Bharat Coking Coal Ltd.
(A Subsidiary of Coal India Limited)
Office of the General Manager, Katras Area
P.O. Sijua, P.S.- Jogta, Dhanbad-828121
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Ref. No.-BCCL/ IV/2017/KA/ENV/661 **Dated- 30/5/2017**

To
The Director,
Ministry of environment, forest and climate charge
Regional office (ECZ)
Bungalow office no.42,Shyamali colony
Ranchi-834002

Sub:-six monthly compliance report on implementation of environmental measures for the period from Oct 2016 to March 2017

Dear sir
Kindly find enclosed herewith the six monthly compliance report on implementation of environmental measures for the period from Oct 2016 to March in respect of cluster IV group of mines under Katras Area, BCCL.

Hope you will find in order.

Enclosed:-As Above.

Yours Faithfully
30/5/17
Area Manager (Environment)
Katras Area, BCCL

Copy:-
1.The Director,1A Monitoring cell,Paryavaran Bhawan,CGO Complex, New Delhi-110003
2. Central Pollution Control Board, Parivesh Bhawan, CBD-cum-Office Complex East Arjun Nagar, DELHI - 110 032, INDIA
3. The Director,(S) Ministry of Environment & Forest,Govt.of India –Bhuneshwar751023
4.The Member Secretary, Jharkhand state Pollution Control Board,Ranchi-834004
5. The Regional Officer, Jharkhand state Pollution Board,Dhanabad-826001
6.Dy.GM(ENV),BCCL,Koyla Bhawan,Dhanbad
6.Office Copy

ENVIRONMENTAL CLEARANCE COMPLIANCE OF CLUSTER-IV

(GRANTED VIDE J-11015/212/2010-IA. II (M) Dated 06.02.2013)

(April to Sept. - 2016)

SN	A. Specific Conditions by MOEF:	Compliance
i	**The maximum production from one opencast section in the cluster shall not exceed beyond that for which environmental clearance has been granted for the cluster IV.**	The normal production of the mines under cluster IV has never exceeded the capacity of production granted under environmental clearance of cluster IV, However the coal recovered during dealing of fire in different coal seams for complying the directive under Jharia Master Plan approved by Government of India and Specific condition no. 2 of Environmental clearance has exceeded the limit of environmental clearance granted. It is pertinent to mention that the quantity of coal, recovered during the dealing of fire can't be predicted or pre-assessed, however with the experience gained over the period we have enabled us to surmise the expected quantity of coal and accordingly we have modified the capacity of environmental clearance and approached MoEFCC in 2013 itself for granting the same. We have dealt fire at Gaslitand mine, Katras Chaitudih and AKWMC under cluster IV to control spread of fire and subsequently Emission of Hazardous gases to prevent environmental pollution thereby recovering fiery coal and we have included the exceeded capacity of all the said mines in our modified environmental clearance. It may kindly be noted that TOR has been already issued in 2014 for peak capacity of 9.55 MTPA. Regional officer, MoEFCC-Ranchi has inspected the mines of cluster IV on dated 22.08.2016 and approval of Modified Environmental clearance of Peak capacity 9.55 MTPA is under finalization. Further it is mentioned that we have dug out the fiery coal just beside the Dhanbad chandrapura railway line to ensure the safety of the train and persons using it. It is also informed here that, during the course of fire dealing activity additional 2616632 Te (Gaslitand colliery –348275 Te, Katras Choitudih colliery-474385 Te and AKWMC- 1793972 Te) of firey coal has been dug out for complying Environmental clearance specific condition no. ii and dovetailing jharia master plan during 2016-17.
ii	**The measure to identify in the Environmental Plan for Cluster- IV groups of mine and the conditions given in this environmental clearance letter shall be dovetailed to the implementation of the Jharia Action Plan.**	Master Plan/Jharia Action Plan is dovetailed with environmental clearance conditions. Gaslitand fire patch, Katras Choitudih Fire Patch and AKWMC Fire Patch are being operated by open cast method to dig out fire and to control further spread of fire to nearby mine in order to implement fire dealing as per Master Plan/ Jharia Action Plan.
iii	**The proponent shall prepare time –series**	The proponent has got a study carried out through NRSC

	maps of the Jharia Coalfields through NRSA to monitor and prevent fire problems in the Jharia Coalfields by Isothermal mapping /imaging and monitoring temperatures of the coal seams (whether they are close to spontaneous ignition temperatures) and based on which, areas with potential fire problems shall be identified. Measures to prevent ingress of air (Ventilation) in such areas, to prevent restart fresh/spread fires in other areas including in mines of cluster IV 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. Monitoring of fire should be carried out regularly.**	Hyderabad. NRSC has been awarded the work to prepare time series map by isothermal mapping after getting EC vide BCCL/D(T) OP/F-Env/2012/148(A) dated 11.02.2013. The last report was submitted by NRSC on April, 2014. The report concluded that there is a decrease in areal extent of fire from 3.01 sq.km. in 2006 to 2.18 sq.km. in 2012 based on the satellite data available for Dec, 2012 and validation by ground truth in done in the year 2013. A Global EOI was floated to control fire in Jharia Coalfield. Two party participated. The technical committee did not find the international parties had expertise in controlling liquidating mine fire. It is informed to HPCC of MoC. Presently, Study is being done by ISM Dhanbad & CIMFR, Dhanbad. All unworked pit and incline has been sealed to protect entry of air to fire area. Annexure 1:- **Work-order to NRSC for Delineation of Surface Coal Fire and associated Land Subsidence in Jharia Coalfield.**
Iv	**Underground mining should be taken up after completion of reclamation of Opencast mine area after 15 years.**	Underground mining will be taken up after completion of reclamation of opencast mine area after 15 years.
V	**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** **Stabilised with plantation so as to withstand the peak water flow and prevent mine inundation.**	The embankment constructed along the river boundary is of suitable dimension and critical patches has been strengthened by concreting and stone pitching as per design made by Central Mine Planning and Design Institute Limited (CMPDIL) on the river front side and stabilized with plantation to withstand the peak water flow and prevent mine inundation. Construction of concrete embankment at critical patch of nallah/Jore has been done. Total length of constructed embankment is 3000 meter.
Vi	**The rejects of washeries in Cluster –IV should be send to FBC based plant.**	There is no washery in cluster – IV at present.
vii	**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.**	No underground mining is continuing where fire exists. However, Mining is being done through opencast excavation method where below ground fire exists. It was stated by the Project Authority that fire control measures are being taken through opencast excavation method to prevent /check its further spread as per the Jharia Action Plan/Master Plan.
Viii	**There shall be no external OB dumps. OB produce from the one OC Patch of cluster IV will be 45.5 Mm^3. OB from one OCP patches in mixed mine shall be backfilled. At the end of the mining there shall be no void and** **The entire mined out area shall be re-vegetated. Areas where opencast mining was**	There are 6 active OB dump in cluster IV. All the OB dump are within the leasehold area/internal. These dumps are created external to excavation area temporarily for reasons to facilitate safe mining. At the end of mining all the dumps will be levelled and backfilled in opencast excavated area. Apart from the above 6 Active OB Dumps, 2 OB dump have been stabilized and re-vegetated through eco-restoration process

