह, मुख्य वैज्ञानिक

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1.0 INTRODUCTION

With the prime objective to have no adverse mining-induced subsidence on the surface, the extraction in XV (Top) and XV (Bottom) seams at Moonidih Mine, Bharat Coking Coal Limited (BCCL), need to be planned keeping two aspects in view, namely,

(a) the extraction spans should be suitably designed to have subsidence strain less than 3mm/m and
(b) the chain/barrier pillars between the extraction spans should have factor of safety (FOS) more than 2.0, i.e., long term stable or stable forever.

These norms are as per guidelines from regulatory authorities/inspectorates. Moonidih colliery of BCCL in Jharia coalfield is the only colliery of India, which is planned for total exploitation of coal seams by longwall with caving only. At localities, wherever there were old overlying goaves of XVII, XVI or such overlying seams, managing no-adverse subsidence seemingly becomes a challenge to the researchers as detailed in this study report.

It is obvious that planning an extraction of width less than the non-effective width (NEW). NEW is the maximum width till which there is no mining-induced subsidence on the surface or a plane of reference, would certainly result into 'completely' no subsidence on the surface. However, the safe limit of 3mm/m mining-induced subsidence strain may also mean "no adverse subsidence impact" on the surface. In latter case, there would obviously be better recovery of coal in comparison. It is, therefore, proposed to take up the latter approach to achieve the prime objectives as mentioned above. In the way, it is also necessary to check, as to whether the planned extraction spans i.e., of 250m face-width [1], would result in 3mm/m subsidence strains or less. If not, the research addresses the issues of possible remedial measures. While taking up this comprehensive research studies as detailed in the text, the aspects of parting stability, especially while extracting XV (Bottom) seam below settled goaf of XV (Top) seam have also been considered with the help of numerical modelling.

Keeping above in view, a research study has been taken up by CSIR-CIMFR. This study report, therefore, includes aspects of subsidence engineering, specifically aspects related to (a) & (b) above and stability of parting between XV (T) and XV (B) seams during extraction. The conclusions and recommendations drawn in this study report would allow the mine operator INDU-SCCL-CGME Consortium to extract longwall panel no. 1-5 belowground in XV (T) and/or XV(Bottom) seams, as the analysis so suggests at Moonidih mine, BCCL without the need to acquire surface land.

2.0 OBJECTIVES

The objectives of this research study include:

a. To design suitable extraction spans to have subsidence strain less than 3mm/m (the safe limit) at the surface, so as to effect no adverse mining-induced subsidence on the surface.

b. To design the chain/barrier pillars between the extractions spans to have a factor of safety (FOS) more than 2.0, i.e., long-term stable.
c. To assess parting stability while longwalling in XV (B) seam below the respective settled goaf of XV (T) Seam.
d. In the case of non-fulfilment or partial fulfilment of (a), (b) or (c), to suggest the remedial measures and associated issues.

3.0 GEO-MINING DETAILS

Plans and sections of the proposed extraction areas of XV (Top) and XV (Bottom) seams at Moonidih colliery were studied with particular attention towards the stability of the immediate roof, caving behaviour of goaf during longwalling and observable conditions of barrier pillars and chain pillars from stability points of view. The geo-mining details are given in Table 1. The mine layout of proposed panels is shown in Fig. 1.

Table 1: Geo-mining details of the coal seams at Moonidih Colliery

1	Workable seams	2 Nos.: XV(T) and XV(B)
2	Thickness of the seam	XV(T):Min.:1.53mMax.: 4.18m XV(B):Min.:1.93mMax.: 7.20m
3	Longwall face width, proposed by the mine management	XV(T): 250 m XV(B): 238.6 m
4	Depth range (By and large)	XV(T): 644 – 782 m XV(B): 647 – 756 m
5	Single chain pillar size (avg.) formed in XVI seam	160 x 55m (corner-to-corner)
6	Width of Tail and Main gate in XV seam	5.7 m (average)
7	% of extraction in the panel	90%
8	Strength of coal tested of XV Seam	5.88 MPa

4.0 FIELD INVESTIGATIONS

XV Seam has been developed in Moonidih mine in the areas from where coal samples were taken for physico-mechanical properties evaluation. To confirm the tested values, twice the sample were collected and evaluation of physic-mechanical properties were revisited. The analysis of plans, sections and earlier submitted reports were led to the conclusion that the proposed area of longwalling in XV (T) and XV (B) were not significantly affected by geological anomalies. Accordingly, the numerical modelling exercises (sections 10.0) did not account for simulation of geological anomalies separately. The latter were subsumed in Rock-mass estimation as detailed in section 10.

Recent visits were made to observe the strata behaviour in overlying longwall panels being extracted at XVI seam in the Moonidih mine. It was observed that the roof caving is regular. The goaf is getting completely packed, more so in the middle of the panel. There was no adverse load coming on the support and the supports were behaving properly even during periodic and local mainfall. No problem is reported till date from supports. This may be perhaps due to regular caving behind the goaf edges as one of the important reasons. The surface properties above the proposed panels were visited and it

was of the opinion that these important properties need to be protected from mining-induced subsidence point of view. At the moment, the mine-management founds the other alternative, i.e., shifting these properties and acquiring the land, not a viable option and therefore research study as detailed in this study report is need of the hour.

5.0 SUBSIDENCE ENGINEERING ASPECTS

Subsidence prediction nomograms/formulations were developed by CSIR-CIMFR, based on extensive scientific subsidence monitoring studies over caved and stowed panels (> 200 in numbers) and subsequent analysis and mathematical treatments [2-7]. These studies included Longwall panels of Moonidih (XVII-Top & XVI-Top seams, caving extraction) with varying depths (H) from 327m to 450m, having w_p/H ratio varying from 0.33 to 1.36. Understandably, width of the panel (w_p) is the face width of the longwall.

Principles of subsidence engineering state that when the width of extraction belowground exceeds a threshold value (depending on the nature of the strata and other geo-mining details), there will be a significant symptom of subsidence (i.e. 5mm or more) on the surface. This value is called as Non-effective width (NEW), expressed as a w_p/H ratio, where w_p = width of extraction-span (or width of a panel) and H = the depth of cover. An important observation in this regard is that harder strata (of all types, not only sandstones) will give a greater value of NEW [2, 3 & 4]. The concept of NEW is simplified to be two-dimensional, although subsidence is associated with three-dimensional (rock) movements. The range of NEW observed in Jharia coalfields is 0.3-0.6 [2]. The critical width (**C_w**), also expressed as a w_p/H ratio, is defined as the width of extraction belowground for which there will be maximum possible subsidence recorded, at least on one point, at surface or on the plane of reference. The observed value of **C_w** in Jharia coalfields is found to be 1.1 to 1.3 [2].

Let us take the minimum value of NEW i.e. 0.33 (in terms of w_p/H) for single seam (say the topmost seam) extraction, as per the scientific observations undertaken by CSIR-CIMFR (erstwhile CMRI) in the past. Understandably, if the proposed w_p/H ratio of longwall panels is less than 0.33 for single seam-extraction situation, there will not be any subsidence on the surface due to extraction of such seams. In case of XV (T) seam extraction, five panels namely P-1, P-2, P-3, P-4 and P-5 are planned to be extracted. The panels P-1, P-2 and P-3 have a settled overlying goaf of XVII (T) seam. The panels P-4 and P-5 are not significantly affected by overlying extracted seam(s) i.e., above the proposed XV (T) seam extraction, there is no caved goaf. Hence, XV (T) & XV (B) seams in these 2 panels can be considered as multi-seam-extraction for the purpose of subsidence parameter calculations. When the XV (B) seam is also extracted below the settled goaf of XV (T) seam, then the total seam thickness of both the seams will be considered for subsidence calculation as the parting is found to be failing, as detailed in section 10.0 of this report.

To account for seam XV (T) in panels P-1, P-2 and P-3, we need to consider XVII (T) seam as goaved out immediately located above the XV (T) seams. Based on the earlier studies [3,5,6,7], a 40% reduction in NEW value has to be incorporated for the

consideration that overlying strata above the extracted XVII (T) seam were regarded as fractured rock types before the proposed extraction in XV(T) may be started. The adjusted NEW for either of lower seams i.e. XV (T) for panels P-1, P-2 and P-3 are given as:

$$NEW' = \frac{[0.6*NEW*(H-P)+NEW*P]}{H} \quad (1)$$

Where, NEW is the non-effective width for single-seam extraction situation, m; P = thickness of intact parting, m; H = depth of the seam, m.

5.1 Empirical subsidence formulation

$$x = \frac{width-to-depth\ ratio}{NEW} = \frac{(w_p/H)}{NEW} \quad (2)$$

Single-seam cases:

$$\frac{S}{h*e} = 0.33 * [1 + 1.1 * tanh\{1.4(x - 1.8)\}] \quad (3)$$

Multi-seam cases (i.e., below goaved out overlying workings):

$$\frac{S}{h*e} = 0.12 * [1 + 5.9 * tan\, h\{0.38(x - 1.45)\}] \quad (4)$$

Where, w_p= width of the panel, m; NEW= non-effective width (as determined) or NEW' (as per eqn. 1), as the case may be, m; S = maximum subsidence, m; h = extraction height, m; e = extraction ratio, 0.9, considering for 90% extraction as may be extracted during longwalling.

Note: For maximum severity to be considered, the minimum depth (and not the average depth) of the seam [here, XV (T)] in the proposed panel should be considered from subsidence management point of view.

The index of determination (R^2) was obtained as 0.85 and 0.86 respectively, for eqns. (3) and (4), which may be regarded as quite satisfactory. It is obvious that the equations are significantly different. A word of caution regarding eqn. (4) is necessary. It may be noted that in multi-seam extractions, the overlying goaf (s) may or may not overlap the extraction panel and also can have widely different and irregular shapes. Eqn. (4), therefore, is only approximate and provides a maximum possible value [6, 7].

$$G = K_1 \frac{S}{H} \quad (5)$$

$$E_{(-)} = K_2 \frac{S}{H} \quad (6)$$

$$E_{(+)} = K_3 \frac{S}{H} \quad (7)$$

Where, G= maximum slope, mm/m;, $E_{(-)}$= maximum compressive strain, mm/m; $E_{(+)}$= maximum tensile strain, mm/m; and H= depth of cover, m.

The calculations made for different panels in XV (Top) and XV (Bottom) seams are given in Table 2. It has been observed that the nature of subsidence at Moonidih would be of continuous one (Fig. 2), as calculated with the help of data in Table 2. Thus, it is reasonable to predict subsidence parameters due to the extraction of these seams. K_1, K_2 and K_3 constants are calculated from the nomograms developed by CSIR-CIMFR (erstwhile CMRI) based on extensive subsidence monitoring and discussed in detail elsewhere [5, 6, 7] – for single seam and multi-seam situations [Fig. 3(a) and 3(b) respectively] [3, 4, 7]. The subsidence damage classification, followed worldwide is taken into consideration while designing coal extraction in XV (T) and XV (B) seams, as listed in Table 3. The safe limit 3mm/m would keep the class of damage in the zone of Sl. No. 1 of Table 3.

Table 2: Subsidence calculations for Panels 1-5 in XV (Top) and XV (Bottom) seams

Panel name	H	P	NEW' (eq. 1)	w_p	x (eq. 2)	h	S (eq. 3 & 4)	K_3	$E_{(+)}$ (eq. 7)	Remarks
Panels in XV (Top)										
Panel 1	564	164	0.236	250	1.88	3	0.633	2	2.247	Multi-seam
Panel 2	640	240	0.247	250	1.58	3	0.418	1.5	0.98	
Panel 3	676	276	0.252	250	1.47	3	0.336	1.5	0.746	
Panels in XV (Bottom)										
Panel 4	704	--	0.33	238.6	1.08	7*	0.329	1	0.467	Single seam
Panel 5	742	--	0.33	238.6	1.02	7*	0.255	1	0.343	

***Note:** The heights of extraction in XV (T) and XV (B) seams were added to be 7m as mentioned against Panel-4 and Panel-5 in Table 2 only for subsidence calculation purpose.

Table 3: Subsidence Damage Classification [2]

Sl. No.	Change in length of structure	Class of damage	Description of typical damage
1	Up to 30 mm	Very slight or negligible	Hair cracks in plaster. Perhaps isolated slight fractures in the buildings, not visible on the outside.
2	30 – 60 mm	Slight	Several slight fractures visible inside the building. Doors and windows may stick slightly. Repairs to decoration probably necessary.
3	60 – 120 mm	Appreciable	Slight fractures visible on outside of buildings (or one main fracture). Doors and windows sticking; service pipes may fracture.
4	120 – 180 mm	Severe	Service pipes disturbed. Open fractures requiring rebending and allowing weathering into the structure. Windows and door frames distorted; floors sloping noticeably. Some loss of bearing in beams. If compressive damage, overlapping of roof joints out lifting of brickwork with open horizontal fractures.
5	More than	Very severe	As above, but worse, and requiring partial or complete

	180 mm		rebuilding. Roof and floor beam loose bearings and needs sharing up. Windows were broken with distortion. Severe slopes on the floor. If compressive damage, severe buckling and bulging of the roof and walls.

As obvious from Table 2, the Panels 1, 2, and 3 are to be extracted either in XV (T) or XV (B) depending on subjective judgements based on quality of coal and thickness of seam in comparison. In this situation, the land above the panels need not to be acquired as the subsidence strain is less than 3mm/m, the safe limit. However, if it is decided to extract both the seams in these panels also, the land over the panels are to be acquired. It may be noted that with the chain pillar size as detailed in section 9, both XV (T) and XV (B) seams may be extracted for a depth range of 670 m and above without affecting surface. Meaning hereby, the future panels on the dip side of Panels 4 and 5 as proposed at the moment, would not require land to be acquired even for double section extraction in XV (T) and XV (B) seams.

6.0 BOREHOLE LITHOLOGY AND PHYSICO-MECHANICAL PROPERTIES OF THE OVERLYING ROOF ROCKS

The borehole no. 1 lies in the center of Panel 5 (Fig. 1), thus its lithology (as shown in Fig. 4) and physico-mechanical properties (given in Table 4), have been considered for numerical modelling exercises undertaken in this report. The lithology of borehole no. 1, has been analysed to get the major bedding planes overlying the seam under consideration and to estimate the immediate roof and main roof so as to get an idea of the variation in the strata over the coal seam. The immediate roof is the fractured lower roof, which readily caves behind the supports forming the goaf during the fracturing process. The main roof can induce vertical load on the supports and cause periodic weighting, if regular caving is not effected after progressive coal extraction during longwalling.

The beds up to a height of 46.45 m above the coal seam are laminated beds of sandstone, shale and carbonaceous shale with a weighted average compressive strength of 44.5 MPa, tensile strength of 8.7 MPa and caving index of 3175. This indicates that the cavability of the roof overlying the coal seam within the caving zone is good and due to the high depth of the coal seam, the goaf will be normally packed behind the supports.

Table 4: Litholog and physico-mechanical properties of Borehole No. 1

Rock Bed Characteristics	Bed	Depth above XV coal seam, **(m)**	Thickness of bed, **t (m)**	RQD, **%**	Avg. Length, est. **L (cm)**	Density **(t/m^3)**	Weighted comp. Str., σ_c **(Kg/cm^2)**	Weighted tens. Str., σ_t **(Kg/cm^2)**	Caving Index
Coal Seam XV	XV Seam	-3.65	-3.65	100.0	24.2	1471	59	12	543
Grey Shale	Bed 1	0	5.45	64.8	12.6	2417	333	68	1954
Sandstone fine to medium grained	Bed 2	5.45	1.2	83.3	18.7	2631	577	107	4242
Sandstone fine to medium grained	Bed 3	6.65	2.2	80.9	17.9	2601	487	95	2581
Sandstone fine to medium grained	Bed 4	8.85	1.9	92.6	21.7	2631	577	107	6407
Grey Shale	Bed 5	10.75	3.7	77.0	16.6	2442	365	74	2332
Sandstone medium grained	Bed 6	14.45	2.87	78.8	17.2	2611	516	99	5302
Grey Shale	Bed 7	17.32	2.88	43.8	5.6	2417	333	68	858
Sandstone fine grained	Bed 8	20.2	1.26	54.0	9.0	2681	699	103	1760
Grey Shale	Bed 9	21.46	1.67	65.9	12.9	2417	333	68	1113
Sandstone medium grained	Bed 10	23.13	2.02	90.1	20.9	2601	487	95	5786
Carbonaceous Shale	Bed 11	25.15	2.9	63.1	12.0	2486	420	83	1715
Sandstone fine grained	Bed 12	28.05	1.17	84.6	19.1	2681	699	103	5212
Carbonaceous Shale	Bed 13	29.22	1.54	92.2	21.6	2463	392	78	2139
Sandstone fine to medium grained	Bed 14	30.76	1.34	88.8	20.5	2631	577	107	5556
Very coarse grained Sanstone	Bed 15	32.1	2.2	82.7	18.5	2586	484	99	2652
Sandstone medium grained	Bed 16	34.3	0.76	73.7	15.5	2601	487	95	2906
Grey Shale	Bed 17	35.06	1.91	99.0	23.8	2361	269	63	1774
Sandstone medium grained	Bed 18	36.97	1.88	99.5	24.0	2601	487	95	6050
Shaly Sandstone	Bed 19	38.85	3.22	87.9	20.2	2498	437	91	3164
Sandstone medium grained	Bed 20	42.07	1.16	91.4	21.3	2601	487	95	4125
Sandy Shale	Bed 21	43.23	1.42	80.3	17.7	2517	458	90	1927
Sandstone medium grained	Bed 22	44.65	1.8	92.8	21.8	2601	487	95	5272
Grey Shale	Bed 23	46.45	17.99	92.8	21.8	2478	421	87	7784
Sandstone medium to coarse grained	Bed 24	64.44	3.51	87.2	19.9	2624	403	90	5486
Alternate Shale & Sandstone	Bed 25	67.95	1.77	85.9	19.5	2591	452	100	2659
Sandstone medium grained	Bed 26	69.72	1.35	85.9	19.5	2601	487	95	4003
Coal Seam XV	Bed 27	71.07	1.08	100.0	24.2	1646	110	23	551
Sandstone medium grained	Bed 28	72.15	1.6	83.1	18.6	2601	487	95	4112
Grey Shale	Bed 29	73.75	1.8	81.1	17.9	2381	281	66	1354
Sandstone medium grained	Bed 30	75.55	0.9	97.8	23.4	2601	487	95	4069
Grey Shale	Bed 31	76.45	2.2	90.5	21.0	2582	461	98	2873
Sandstone medium grained	Bed 32	78.65	2.2	86.4	19.7	2601	487	95	5156
Grey Shale	Bed 33	80.85	5.7	85.8	19.5	2558	451	95	4196

7.0 BARRIER PILLAR DESIGN

For the stability of the workings, barrier pillar design is the major requirement for any successful longwall mining endeavour. Such a design is made using the safety factor concept of structural mechanics, which consists of estimating load and strength of the pillars and linking the two through a proper safety factor.

7.1 Pillar Strength

The barrier pillars or chain pillars designed so far in all the Indian sites are primarily using CIMFR empirical equation, owing to the confidence gained over a couple of decades of its use in real cases and obtained results. The strength of the chain pillars can be estimated using the CIMFR pillar strength equation as given below [8]:

$$S = 0.27\sigma_c h^{-0.36} + \left(\frac{H}{250} + 1\right)\left(\frac{W_e}{h} - 1\right) \quad (8)$$

$$W_e = \frac{2ww_1}{w + w_1}$$

Where, S = pillar strength, MPa, σ_c = compressive strength of 1" coal cube, MPa, h = working height, m, H = depth of cover of the seam, m, w = width of rectangular pillar, m, w_1= length of rectangular pillar, m, W_e= effective width of pillar, m

7.2 Calculation of Load on chain pillars

With reference to longwall extraction, chain pillar loading has been established by Wilson who analysed roof-to-floor convergence measurements behind caved longwall faces. Based on these, he proposed a linear rise in the vertical goaf stress starting from zero at the rib-side or face to the cover pressure γH at a distance of 0.3-0.4H [9]. American findings from extensive measurements propose this distance of goaf settlement on an average as 0.38H [10]. This range can thus be accepted for normally caveable strata. In India, the value of 0.3H is taken for normally cavable strata. For hard, difficult to cave strata, it is assumed that no caving takes place and the goaf does not offer any support. Some differences in this distance can obviously exist depending on the nature of strata. Some observations at CIMFR, Dhanbad have put this distance of 0.2H for stowed panels.

7.2.1 Chain pillar load for both-side goaf

The chain pillar load can be estimated based on the 'vertical stress balance' concept of Wilson. According to this concept, since no part of the cover is added or removed during mining, the total vertical load before mining must remain the same as the total vertical load after mining. This implies that the load reduction in the goaf area must be compensated for by an increase in the load at rib-sides or on chain pillars. If the general

pattern of load distribution is known, knowledge of the one can lead to an estimate of the other.

A typical chain pillar, during its life, will be subjected to the following types of loads:

(a) Development load before extraction starts.
(b) Front abutment load, when the face is at the pillar.
(c) Side abutment load, when the face advances further from the pillar.

If goaf exists on both sides, the pillars will be subjected to loads (b) and (c) twice during their life period. If the panel width is less than 2*fH*, the load in the centre will not reach cover load. If goafs exist on both sides of the pillar chain, the average pillar load could be obtained from the equation below. In this case, 2*fH* = 2*0.3*862 = 517.2 i.e., > Panel width (L_1, L_2) as shown in Fig. 5.

$$P = \frac{\gamma(w_1 + B)}{w w_1}\left[H\left(w + \frac{L_1 + L_2}{2} \right) - \frac{1}{8f}\left(L_1^2 + L_2^2 \right) \right] \quad (9)$$

Where, P = Chain pillar load, MPa, γ = rock load density, MPa/m, H = depth below surface, m, B = gate road width, m, w = width of rectangular pillar, m, w_1= length of rectangular pillar, m, L_1=L_2=L= width of panels, m, f = 0.3 (for caving)

7.3 Safety Factor

The safety factor of the pillars can be calculated as given below:

$$Safety\,Factor,\, S.F. = \frac{Strength of\ barrier\ pillar}{Pillar\ Load} = \frac{S}{P} \quad (10)$$

Chain pillar sizing should normally be done on the basis of the safety factor. It is felt that if the pillars have an adequate safety factor, the chain pillars should remain stable during first-panel extraction i.e. under one-sided goaf loading. During extraction of a neighbouring panel, these chain pillars will undergo both-side goaf loading and it is desirable that they remain short term stable or yield. For short term stability of this chain pillar, the pillar size should be calculated so as to have a safety factor of greater than 1.5 with goaf on both sides; and the safety factor should be greater than 2.0 with goaf on one side. However, to prevent mining-induced subsidence impact at the surface the pillars must be long-term stable. Hence, in this study, the pillar size has been calculated so as to have a safety factor, more than 2.0 with goaf on both sides.

Had this long-term (i.e., stable for ever) stability not ensured, the face width of one panel would combine with the width of the neighbouring panel along with failing chain pillar. On long term basis, w_p (now)=250 + 55 (say)+ 250+ 10 (gallery width)= 565m, and H=742m, i.e., w_p/H= 0.76, which is much more than NEW. Therefore, in case of not-long-term stable chain pillars or arrays of pillars, the subsidence would eventually take place even if the extraction span of each longwall panel is less than NEW. Thus, it is

prudent to opt for numerical modelling to assess the load on pillars, especially when there is extraction nearby and depth of cover is more than 300m as shown in Table 7.

8.0 CALCULATIONS BASED ON WILSON'S MODEL

Pillar stability calculations are based on mine management proposal of the inter-panel barrier of pillar size of 55 m x 160 m corner to corner. Table 5 gives the calculated average load on the pillar, its strength and safety factor as explained in section 7. The depths of the inter-panel barriers have been considered according to those shown in Fig. 6.

Taking σ_c = 5.9 MPa, γ = 0.025 MPa/m, h = 3.5 m, L_1=L_2=L=250 m, B = 5.7 m, f = 0.3 for caving, H = 862 m

Table 5: Calculation of barrier pillar load and safety factor based on Wilson's formula

Width (m)	Length (m)	Load (MPa)	Strength, MPa	S.F.
70	195	81.59	122.09	1.50
75	195	77.62	128.57	1.66
80	195	74.14	134.81	1.82

It has been found that Wilson's formulae overestimate the load on pillars as it is based on tributary area method. The overestimation in a typical case study may be as high as 40% [11].

9.0 NUMERICAL MODELLING PROCEDURE

This part of the report deals with numerical modelling to study the stability of inter-panel barriers and its effect on longwall workings.

Numerical modelling using FLAC^{3D} software [12] has been done for analysis of the stability of the barrier pillars (Fig. 6) for the depth of 862 m corresponding to the maximum depth of Panel No. 5. The modulus of elasticity and Poisson's ratio values of the goaf material are taken based on its values assumed for numerical modelling in published literature.

To have a better understanding of the problem a fine mesh/grid was prepared at the zone of interest. Fig. 7(a) shows the mesh/grid of the numerical models of the barrier pillar with applied load on the surface of the model before the start of the extraction of longwall panels. The boundary of the model lies on the centre line of the two longwall panels on both sides of the line of the barrier pillar. The model boundary, coal seam and the rock beds are shown in the figure. The boundaries are placed sufficiently far away from the area of interest and the behaviour in the area of interest is not affected. Fig. 7(b) shows the mesh/grid of the numerical model after drive of the gate roads. Fig. 7(c) shows the numerical model to estimate the load on the barrier pillar with goaf present on both sides.

Table 6 lists the different rock beds obtained from analysis of the litholog of Borehole No. 1 (Table 4). Bed 2 corresponds to coal of the XV seam and Bed 3 to Bed 1 (grey

shale) of Table 4. Bed 4 comprises of Bed nos. 2 to 4 of Table 4. Bed 5 consists of Bed nos. 5 to 13, Bed 6 is made up of Bed nos. 14 to 16, Bed 7 comprises of Bed nos. 17 to 22. Bed 8 corresponds to Bed no. 23 of Table 4. Bed nos. 24 to 26 constitute the Bed 9. Bed 10 corresponds to Bed no. 27, Bed 11 comprises of Bed nos. 28 to 32 and Bed 12 corresponds to Bed no. 33 of Table 4.

Table 6: Physico - mechanical properties of different rock beds considered for numerical modelling

Bed No.	Bed (Table 4)		Bed Thickness (m)	Young's Modulus (Pa)	Density	Comp. Str. (Pa)	Tens. Str. (Pa)
	From	To					
N_Bed 1 (Floor)	-		50	6E+09	2313	3.61E+07	7.30E+06
N_Bed 2 (Coal)	Coal XV seam		3.65	2E+09	1471	5.90E+06	1.20E+06
N_Bed 3	1	1	5.45	5E+09	2417	3.33E+07	6.80E+06
N_Bed 4	2	4	5.3	6E+09	2619	5.40E+07	1.02E+07
N_Bed 5	5	13	20.01	7E+09	2514	4.42E+07	8.40E+06
N_Bed 6	14	16	4.3	9E+09	2603	5.14E+07	1.01E+07
N_Bed 7	17	22	11.39	8E+09	2521	4.33E+07	8.80E+06
N_Bed 8	23	23	17.99	8E+09	2478	4.21E+07	8.70E+06
N_Bed 9	24	26	6.63	8E+09	2610	4.33E+07	9.40E+06
N_Bed 10	27	27	1.08	2E+09	1646	1.10E+07	2.30E+06
N_Bed 11	28	32	8.7	8E+09	2551	4.38E+07	9.00E+06
N_Bed 12	33	33	5.7	8E+09	2558	4.51E+07	9.50E+06

9.1 In-situ Stress field Initialisation

In the absence of measurements of the in-situ stress values, theoretical values were calculated by the following equation [13]:

$$K = \frac{S_h}{S_v} = \frac{\nu}{1-\nu} + \frac{\alpha E G}{(1-\nu)\gamma}\left(1+\frac{1000}{H}\right) \qquad (11)$$

Where, K= ratio of in-situ horizontal to vertical stress, ν = Poisson's ratio, α = Coefficient of thermal expansion of rock=$0.3\text{x}10^{-5}/^{0}$C, E= Modulus of elasticity, Mpa, G= Thermal Gradient = 0.03^{o}C/m, γ = Volumetric density 0.025 MPa/m, H= Depth of cover, m.

9.2 Steps for Numerical Modelling

STEP-1 **:**
a. Grid generation;
b. Selection of appropriate material behaviour model;
c. Incorporation of material properties, in situ stresses and boundary conditions;

d. The model is run in virgin state;

STEP-2 **:** Development of roadway excavations in the model; The gallery of width 5 m and height 3.65 m was driven on both sides of the barrier pillar in the coal seam.

STEP-3 **:** Panel 1 is extracted and is filled with goaf.

STEP-4 **:** The adjoining longwall panel is also extracted and is filled with goaf.

9.3 Numerical Modelling Result

Numerical modelling was carried out to estimate the average load on the barrier pillars considering the different width of the pillars. Pillar strength was calculated using CIMFR pillar strength eqn. (8) mentioned above. From the above two parameters safety factor was determined to analyse the stability of the barrier pillars of various width using eqn. (10).

Option I:

Numerical modelling was carried out considering different values of barrier pillar width viz. 70 m, 75 m and 80 m. The result of this activity is tabulated below.

Taking σ_c = 5.9 MPa, γ = 0.025 MPa/m, h = 3.5 m, $L_1=L_2=L$=250 m, B = 5.7 m, f = 0.3 for caving, H = 862 m.

Table 7: Pillar load and safety factor obtained from numerical modelling

Barrier width (m)	Barrier length (m)	Modelled Load (MPa)	Strength (MPa)	S.F.
70	195	70.76	122.09	1.72
75	195	67.45	128.57	1.91
80	195	64.48	134.81	2.09

From the above study, as shown in Fig. 8, it is evident that for long-term stability, the width of the inter-panel barriers has to be 80 m (rib to rib). The idea behind long-term stable chain/barrier pillar rests on the fact that if barrier pillars(s) or an array of barrier pillars fails [having F.O.S less than 2.0], say at much later period after completion of coal extraction in the panel, the load, before failure, are shared among these pillars, would now be redistributed, resulting into higher abutments on non-failed barrier pillars. This redistribution may make non-failed pillars more vulnerable to failure. Eventually, there can be likely subsidence on the surface, although not expected. Ensuring long-term stable-designed chain pillars is therefore very important, not only from operational working reasons but also from surface subsidence management aspects.

Option II:

As per the approved mine plan, the dimensions of inter-panel barriers are suggested to be 55 m width and 160 m length (both rib to rib). Due to operational convenience, the mine operator has insisted on the approved mine plan dimensions for chain/barrier pillar.

Numerical modelling was also carried out using the above-mentioned pillar dimensions the result of which is given below.

Taking σ_c = 5.9 MPa, h = 3.65 m, H = 862 m, w = 55 m, w_1 = 160 m.

$$W_e = \frac{2 * w * w_1}{w + w_1} = \frac{2 * 55 * 160}{55 + 160} = 81.86$$

$$Pillar\ Strength(S) = 0.27\sigma_c h^{-0.36} + \left(\frac{H}{250} + 1\right)\left(\frac{W_e}{h} - 1\right)$$

$$= 0.27 * 5.9 * 3.65^{-0.36} + \left(\frac{862}{250} + 1\right)\left(\frac{81.86}{3.65} - 1\right)$$

$$= 96.309 MPa$$

As in Option I, numerical modelling was carried out to assess the average load on the barrier pillar.

Average load on barrier pillar (P) = 84.88 MPa

Safety Factor = $\frac{S}{P} = \frac{96.309}{84.88} = 1.13$

Option III:

As the safety factor of the barrier pillar calculated using option II is quite low, it will be necessary to increase the pillar strength by employing side bolting. The best policy is to install bolts such that the top and bottom ones in a vertical row enter the roof and floor at an angle. To prevent both spalling and robbing it will be necessary to place the bolts over a wire mesh. Grouted or resin-anchor pre-tensioned bolts should be preferred to other types. The strength of the bolted pillar is given by eqn. (12) [13].

$$S_b = S + \frac{20A_s(q-1)}{\sigma_c a^2} S \qquad (12)$$

Where, S_b = strength of bolted pillar, S = strength of unbolted pillar, A_s = anchorage strength of rock bolts, T, q = 3.4, σ_c = uniaxial compressive strength of coal, T/m^2, a = spacing between rock bolts, m.

The anchorage strength of rock bolts depends, among other things, upon the care adopted during bolting operation. Considering anchorage strength of 15 T, σ_c of 5.9 MPa = 590 T/m^2 and spacing of 1.25 m, the strength of bolted barrier pillar is calculated in the following manner.

$$S_b = S + \frac{20A_s(q-1)}{\sigma_c a^2} S$$

$$= 96.309 * \left(1 + \frac{20 * 15 * (3.4-1)}{590 * 1.25^2}\right)$$

$$= 171.528$$

Safety Factor = $\frac{S_b}{P} = \frac{171.528}{84.88} = 2.02$

Therefore, for long-term stability of 55 m wide barrier pillars, bolting needs to be carried out at a spacing of 1.25 m. There are various patterns as shown in Fig. 9 in which side bolting can be done.

Further Option I is recommended for the size of chain pillars/arrays of pillars including barrier pillars in XV (T) and XV (B) seams at Moonidih colliery. However, if there is insipient side-falls expected and/or observed from instrumentation-data analysis then side bolting/suitable side supports, if necessary with more support-reinforcement may be put in place at such locations.

10.0 NUMERICAL MODELLING FOR EVALUATION OF PARTING STABILITY

This part of the report deals with numerical modelling for evaluation of parting stability during extraction of Panels 4 and 5 in XV (Bottom) seam.
Numerical modelling using FLAC 3D software has been done for analysis of the stability of the parting between top and bottom section of the XV seam in two stages-

Stage I: Extraction of the Top Section and Goaf formation
Stage II: Extraction of the Bottom Section under stabilised goaf of Top Section

The model is prepared at the centre line of the longwall panel, along the section BB', as shown in Fig. 6. It is 200 m along the X-axis and 3 m along the Y axis. The beds as given in Table 4 are along the Z-axis. A fine mesh/grid of 1 m along X-axis and 1 m along Y-axis was prepared. Fig. 10(a) shows the mesh/grid of the numerical model before the start of the extraction of Top and Bottom Section. The model boundary, coal seam (Top Section Bed 6 and Bottom Section Bed 2) and the rock beds are shown in the figure. The Bed 3 (coal), Bed 4 (sandstone) and Bed 5 (coal) of thickness 1 m each constitute the parting of total thickness 3 m.

The boundaries are placed sufficiently far away from the area of interest and the behaviour in the area of interest is not affected. Fig. 10(b) shows the typical mesh/grid of the numerical model during extraction of Top section. Fig. 10(c) shows the numerical model to estimate the stability of the parting during extraction of Bottom section. Longwall Powered supports are modelled as nodal forces as shown in Fig. 10(d).

The elastic properties assumed in the model are given below in Table 8.

Table 8: Elastic properties of goaf used in the model

Sl. No.	Rock Bed	Young's Modulus 'E' (Pa)	Poisson's ratio 'ν'
1.	Goaf	0.6 e 9	0.1
2.	Stabilised Goaf	1.0 e 9	0.1

10.1 In-situ Stress field initialization

In the absence of measurements of the in-situ stress values, theoretical values were calculated by the following equation [13]:

$$K = \frac{S_h}{S_v} = \frac{\nu}{1-\nu} + \frac{\alpha E G}{(1-\nu)\gamma}\left(1+\frac{1000}{H}\right) \quad (11)$$

Where, K= ratio of in-situ horizontal to vertical stress, ν = Poisson's ratio, α = Coefficient of thermal expansion of rock=0.3x10-5/0C, E= Modulus of elasticity, Mpa, G= Thermal Gradient = 0.03oC/m, γ = Volumetric density 0.025 MPa/m, H= Depth of cover, m.

10.2 Steps for Numerical Modelling

Stage I:Extraction of the Top Section and Goaf formation

STEP-1 **:**
a. Grid generation
b. Selection of appropriate material behaviour model
c. Incorporation of material properties, in situ stresses and boundary conditions
d. The model is run in virgin state

STEP-2 **:** The face is advanced to 68 m with caved goaf behind. The goaf behind the face is simulated with modulus of elasticity as 0.6 GPa.

STEP-3 **:** The face is advanced in stages with 8 m advance and progressive goaf filling till 196 m.

STEP-4 **:** The face is advanced 4 m and thereby entire Top Section is extracted and goaf is formed up to a height of 105 m.

Stage II: Extraction of the Bottom Section under stabilised goaf of Top Section

STEP-1 **:** The face is advanced to 68 m with caved goaf behind. The goaf behind the face is simulated with modulus of elasticity as 0.6 GPa. The stabilised goaf of the Top Section is simulated with modulus of elasticity as 1 GPa.

STEP-2 **:** The face is advanced in stages with 8 m advance and progressive goaf filling till 92 m.

STEP-3 **:** The face is advanced in stages with 2 m advance and progressive goaf filling till 108 m.

10.3 Safety Factor Calculations

The best way to know about the roof stability of the working area and its caving characteristics in the goaf is by calculating the safety factor for each element in the

overlying strata using the induced principal stress obtained from the output of the numerical model. Safety factor calculation was done using the Sheorey criterion for jointed rock masses developed at CIMFR for this purpose.

$$\sigma_{cm} = \sigma_c \exp\left(\frac{RMR-100}{20}\right)$$

$$\sigma_{tm} = \sigma_t \exp\left(\frac{RMR-100}{27}\right)$$

$$b_m = b^{\frac{RMR}{100}}$$

Where,

σ_1 & σ_3 are major and minor principal stresses induced on an element at failure
σ_c is intact rock compressive strength, MPa
σ_t is intact rock tensile strength, MPa
b is constant for rock type
RMR is Bieniwaski's Rock Mass Rating

The safety factor 'F' is obtained as-

$$F = \frac{\sigma_1 - \sigma_{3i}}{\sigma_{1i} - \sigma_{3i}}$$

Except when $\sigma_{3i} > \sigma_{tm}$,

$$F = \frac{\sigma_{tm}}{-\sigma_{3i}}$$

10.4 Numerical Modelling Result

Numerical modelling was done to understand the stress redistribution during extraction of the bottom section below the caved goaf of the top section of XV seam. The observations from numerical modelling are plotted in the following figures:

Fig. 11(a) : Contour of Major Principal Stress
The maximum major principal stress (σ_1) of magnitude 122 MPa is observed in the abutment zone and the minimum σ_1 of 3.7 MPa is observed in the cantilever behind the supports.

Fig. 11(b) : Contour of Minor Principal Stress
The maximum minor principal stress (σ_3) is compressive of magnitude 33.6 MPa is observed in the abutment zone and the minimum σ_3 is tensile with magnitude of 7.7 MPa which is observed over the canopy behind the supports.

Fig. 11(c) : Principal Stress Vectors and orientation
The orientation are in line with the observed principal stresses in the

abutment zone and in the cantilever roof

Fig. 11(d) : Contour of Vertical Stress
The maximum vertical stress (σ_{zz}) of magnitude 117 MPa is observed in the abutment zone which is approximately 5 times the cover load.

Fig. 11(e) : Safety Factor Contour
The major portion of the parting overlying XV (Bottom) seam, especially in the cantilever section over the powered supports has a safety factor of less than 0.5 which indicates that the coal roof is expected to be fractured and will be prone to cavity formation primarily due to high vertical stress at such high depth of cover. The stone roof is having a safety factor of more than 0.6 which indicates that it will be stable on a short-term basis. The canopy of the powered supports should be kept within 0.2-0.3 m out-bye from the face at all times to prevent any shear fracture and cavity formation ahead of the supports. This may facilitate ease of coal extraction in XV(B) seam below caved goaf of XV(T) seam.

Fig. 11(f) : Distribution of vertical stress along the panel
The distribution of vertical stresses all along the panel is plotted. As can be seen, cover pressure in a distant inbye from the abutment zone is re-established within the goaf and the coal block pillar, proposed to be extracted,.

It may be recommended to opt for the instrumentation plan with a suite of geotechnical instruments as mentioned in Fig. 13 on a “design by measurement” mode and Annexure I. Based on instrumentation data, parting stability should be ensured with respect to gate-road stability and its maintenance. The strata evaluation, monitoring and management should be done by the mine management under supervision of a scientific body. As understandable, the gate road has a better stability if the adjoining chain pillars and array of pillars are stable, meaning hereby, that the FOS should be more than 2.0. As already mentioned in section 8.0 of the report, with forward analysis of eqn. (10), the strength of barrier pillar is calculated using eqn. (8) and chain pillar load by the use of numerical modelling as described in section 9.0. It is pertinent to highlight that the prime objective of this research project was to suggest a method of extraction with an aim to have no mining-induced subsidence impact on the surface. The extensive numerical modelling exercise were executed with focus on extraction areas, and the parting stability while extracting in, longwall panels of XV (B) seam below caved goaf of XV(T) seam. The issues of parting stability affecting gate road stability, especially in XV (B) seam would require therefore a separate treatment of research where the strength of pillars has to be estimated using numerical modelling on one hand and on the other hand, the focus area of modelling need to be concentrated on roof and floor of gate road in addition to the chain pillars.

11.0 CONCLUSIONS AND RECOMMENDATIONS

1. Subsidence strain is calculated to be less than 3 mm/m, the safe limit. Here two types of considerations have been made: (a) single-section extraction in Panel nos. 1, 2 and

3 – subjective solution based primarily on the thickness of XV (Top) and XV (Bottom) seams and the quality of coal, and (b) double-section vertically-superimposed extraction in XV (Top) and XV (Bottom) seams, where the latter would be below settled goaf. Understandably the surface land need not to be acquired based on details of subsidence study in Section 5 of the report.

2. Subsidence monitoring for suitably laying out the monitoring stations over each panel of extraction on the surface needs to be undertaken during and one year after the completion of extraction in the respective panel(s).
3. In case it is feasible to acquire the surface land, scientific study needs to be conducted with new objectives and applicable guidelines. For example, the stability requirement of chain/barrier pillars would be reduced from a factor of safety of 2 or more to a new requirement.
4. Based on the stability criteria of chain/barrier pillars, it is recommended that chain pillars of width at least 80 m be left between longwall panels having length not less than 195 m for the long-term stability of the pillars.
5. Due to operational constraints as envisaged by the mine operator and as communicated to CSIR-CIMFR, the length of the chain pillars was modified to 160 m where the width of the chain pillar should not be less than 55 m as approved in the mine plan. Taking these two parameters, the FOS of the chain pillars was calculated to be 1.135, i.e., less than the design criteria of FOS 2.0. A pattern of side bolting therefore is recommended in this case, with a grid spacing of not more than 1.25 m (as per Fig. 9) so that pillar has adequate enhanced strength and for which the FOS calculated was 2.02.
6. As a corollary to (5) above, it is recommended to opt for side-bolting of chain pillars as per Fig. 9, not only to ensure stability of chain/barrier pillars but also to prevent side falls that may happen at high stress regime of such high depth of cover as in XV (T) and XV (B) seams of Moonidih Colliery.
7. Once the chain pillars are developed, the above recommendations (4-6) shall be suitably revisited depending on the ‘design by measurement’ approach using a suite of geotechnical instruments as per instrumentation plan. As per discussions with DGMS and recommendations of a technical workshop conducted at DGMS Dhanbad on 20.01.2017 on latest trends in strata control in longwall mining with a special reference to strata monitoring techniques, the instrumentation plan for longwall is given in Annexure I. The recommended plan shall be put in place pillar-after-pillar. The modifications can be either reducing or increasing the spacing of side bolts or using the calculated anchorage test values which may be higher than 15 T taken in this study report, supposing the better practice of side-bolting put in place at the mine sites.
8. The XV (B) seam can be worked with not less than 3 m thick parting in between.
9. After extraction of the XV (T) seam, it is observed from numerical modelling exercises (please refer to Section 10) that the safety factor of the 3 m parting is varying between 1.0 and 2.5. Accordingly, the width of the barrier/chain pillars in bottom section will be increased by 11.4 m (2 x 5.7 m) compared to those of the top section as shown in Fig. 12. The width of gate roads is recommended to be 5.7 m.
10. During development and final extraction, the relevant guidelines of Coal Mines Regulations should be followed, maintaining straight line of extraction all along.

12.0 ACKNOWLEDGEMENTS

The authors are obliged to Late Sri N. Kumar (then CMD, BCCL), Sri Gopal Singh, CMD, BCCL, Sri D. Gangopadhyay, D (T), BCCL, Sri Soumen Chatterjee, GM, BCCL, Sri R.B. Kumar, GM, Western Jharia Area, Sri J.S. Mohapatra, Project Officer, Moonidih Colliery, Mr. Rahul Sarkar, then-Area Safety Officer and all officers of Moonidih Colliery, BCCL for keeping keen interest in this research study and providing all necessary helps and logistic supports. CSIR-CIMFR team expresses deep gratitude to Mr. B. Mukund Reddy, Mr. K. Srinivas Rao, Mr. R. K. Sharma of M/s Indu Projects, and Sri V.K. Sinha, then RD, RI-II, and Sri Manwendra Kumar, RD, RI-II, CMPDI, for their keen interest in the research study. The authors are also thankful to Dr. Pradeep K. Singh, Director, CSIR-CIMFR for necessary guidance and support.