	carried out and completed shall be reclaimed immediately thereafter.	(one 3.4 hectare and another 3.02 hectare). Backfilling of quarry is going on with mining operation. At the end of mining there shall be no void and external OB dumps, area will be re-vegetated and reclaimed.
Ix	**A detailed calendar plan of production with plan for OB dumping and backfilling (for OC mines) and reclamation and final mine closure plan for each mine of cluster-IV shall be drawn up and implemented.**	Detailed calendar plan of coal production, OB recovered has been prepared for 5 years. Mine closure plan of AKWMC, AARC, Salanpur Colliery and Katras Choitidih Colliery as per the guidelines of Ministry of Coal and on the basis of cluster concept has been prepared. For Gaslitard is under preparation by Central Mine planning and Design Institute (CMPDI).
X	**Mining shall be carried out as per statuette from the streams/nalas flowing within the lease and maintaining a safe distance from the Nalas flowing along the lease boundary. A safety barrier of a minimum 60m width shall be maintained along the nalas/water bodies. The small water bodies in OC shall be protected to the extent feasible and the embankment proposed along water body shall be strengthened with stone pitching taking into account the highest flood level, based on past data, so as to guard against mine inundation. The slope of the embankment shall at least 2:1 towards the ML. The height of the embankment shall be at least 3 m higher than the HFL. The embankment to be constructed by OB /solid waste shall be strengthened with stone pitching. Slope stability of the embankment shall be done by planting suitable grass and shrubs using native species selected from the study area.**	Mining is carried out as per statute regarding maintaining of safe distance from streams/nalas flowing within the leasehold area of cluster – IV. A safety barrier as per CMR 126, 2(b) is maintained along the nalas/water bodies. The embankment along water bodies is strengthened with stone pitching/concreting taking into account the HFL so as to guard against mine inundation as per design of CMPDIL. Concrete embankment at critical patch of the nallah/ Jore has been made.
xi	**Active OB dumps near water bodies and rivers should be rehandled for backfilling abandoned mine voids. However, those which have been biologically reclaimed need not be disturbed.**	No active OB dump exist near water bodies. The OB dump of AKWMC OCP near Kumarijore has been biologically reclaimed.
xii	**Thick green belt shall be developed along undisturbed areas, mine boundary and in mine reclamation. During post mining stage, a total of 794.09 ha area would be reclaimed. The total additional area under plantation would be 719.42 ha (101.7 ha abandoned**	The Plan is prepared for plantation at undisturbed areas and in Mine Reclamation. Ecological Restoration (3-tier Plantation) on 3.4 ha land (2014-15) and 3.02 ha land (2015-16) has been done in the year 2014-15, 2015-16 respectively. In the year 2016-17 at mine boundary 720 Nos of Gabion Plantation has been done by DFO, another 965 Nos of Bamboo

	quarry area, 103.31 ha active quarry area, 14.82 OB dump outside quarry area, 4.36 ha service building /mine infrastructure area /coal dump etc, 160.25 ha green belt around OCP, 334.94 ha barren area), by planting 17,98,550 plants at a total cost of Rs 396.41 lakhs.	Gabion plantation has been done by DFO. A new ecological restoration site at AKWMC of area 5.7 ha has been taken up in the year 2017-18. The remaining life of cluster IV is more than 30 years during which period the greenery shall be developed over an area of 794.09 Ha, however over an area of 51.42 ha the greenery has been developed till date and we have planned we will developed the greenery @ 4-5 ha per year during coming 5 years after which we will able to do it for more area to meet the target 794.09 Ha at the end of the life of the cluster.
xiii	**The road should be provided with avenue plantation on both side as trees act as sink of carbon and other pollutant.**	Avenue plantation on both side, as trees act as sink on carbon and other pollutant, has been done along DB road from Shakti Chowk to Tetulmari for a distance of 7-8 Km. Forest authority have been pursued for timely completion of avenue plantation. 2135 Nos of gabion plantation has been done as avenue plantation by forest department Dhanbad since 2014-15. In the FY 2017-18 600 Nos of Gabion plantation has also been processed.
Xiv	**Specific mitigative measures identified for the Jharia Coalfields in the Environmental Action Plan prepared for Dhanbad as a critically polluted are and relevant for Cluster- IV shall be implemented.**	Dhanbad Action Plan is being implemented. The salient actions of this cluster 1. Transportation by covered truck. 2. Water sprinkling 3. Plantation. 4. Ecological Restoration 5. Water harvesting and water treatment 6. Regularly Air, water and Noise monitoring
xv	**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, flyash from TPPs, silica from natural dust, etc) and a Source Apportionment Study should be got carried out for the entire Jharia Coalfields. Mineralogical composition study should be undertaken on the composition of the suspended particulate matter (PM_{10} and $PM_{2.5}$) in Jharia Coalfields and also quantified. These studies would help ascertain source and extent of the air pollution, based on which appropriate mitigative measures could be taken.**	The locations of monitoring station in the Jharia coalfield has been finalised in consultation with the Jharkhand State Pollution Control Board at Ramkanali (Gobindpur Village) and Chotudih in the core zone, Block IV- Kooridih OCP, Mine Office- Nichitpur and Rudhi Basti in the buffer Zone for Air Quality and noise Monitoring. Katri River & Kumari Jore (Both Upstream & Downstream), Malkera New colony (Ground Water), Choitodih U/G Mine (Mine Effluent) for water Quality Monitoring. The work of monitoring of ambient environment is being done by CMPDIL, Dhanbad. Annexure2**:-** **<u>Monitoring Report.</u>** Tender for conducting source apportionment study for BCCL was floated twice, however, none of the bidders qualified. Therefore, as per the MoU "Sustainable Coal Mining in Coal India Limited" entered between CIL and NEERI, NEERI Nagpur was approached for conducting Source Apportionment Study BCCL for compliance of EC conditions.The proposal regarding Conducting the Source Apportionment Study has been submitted by NEERI.

		Presently it has been submitted to CIL for further scrutiny and approval. An undertaking in this regard has also sbeen submitted to Regional Director, MoEFCC-Ranchi to complete the job by Dec-2018.
Xvi	**The Transportation Plan for conveyor-cum–rail for Cluster-IV should be dovetailed with Jharia Action Plan. Road transportation of coal during Phase–I should be by mechanically covered trucks, which should be introduced at the earliest. The Plan for conveyor-cum–rail for Cluster-IV should be dovetailed with Jharia Action Plan. The Committee desired that road transportation of coal during phase–I should be by mechanically covered trucks.**	Presently tarpaulin covered coal transportation is being done. Initiatives has been taken at corporate level of coal India Limited for developing the mechanically covered trucks and a meeting for the same has been held with the OEM on dated 07.05.2016. Vender list is awaited. The conveyor-cum–rail for Cluster-IV will be installed in 2nd phase of Master Plan.
Xvii	**A study should be initiated to analyze extent of reduction in pollution load every year by reducing road transport**	CMPDIL, Ranchi has already been awarded the work to conduct this study. Annexure 3:- **Study report is enclosed.**
Xviii	**R&R of 7012 nos of PAF's involved. They should be rehabilitated at cost of Rs 26274 lakhs as per the approved Jharia Action Plan.**	Rehabilitation of BCCL families are being done by BCCL and Non-BCCL families are being done by Jharia Rehabilitation Development Authority (JRDA) of Govt. of Jharkhand. 620 Nos of BCCL families and 255 Nos of Non BCCL families has been shifted. BCCL families have been shifted to Coal dump colony and non BCCL family to National Angarpathra, MAZAR. Coal India Limited has provided heavy fund to JRDA for shifting of encroachers and privates people following master plan approved by Government of India. JRDA has prepared 3360 NOs of quarter till date for shifting of encroachers and privates people residing in all clusters of BCCL. Phase wise shifting of encroachers and privates people are being done as per priority basis.
xix	**Regular monitoring of groundwater level and quality of the study area shall be carried out by establishing a network of existing wells and construction of new peizometers. The monitoring for quantity shall be dome four times a year in pre-monsoon (May), monsoon (August), post-monsoon (November) and winter (January) seasons and for quality including Arsenic and Fluoride during the month of May. Data thus collected shall be submitted to the Ministry of Environment & Forest and to the Central Pollution Control Board/SPCB quarterly within one month of monitoring. Rainwater harvesting measures**	Regular monitoring of ground water level and quality are being monitored by CMPDIL, Ranchi. Regarding establishing a network of existing wells and construction of new piezometers the design and location has been finalized by CMPDIL, Ranchi and tender has been floated. An undertaking in this regard has been submitted to Regional Director, MoEFCC to complete the job by Dec-2018.