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Fig. 1: Mine layout showing workings of XV seam

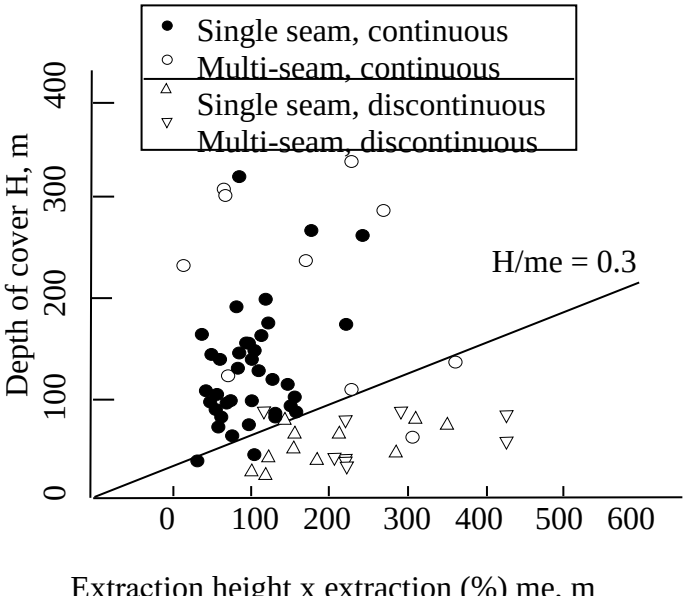


Fig. 2: Line of demarcation between continuous and discontinuous subsidence

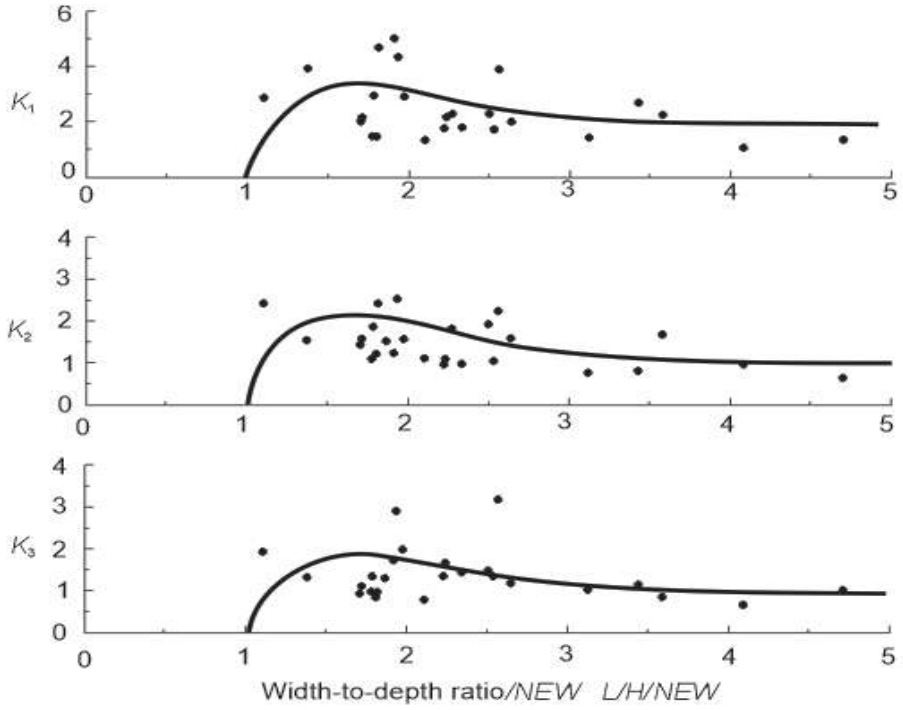


Fig. 3(a): Reference graph for estimation of K_1, K_2 and K_3 constants for Single Seam

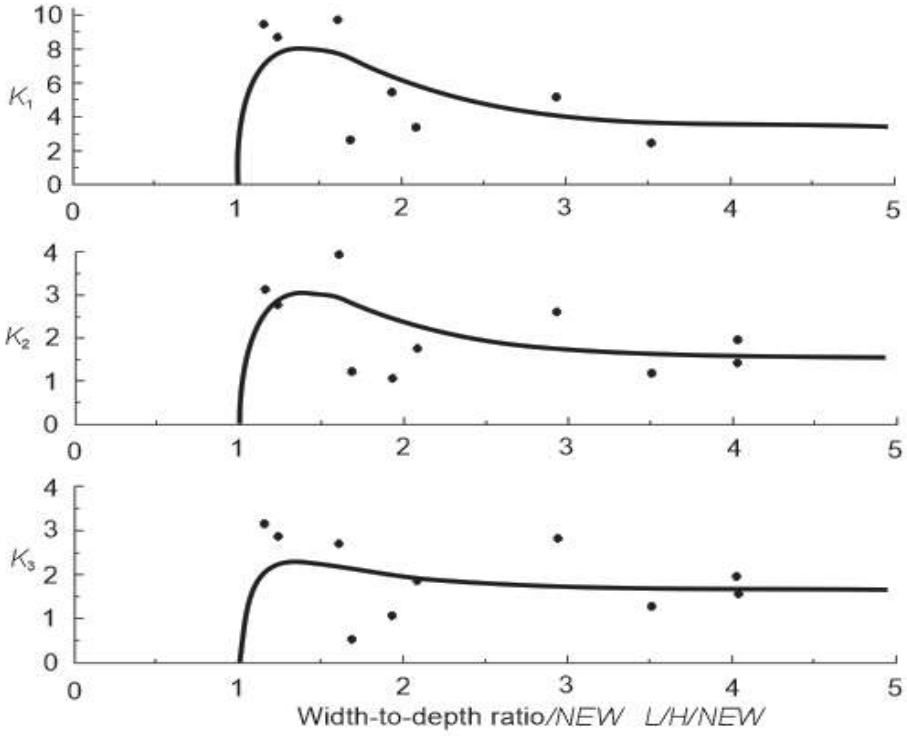


Fig. 3(b): Reference graph for estimation of K_1, K_2 and K_3 constants for multi-seam

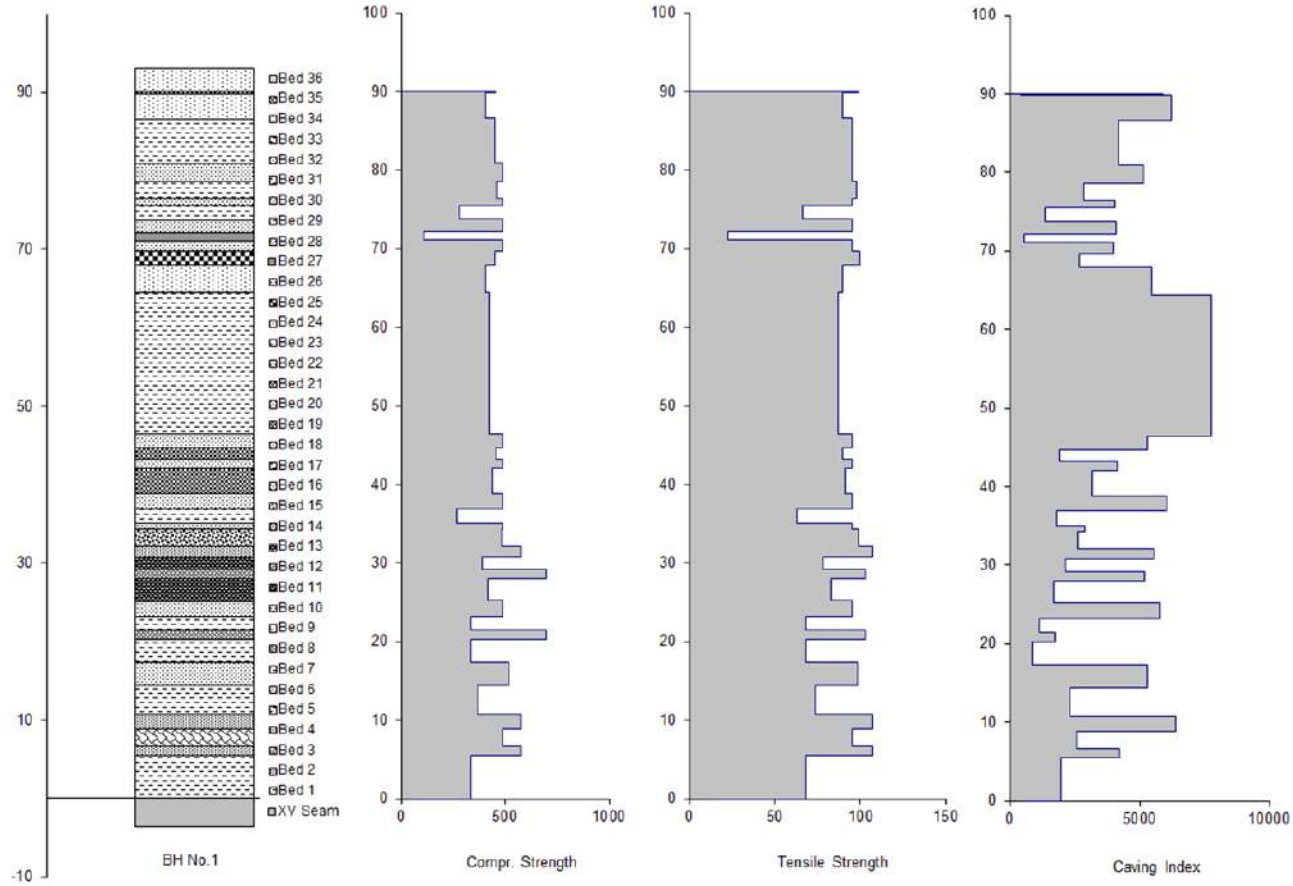


Fig. 4: Histogram of physico-mechanical properties and caving index for different rock beds overlying XV seam at Moonidih Mine as per Borehole No. 1. More intricate and sub-divided beds are listed above, for modelling purpose the beds are suitably merged as listed in Table 4 with determined properties.

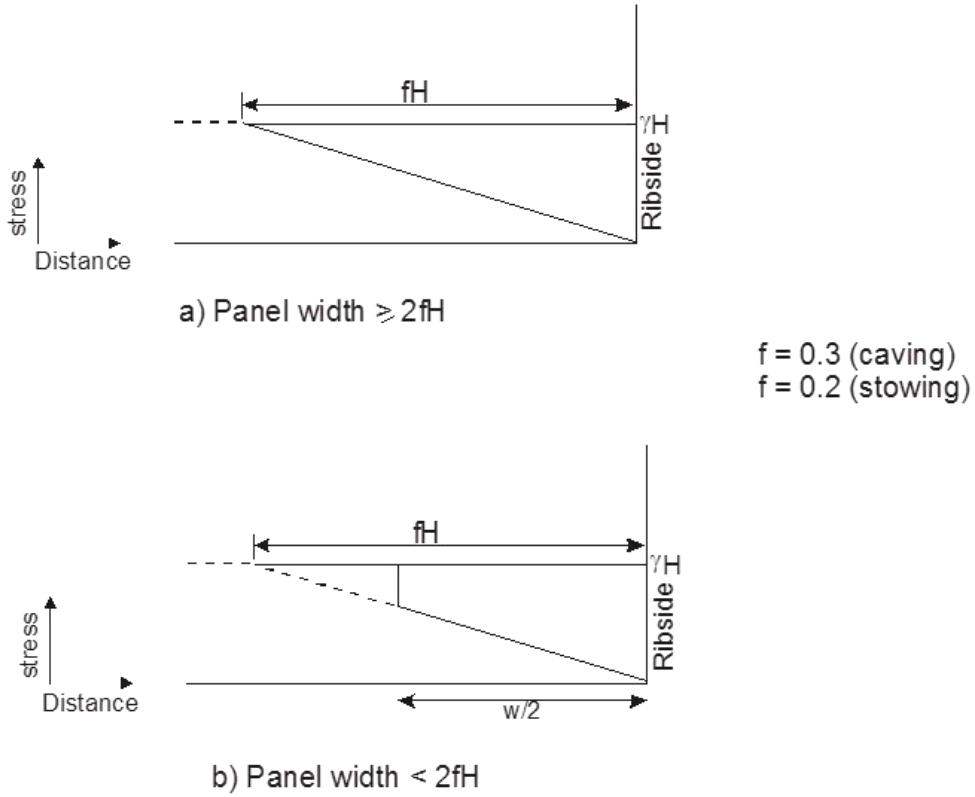


Fig. 5: Stress distribution in the goaf: a) panel width ≥ 2fH b) panel width < 2fH

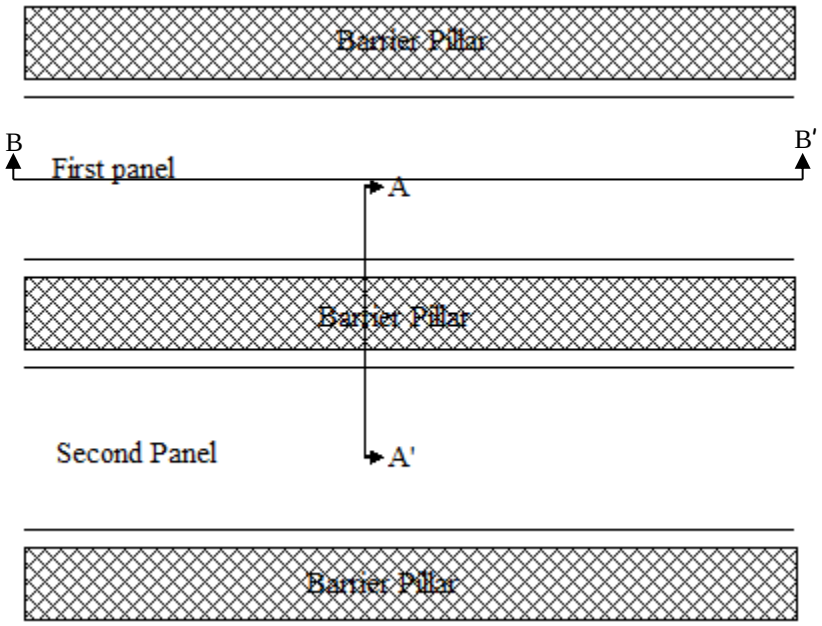


Fig. 6: Schematic diagram showing proposed Longwall panels (Plan view)

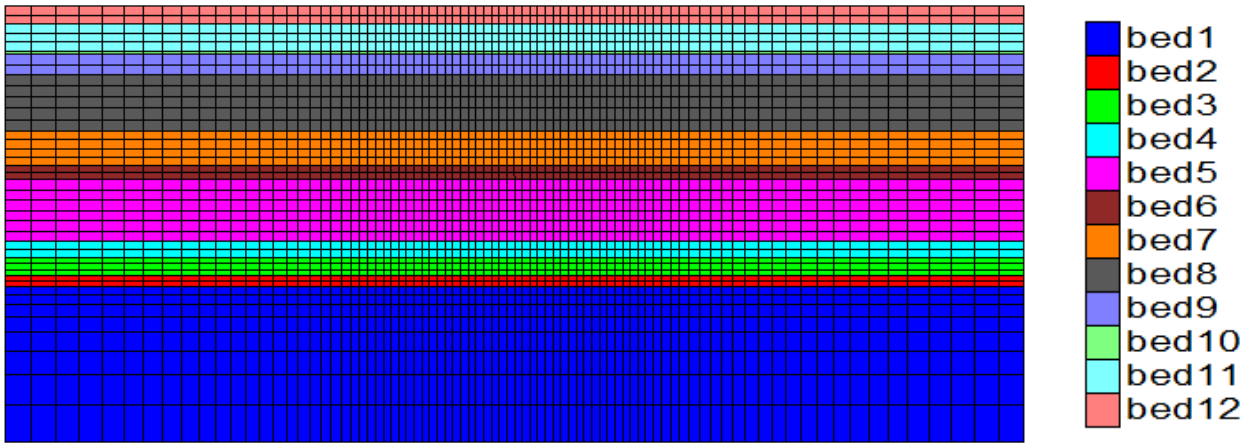


Fig. 7(a): Mesh/grid of the numerical models at virgin state

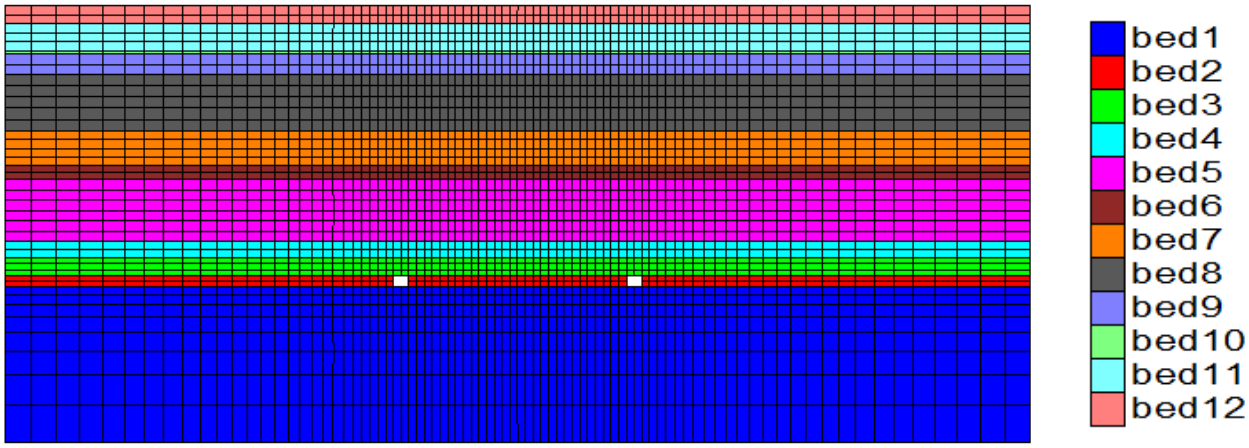


Fig. 7(b): Mesh/grid of the numerical models after drive of the gate roads

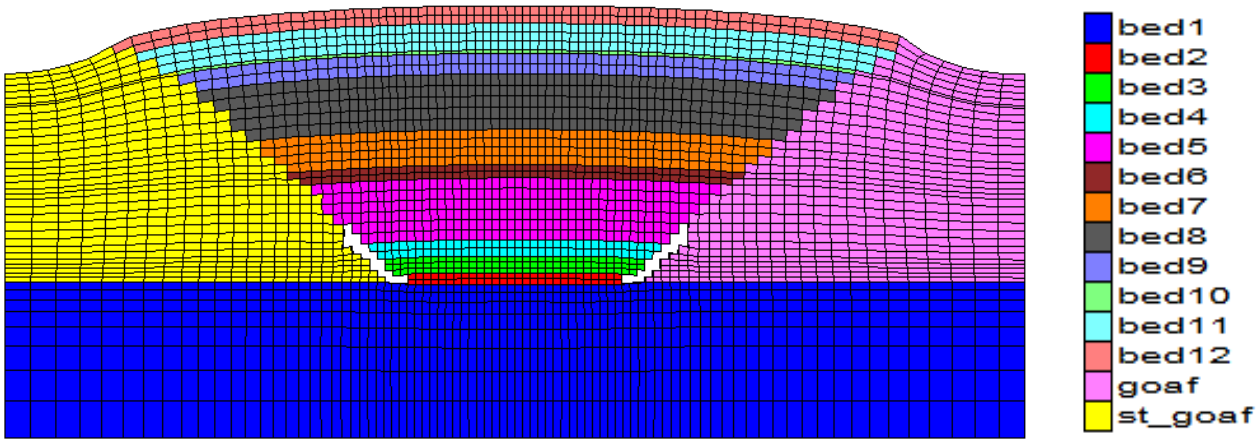


Fig. 7(c): Mesh/grid of the numerical models to study the stability of the barrier pillar with goaf on both sides

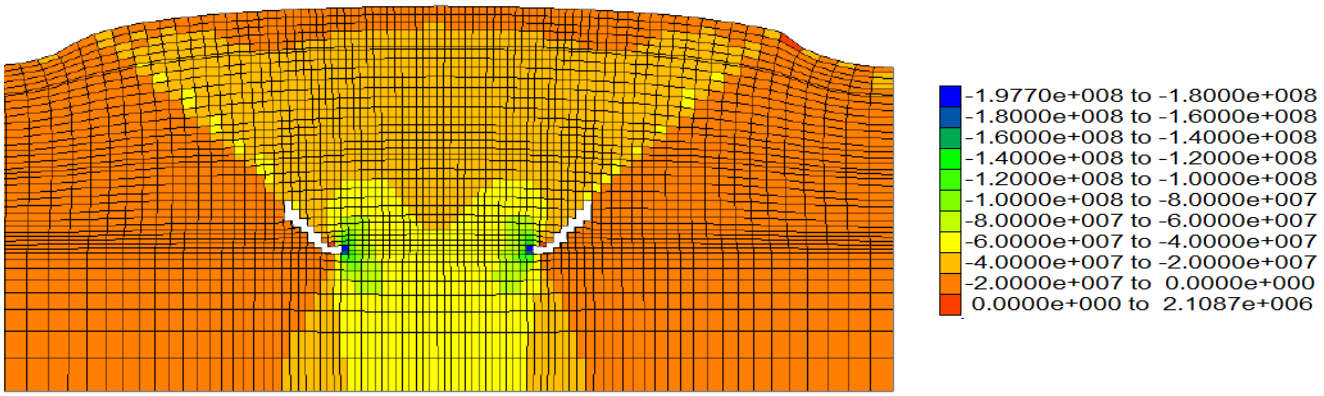


Fig. 8: Block contour of vertical stresses

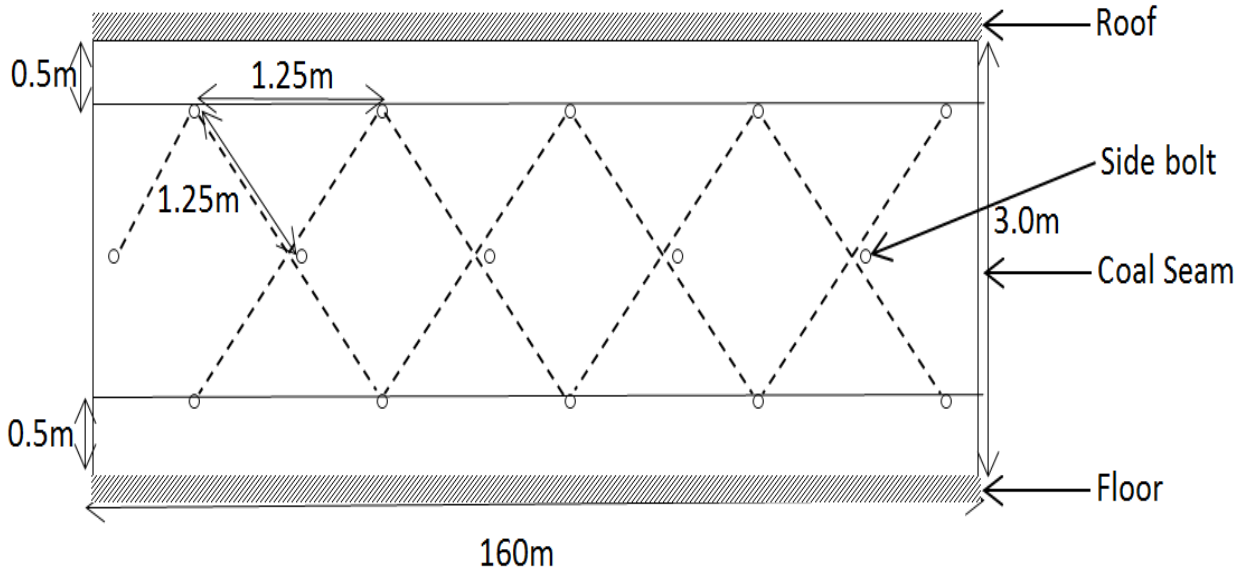


Fig. 9: Pattern of side bolting (not to scale)

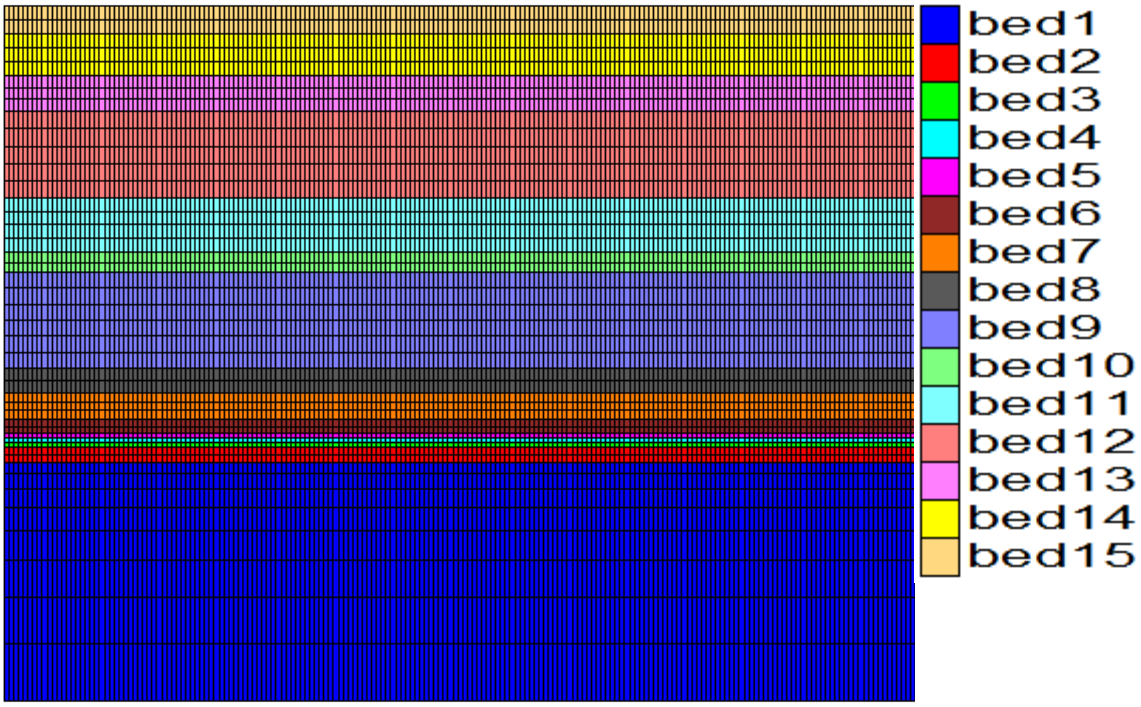


Fig. 10(a) : Mesh/grid of the numerical model in virgin condition

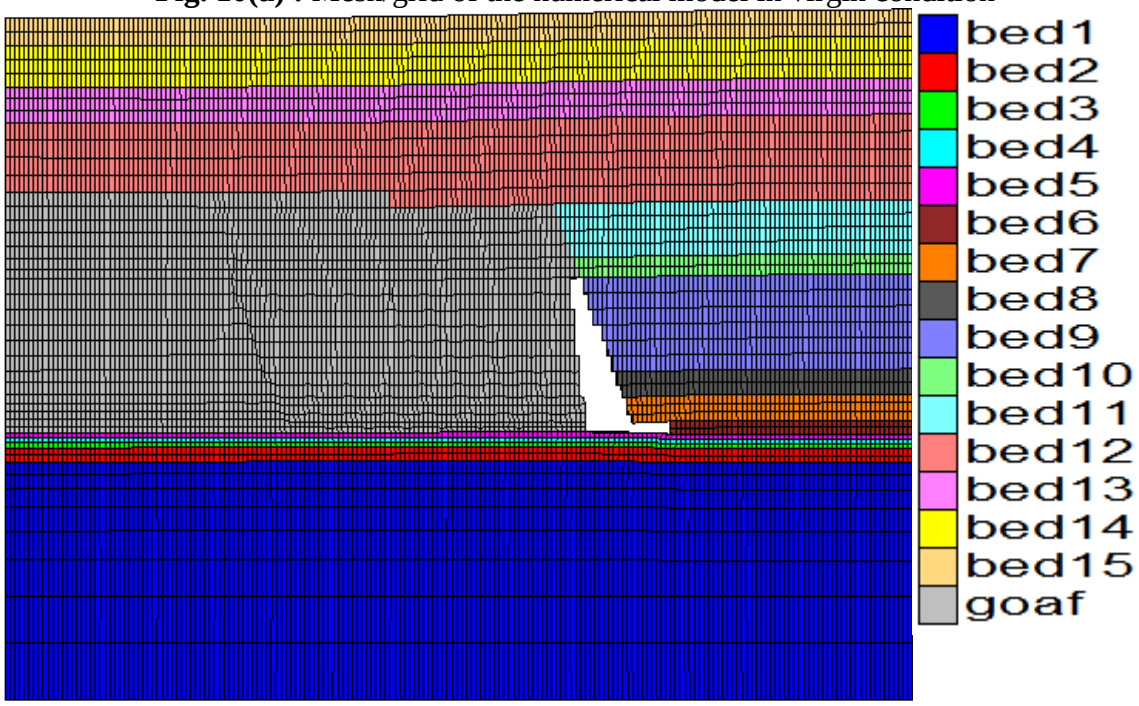


Fig. 10(b): Mesh/grid of the numerical model during extraction of Top section

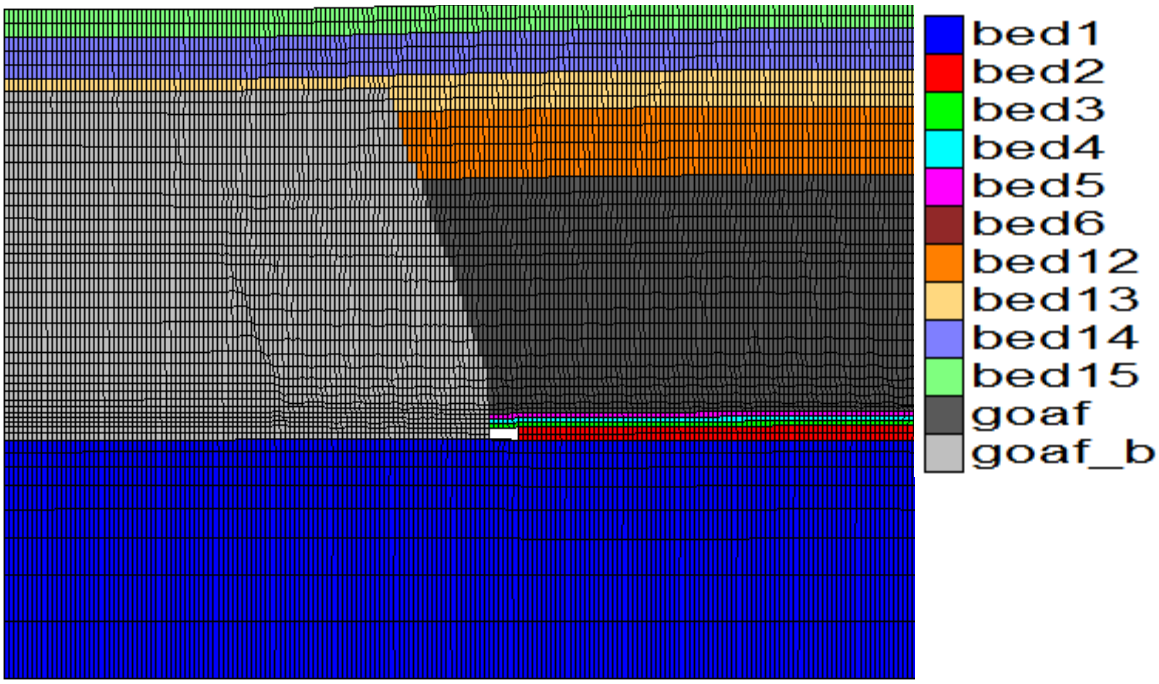


Fig. 10(c): Mesh/grid of the numerical model during extraction of Bottom section

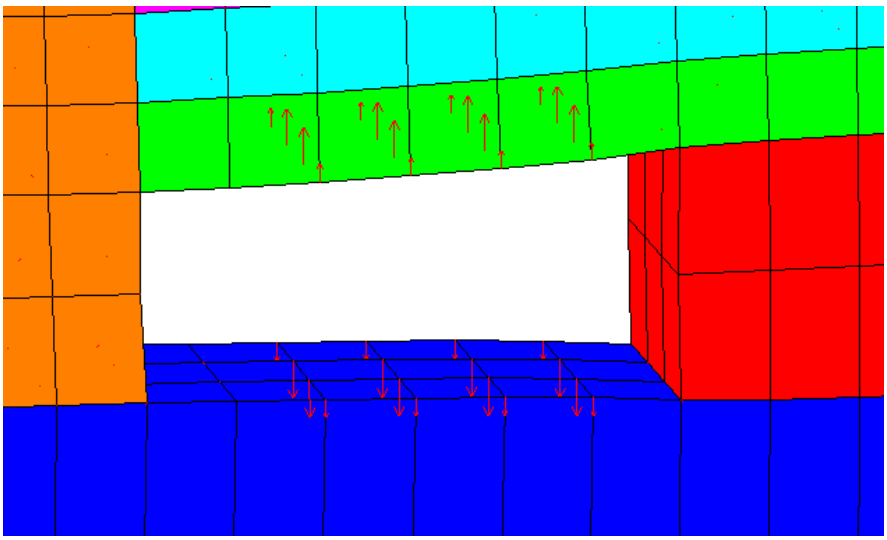


Fig. 10(d): Longwall Powered supports are modelled as nodal forces

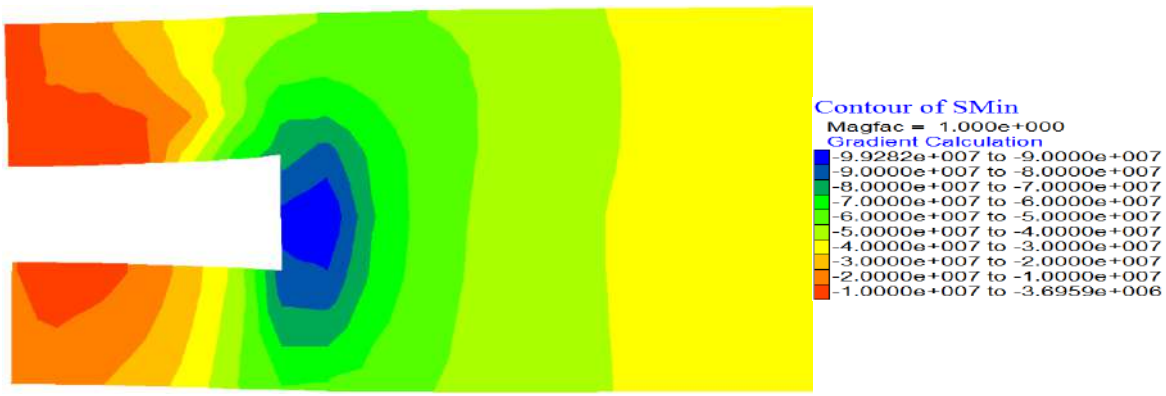


Fig. 11(a): Contour of Major Principal Stress

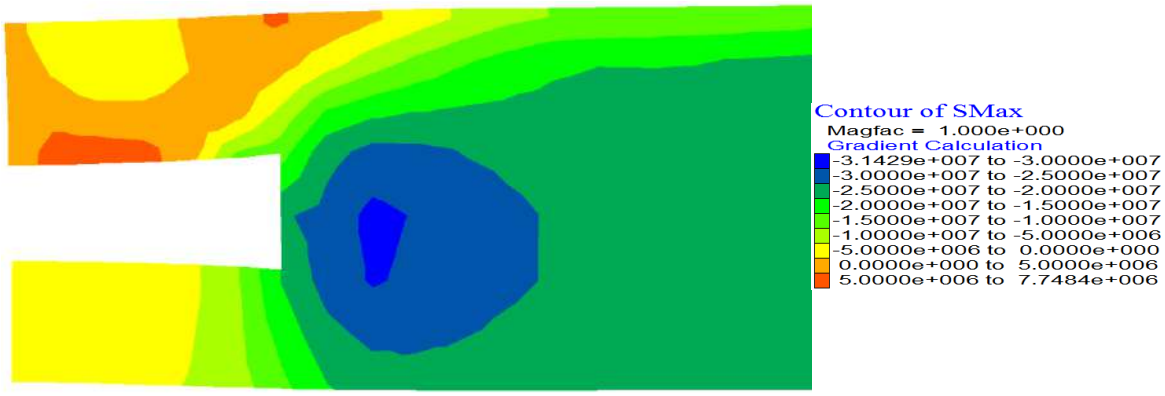


Fig. 11(b): Contour of Minor Principal Stress

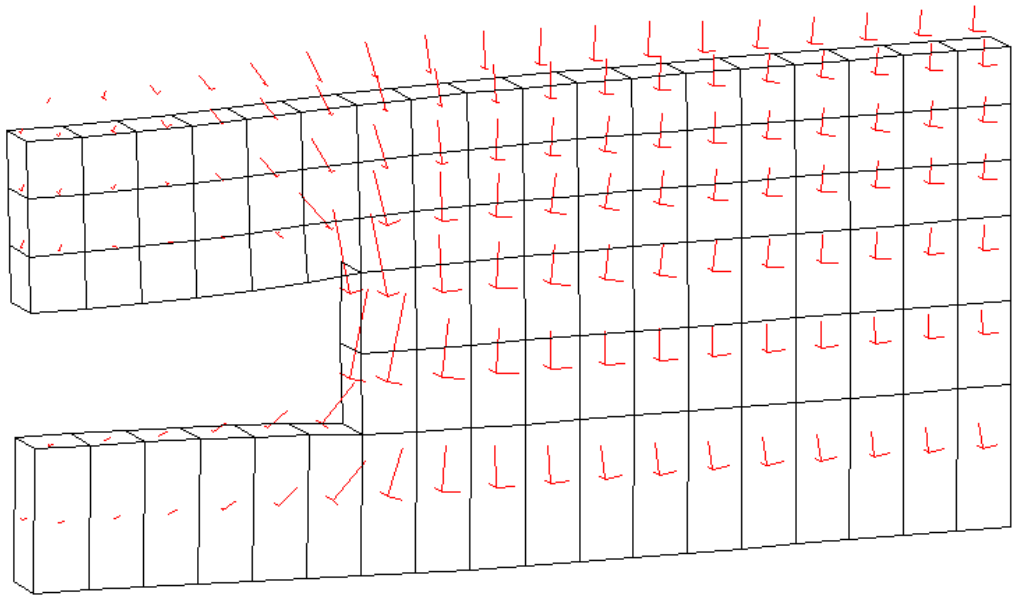


Fig. 11(c): Principal Stress Vectors and orientation

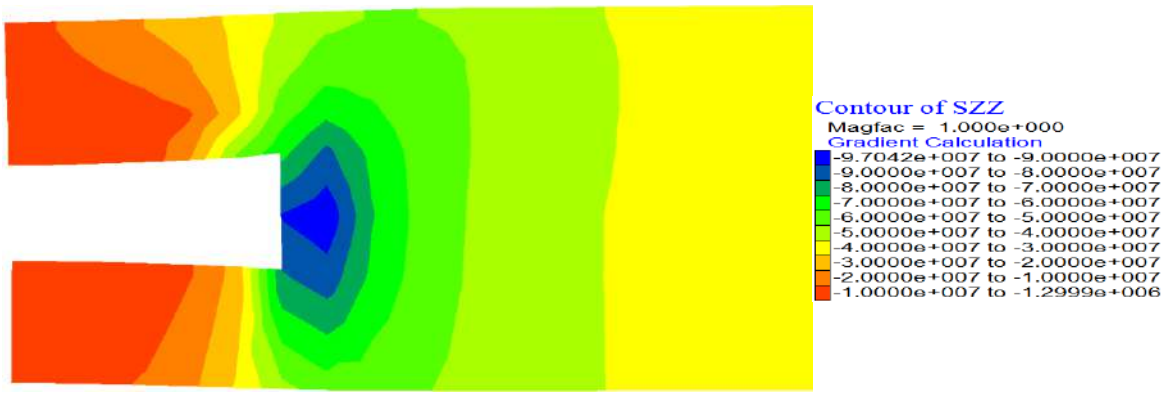


Fig. 11(d): Contour of Vertical Stress

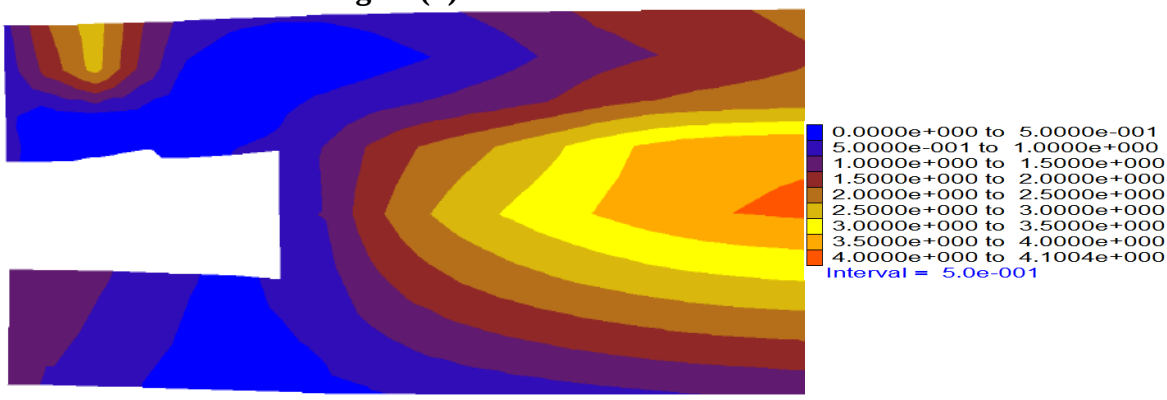


Fig. 11(e): Safety Factor Contour

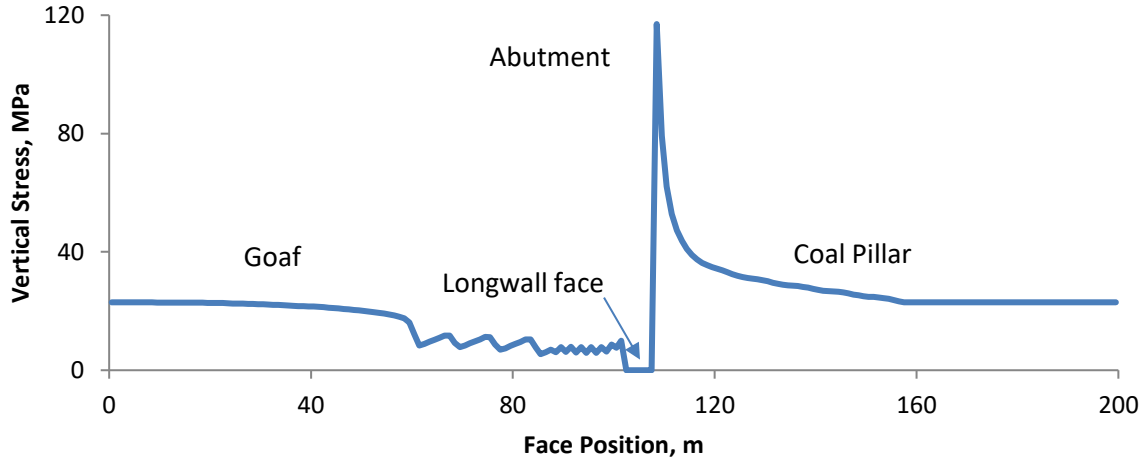


Fig. 11(f): Distribution of vertical stress along the panel

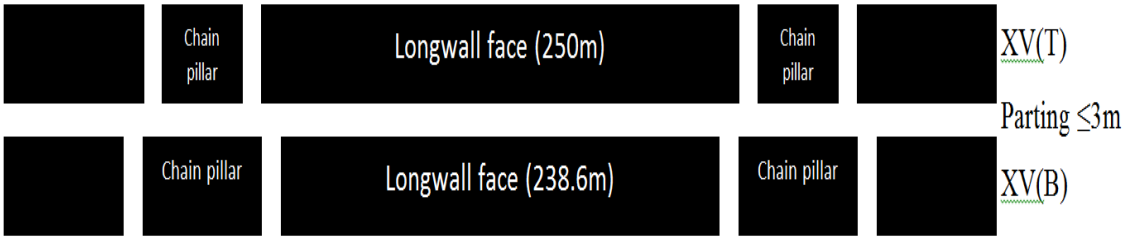
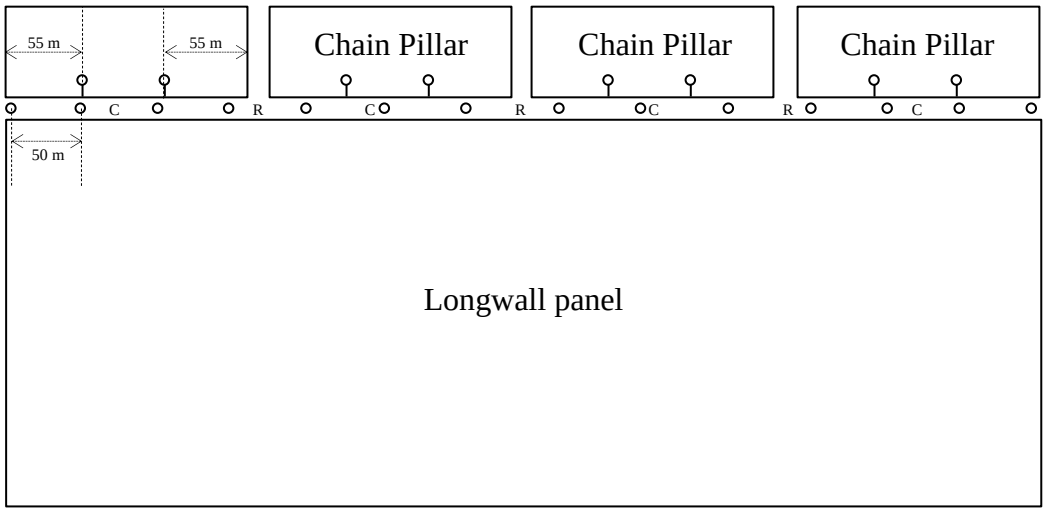


Fig. 12: Schematic diagram of multiple sections working of longwall face (not to scale)



Key:
o – Telltale;
C – Convergence station (for both vertical and horizontal closure);
R – Rotary Telltale;
o – Stress Cell.

Fig. 13: Schematic diagram of instrumentation plan (not to scale)

ANNEXURE I: Instrumentation Plan

1. Roof to floor convergence and floor heaving of gate roadways shall be monitored on regular basis (once at least in every shift) up to a distance of minimum 40m from the face at an interval not exceeding 10m by convergence indicators.

2. Floor heaving of gate roads in XV (T) seam should be additionally monitored if XV (B) seam is planned to be extracted below.

3. Load cells shall be installed in main-gate and tail gate roadways up to a distance of minimum 40m from the face at an interval not exceeding 10m on Open-circuit (OC) props or with the roof bolts as the case may be. Readings of the load cells shall be recorded in every shift in a bound-paged book kept for the purpose.