	shall be undertaken in case monitoring of water table indicates a declining trend.	
Xx	**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.**	No depillaring in underground mine is going on hence no mining induced subsidence is taking place. Regular monitoring of the area is being done by mine officials in this regard. A Certificate of Project Officers and General Manager of the Cluster IV, indicating no subsidence due to mining operation has been submitted.
Xxi	**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.**	Sufficient coal pillars will be left unextracted around the air shafts as per the statutes and DGMS guidelines to protect from any damage from subsidence.
Xxii	**High root density tree species shall be selected and planted over areas likely to be affected by subsidence.**	High Root density plants has been planted as seesam, Gamhar, Aam, Peepal,Bargad, Sagwan, Kathal etc. over areas likely to be affected by subsidence.
Xxiii	**Depression due to subsidence resulting in water accumulating within the low lying areas shall be filled up or drained out by cutting drains.**	No depillaring in underground mine is going on hence no mining induced subsidence is taking place.
Xxiv	**Solid barriers shall be left below the roads falling within the blocks to avoid any damage to the roads.**	Sufficient barriers are left for saving the surface installation and infra structures (like road etc.) as per the clause no. – (i) of 105 of Coal Mines Regulation, 1957 and DGMS guidelines.
Xxv	**No depillaring operation shall be carried out below the township/colony.**	It is being followed. No depillaring operation shall be carried out below the township/colony.
Xxvi	**A detailed CSR Action Plan shall be prepared for Cluster IV croup of mines. Specific activities shall be identified for CSR for the budget of Rs 142 .55 Lakhs /annum @ Rs 5/T of coal provided for CSR and Rs. 5/T of coal as recurring expenditure. The 416.98 ha of area within Cluster IV ML existing as waste land and not being acquired shall be put to productive use under CSR and developed with fruit bearing and other useful species for the local communities. Third party evaluation shall be got carried out regularly for the proper implementation of activities**	Action plan of CSR works has been taken up at Katras Area/cluster- IV and the activities are going on. For detailed CSR action plan and framework, Tata Institute of Social Science (TISS) has been consulted. TISS has conducted necessary survey in the project area-IV and CSR Action plan has been formulated**.** Details of the TISS study is uploaded on the website. Cluster-IV has given priority to Vocational Training/Skill development training to Local People/PAP.

	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.	
Xxvii	**Details of transportation, CSR, R&R and implementation of environmental action plan for the clusters-IV should be brought out in a booklet form within a year and regularly updated.**	Details of transportation, CSR, R&R and implementation of environmental action plan are prepared in a booklet form for Cluster-IV same has been uploaded on the website.
Xxviii	**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.**	Mine water is being treated to supply for domestic and drinking water purposes to nearby population. Pressure filters are being installed to further enhance mine water utilization capacity. The quality of the water is monitored by CMPDIL, Dhanbad at the outlet points and proper records maintained thereof. The data has been uploaded on the website**.**
xxix	**No groundwater shall be used for the mining activities. Additional water required, if any, shall be met from mine water or by recycling/reuse of the water from the existing activities and from rainwater harvesting measures.** **The project authorities shall meet water requirement of nearby village(s) in case the village wells go dry to dewatering of mine.**	Groundwater is not being used for mining activities. Mine water is being used for industrial purposes (sprinkling on road, firefighting etc.) Mine water is being treated at Water Treatment Plant and being supplied to nearby villages.
Xxx	**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 recognized 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.**	It is being complied. Water bodies and ponds has been created.
Xxxi	**Regular monitoring of groundwater level and quality of the study area shall be carried out**	Presently CMPDI is monitoring the ground water level. The location of the monitoring stations has been finalized in

	by establishing a network of existing wells and construction of new peizometers. The monitoring for quantity shall be dome four times a year in pre-monsoon (May), monsoon (August), post-monsoon (November) and winter (January) seasons and for quality including Arsenic and Fluoride during the month of May. Data thus collected shall be submitted to the Ministry of Environment & Forest and to the Central Pollution Control Board/SPCB quarterly within one month of monitoring. Rainwater harvesting measures shall be undertaken in case monitoring of water table indicates a declining trend.	consultation with JSPCB. Annnexure 4:- **Ground water quality monitoring report**
Xxxii	**ETP shall also be provided for workshop, and CHP, if any. Effluents shall be treated to confirm to prescribed standards in case discharge into the natural water course**	An undertaking regarding installation of ETP has been submitted to Regional Director, MoEFFCC-Ranchi to complete the job by FY 2018-19. A certificate regarding installation of Oil and grease trap by FY 2017-18 has been submitted to RO, Ranchi.
Xxxiii	**The location of monitoring stations in the Jharia coalfield should be finalized in consultation with Jharkhand State Pollution Control Board.**	The locations of monitoring stations are finalized in consultation with Jharkhand State Pollution Control Board.
Xxxiv	**For monitoring land use pattern and for post mining land use, a time series of land use maps, based on satellite imagery (on a scale of 1:5000) of the core zone and buffer zone, from the start of the project until end of mine life shall be prepared once in 3 years (for any one particular season which is consistent in the time series), and the report submitted to MOEF and its Regional office at Bhubaneswar.**	For monitoring land use pattern and for post mining land use, a time series of land use maps, based on satellite imagery of the core zone and buffer zone has been prepared by CMPDI Ranchi. Land-use pattern monitoring report done by CMPDIL has been submitted to MoEF.
Xxxv	**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.**	All mines under cluster IV has life of more han five years. It will be submitted online.

Xxxvi	**Implementation of Final Mine Closure Plan for Cluster IV, subject to obtaining prior approval of the DGMS in regard to mine safety issues.**	Final mine closure plan for cluster – IV shall be implemented subject to obtaining prior approval of the DGMS with regard to mine safety issues.
Xxxvii	**A separate management structure for implementing environment policy and socio-economic issues and the capacity building required in this regard.**	Separate Environmental Management structure has been established.
Xxxviii	**Corporate Environment Responsibility:** **a) The Company shall have a well laid down Environment Policy approved by the Board of Directors.** **b) The Environment Policy shall prescribe for standard operating process/procedures to bring into focus any infringements/deviation/violation of the environmental or forest norms/conditions.** **c) The hierarchical system or Administrative Order of the company to deal with environmental issues and for ensuring compliance with the environmental clearance conditions shall be furnished.** **d) To have proper checks and balances, the company shall have a well laid down system of reporting of non-compliances/violations of environmental norms to the Board of Directors of the company and/or shareholders or stakeholders at large.**	A well-defined Corporate Environment Policy has already been laid down and approved by the Board of Directors. This is also posted on BCCL website. The environmental policy has been complied. A hierarchical system of the company to deal with environmental issues from corporate level to mine level already exists. 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 is being complied. CSR expenditure are being done as per actual production.
B	**General Conditions by MOEF:**	
i	**No change in mining technology and scope of working shall be made without prior approval of the Ministry of Environment and Forests.**	Being complied. No change in mining technology and scope of working shall be made without prior approval of the Ministry of Environment and Forests.
Ii	**No change in the calendar plan of production for quantum of mineral coal shall be made.**	Being complied. No change in the calendar plan of production for quantum of mineral coal shall be made.
Iii	**Four ambient air quality monitoring stations shall be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2 and NOx monitoring. Location of the stations shall be decided based on the meteorological**	Location of Monitoring station in the Jharia Coal Field have been finalized with the Jharkhand State Pollution Control Board. Four ambient air quality monitoring station has been established at AARC agent office (Ramkanali), Mine office - Kooridih OCP, Mine office- Nichitpur and RudhiBasti. It has been informed to JSPCB