4. At least 2 to 3 instrumented roof bolts shall also be installed in each gate roadway at strategic places to monitor the loading pattern on the bolts and their performance.

5. Multi point extensometers/Tell tales/Rotary tale tales/Sonic probe extensometers shall be installed in main-gate and tailgate roadways at interval not exceeding 50m to monitor dilation/ bed separation at least up to 400m from the face.

6. To predict abutment stresses in longwall pillar under extraction, stress cells shall be installed in the longwall pillar from main gate road and tail gate roadways up to a distance of minimum 400m from the face at 100 m intervals. The first stress cell shall be installed at the expected main fall position.

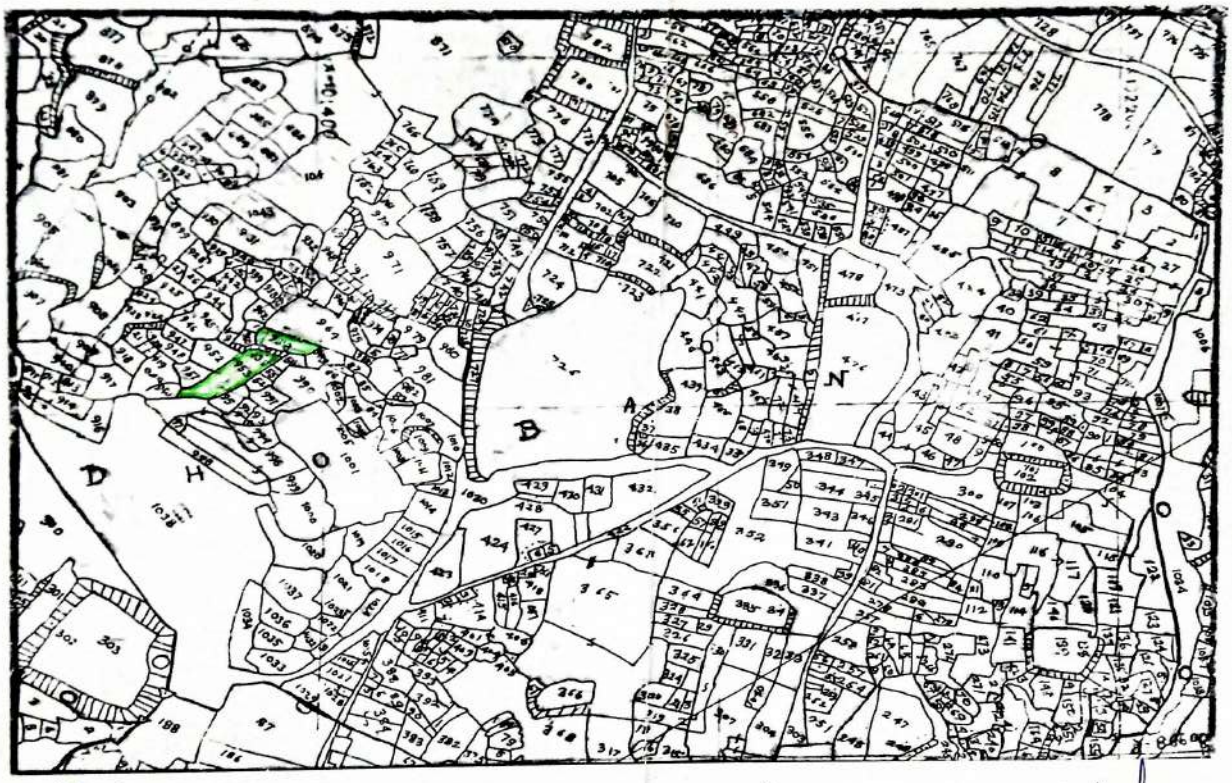
7. To monitor the stability of the barrier/chain pillars and predict magnitude and location of the abutment stresses, stress cells shall be installed in the barrier/chain pillars from main gate road and tail gate roads up to a distance of minimum 400m from the face at 200 m intervals. The first stress cell shall be installed at the expected main fall position.

8. The instrumentation suggest as above is primarily related to gate roads and chain pillars for their detailed evaluation and should be done under the guidance of a reputed scientific institution having expertise in this subject.

ANNEXURE - IX

ANNEXURE-IX

Mauza Plan of Dhobni Showing Plantation Site in Moonidih for the year of 2020-21



29/5/21
Area Survey Officer
Moonidih Colliery

Mine Manager
Moonidih Colliery

29-5-21
Area Manager (Estate)
W.J. Area

27/05/2021
Area Manager (Env.)
W.J. Area

ANNEXURE – X

OCTOBER- 2021

DATE	Rainfall on date	Rainfall To - date	Rain fall in the last Year - 2020	
1.10.2021	6.00	1558.00	932.50	Lucahato
2.10.2021	NIL	1558.00	932.50	Lucahato
3.10.2021	NIL	1558.00	934.50	Lucahato
4.10.2021	NIL	1558.00	934.50	Lucahato
5.10.2021	11.00	1569.00	934.50	Lucahato
6.10.2021	NIL	1569.00	934.50	Lucahato
7.10.2021	NIL	1569.00	939.50	Lucahato
8.10.2021	50.00	1619.00	939.50	Lucahato
9.10.2021	NIL	1619.00	963.50	Lucahato
10.10.2021	NIL	1619.00	963.50	Lucahato
11.10.2021	NIL	1619.00	963.50	Lucahato
12.10.2021	NIL	1619.00	963.50	Lucahato
13.10.2021	NIL	1619.00	963.50	Lucahato
14.10.2021	NIL	1619.00	964.50	Lucahato
15.10.2021	7.00	1626.00	964.50	Lucahato
16.10.2021	NIL	1626.00	964.50	Lucahato
17.10.2021	12.00	1638.00	964.50	Lucahato
18.10.2021	28.00	1666.00	964.50	Lucahato
19.10.2021	1.00	1667.00	964.50	Lucahato
20.10.2021	NIL	1667.00	964.50	Lucahato
21.10.2021	NIL	1667.00	964.50	Lucahato
22.10.2021	NIL	1667.00	964.50	Lucahato
23.10.2021	NIL	1667.00	964.50	Lucahato
24.10.2021	NIL	1667.00	964.50	Lucahato
25.10.2021	NIL	1667.00	964.50	Lucahato
26.10.2021	NIL	1667.00	964.50	Lucahato
27.10.2021	NIL	1667.00	964.50	Lucahato
28.10.2021	NIL	1667.00	964.50	Lucahato
29.10.2021	NIL	1667.00	964.50	Lucahato
30.10.2021	NIL	1667.00	964.50	Lucahato
31.10.2021	NIL	1667.00	964.50	Lucahato

ANNEXURE-XI

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

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

11/10/19

GM (Environment)

REGIONAL OCCUPATIONAL HEALTH CENTRE (EASTERN), KOLKATA

&

NATIONAL INSTITUTE OF OCCUPATIONAL HEALTH, AHMEDABAD

(Indian Council of Medical research)

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

REGIONAL OCCUPATIONAL HEALTH CENTRE (EASTERN), KOLKATA

&

NATIONAL INSTITUTE OF OCCUPATIONAL HEALTH, AHMEDABAD

(Indian Council of Medical research)

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Dr D S Munda, Scientist D

Dr R R Tiwari, Ex- Scientist E (Involvement in initial planning and framing the project, write up)

Technical Staff

Mr. Sk. J. Alam, Technical Assistant

Mr. M. K. Chakraborty, Technical Assistant

Mr. A. Das, Technician C

Mr. S. Meena, Technician C

Mr. T. K. Dasgupta, Technician B

Mr. B. B. Patel, Technician B

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BACKGROUND

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

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

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INTRODUCTION

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

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

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

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AIM AND OBJECTIVES

AIMS

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

OBJECTIVES

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

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Questionnaire survey

Medical Examination

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Pulmonary Function Test

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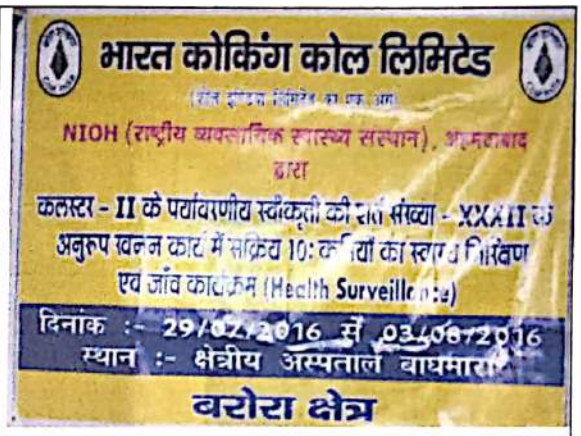
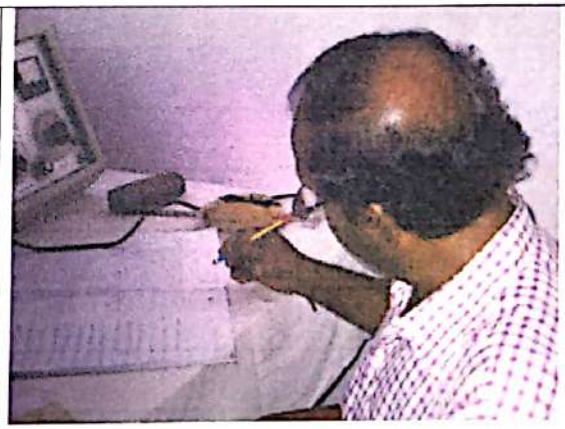


Information- Communication



Audiometry

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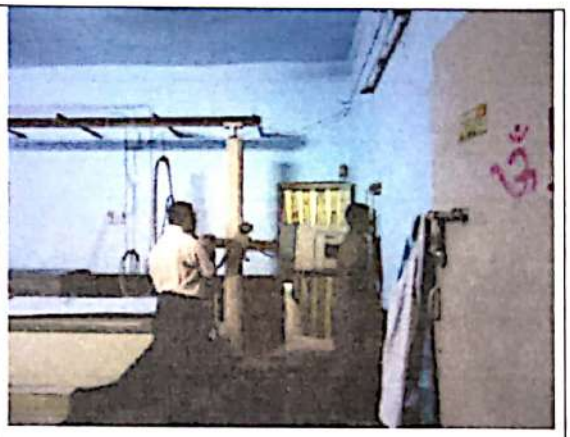

Haematology & Radiology Examination

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RESULT

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DISCUSSION

(Total subjects)

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

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

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

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

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Table 2: Demographic characteristics of the study subjects

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

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

Table 3: Personal habits of the study subjects

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

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

Table 4: Occupational characteristics of Supervisory workers & Coal miners

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

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

Table 5: Distribution of symptoms among study subjects

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

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Table 8: Pulmonary function impairments among study subjects

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

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

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

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

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

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

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

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

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

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

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

Table 12: Chest radiographic findings among the study subjects

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

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

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Table 13: Haematological & Biochemical findings of study subjects

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

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

Table 14: Ophthalmological findings of study subjects

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

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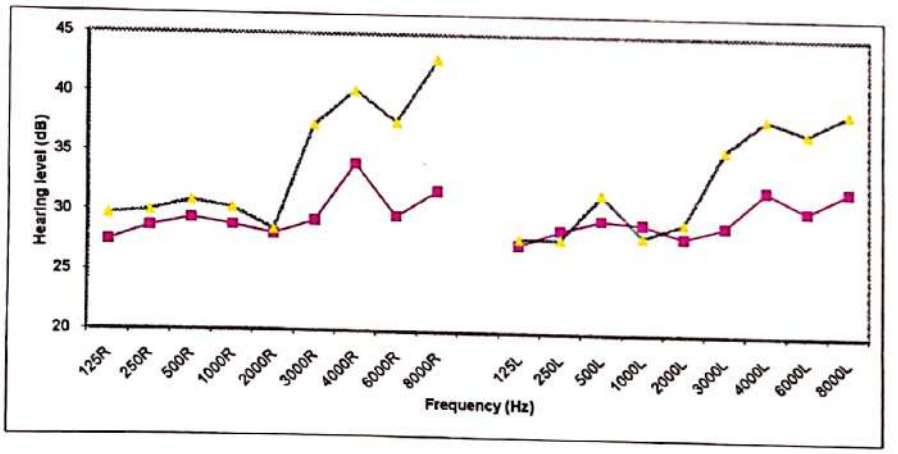
Figure 1 describes hearing ability of workers examined by audiometry. Two curves depict the median hearing ability of subjects with <10 years (lower curve), and ≥ 10 years (higher curve) of job experience. On preliminary observation, decreased hearing ability at high frequency was observed in some workers.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

Figure 1: Distribution of hearing ability according to job experience



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CONCLUSION

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RECOMMENDATION

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CONCLUSION

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

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

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

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

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

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

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

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

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RECOMMENDATION

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

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

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

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

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

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EXECUTIVE SUMMARY

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BACKGROUND

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

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

OBJECTIVES

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

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METHODOLOGY

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

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

Study design: Cross sectional study

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

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

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

RESULTS

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

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

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

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ANNEXURE - XII

Moonidih Plantation Site

No. of plants – 600

Variety – Mango, Bamboo, Babul, Jamun, Guava, Kathal, Siris, kachnar, Kaju, neem

Plantatation in Moonidih XV Seam Incline in Vriksharopan Abhiyan, 2021

ANNEXURE - XIII

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

(FOR THE Q.E. SEPTEMBER 2021)

E. C. no. J-11015/77/2011-IA.II (M) dated 26.08.2013.

CMPDI

ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CLUSTER - XI

(FOR THE Q.E. SEPTEMBER 2021)

CONTENTS

WATER QUALITY

(SURFACE WATER- 17 PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2021-22**

Name of the Project : **Cluster - XI** Period: **Q.E. SEPT 2021.**

Stations: **Date of Sampling:**

1. Upstream in Jarian Nala SW-23 — 20/09/2021
2. Downstream in Jarian Nala Sw-24 — 20/09/2021
3. Upstream in Damodar river SW-25 — 20/09/2021
4. Downstream in Damodar river SW-26 — 20/09/2021

Sl. No	Parameter	Sampling Stations				IS: 2296	Detection Limit	BIS Standard & Method
		SW23	SW24	SW25	SW26			
1	Arsenic (as As), mg/l, Max	<0.006	<0.006	<0.006	<0.006	0.2	0.006	IS-3025,part 37:1988, R-2019/ APHA 23rd Edition AAS-VGA
2	BOD (3 days 27°C), mg/l, Max	2.1	<2.1	<2.0	<2.0	3.00	2.00	IS 3025 (Part 44) : 1993 Reaffirmed 2019 , 3 day incubation at 27°C
3	Colour	2	3	3	2	1-100.0 Hazen Units	1	APHA,23RD Edition ,2120-B-:2017
4	Chlorides (as Cl), mg/l, Max	48	52	27	31	600	2.00	IS-3025/32:1988, R-2019 Argentometric
5	Copper (as Cu), mg/l, Max	<0.2	<0.2	<0.2	<0.2	1.5	0.2	IS 3025/42 : 1992 R : 2019, AAS-Flame
6	Dissolved Oxygen, min.	4.1	4.3	4.6	4.5	4	0.10	IS 3025 (Part 38) : 1989, Reaffirmed 2019 Modified Winkler Azide Method
7	Fluoride (as F) mg/l, Max	0.37	0.49	0.34	0.41	1.5	0.02	APHA, 23RD Edition, Page 4-90 to , 4500 –F- D (SPADNS Method)
8	Hexavalent Chromium, mg/l, Max	0.013	<0.01	<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	<0.2	<0.2	50	0.2	IS 3025 /53 : 2003,R : 2019 , AAS-Flame Method
10	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	<0.005	0.1	0.005	APHA, 23rd Edition, AAS-GTA
11	Nitrate (as NO_3), mg/l, Max	10.97	11.64	4.16	3..67	50	0.50	APHA, 23rd Edition, P-4-127, 4500 - NO_3^- B , UV-Spectrophotometric Screening Method
12	pH value	7.98	7.84	7.89	7.84	6.5-8.5	2.5	IS 3025, Part 11 : 1983 R 2017 Electrometric method
13	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.005	0.002	APHA, 22nd Edition 4-Amino Antipyrine
14	Selenium, mg/l, Max	<0.007	<0.007	<0.007	<0.007	0.05	0.007	IS-3025,part 56:2003, R-2019/ APHA 23rd Edition, AAS-VGA
15	Sulphate (as SO_4) mg/l, Max	216	197	63	55	400	10	APHA –23rd Edition. P-4-199, 4500 SO_4^{2-} E
16	Total Dissolved Solids, mg/l, Max	464	408	229	246	1500	25.00	IS 3025, Part 16: 1984 R 2017 Gravimetric method
17	Zinc (as Zn), mg/l, Max	<0.1	<0.1	<0.1	<0.1	15	0.1	IS 3025/ 49 : 1994, R : 2019, AAS-Flame

All values are expressed in mg/lit unless specified.

Analysed By
JSA/SA/SSA

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Lab In Charge
RI-2, CMPDI, Dhanbad

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

WATER QUALITY

(DRINKING WATER- 25 PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2021-22**

Name of the Project : **Cluster - XI** Period: **Q.E. SEPT 2021**

Stations: **Date of Sampling:**

1. Drinking Water from **Bhagaband DW-11** 02/08/2021

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		DW11					
1	Boron (as B), mg/l, Max	<0.2			0.2	0.5	APHA, 23rd Edition ,Carmine
2	Colour,in Hazen Units	3			1	5	APHA, 23rd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	127			1.6	75	IS 3025, Part 40: 1991 R 2019 EDTA Method
4	Chloride (as Cl), mg/l, Max	88			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	0.54			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	46.81			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	7.28			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	211			10	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	211			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/APHA23rd 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	867			25	500	IS 3025, Part 16: 1984 R 2017 Gravimetric method
22	Total Hardness (c_aco_3), mg/l, Max	672			4	200	IS 3025, Part 21, 2009 R 2019 EDTA Method
23	Turbidity, NTU, Max	0.45			1	5	IS 3025, Part 10 : 1984 R 2017 Nephelometric Method
24	Zinc (as Zn), mg/l, Max	0.44			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

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

(FOR THE Q.E. DECEMBER 2021)

E. C. no. J-11015/77/2011-IA.II (M) dated 26.07.2019.

CMPDI

ISO 9001 Company

Regional Institute-II

Dhanbad, Jharkhand

CLUSTER - XI

(FOR THE Q.E. DECEMBER 2021)

CONTENTS

CHAPTER – II

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

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

2.2 Ambient Air Quality Sampling Locations

I. CORE ZONE Monitoring Location

i) Pootkee Balihari Office (A16): Industrial Area

The location of the sampling station is 23°45'17.23"N 86°21'46.27"E.

ii) Moonidih UGP (A17): Industrial Area

The location of the sampling station is 23°44'30.00"N 86°20'56.00"E.

iii) Moonidih Washery (A29): Industrial Area

The location of the sampling station is 23°44'26.00"N 86°21'16.00"E.

II. BUFFER ZONE Monitoring Location

I) Kusunda OCP (A10)

The location of the sampling station is 23°46'49.07"N 86°24'15.71"E.

2.3 Results and interpretations

The results of Heavy metal in Ambient Air Quality are presented in tabular form for each monitoring station. The concentration of heavy metals in ambient air is well within the permissible limit.

AMBIENT AIR QUALITY DATA

Name of the Company: **Bharat Coking Coal Limited** Year : **2021-22.**
Name of the Cluster : **Cluster -XI** PERIOD: **Q. E. DEC- 2021.**

Heavy Metal Analysis report of Ambient Air Quality

SAMPLE	Cadmium(Cd) (µg/m3)	Mercury(Hg) (µg/m3)	Arsenic(As) (ng/m3)	Chromium(Cr) (µg/m3)	Nickel (Ni) (ng/m3)	Lead (Pb) (µg/m3)
Kusunda OCP (A10)	<0.001	<0.001	<0.005	0.037	0.12	0.177
Pootkee Balihari Office (A16)	<0.001	<0.001	<0.005	0.032	2.38	0.140
Moonidih UGP (A17)	<0.001	<0.001	<0.005	0.022	1.53	0.109
Moonidih Washery (A29)	<0.001	0.001	<0.005	<0.01	1.36	0.026

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RI-2, CMPDI, Dhanbad

CHAPTER – III
WATER QUALITY MONITORING

3.1 Location of sampling sites

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

1. Drinking Water quality at **Bhagabandh (DW11)**
2. Surface Water quality at **U/S of Jarian Nala (SW23)**
3. Surface Water quality at **D/S of Jarian Nala (SW24)**
4. Surface Water quality at **U/S of Damodar River (SW25)**
5. Surface Water quality at **D/S of Damodar River (SW26)**
6. Mine Effluent Quality **at Bhagabandh UG (MW-11)**

3.2 Methodology of sampling and analysis

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

3.3 Results & Interpretations

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

WATER QUALITY

(SURFACE WATER- 17 PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2021-22**

Name of the Project : **Cluster - XI** Period: **Q.E. DEC 2021.**

Stations: **Date of Sampling:**

1. Upstream in Jarian Nala SW-23 — 06/12/2021
2. Downstream in Jarian Nala Sw-24 — 06/12/2021
3. Upstream in Damodar river SW-25 — 20/12/2021
4. Downstream in Damodar river SW-26 — 20/12/2021

Sl. No	Parameter	Sampling Stations				IS: 2296	Detection Limit	BIS Standard & Method
		SW23	SW24	SW25	SW26			
1	Arsenic (as As), mg/l, Max	<0.006	<0.006	<0.006	<0.006	0.2	0.006	IS-3025,part 37:1988, R-2019/ APHA 23rd Edition AAS-VGA
2	BOD (3 days 27°C), mg/l, Max	2.2	2.0	<2.0	<2.0	3.00	2.00	IS 3025 (Part 44) : 1993 Reaffirmed 2019 , 3 day incubation at 27°C
3	Colour	3	2	3	3	1-100Hazen Units	1	APHA,23RD Edition ,2120-B-:2017
4	Chlorides (as Cl), mg/l, Max	65	54	25	29	600	2.00	IS-3025/32:1988, R-2019 Argentometric
5	Copper (as Cu), mg/l, Max	<0.2	<0.2	<0.2	<0.2	1.5	0.2	IS 3025/42 : 1992 R : 2019, AAS-Flame
6	Dissolved Oxygen, min.	6.8	7.0	8.1	8.0	4	0.10	IS 3025 (Part 38) : 1989, Reaffirmed 2019 Modified Winkler Azide Method
7	Fluoride (as F) mg/l, Max	0.91	0.87	0.65	0.62	1.5	0.02	APHA, 23RD Edition, Page 4-90 to , 4500 –F- D (SPADNS Method)
8	Hexavalent Chromium, mg/l, Max	0.014	0.010	<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	<0.2	<0.2	50	0.2	IS 3025 /53 : 2003,R : 2019 , AAS-Flame Method
10	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	<0.005	0.1	0.005	APHA, 23rd Edition, AAS-GTA
11	Nitrate (as NO_3), mg/l, Max	9.51	11.34	7.37	8.02	50	0.50	APHA, 23rd Edition, P-4-127, 4500 - NO_3^- B , UV-Spectrophotometric Screening Method
12	pH value	7.83	8.03	8.25	8.41	6.5-8.5	2.5	IS 3025, Part 11 : 1983 R 2017 Electrometric method
13	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.005	0.002	APHA, 22nd Edition 4-Amino Antipyrine
14	Selenium, mg/l, Max	<0.007	<0.007	<0.007	<0.007	0.05	0.007	IS-3025,part 56:2003, R-2019/ APHA 23rd Edition, AAS-VGA
15	Sulphate (as SO_4) mg/l, Max	262	147	108	95	400	2.00	APHA –23rd Edition. P-4-199, 4500 SO_4^{2-} E
16	Total Dissolved Solids, mg/l, Max	814	550	283	239	1500	25.00	IS 3025, Part 16: 1984 R 2017 Gravimetric method
17	Zinc (as Zn), mg/l, Max	<0.1	<0.1	<0.1	<0.1	15	0.1	IS 3025/ 49 : 1994, R : 2019, AAS-Flame

All values are expressed in mg/lit unless specified.

Analysed By
JSA/SA/SSA

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Lab In Charge
RI-2, CMPDI, Dhanbad

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

WATER QUALITY

(DRINKING WATER- 25 PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2021-22**

Name of the Project : **Cluster - XI** Period: **Q.E. DEC 2021**

Stations: **Date of Sampling:**

1. Drinking Water from **Bhagaband DW-11** 15/11/2021

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		DW11					
1	Boron (as B), mg/l, Max	<0.02			0.2	0.5	APHA, 23rd Edition ,Carmine
2	Colour,in Hazen Units	3			1	5	APHA, 23rd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	237			1.6	75	IS 3025, Part 40: 1991 R 2019 EDTA Method
4	Chloride (as Cl), mg/l, Max	86			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	0.51			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	0.50			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	0.04			0.02	0.1	APHA, 23rd Edition, 3111B, Direct Air Acetylene Flame AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	1.15			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	7.83			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	246			10	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 ($c_ac_{o_3}$),, mg/l, Max	186			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/APHA23rd 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	814			25	500	IS 3025, Part 16: 1984 R 2017 Gravimetric method
22	Total Hardness ($c_ac_{o_3}$), mg/l, Max	647			4	200	IS 3025, Part 21, 2009 R 2019 EDTA Method
23	Turbidity, NTU, Max	3.5			1	5	IS 3025, Part 10 : 1984 R 2017 Nephelometric Method
24	Zinc (as Zn), mg/l, Max	0.81			0.1	5	IS 3025 Part 49 : 1994,R : 2019, AAS-Flame
25	Nickel as Ni, mg/l Max	<0.01			0.01	0.02	IS 3025 Pat 54 : 2003,R : 2019, AAS-Flame APHA 23rd Edition, AAS-GTA

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

WATER QUALITY

(MINE WATER- 17 PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2021-22.**

Name of the Project : **Cluster - XI** Period: **Q.E. DEC 2021.**

Effluent water of BCCL Mines					**Date of Sampling:**
Sample Code :					20.12.2021
Sl.No.	**Parameter**	**Results MW-11**	**Detection Limit**	**MOEF -SCH-VI STANDARDS Class 'A'**	**BIS Standard & Method**
1	Ammonical Nitrogen, mg/l, Max	<0.02	0.02	50.0	IS 3025/34:1988, R : 2009, Nessler's
2	Arsenic (as As), mg/l, Max	<0.006	0.006	0.2	IS-3025,part 37:1988, R-2019/ APHA 23rd Edition AAS-VGA
3	B.O.D (3 days 27ºC), mg/l, Max	<2.0	2.00	30.0	IS 3025 /44:1993,R:2003 3 day incubation at 27°C
4	Colour	3	1-100Hazen Units	1	APHA,23RD Edition ,2120-B-:2017
5	COD, mg/l, Max	24	4.00	250.0	APHA 23rd Edition 5220 C Titrimetric Method
6	Copper (as Cu), mg/l, *Max*	<0.2	0.2	3.0	IS 3025(Part42): 1992 R : 2019, AAS-Flame
7	Dissolved Phosphate (as P), mg/l, Max	<0.1	0.1	5.0	IS 3025/ 31, 1988 R 2019
8	Fluoride (as F) mg/l, *Max*	0.54	0.02	2.0	APHA, 23RD Edition, Page 4-90 to , 4500 – F- D (SPADNS Method)
9	Free Ammonia, mg/l, Max	<0.01	0.01	5.0	IS:3025/34:1988, Nesseler's
10	Hexavalent Chromium, mg/l, Max	<0.01	0.01	0.1	IS 3025 (Part 52) : 2003,Reaffirmed 2019
11	Iron (as Fe), mg/l, *Max*	<0.2	0.2	3.0	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame
12	Lead (as Pb), mg/l, *Max*	<0.005	0.005	0.1	APHA, 23rd Edition, AAS-GTA
13	Manganese(as Mn), mg/l, Max	<0.2	0.2	2.0	IS-3025(Part 59):2006, R 2017 AAS-Flame /APHA, 23rd Edition, 3111B, AAS-Flame
14	Nickel (as Ni), mg/l, *Max*	<0.1	0.1	3.0	IS-3025(Part 54):2003, R:2019 AAS-Flame
15	Nitrate Nitrogen, mg/l, *Max*	<0.5	0.50	10.0	APHA, 23 rd Edition,UV-Spectrphotometric
16	Oil & Grease, mg/l, Max	<2.0	2.00	10.0	IS 3025/39:1991, R : 2019, Partition Gravimetric
17	pH value	8.07	2.5	5.5 to 9.0	IS-3025/11:1983, R-2017, Electrometric
18	Phenolic compounds (as C_6H_5OH),mg/l, *Max*	<0.002	0.002	1.0	APHA, 23rd Edition 4-Amino Antipyrine
19	Selenium, mg/l, Max	<0.007	0.007	0.05	IS-3025,part 56:2003, R-2019/ APHA 23rd Edition, AAS-VGA
20	Sulphide (as S^{2-}) mg/l Max.	<0.005	0.005	2.0	APHA 23rd Edition Methylene Blue Method
21	Temperature (°C)	20.2	Shall not exceed 5^0 C above the receiving temp.		IS-3025/09:1984, Thermometeric
22	Total Chromium (as Cr), mg/l, *Max*	<0.1	0.1	2.0	IS-3025(Part 52):2003, R:2019 AAS-Flame
23	Total Kjeldahl Nitrogen, mg/l, Max	<1.00	1.00	100.0	IS:3025/34:1988, Nesseler's
24	Total Residual Chlorine, mg/l, Max	<0.04	0.04	1.0	APHA, 23rd Edition, , 4500-Cl B. (Iodometric Method-I)
25	Total Suspended Solids, mg/l, Max	39	10.00	100.0	IS 3025/17:1984, R :2017, Gravimetric
26	Zinc (as Zn), mg/l, *Max*	<0.1	0.1	5.0	IS 3025 /49 : 1994, R : 2019, AAS-Flame
27	Odour	Agreeable		Qualitative	APHA, 23rd Edition, , 2150-C

All values are expressed in mg/lit unless specified.

Analysed By
JSA/SA/SSA

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

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

ANNEXURE - 14

GROUNDWATER LEVEL & QUALITY REPORT

FOR CLUSTER OF MINES, BCCL

(Assessment year – 2020-21)

[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 – 2021

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CENTRAL MINE PLANING & DESIGN INSTITUTE

HYDROGEOLOGY SECTION, EXPLORATION DEPARTMENT

GONDWANA PLACE, KANKE ROAD, RANCHI, JHARKHAND– 834031

(Accredited Groundwater Professional Institutions by CGWB/CGWA)

(Accredited by NABL, valid upto: 2022)

(Accredited as a FAE in (HG) by QCI-NABET, valid upto: Aug'2021)

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Annexure – II

GROUNDWATER LEVEL & QUALITY REPORT FOR CLUSTER OF MINES OF BCCL

1.0 INTRODUCTION

1.1 LOCATION DETAILS AND BRIEF ABOUT THE PROJECT

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

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

1.2 OBJECTIVE OF THE STUDY:

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

1.3 SCOPE OF THE STUDY:

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

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

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

भारत कोकिंग कोल लिमिटेड
एक मिनी रत्न कंपनी
(कोल इंडिया लिमिटेड का एक अंग)
कोयलाभवन, कोयलानगर,धनबाद –826005

Bharat Coking Coal Limited
A Mini Ratna Company
(A Subsidiary of Coal India Limited)
Regd.Off: Koyla Bhawan, Koyla Nagar

CIN: U10101JH1972GOI000918
Environment Department

पत्र संख्या भाकोकोलि/उप महाप्रबंधक(पर्या0)/संचिका-/18/1086-1088/H) दिनांक : 14.06.2018

सेवा में,
महाप्रबंधक
व्यापार विकास
सीएमपीडीआई - कांके रोड रांची ८३४०३१-

Sub: For work of Ground water level and quality monitoring

महोदय,

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

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

This is for your kind information and further necessary action

भवदीय

14/6/18

उप-महाप्रबंधक (पर्यावरण)

Copy To:
१ महाप्रबंधक (गवेषण), कांके रोड रांची ८३४०३१-

1.6 CLIMATE & RAINFALL

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

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

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

Daily station rainfall data utilized for identification of the mean spatial patterns and rainfall intensity trends. From mean and standard deviation (SD), the coefficient of variation (CV) calculated as follows: Coefficient of variation (CV) = [Standard Deviation / Mean] × 100

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

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

Jharkhand State

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

Dhanbad District

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

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

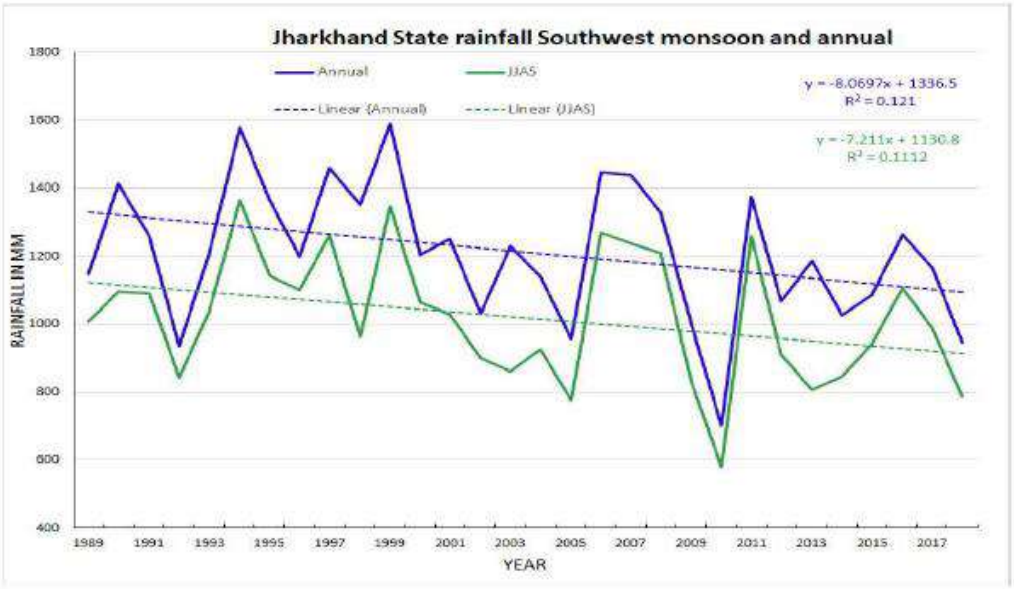


Fig-1.

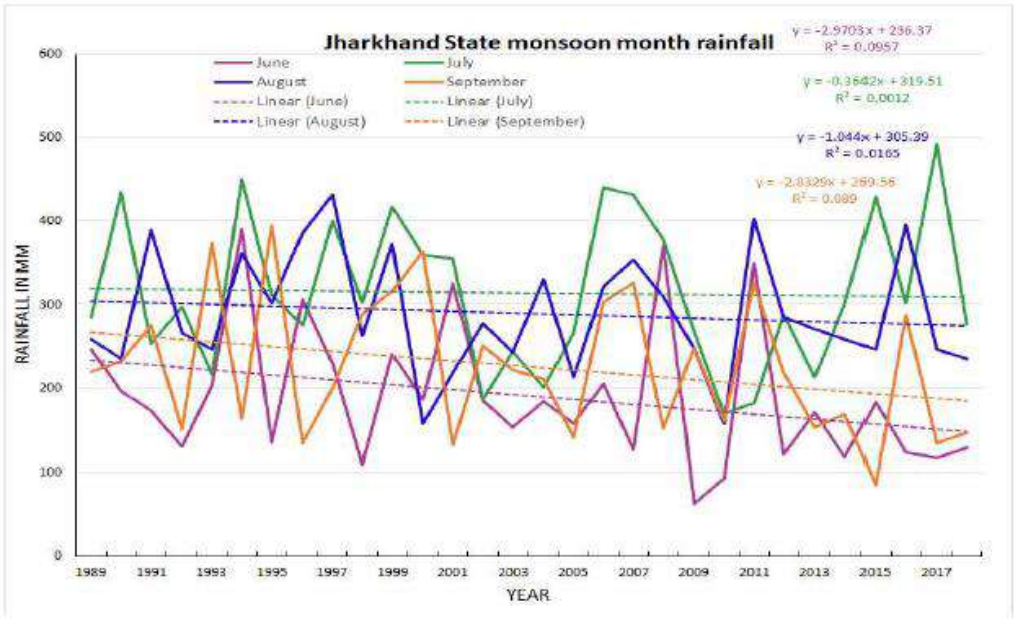


Fig-2.

K. GROUND WATER LEVEL OF CLUSTER-XI

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

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

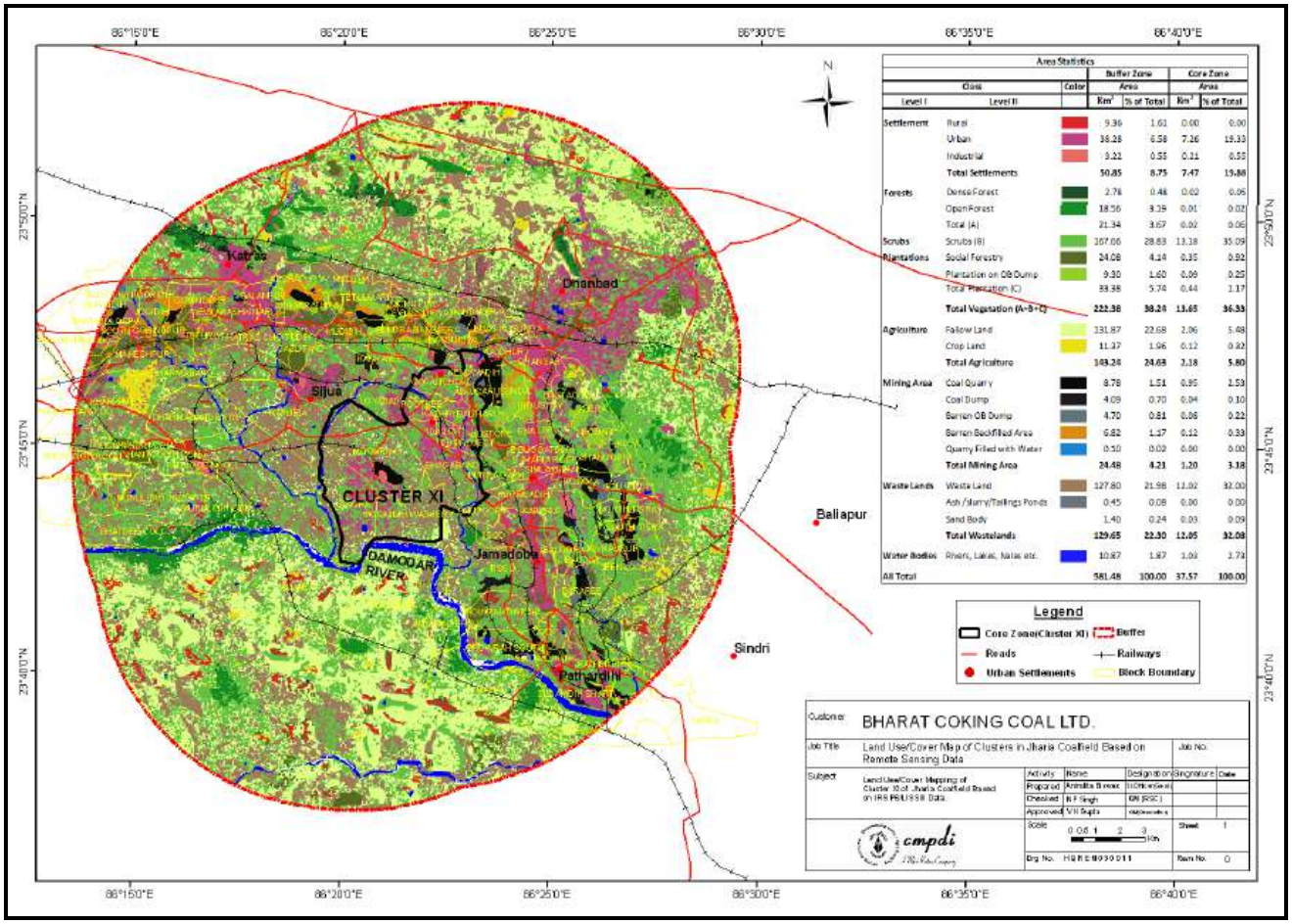
Monitoring stations (**A-17, A-18, A-20 and A-32**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'20, August'20, and Nov'20 and January'21, the Ground water level data enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2020-21				2019-20				2018-19			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	Feb	May	Aug	Nov
1	A-17	Kachi Balihari	2.14	0.64	1.69	1.79	2.94	0.34	2.24	2.42	2.07	3.34	1.64	2.84
2	A-18	Baghaband	1.09	0.39	0.34	0.89	2.29	1.09	0.69	1.09	0.89	1.24	1.34	0.99
3	A-20	Gorbudih	8.47	1.44	3.87	4.42	4.57	3.32	1.82	4.02	3.59	4.57	1.92	2.57
4	A-32	Baludih	1.90	0.36	1.75	1.80	2.75	0.62	0.95	1.65	0.60	2.80	0.45	0.70
Average WL (bgl)			3.40	0.71	1.91	2.23	3.14	1.34	1.43	2.30	2.26	3.20	1.64	2.16

LAST THREE-YEAR ASSESSMENT:

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

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



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

trends in both Pre and Post-monsoon GW level trends (max. upto 0.55 cm/year in Cluster-I, Cluster-V and Cluster-VII) but no significant decline trend (>1.0 m/year) of water level is noticed in any particular area for the last 10 years within the coalfield area. Regarding quality monitoring, the water sample location map (**Plate–II**) with collection points details (dug wells) given in **Annexure–V** and Quality is given in **Annexure–VII**.

5.0 GROUND WATER QUALITY

The ground water sample of the study area (15 nos. of Cluster of mines, BCCL) collected from dug wells and analyzed. Fifteen ground water samples (GW-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15 & 16) analyzed during the month of June'2020 at CMPDI, RI-II, Dhanbad. The water sampling details given in **Annexure–V** and Water sample locations shown in **Plate-II**. The water quality data enclosed in **Annexure–VII.**

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

The pH of the groundwater samples varies between 7.81 (GW-6) to 8.21 (GW-3), the pH is within the IS 10500 limit of drinking water standard.

The mineral constituents dissolved in water constitute the dissolved solids. The total dissolve solids vary from 178 (GW-11) to 764 mg/l (GW-5), the TDS values ranges from well within the IS 10500:2012 standards to occasionally exceeding the standard limits of drinking water.

The alkalinity of the water samples varies from 76 (GW-6) to 152 mg/l (GW-11) and are within the stipulated standard of (200 mg/l) drinking water. The concentrations of calcium in the water samples vary from 32 (GW-11) to 180 mg/l (GW-15) and are ***slightly above*** the permissible limit (75 mg/l) of drinking water standards. The total hardness ranges between 148 (GW-8) to 680 mg/l (GW-5) and the value of total hardness in water samples are ***above*** the permissible limit (200 mg/l). The sulphate ranges between 38 (GW-8) to 178 mg/l (GW-13) and the value of sulphate in water sample are within the permissible limit (200 mg/l). The Iron, Copper, Manganese, Lead, Zinc and Chromium concentration in the water samples found to be below the upper ISI limits for drinking water.

Table–8B: Cluster wise Groundwater development scenario

Cluster/ Area	Adminis-trative Blocks/Stage Of GW Extraction	Total Water demand (cum/day)				Avg. GW level (bgl in m) 2020		GW level declining trend 2005-2020		Remarks
		Mine Discharge + BH pumping	Surface Water Source	Total Use (Domestic + Industrial)	Excess Or other use	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
Cluster-I	Bermo (SOD: Over-exploited)	2173 (2065+108)	NIL	2112 (1698+414)	61	5.46	2.69	YES	YES	Recharge structure needed
Cluster-II	Baghmara (SOD: Critical)	8350	Jamunia river	6737 (2755+3982)	1613	5.83	2.17	NO	NO	Excess mine water needed to be utilized
Cluster-III		12760 (10960+1800)	NIL	8946 (7849+1097)	3814	4.91	1.96	NO	NO	
Cluster-IV		5900	MADA	5100 (3605+1495)	800	5.52	2.25	NO	NO	
Cluster-V		12690 (11025+1665)	MADA	11063 (5710+5353)	1897	4.18	1.67	YES	YES	
Cluster-VI	Dhanbad (SOD: Over-exploited)	4150	MADA	4150 (1664+2486)	0.0	7.50	3.49	YES	NO	--
Cluster-VII		21565	MADA	20826 (17596+3230)	739	5.56	3.71	YES	YES	Excess mine water needed to be utilized water
Cluster-VIII	Jharia (SOD: Over-exploited)	9320	MADA	5294 (3730+1564)	4026	6.03	3.16	NO	NO	
Cluster-IX		12980	MADA	9358 (4549+4809)	3622	5.81	4.28	NO	NO	
Cluster-X		11825	Damodar river	6201 (4255+1946)	5624	5.69	3.29	YES	NO	
Cluster-XI	Dhanbad (SOD: Over-exploited)	24960	MADA & DVC	19425 (14015+5410)	5535	3.40	1.91	NO	NO	
Cluster-XIII	Baghmara (SOD: Critical)	4815	Damodar river	4815 (4679+136)	0.0	6.80	3.22	NO	NO	--
Cluster-XIV		2600	NA	2550 (2412+138)	50	5.42	3.08	NO	NO	--
Cluster-XV		6200	NA	5941 (4600+1341)	259	3.83	2.63	NO	NO	--
Cluster-XVI	Nirsa (SOD:Safe)	1910	DVC (Barakar river)	1730 (1380+350)	180	3.18	3.13	NO	NO	--

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

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

7.0 IMPACT OF MINING ON GROUND WATER REGIME

7.1 GENERAL CONSEQUENCES OF COAL MINES ON AMBIENT HYDROGEOLOGICAL REGIME

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

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

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

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

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

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

During mining the hydraulic gradients generally, steeps down near mine i.e. within the mine influence area. In the up-dip region, only un-confined aquifer punctured through the mining process and thus only it

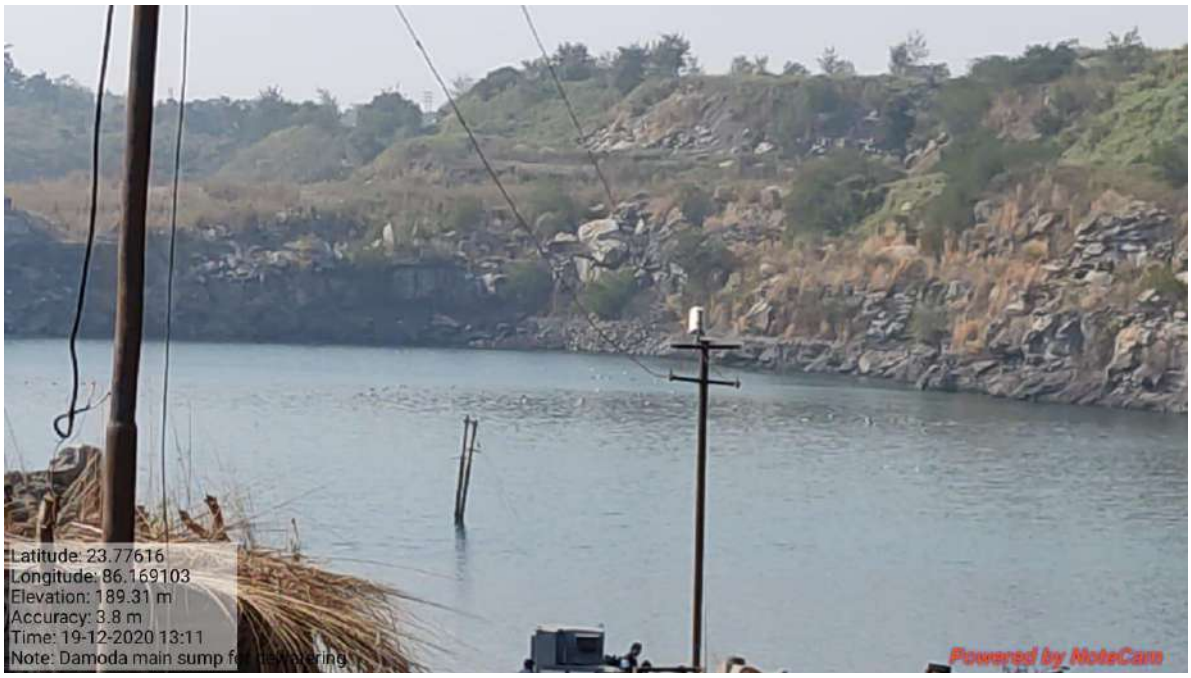
RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

Fig-11 to 12.

RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

Fig-13 to 14.



RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

FILTER PLANT IN THE MINE AREA

Fig-15.

ANNEXURE - XV

BHARAT COKING COAL LIMITED
(A Subsidiary of Coal India Limited – A Maharatna Company)

CORPORATE ENVIRONMENTAL POLICY

Bharat Coking Coal Limited (BCCL), a subsidiary of Coal India Limited, is a Public Sector Undertaking engaged in mining of coal and allied activities. It is the only producer of Prime Coking Coal in India. BCCL was incorporated in 1972 to operate coking coal mines operating in the Jharia and Raniganj Coalfields. Currently, the Company operates 66 coal mines and 8 Coal Washeries.

Our mission is to produce the planned quantity of coal efficiently and economically with due regard to safety, conservation and quality. BCCL affirms its commitment for environment friendly mining with right mitigation of pollution, reclamation of the degraded land, preservation of biodiversity and proper disposal of waste following the best environmental practices including judicious use of the non-renewable energy on the path of continual improvement. Towards this commitment, BCCL shall endeavor to:

- Conduct mining and associated operations in an environmentally responsible manner to comply with applicable laws and other requirements related to environmental aspects.
- Design projects with due consideration of Sustainable Development by integrating sound environmental management practices in all our activities.
- Prevent pollution of surrounding habitation by continuous monitoring and adopting suitable measures for environment protection.
- Ensure compliance of all applicable Environmental and Forest Clearance conditions and other statutory conditions issued by regulatory agencies.
- Implement the Environmental Management Plans in all our mines effectively to mitigate pollutions on air, water and noise; proper disposal of wastes and reclamation and ecological restoration of degraded land; and by also dovetailing the Jharia action/ Master Plan for dealing with Fires, Subsidence and Rehabilitation of affected people with the Environmental Management Plans under the Cluster Concept.
- Strive to conserve Bio-Diversity through Ecological restoration methods.
- Conserve natural resources through recycling of wastes on the principle of Reduce, Recycle and Reuse. Put special thrusts on efficient energy utilization as a measure to reduce carbon foot-print.
- Strive for continual improvement in our environmental performances by setting targets, measuring progress and taking corrective action.
- Create environmental awareness among the employees and the local communities through pro-active communication and training and encourage our business associates to adopt similar approach for environmental protection.

Place: Dhanbad
Date: 25.5.12

Chairman-cum-Managing Director

Chairman-cum-Mg. Director
BHARAT COKING COAL LIMITED
Koyla Bhawan, Dhanbad-826 005

ANNEXURE - XVI

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED
The information given in this report is not to be communicated either directly or indirectly to the press or to any person not holding an official position in the CIL /GOVERNMENT.

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

(FOR THE MONTH OCTOBER, 2021)

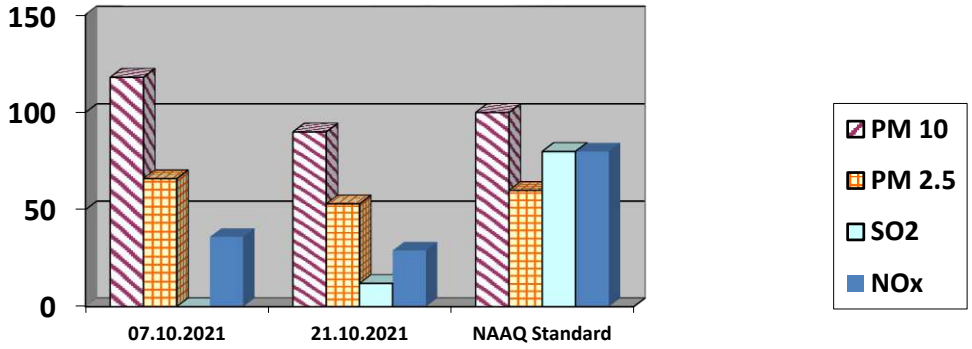
E. C. no. J-11015/77/2011-IA.II (M) dated 26.07.2019.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

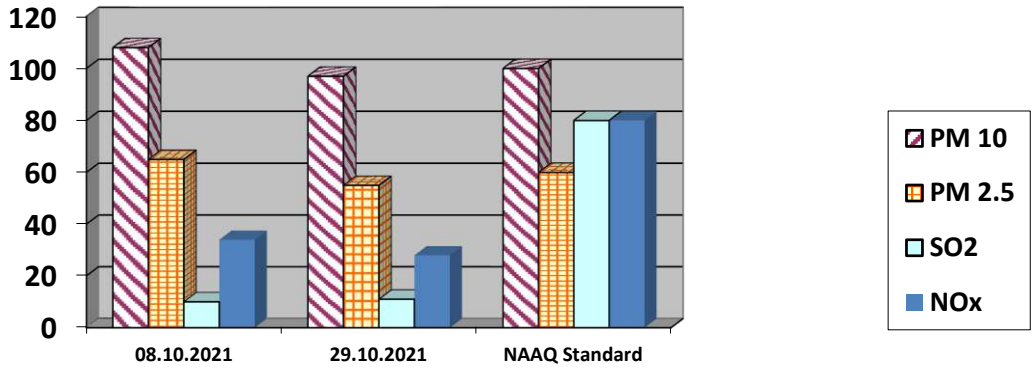
AMBIENT AIR QUALITY DATA

Cluster –XI, Bharat Coking Coal limited Month: **OCT 2021** Year: **2021-22.**

StationNameA16-Pootkee Balihari office		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	07.10.2021	118	66	<10	36
2	21.10.2021	90	53	12	29
	NAAQ Standard	100	60	80	80



Station Name: A17- Moonidih UGP		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	08.10.2021	108	65	10	34
2	29.10.2021	97	55	11	28
	NAAQ Standard	100	60	80	80

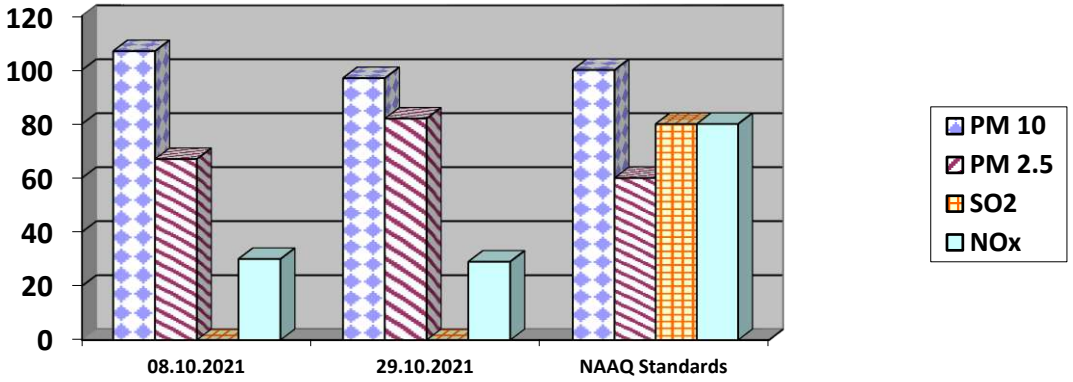


Analysed By
JSA/SA/SSA

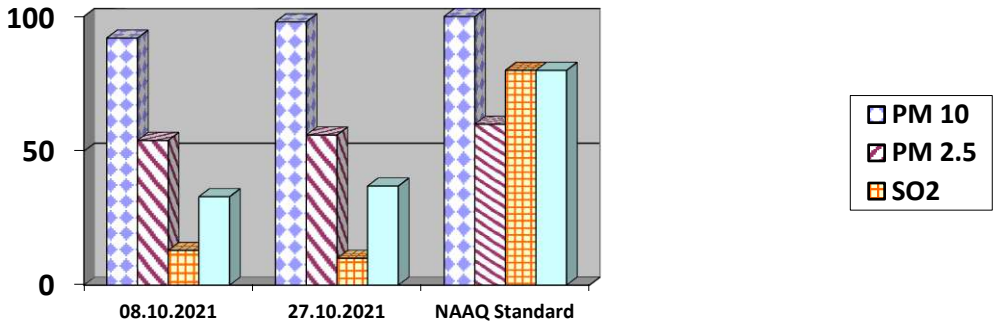
Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

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

Station Name:A29-Moonidih Washery		Zone: Core		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO2	NOx
1	08.10.2021	107	67	<10	30
2	29.10.2021	97	82	<10	29
	NAAQ Standards	100	60	80	80



StationName: Kusunda OCP (A10)		Zone: Buffer		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO_2	NO_X
1	08.10.2021	92	54	13	33
2	27.10.2021	98	56	10	37
	NAAQ Standard	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 Bhagabandh (MW11)**

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

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-XI**		Month: **OCT ,2021**	Name of the Station: **Mine Discharge of Bhagabandh**	
Sl. No.	**Parameters**	**MW11** First Fortnight	**MW11** Second Fortnight	**As per MOEF General Standards for schedule VI**
		04.10.2021	25.10.2021	
1	Total Suspended Solids	45	41	*100 (Max)*
2	pH	8.06	8.06	*5.5 - 9.0*
3	Oil & Grease	<2.0	<2.0	*10 (Max)*
4	COD	20	28	*250 (Max)*

All values are expressed in mg/lit except pH.

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

1. **Pootkee Balihari Office (N16)**
2. **Moonidih UGP (N17)**
3. **Moonidih Washery (N29)**
4. **Kusunda OCP (N10)**

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).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time and the observed values were compared with standards prescribed by MoEF&CC. 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 -XI**			Month: **OCT 2021**		
Sl. No.	**Station Name/Code**	**Category of area**	**Date**	**Noise level dB(A)LEQ**	***Permissible Limit of Noise level in dB(A)***
1	Pootkee Balihari Office (N16)	Industrial area	07.10.2021	63.5	*75*
2	PootkeeBalihari Office (N16)	Industrial area	21.10.2021	63.2	*75*
3	MoonidihUGP (N17)	Industrial area	08.10.2021	63.2	*75*
4	MoonidihUGP (N17)	Industrial area	29.10.2021	63.1	75
5	Moonidih Washery (N29)	Industrial area	08.10.2021	62.4	*75*
6	Moonidih Washery (N29)	Industrial area	29.10.2021	62.3	75
7	KusundaOCP (N10)	Industrial area	08.10.2021	61.3	*75*
8	KusundaOCP (N10)	Industrial area	27.10.2021	60.4	*75*

Permissible limits of Noise Level as per MOEF Gazette Notification No. GSR 742(E) dt. 25.09.2000 Standards for Coal Mines and Noise Pollution (Regulation and Control) Rules, 2000.

*** Day Time: 6.00 AM to 10.00 PM.**

Analysed By
JSA/SA/SSA

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

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

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

(FOR THE MONTH NOVEMBER, 2021)

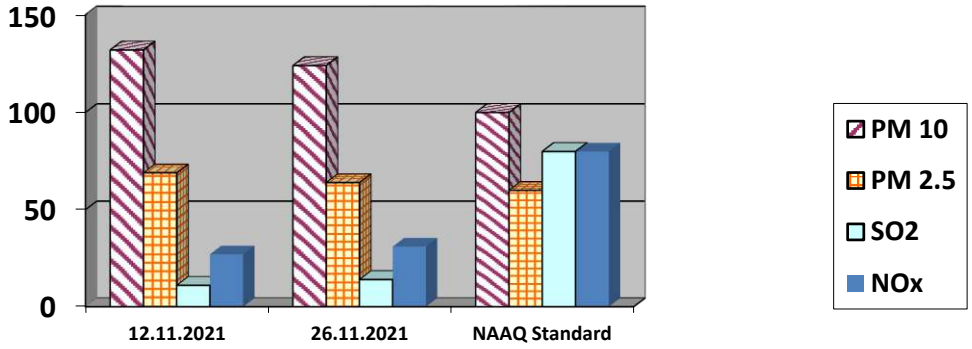
E. C. no. J-11015/77/2011-IA.II (M) dated 26.07.2019.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

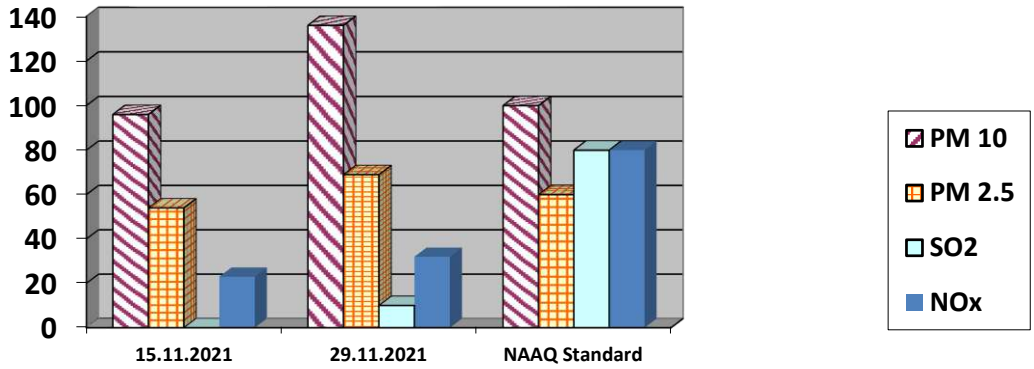
AMBIENT AIR QUALITY DATA

Cluster –XI, Bharat Coking Coal limited Month: **NOV 2021** Year: **2021-22.**

StationNameA16-Pootkee Balihari office		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	12.11.2021	132	69	11	27
2	26.11.2021	124	64	14	31
	NAAQ Standard	100	60	80	80



Station Name: A17- Moonidih UGP		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	15.11.2021	96	54	<10	23
2	29.11.2021	136	69	10	32
	NAAQ Standard	100	60	80	80

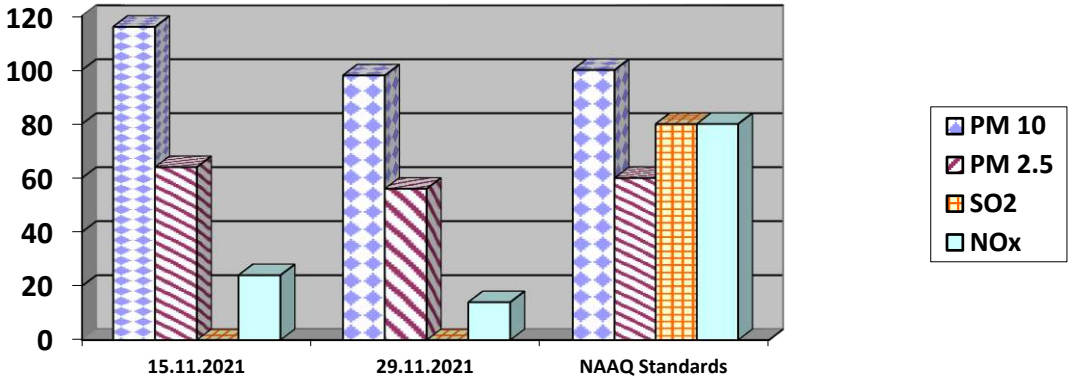


Analysed By
JSA/SA/SSA

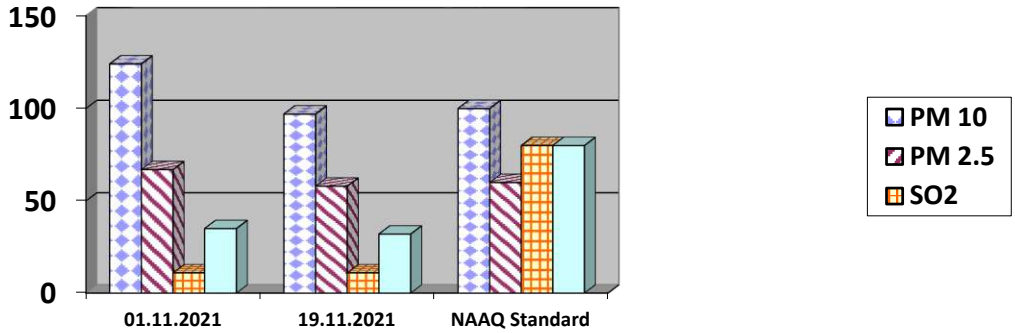
Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

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

Station Name:A29-Moonidih Washery		Zone: Core		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO2	NOx
1	15.11.2021	116	64	<10	24
2	29.11.2021	98	56	<10	14
	NAAQ Standards	100	60	80	80



StationName: Kusunda OCP (A10)		Zone: Buffer		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO_2	NO_X
1	01.11.2021	124	67	11	35
2	19.11.2021	97	58	11	32
	NAAQ Standard	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 Bhagabandh (MW11)**

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

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-XI**		Month: **NOV ,2021**	Name of the Station: **Mine Discharge of Bhagabandh**	
Sl. No.	**Parameters**	**MW11** First Fortnight	**MW11** Second Fortnight	**As per MOEF General Standards for schedule VI**
		15.11.2021	29.11.2021	
1	Total Suspended Solids	39	43	*100 (Max)*
2	pH	8.24	8.17	*5.5 - 9.0*
3	Oil & Grease	<2.0	<2.0	*10 (Max)*
4	COD	20	24	*250 (Max)*

All values are expressed in mg/lit except pH.

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

1. **Pootkee Balihari Office (N16)**
2. **Moonidih UGP (N17)**
3. **Moonidih Washery (N29)**
4. **Kusunda OCP (N10)**

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).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time and the observed values were compared with standards prescribed by MoEF&CC. 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 -XI**			Month: **NOV 2021**		
Sl. No.	**Station Name/Code**	**Category of area**	**Date**	**Noise level dB(A)LEQ**	***Permissible Limit of Noise level in dB(A)***
1	Pootkee Balihari Office (N16)	Industrial area	12.11.2021	60.4	*75*
2	PootkeeBalihari Office (N16)	Industrial area	26.11.2021	61.8	*75*
3	MoonidihUGP (N17)	Industrial area	15.11.2021	56.3	*75*
4	MoonidihUGP (N17)	Industrial area	29.11.2021	62.2	75
5	Moonidih Washery (N29)	Industrial area	15.11.2021	55.7	*75*
6	Moonidih Washery (N29)	Industrial area	29.11.2021	63.2	75
7	KusundaOCP (N10)	Industrial area	01.11.2021	56.3	*75*
8	KusundaOCP (N10)	Industrial area	20.11.2021	57.2	*75*

Permissible limits of Noise Level as per MOEF Gazette Notification No. GSR 742(E) dt. 25.09.2000 Standards for Coal Mines and Noise Pollution (Regulation and Control) Rules, 2000.