	data, topographical features and environmentally and ecologically sensitive targets in consultation with the State Pollution Control Board. Monitoring of heavy metals such as Hg, As, Ni, Cd, Cr, etc carried out at least once in six months.	and RO, Ranchi that monitoring of rudhibasti is not being done due to lack of safety there and a request regarding relocating the monitoring station has also made to JSPCB, but we are yet to receive any further correspondence from JSPCB in connection with said matter. Finally we have started air quality monitoring at Katras Chotudih in place of Rudhi Basti and a letter regarding this has also been sent to JSPCB. Monitoring of Ambient air quality has already been done by ISM Dhanbad as per NAAQS, 2009. Annexure 5:- **Letter to JSPCB regarding relocation of AAQ monitoring station**.
Iv	**Data on ambient air quality (PM_{10}, $PM_{2.5}$, SO_2 and NO_x) and heavy metals such as Hg, As, Ni, Cd, Cr and other monitoring data shall be regularly submitted to the Ministry including its Regional Office at Bhubaneswar and to the State Pollution Control Board and the Central Pollution Control Board once in six months. Random verification of samples through analysis from independent laboratories 10recognized under the EPA rules, 1986 shall be furnished as part of compliance report.**	Monitoring data regularly submitted to the Ministry including its Regional Office at Ranchi. Monitoring of air quality is being done by Central Mining & Planning Design Institute (CMPDIL), Dhanbad. Monitoring of Ambient air quality has already been done by ISM Dhanbad as per NAAQS, 2009. Annexure: 6- **Ambient air quality monitoring by NAAQS 2009.**
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.**	Personnel operating near HEMMs, drilling machine comply with safety regulation and are equipped with Personal Protective Equipment.
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.**	Installation of Oil and grease in AKWMC, Katras Area workshop has been processed. Tender has been floated for the same. A certificate regarding installation of Oil and grease trap by FY 2017-18 has been submitted to RO, Ranchi.
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.**	Vehicular emission is kept under control by proper maintenance of vehicles. Vehicular emissions are being monitored in every prescribed period. Only those vehicles are being allowed to run having PUC. In addition to the above coal transportation is done by tarpaulins covered and optimally loaded vehicles. The project authorities are regularly checking all the loaded trucks/dumpers coming inside the plant about their valid PUC.

<table>
<tr><td>Viii</td><td>Monitoring of environmental quality parameters shall be carried out through establishment of adequate number and type of pollution monitoring and analysis equipment in consultation with the State Pollution Control Board and data got analysed through a laboratory recognized under EPA Rules, 1986.</td><td>The locations in the Jharia coalfield have been finalized in consultation with the Jharkhand State Pollution Control Board. Monitoring of air quality is being done by Central Mining & Planning Design Institute (CMPDIL), Dhanbad.</td></tr>
<tr><td>Ix</td><td>Personnel working in dusty areas shall wear protective respiratory devices and they shall also be provided with adequate training and information on safety and health aspects.</td><td>Training and awareness programmes are being given to all the personnel working in dusty areas. All personnel working in such areas are also provided with mask to wear themselves. In the Fy 2016-17 different types of training/skill development activities has been given to the worker and PAF. Total 2796 nos of people benefited from the said programme.
Performance of Vocational training of workers during last three years is as follows:

<table>
<tr><th>Year</th><th>Target (Refresher)</th><th>Achievement (Refresher)</th></tr>
<tr><td>2010</td><td>750</td><td>788</td></tr>
<tr><td>2011</td><td>650</td><td>777</td></tr>
<tr><td>2012</td><td>660</td><td>743</td></tr>
<tr><td>2013</td><td>610</td><td>708</td></tr>
<tr><td>2014</td><td>610</td><td>687</td></tr>
<tr><td>2015</td><td>590</td><td>811</td></tr>
<tr><td>2016</td><td>650</td><td>909</td></tr>
</table>
Safety talk in the Mine/pit office on safety and health hazards is in regular practice.</td></tr>
<tr><td>X</td><td>Occupational health surveillance programme of the workers shall be undertaken periodically to observe any contractions due to exposure to dust and to take corrective measures, if needed and records maintained thereof. The quality of environment due to outsourcing and the health and safety issues of the outsourced manpower should be addressed by the company while outsourcing.</td><td>Initial Medical Examination (IME) and Periodical Medical Examination (PME) of all the personnel are carried out as per the Statutes and Director General of Mines Safety (DGMS) guideline.
Performance of IME/PME of workers of Katras Area is as follows: -
<table>
<tr><th>Year</th><th>IME Done</th><th>PME Done</th></tr>
<tr><td>2013</td><td>283</td><td>1940</td></tr>
<tr><td>2014</td><td>423</td><td>1826</td></tr>
<tr><td>2015</td><td>298</td><td>1593</td></tr>
<tr><td>2016</td><td>248</td><td>672</td></tr>
<tr><td>2017</td><td>303</td><td>1348</td></tr>
<tr><td>Total</td><td>877</td><td>4372</td></tr>
</table></td></tr>
<tr><td>Xi</td><td>A separate environmental management cell with suitable qualified personnel shall be set up under the control of a Senior Executive,</td><td>A separate environmental management cell has been established.</td></tr>
</table>

	who will report directly to the Head of the company.	
Xii	**The funds earmarked for environmental protection measures shall be kept in separate account and shall not be diverted for other purpose. Year-wise expenditure shall be reported to this Ministry and its Regional Office at Bhubaneswar.**	Funds for environmental protection kept in separate budget for each year has not been diverted for other purposes. In the Cluster IV, a lot of work has been done to mitigate environment pollution and maintain a safe and healthy environment in its core and buffer zone. Plantation, water harvesting, Environmental monitoring (Air, Water and Noise), Firefighting, Dust suppression, Water treatment is done regularly to protect the environment. Since last three-year Cluster-IV has started ecological restoration work to restore the degraded, damaged, or destroyed ecosystems and habitats in the environment. Till date ecological restoration is in progress on 12.12 Ha area. In the cluster IV a good number of Manpower and machineries are deployed on permanent basis for looking after the environment protection. Annexure 7:- **Environmental Protection Measures Cost.**
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.**	It has been 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. Copy also displayed on company's website.
Xv	**A copy of the environmental clearance letter shall be shall also be displayed on the website of the concerned State Pollution Control Board. The EC letter shall also be displayed at the Regional Office, District Industry Sector and Collector's Office/Tehsildar's Office for 30 days.**	**Complied.**

Xvi	**The clearance letter shall be uploaded on the company's website. The compliance status of the stipulated environmental clearance conditions shall also be uploaded by the project authorities on their website and updated at least once every six months so as to bring the same in public domain. The monitoring data of environmental quality parameter (air, water, noise and soil) and critical pollutant such as PM_{10}, $PM_{2.5}$, SO_2 and NO_x (ambient) and critical sect oral parameters shall also be displayed at the entrance of the project premises and mine office and in corporate office and on company's website.**	Complied. The Environmental clearance letter has been uploaded on the company's website. The compliance status of the stipulated environmental clearance conditions has also been uploaded. The monitoring data of environmental quality parameter (air, water, noise and soil) and critical pollutant such as PM_{10}, $PM_{2.5}$, SO_2 and NO_x (ambient) and critical sectoral parameters has displayed at the entrance of the project premises and mine office and in corporate office and on company's website. Annexure 8:- **Display Board**
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 offices of CPCB and the SPCB.**	It is being complied.
XVIII	**The Regional office of this Ministry located at Bhubaneswar shall monitor compliance of the stipulated conditions. The project authorities shall extend full cooperation to the officer(s) of the Regional office by furnishing requisite data/ information/ monitoring reports.**	**It shall be complied.**
XIX	**The Environmental statement for each financial year ending 31st March in form-V is mandated to be submitted by the project proponent for the concerned state pollution control board under the environment (protection) Rules, 1985 as amended subsequently, shall also be uploaded on the company's website along with the status of compliances of EC conditions and shall be sent to the respective Regional offices of the MOEF by e-mail.**	**Being complied.**
C	**Other conditions by MOEF**	
i	**The ministry or any other competent authority may stipulate any further condition(s) for environmental protection.**	**Agreed**

ii	**Failure to comply with any of the conditions mentioned above may result in withdrawal of this clearance and attract the provisions of the environment (protection) Act, 1986.**	**Agreed**
iii	**The above condition will be enforced inter-alia under the provision of the water (protection & Control of Pollution)Act,1974, the Air (prevention & Control of Pollution) Act, 1981, the Environment (protection) Act, 1985, and the public liability insurance Act, 1991 alongwith their amendments and Rules. The proponent shall ensure to undertake and provide for the costs incurred for taking up remedial measures in case of soil contamination, contamination of groundwater and surface water, and occupational and other diseases due to the mining operations.**	**Being complied.**
IV	**The Environmental clearance is subject to the outcome of the writ petition filed by M/s Bharat Coking Coal Limited (BCCL) in response to the closure order issued by the Jharkhand State Pollution Control Board which is pending in the Jharkhand High Court.**	**Agreed.**

-sd-
General Manager
Katras Area

भारत कोर्किंग कोल लिमिटेड
एक मिनीरत्न कंपनी
(कोल इंडिया लिमिटेड का एक अंग)
पंजीक्रत कार्यालय कोयला भवन ,कोयला नगर ,
(धनबाद)झारखंड826005(
CIN:U10101JH1972GOI000918
Tele: 0326 2230174 FAX: 0326 2230176
ईमेल :cgmsafety@bccl.gov.in

Bharat Coking Coal Limited
A Miniratna Company
(A subsidiary of Coal India Ltd)
Office of GM I/C(S&R)
Koyla Bhawan, Koyla Nagar,
Dhanbad, Jharkhand-826005
CIN:U10101JH1972GOI000918
Tele: 0326 2230174 FAX: 0326 2230176 Email: cgmsafety@bccl.gov.in

पत्र संख्या भाकोकोलि/उप महाप्रबंधक(एस&आर)I/C/संचिका-MP/17 323 दिनांक-:07.04.2017

To,
Dr, Vinod Kumar,
Group Head, Geosciences group
National Remote Sensing Center
India Space Research Organization
Dept of Space, Govt of India,
Balanagar, Hyderabad - 500037

Sub:- Work –Order for " Delineation of Surface Coal Fire and associated Land Subsidence in Jharia Coalfield, Jharkhand using satellite based remote – sensing techniques"

Dear Sir,

Consequent upon competent approval of proposal on aforesaid subject and subsequent signing o MOU between BCCL and NRSC, the aforesaid work is awarded to NRSC for Rs.18,10500/- (Eighteen lac ten thousand five hundred) only, against 100% payment in advance subject to terms and conditions listed in MOU. As per agreed payment terms and Demand Note No. 07/2016-17,

You are therefore requested to initiate all necessary activities for commencing the subject work as early as possible.

Thanking you,

Yours faithfully,
7/4/17
General Manager I/C (S & R)

Cc to :
1. Director (T) P&P, BCCL- for kind information.
2. TS to CMD, BCCL – for kind information.
3. Sri Mithilesh Kumar, Sr.Mgr.(M),Safety.Deptt., KoylaBhawan

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

(FOR THE Q.E. DECEMBER, 2016)

E. C. no. J-11015/212/2010-IA.II(M) dated 06.02.2013.

March, 2017

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CLUSTER - IV

(FOR THE Q.E. December, 2016)

CONTENTS

ENVIRONMENTAL MONITORING REPORT OF BHARAT COKING COAL LIMITED CLUSTER – IV

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CMPDI
ISO 9001 Company
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EXECUTIVE SUMMARY

1.0 Introduction

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

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

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

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

2.2 Water sampling stations

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

2.3 Noise level monitoring locations

Noise levels vary depending on the various activities in mining areas. The monitoring of noise level in different locations will be helpful to take appropriate mitigating measures. The noise levels were recorded in mining area, washery and in residential area.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_x). Respirable Dust Samplers (RDS) and Fine Dust Sampler (PM2.5 sampler) were used for sampling of PM_{10}, SO_2, & NO_x and Fine Dust Sampler (PM2.5 sampler) were used for

sampling of $PM_{2.5}$ at 24 hours interval once in a fortnight and the same for the gaseous pollutants. The samples were analysed in Environmental Laboratory of CMPDI, RI-I, Asansol.

3.2 Water quality

Water samples were collected as per standard practice. The Mine effluent samples were collected and analysed for four parameters on fortnightly basis. The Ground and Surface water samples were collected and analysed for 25 and 17 parameters respectively, on quarterly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory at CMPDI (HQ), Ranchi.

3.3 Noise level monitoring

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

4.0 Results and interpretations

4.1 Air quality

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

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines, IS.10500/2012 (Drinking water) and IS: 2296 (Surface water), are with in permissible limits.

4.3 Noise Level

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

CHAPTER - I

INTRODUCTION

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

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

Bharat Coking Coal Limited (BCCL), a subsidiary company of Coal India Limited (CIL) is operating UG Mines and Opencast Mines in Jharia Coalfield (JCF). The Jharia Coalfield (JCF) having an area of 450 Sq.KM.

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

1.1 The cluster IV is in the Northern part of the Jharia coalfield. It includes Salanpur Colliery, Katras Choitodih Colliery, Amalgamated Keshalpur – west Mudidih Colliery, Amalgamated Ramkanali – Angarpathra Colliery, Gaslitand Colliery. The cluster– IV is situated about 25 - 30 kms from Dhanbad Railway Station. The mines of this cluster-IV are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Katri River and Kumari Jore.

1.2 The cluster IV is designed to produce 2.851 Mtpa (normative) and 3.706 Mtpa peak capacity of coal. The average grade of coal W – I to IV.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 2.851 Mtpa (normative) and 3.706 Mtpa peak capacity of coal production vide letter no. J-11015/212/2010-IA.II (M) dated 06th February, 2013.

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

Pollution Control Board." And other conditions regarding water / effluent and noise level monitoring.

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

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)

2.1.1 Ambient Air Quality Sampling Locations

I. CORE ZONE Monitoring Location

i) Govindpur village (A7): Industrial Area

The location of the sampling station is 23^0 48'34" N, 86^0 18'22" E. The sampler was placed at 1.5 m above the ground level at AARC agent Office, Ramkanali. The station was selected to represent the impact of mining activities of Ramkanali Colliery, poor roads condition, heavy public traffic, burning of coal by the surrounding habitants.

ii) Chotudih (A37): Industrial Area

The location of the sampling station is at the roof top of the Manager Office.

II. BUFFER ZONE Monitoring Location

i) Block IV (A6) : industrial area

The location of the sampling station is 23^0 47.916' N 86^0 15.333' E. The sampler was placed at a height of 1.5 m above the ground level in Safety office of Block IV OCP.

ii) Nichitpur (A8): **Industrial Area**

The location of the sampling station is 23^0 48'20" N 86^0 21'30" E. The sampler was placed at roof top at Safety office of Nichitpur.

2.2 Methodology of sampling and analysis

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM 10), Particulate Matter (PM 2.5), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_X). Respirable Dust Samplers (RDS) & fine particulates for PM 2.5 sampler were used for sampling PM 10 & PM 2.5 respectively at 24 hours interval once in a fortnight and the same for the gaseous pollutants. The samples were analysed in Environmental Laboratory of CMPDI, RI-I, Asansol.