*** Day Time: 6.00 AM to 10.00 PM.**

Analysed By
JSA/SA/SSA

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

Approved By
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RI-2, CMPDI, Dhanbad

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

(FOR THE MONTH DECEMBER, 2021)

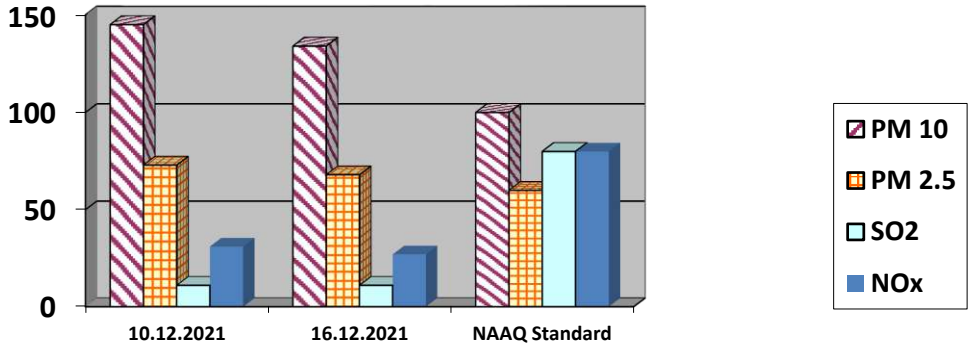
E. C. no. J-11015/77/2011-IA.II (M) dated 26.07.2019.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

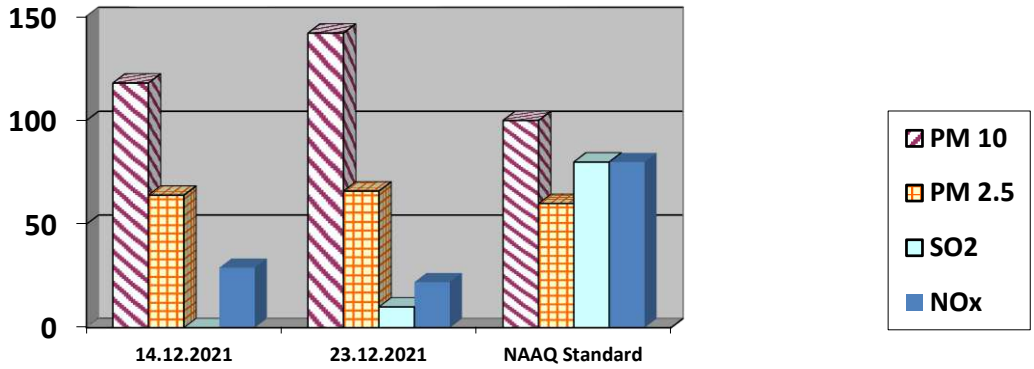
AMBIENT AIR QUALITY DATA

Cluster –XI, Bharat Coking Coal limited Month: **DEC 2021** Year: **2021-22.**

StationNameA16-Pootkee Balihari office		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	10.12.2021	145	73	11	31
2	16.12.2021	134	68	11	27
	NAAQ Standard	100	60	80	80



Station Name: A17- Moonidih UGP		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	14.12.2021	118	64	<10	29
2	23.12.2021	142	66	10	22
	NAAQ Standard	100	60	80	80



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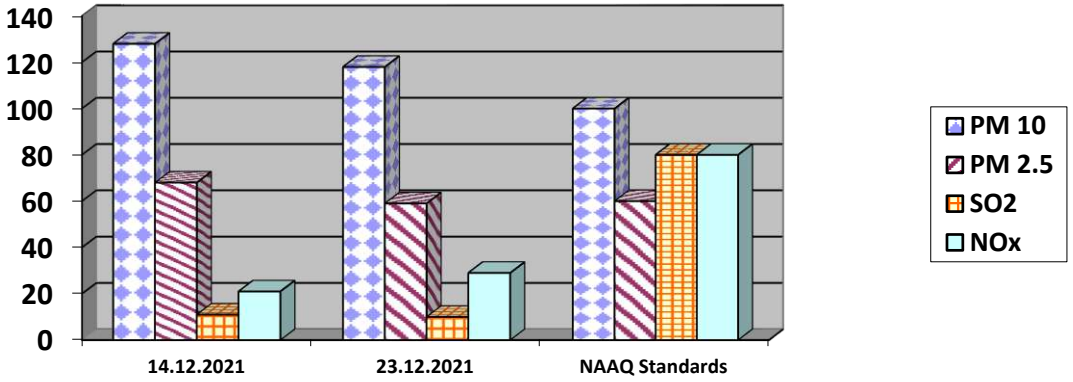
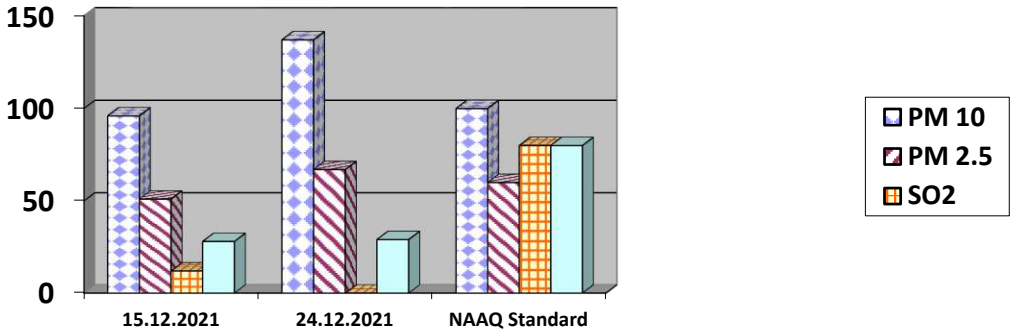
RI-2, CMPDI, Dhanbad

Station Name:A29-Moonidih Washery		Zone: Core		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO2	NOx
1	14.12.2021	128	68	11	21
2	23.12.2021	118	59	10	29
	NAAQ Standards	100	60	80	80



StationName: Kusunda OCP (A10)		Zone: Buffer		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO_2	NO_X
1	15.12.2021	96	51	12	28
2	24.12.2021	137	67	<10	29
	NAAQ Standard	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 Bhagabandh (MW11)**

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

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-XI**		Month: **DEC ,2021**	Name of the Station: **Mine Discharge of Bhagabandh**	
Sl. No.	**Parameters**	**MW11** First Fortnight	**MW11** Second Fortnight	**As per MOEF General Standards for schedule VI**
		06.12.2021	20.12.2021	
1	Total Suspended Solids	37	39	*100 (Max)*
2	pH	8.12	8.07	*5.5 - 9.0*
3	Oil & Grease	<2.0	<2.0	*10 (Max)*
4	COD	32	24	*250 (Max)*

All values are expressed in mg/lit except pH.

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

1. **Pootkee Balihari Office (N16)**
2. **Moonidih UGP (N17)**
3. **Moonidih Washery (N29)**
4. **Kusunda OCP (N10)**

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).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time and the observed values were compared with standards prescribed by MoEF&CC. 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 -XI**			Month: **DEC 2021**		
Sl. No.	**Station Name/Code**	**Category of area**	**Date**	**Noise level dB(A)LEQ**	***Permissible Limit of Noise level in dB(A)***
1	Pootkee Balihari Office (N16)	Industrial area	11.12.2021	57.4	*75*
2	PootkeeBalihari Office (N16)	Industrial area	17.12.2021	60.7	*75*
3	MoonidihUGP (N17)	Industrial area	13.12.2021	63.3	*75*
4	MoonidihUGP (N17)	Industrial area	23.12.2021	61.8	75
5	Moonidih Washery (N29)	Industrial area	13.12.2021	64.4	*75*
6	Moonidih Washery (N29)	Industrial area	23.12.2021	60.6	75
7	KusundaOCP (N10)	Industrial area	15.12.2021	57.2	*75*
8	KusundaOCP (N10)	Industrial area	25.12.2021	58.6	*75*

Permissible limits of Noise Level as per MOEF Gazette Notification No. GSR 742(E) dt. 25.09.2000 Standards for Coal Mines and Noise Pollution (Regulation and Control) Rules, 2000.

*** Day Time: 6.00 AM to 10.00 PM.**

Analysed By
JSA/SA/SSA

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Lab In Charge
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(FOR THE MONTH JANUARY, 2022)

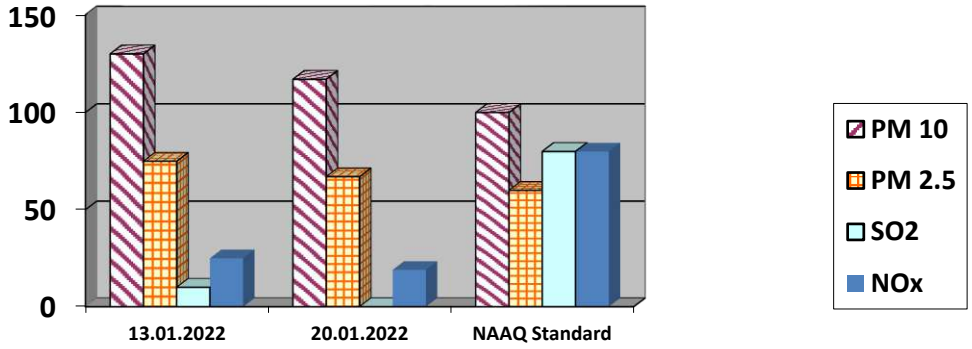
E. C. no. J-11015/77/2011-IA.II (M) dated 26.07.2019.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

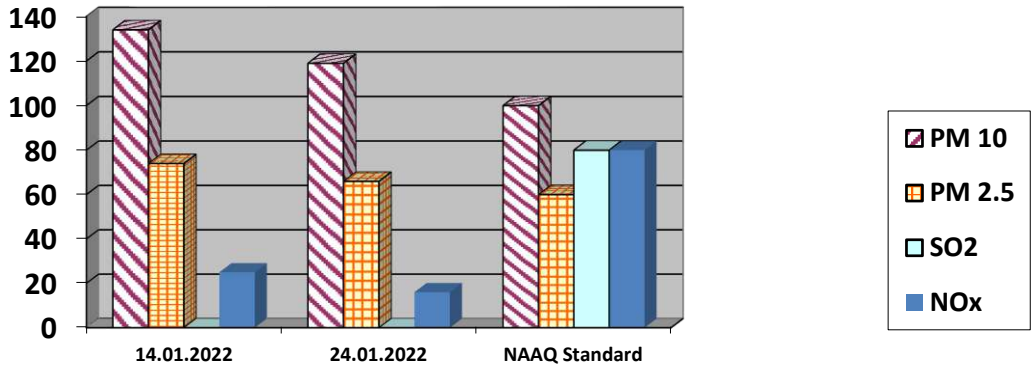
AMBIENT AIR QUALITY DATA

Cluster –XI, Bharat Coking Coal limited Month: **JAN 2022** Year: **2021-22.**

StationNameA16-Pootkee Balihari office		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	13.01.2022	130	75	10	25
2	20.01.2022	117	67	<10	19
	NAAQ Standard	100	60	80	80



Station Name: A17- Moonidih UGP		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	14.01.2022	134	74	<10	25
2	24.01.2022	119	66	<10	16
	NAAQ Standard	100	60	80	80

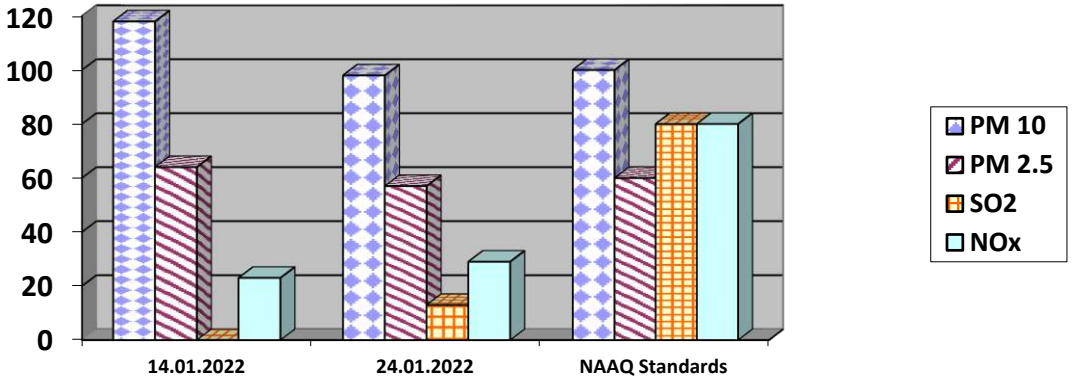


Analysed By
JSA/SA/SSA

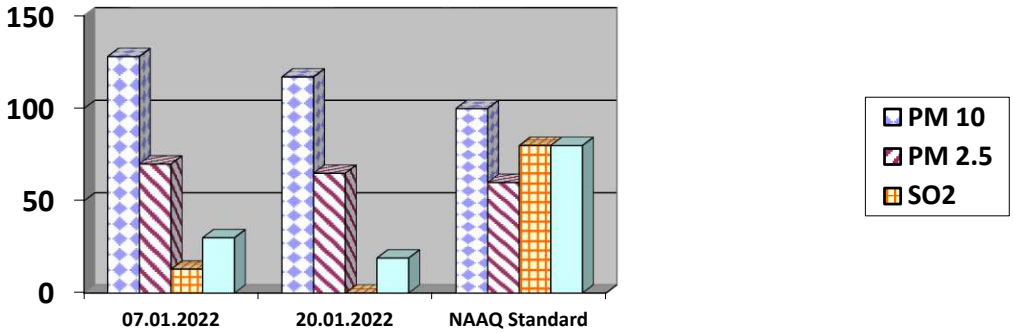
Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

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

Station Name:A29-Moonidih Washery		Zone: Core		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO2	NOx
1	14.01.2022	118	64	<10	23
2	24.01.2022	98	57	13	29
	NAAQ Standards	100	60	80	80



StationName: Kusunda OCP (A10)		Zone: Buffer		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO_2	NO_X
1	07.01.2022	128	70	13	30
2	20.01.2022	117	65	<10	19
	NAAQ Standard	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 Bhagabandh (MW11)**

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3.3 Results & Interpretations

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WATER QUALITY DATA

(EFFLUENT WATER- FOUR PARAMETERS)

Name of the Cluster: **Cluster-XI**		Month: **JAN 2022**	Name of the Station: **Mine Discharge of Bhagabandh**	
Sl. No.	**Parameters**	**MW11** First Fortnight	**MW11** Second Fortnight	**As per MOEF General Standards for schedule VI**
		03.01.2022	31.01.2022	
1	Total Suspended Solids	33	50	*100 (Max)*
2	pH	7.77	7.84	*5.5 - 9.0*
3	Oil & Grease	<2.0	<2.0	*10 (Max)*
4	COD	32	44	*250 (Max)*

All values are expressed in mg/lit except pH.

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

1. **Pootkee Balihari Office (N16)**
2. **Moonidih UGP (N17)**
3. **Moonidih Washery (N29)**
4. **Kusunda OCP (N10)**

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).

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Ambient noise levels were recorded during day time and the observed values were compared with standards prescribed by MoEF&CC. 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 -XI**			Month: **JAN 2022**		
Sl. No.	**Station Name/Code**	**Category of area**	**Date**	**Noise level dB(A)LEQ**	***Permissible Limit of Noise level in dB(A)***
1	Pootkee Balihari Office (N16)	Industrial area	14.01.22	56.4	*75*
2	PootkeeBalihari Office (N16)	Industrial area	20.01.22	57.6	*75*
3	MoonidihUGP (N17)	Industrial area	14.01.22	57.4	*75*
4	MoonidihUGP (N17)	Industrial area	21.01.22	56.7	75
5	Moonidih Washery (N29)	Industrial area	14.01.22	56.8	*75*
6	Moonidih Washery (N29)	Industrial area	18.01.22	56.2	75
7	KusundaOCP (N10)	Industrial area	07.01.22	56.4	*75*
8	KusundaOCP (N10)	Industrial area	20.01.22	57.1	*75*

Permissible limits of Noise Level as per MOEF Gazette Notification No. GSR 742(E) dt. 25.09.2000 Standards for Coal Mines and Noise Pollution (Regulation and Control) Rules, 2000.

*** Day Time: 6.00 AM to 10.00 PM.**

Analysed By
JSA/SA/SSA

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

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

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

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

(FOR THE MONTH FEBRUARY, 2022)

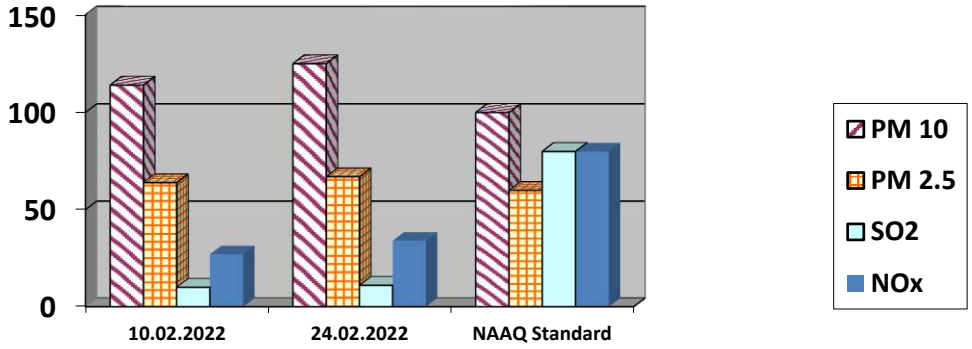
E. C. no. J-11015/77/2011-IA.II (M) dated 26.07.2019.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

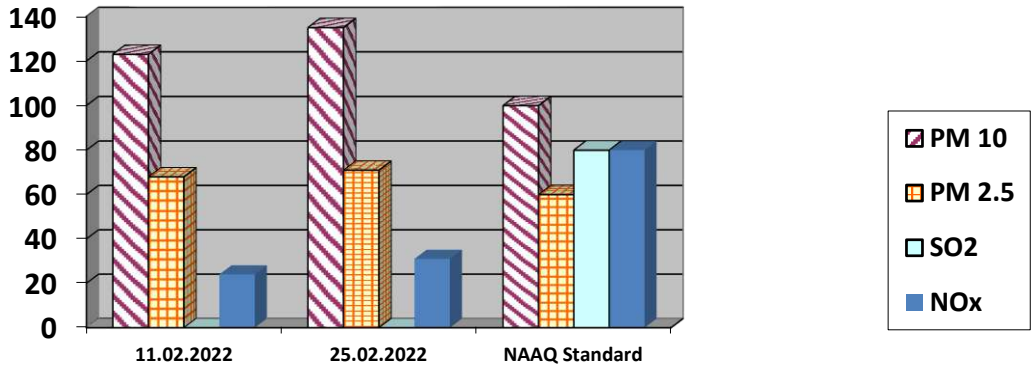
AMBIENT AIR QUALITY DATA

Cluster –XI, Bharat Coking Coal limited Month: **FEB 2022** Year: **2021-22.**

StationNameA16-Pootkee Balihari office		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	10.02.2022	114	64	10	27
2	24.02.2022	125	67	11	34
	NAAQ Standard	100	60	80	80



Station Name: A17- Moonidih UGP		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	11.02.2022	123	68	<10	24
2	25.02.2022	135	71	<10	31
	NAAQ Standard	100	60	80	80



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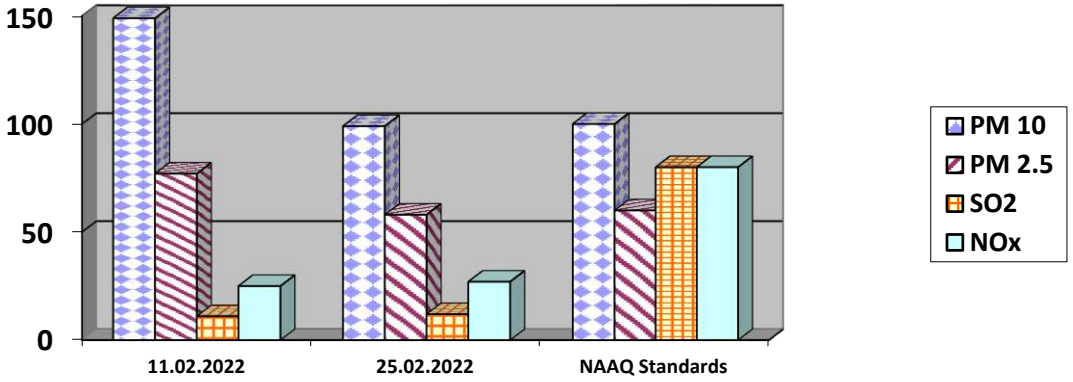
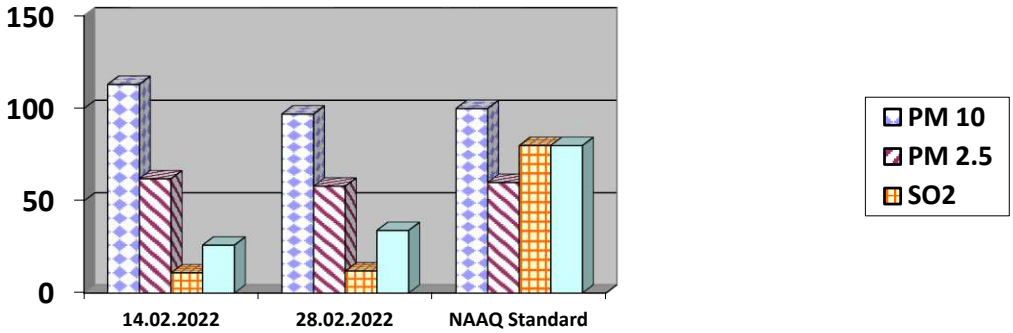
Station Name:A29-Moonidih Washery		Zone: Core		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO2	NOx
1	11.02.2022	149	77	11	25
2	25.02.2022	99	58	12	27
	NAAQ Standards	100	60	80	80



StationName: Kusunda OCP (A10)		Zone: Buffer		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO_2	NO_X
1	14.02.2022	113	62	11	26
2	28.02.2022	97	58	12	34
	NAAQ Standard	100	60	80	80



- *All values are expressed in microgram per cubic meter.*

24 hours duration

Analysed By
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WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) **Mine Discharge of Bhagabandh (MW11)**

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

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-XI**		Month: **FEB 2022**	Name of the Station: **Mine Discharge of Bhagabandh**	
Sl. No.	**Parameters**	**MW11** First Fortnight	**MW11** Second Fortnight	**As per MOEF General Standards for schedule VI**
		14.02.2022	28.02.2022	
1	Total Suspended Solids	46	44	*100 (Max)*
2	pH	7.99	7.85	*5.5 - 9.0*
3	Oil & Grease	<2.0	<2.0	*10 (Max)*
4	COD	52	48	*250 (Max)*

All values are expressed in mg/lit except pH.

Analysed By
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Checked By
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RI-2, CMPDI, Dhanbad

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RI-2, CMPDI, Dhanbad

NOISE LEVEL QUALITY MONITORING

4.1Location of sampling sites

1. **Pootkee Balihari Office (N16)**
2. **Moonidih UGP (N17)**
3. **Moonidih Washery (N29)**
4. **Kusunda OCP (N10)**

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).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time and the observed values were compared with standards prescribed by MoEF&CC. 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 -XI**			Month: **FEB 2022**		
Sl. No.	**Station Name/Code**	**Category of area**	**Date**	**Noise level dB(A)LEQ**	***Permissible Limit of Noise level in dB(A)***
1	Pootkee Balihari Office (N16)	Industrial area	10.02.22	56.2	*75*
2	PootkeeBalihari Office (N16)	Industrial area	24.02.22	55.2	*75*
3	MoonidihUGP (N17)	Industrial area	12.02.22	56.8	*75*
4	MoonidihUGP (N17)	Industrial area	26.02.22	57.2	75
5	Moonidih Washery (N29)	Industrial area	12.02.22	57.2	*75*
6	Moonidih Washery (N29)	Industrial area	26.02.22	56.3	75
7	KusundaOCP (N10)	Industrial area	12.02.22	56.7	*75*
8	KusundaOCP (N10)	Industrial area	26.02.22	57.2	*75*

Permissible limits of Noise Level as per MOEF Gazette Notification No. GSR 742(E) dt. 25.09.2000 Standards for Coal Mines and Noise Pollution (Regulation and Control) Rules, 2000.

*** Day Time: 6.00 AM to 10.00 PM.**

Analysed By
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ANNEXURE - XVII

A. Training from Oct'2021 – March'2022

No. of employees (Department & Contractual) received training in Cluster XI (Oct'2021 – March'2022)		
Colliery	**Types of Training**	**Number**
Moonidih	**Initial training**	200
	Refresher training	107
	Special	183
	Special (GT)	77
Gopalichuck, Pootkee, Bhagabandh, KB 10-12, PBP colliery, P.B. Area Office, etc.	**Training of Contractual workers**	10
	Refresher training	432
	Special	165
Total		1,174

B. IME & PME report for Cluster XI from Oct'2021 – March'2022

IME & PME of Cluster XI	
Area Covered	**Beneficiary**
Moonidih Colliery	584
Gopalichuck, Pootkee, Bhagabandh, KB 10-12, PBP colliery, P.B. Area Office, etc.	634
Total	1218