2.3 Results & Interpretations

The results of Ambient Air Quality are presented in tabular form along with Bar chart for each monitoring station. The interpretations of different parameters are given below:

2.3.1 **Ambient air quality**

Particulate Matter PM_{10}

In **core zone** under **Industrial area** varies from 70 to 86 µ/m^3
In **buffer zone** in **Industrial area** varies from 84 to 114 µ/m^3

Particulate Matter $PM_{2.5}$

In **core zone** under **Industrial area** varies from 31 to 49 µ/m^3
In **buffer zone** in **Industrial area** varies from 39 to 51 µ/m^3

Sulphur Dioxide:

In **core zone** under **Industrial area** varies from 10 to 12 µ/m^3
In **buffer zone** in **Industrial area** varies from 11 to 14 µ/m^3

Oxides of Nitrogen:

In **core zone** under **Industrial area** varies from 22 to 28 µ/m^3
In **buffer zone** in **Industrial area** varies from 24 to 29 µ/m^3

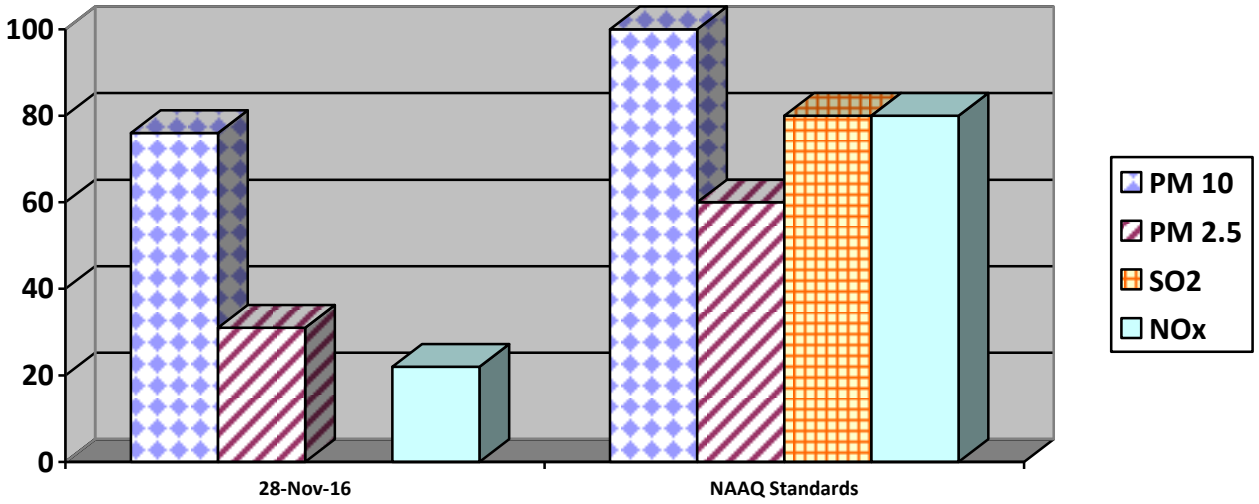
AMBIENT AIR QUALITY DATA

Name of the Company: **Bharat Coking Coal limited** Year : **2016-17.**
Name of the Cluster : **Cluster – IV** Q.E.: **Dec 2016**

Station Code/Name: (a) A7 Govindpur village **Category: Industrial.**
(b) A37 Chotudih
ZONE: Core

(a). Station Code/Name: A7 - Govindpur village Category: Industrial[1].

Sl. No.	Dates of sampling	PM 10	PM 2.5	SO2	NOx
1	28 - Nov -16	76	31	<10.0	22
NAAQ Standards		100	60	80	80



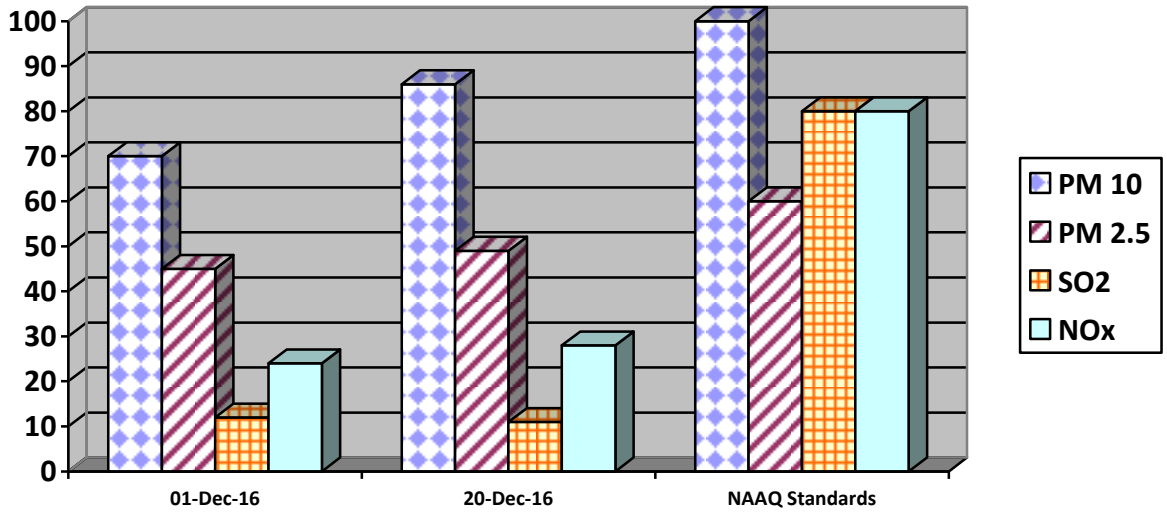
Note:

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

[1] Report released by Shri Indranil De, Manager (Env), CMPDI, RI-1, Asansol, Signed……  …….Dated 22.02.2017. Job No. 110310

(b). Station Code/Name: A37 – Chotudih Category: Industrial[2].

Sl. No.	Dates of sampling	PM 10	PM 2.5	SO2	NOx
1	01 - Dec -16	70	45	12	24
2	20 - Dec -16	86	49	11	28
NAAQ Standards		100	60	80	80



Note:

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

[2] Report released by Shri Indranil De, Manager (Env), CMPDI, RI-1, Asansol, Signed…… …….Dated 22.02.2017. Job No. 110310

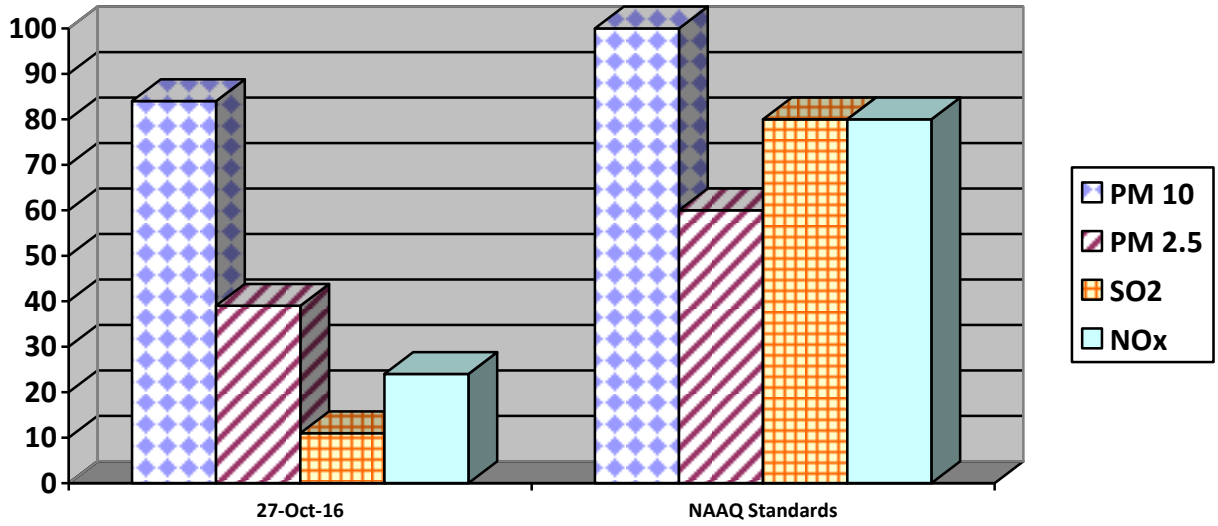
AMBIENT AIR QUALITY DATA

Name of the Company: **Bharat Coking Coal limited** Year : **2016-17.**
Name of the Cluster : **Cluster – IV** Q.E.: **Dec 2016**

Station Code/Name: (a) A6 Block IV OCP **Category: Industrial.**
(b) A8 Nichitpur
ZONE: BUFFER

(a). Station Code/Name: A6 Block IV Kooridih OCP Category: Industrial[3].

Sl. No.	Dates of sampling	PM 10	PM 2.5	SO_2	NO_X
1	27 - Oct -16	84	39	11	24
NAAQ Standards		100	60	80	80



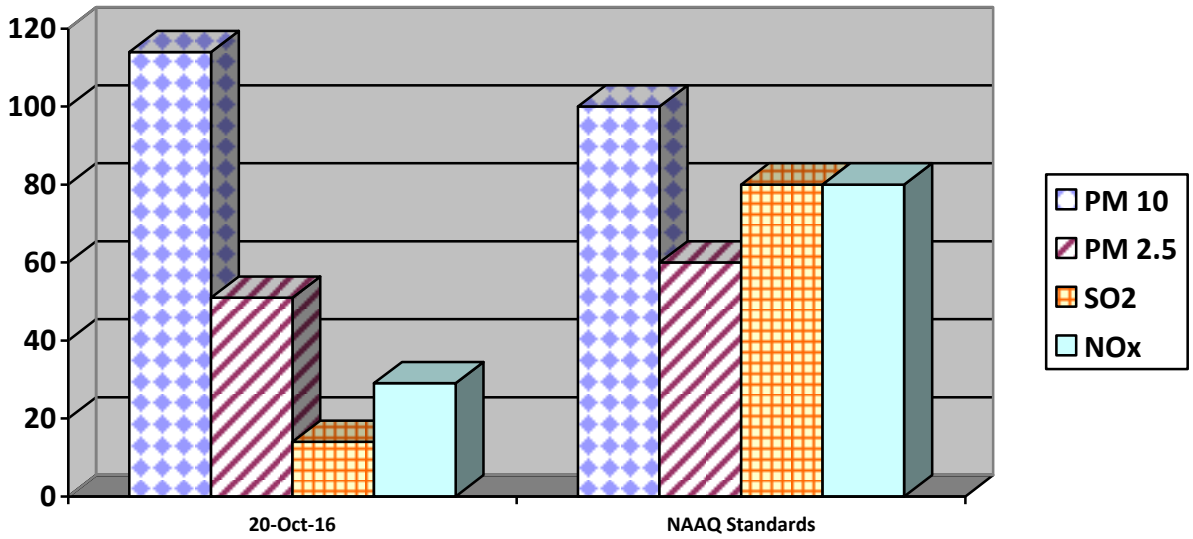
Note:

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

[3] Report released by Shri Indranil De, Manager (Env), CMPDI, RI-1, Asansol, Signed……  …….Dated 22.02.2017. Job No. 110310

(b). Station Code/Name: A8 – Nichitpur, Category: Industrial[4].

Sl. No.	Dates of sampling	PM 10	PM 2.5	SO_2	NO_X
1	20 - Oct -16	114	51	14	29
	NAAQ Standards	100	60	80	80

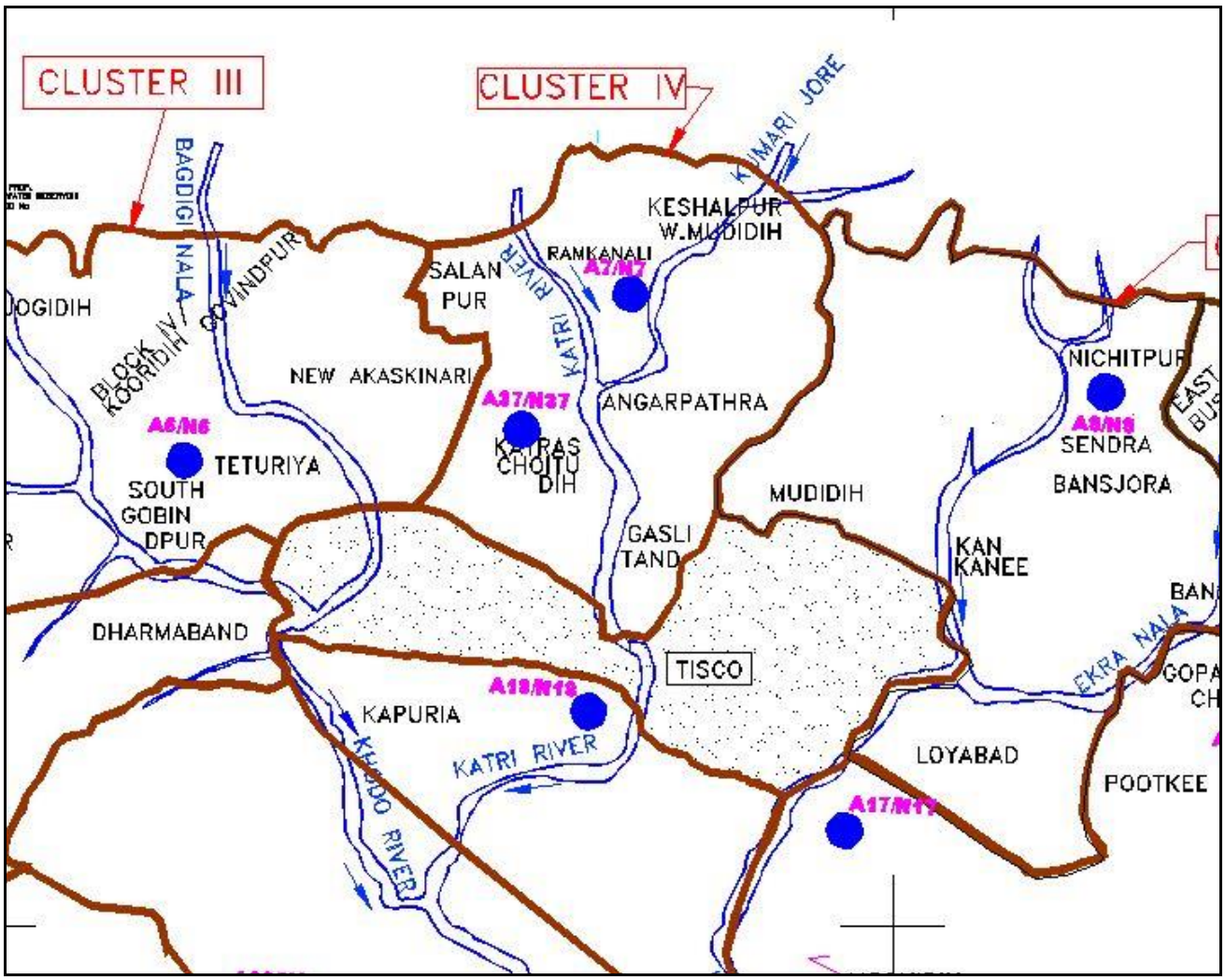


Note:

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

[4] Report released by Shri Indranil De, Manager (Env), CMPDI, RI-1, Asansol, Signed…… …….Dated 22.02.2017. Job No. 110310

Fig I: Ambient Air Monitoring Stations in Cluster- IV in Core & Buffer Zones



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

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

Note:

* Annual Arithmetic mean for the measurements taken in a year, following the guidelines for frequency of sampling laid down in clause 2.

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

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

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

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

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

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

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

CHAPTER – III

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Fig. No. - II**)

i) **Mine Discharge of Chotudih (MW4)**
A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Katri River.

ii) Ground Water quality at **Kankanee Village (GW4)**

iii) Surface Water quality at **U/S of Katri River (SW8)**

iv) Surface Water quality at **D/S of Katri River (SW11)**

v) Surface Water quality at **U/S kumari Jore (SW9)**

vi) Surface Water quality at **D/S Kumari Jore (SW10)**

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analysed for four parameters on fortnightly basis. The Ground and Surface water samples were collected and analysed for 25 and 17 parameters respectively, on quarterly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory at CMPDI (HQ), Ranchi.

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 parmeters are within the permissible limits.

WATER QUALITY DATA

(EFFLUENT WATER- FOUR PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2016-17.**

Name of the Cluster: **Cluster - IV** Month: **Oct, 2016.**

Name of the Stations & Code : **1. MW4- Mine Discharge of Chotudih**

First Fortnight

Sl. No.	Parameters	MW4 (Mine Discharge) 04.10.2016	As per MOEF General Standards for schedule VI
1	Total Suspended Solids	24	*100 (Max)*
2	pH	8.33	*5.5 - 9.0*
3	Oil & Grease	<2.0	*10 (Max)*
4	COD	28	*250 (Max)*

Second Fortnight

Sl. No.	Parameters	MW4 (Mine Discharge) 27.10.2016	As per MOEF General Standards for schedule VI
1	Total Suspended Solids	20	*100 (Max)*
2	pH	7.79	*5.5 - 9.0*
3	Oil & Grease	<2.0	*10 (Max)*
4	COD	24	*250 (Max)*

All values are expressed in mg/lit unless specified.

1
2
Analysed By

Approved By
Dy.Technical Manager
Env. Lab, CMPDI (HQ),
(Authorized Signatory)

WATER QUALITY DATA

(EFFLUENT WATER- FOUR PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited**
Year : **2016-17.**
Name of the Cluster: **Cluster - IV**
Month: **Nov, 2016.**
Name of the Stations & Code : **1. MW4- Mine Discharge of Chotudih**

First Fortnight

Sl. No.	Parameters	MW4 (Mine Discharge) 04.11.2016	As per MOEF General Standards for schedule VI
1	Total Suspended Solids	20	*100 (Max)*
2	pH	7.76	*5.5 - 9.0*
3	Oil & Grease	<2.0	*10 (Max)*
4	COD	28	*250 (Max)*

Second Fortnight

Sl. No.	Parameters	MW4 (Mine Discharge) 28.11.2016	As per MOEF General Standards for schedule VI
1	Total Suspended Solids	32	*100 (Max)*
2	pH	8.24	*5.5 - 9.0*
3	Oil & Grease	<2.0	*10 (Max)*
4	COD	38	*250 (Max)*

All values are expressed in mg/lit unless specified.

Analysed By

Approved By
Dy.Technical Manager
Env. Lab, CMPDI (HQ),
(Authorized Signatory)

WATER QUALITY DATA

(*EFFLUENT WATER- FOUR PARAMETERS)*

Name of the Company: **Bharat Coking Coal Limited**

Year : **2016-17.**

Name of the Cluster: **Cluster - IV**

Month: **Dec, 2016.**

Name of the Stations & Code : **1. MW4- Mine Discharge of Chotudih**

First Fortnight

Sl. No.	Parameters	MW4 (Mine Discharge) 01.12.2016	As per MOEF General Standards for schedule VI
1	Total Suspended Solids	32	*100 (Max)*
2	pH	8.59	*5.5 - 9.0*
3	Oil & Grease	<2.0	*10 (Max)*
4	COD	24	*250 (Max)*

Second Fortnight

Sl. No.	Parameters	MW4 (Mine Discharge) 19.12.2016	As per MOEF General Standards for schedule VI
1	Total Suspended Solids	28	*100 (Max)*
2	pH	8.50	*5.5 - 9.0*
3	Oil & Grease	<2.0	*10 (Max)*
4	COD	24	*250 (Max)*

All values are expressed in mg/lit unless specified.

Analysed By
JSA/SA/SSA

Checked By
Lab Incharge
Env. Lab, RI-2, CMPDI

Approved By
Dy.Technical Manager
Env. Lab, CMPDI (HQ),
(Authorized Signatory)

WATER QUALITY

(SURFACE WATER- ALL PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2016-17.**

Name of the Project : **Cluster - IV** Period: **Q. E. Dec, 2016.**

Area : Chotudih **Project: Chotudih Cluster IV**

Stations: **Date of Sampling:**

1. Upstream in Katri River SW-8 13/12/2016
2. Downstream in KatriRiver SW-11 13/12/2016
3. Upstream in Kumar Jore SW-9 19/12/2016
4. Downstream in Kumar Jore SW-10 13/12/2016

Sl. No	Parameter	Sampling Stations				IS:2296 – 1982 (Inland surface water) Class C	Detection Limit	BIS Standard & Method
		SW-8	SW-9	SW-10	SW-11			
1	Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.2	0.002	IS 3025/37:1988 R : 2003, AAS-VGA
2	BOD (3 days 27°C), mg/l, Max	2.6	2.8	3.0	2.8	300	2.00	IS 3025 /44: 1993, R : 2003 3 day incubation at 27°C
3	Colour (Hazen Unit)	colourless	colourless	colourless	colourless	300	Qualitative	Physical/Qualitative
4	Chlorides (as Cl), mg/l, Max	82	62	32	78	600	2.00	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	<0.03	1.5	0.03	IS 3025 /42 : 1992 R : 2009, AAS-Flame
6	Disolved Oxygen, min.	4.4	4.6	3.8	3.6	4	0.10	IS 3025/381989, R : 2003, Winkler Azide
7	Fluoride (as F) mg/l, Max	0.60	0.73	0.99	0.72	1.5	0.02	APHA, 22nd Edition SPADNS
8	Hexavalent Chromium, mg/l, Max	0.023	0.005	0.024	0.012	0.05	0.01	APHA, 22nd Edition, 1,5 - Diphenylcarbohydrazide
9	Iron (as Fe), mg/l, Max	1.008	1.008	1.186	1.147	50	0.06	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
10	Lead (as Pb), mg/l, Max	0.053	0.053	0.053	0.053	0.1	0.005	APHA, 22nd Edition AAS-GTA
11	Nitrate (as NO_3), mg/l, Max	15.69	18.51	17.93	14.47	50	0.50	APHA, 22nd Edition, UV-Spectrphotometric
12	pH value	8.53	8.59	8.29	7.79	6.5-8.5	2.5	IS-3025/11:1983, R-1996, Electrometric
13	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.0005	0.002	APHA, 22nd Edition 4-Amino Antipyrine
14	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	<0.002	0.05	0.002	APHA, 22nd Edition AAS-GTA
15	Sulphate (as SO_4) mg/l, Max	89	96	115	88	400	2.00	APHA, 22nd Edition Turbidity
16	Total Dissolved Solids, mg/l, Max	586	657	694	595	1500	25.00	IS 3025 /16:1984 R : 2006, Gravimetric
17	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	<0.01	0.2	0.01	IS 3025 /49 : 1994, R : 2009, AAS-Flame

*All values are expressed in mg/lit unless specified.

Analysed By
JSA/SA/SSA

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Approved By
Dy.Technical Manager
Env. Lab, CMPDI (HQ),
(Authorized Signatory)

WATER QUALITY

(GROUND WATER- ALL PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2016-17.**

Area : **Chotudih** **Project: Chotudih** **Cluster IV**

Stations: **Date of Sampling:**

1. Ground Water from Kankanee/Malkera Village GW-4 13.12.2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW-4	2	3			
1	Boron (as B), mg/l, Max	<0.20			0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	5			1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	67.2			1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	78			2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03			0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.91			0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.02			0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	1.392			0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	0.134			0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02			0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	16.4			0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable			Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.27			2.5	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.002			0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002			0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	308			2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable			Qualitative	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	264			4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002			0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	0.180			0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	862			25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	568			4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	42			1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01			0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*All values are expressed in mg/lit unless specified.

Analysed By
JSA/SA/SSA

Checked By
Lab Incharge
Env. Lab, RI-2, CMPDI

Approved By
Dy.Technical Manager
Env. Lab, CMPDI (HQ),
(Authorized Signatory)

CHAPTER - IV

NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites and their rationale

i) **Govindpur village (N7)**

To assess the noise level in mine site, the noise levels were recorded in the mine area where all mining activities are in progress.

ii) **Chotudih (N37)**

To assess the noise generated in the mines activity. Noise levels were recorded in the mines area

iii) **Block IV (N6)**

To assess the noise level in the industrial area,

iv) **Nichitpur (N8)**

To assess the noise level in the industrial area, noise levels were recorded during day time in the Mines area.

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter (NL-52 OF RION CO. Ltd. Make) during day time. Noise levels were measured for about one hour time in day time. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB (A).

4.3 Results & Interpretations

Ambient noise levels were recorded during day time and the observed values were compared with standards prescribed by MoEF&CC.

The results of Noise levels recorded during day and night time on fortnightly basis are presented in tabular form along with the applicable standard permissible limits. The observed values in terms of L_{EQ} are presented**.**

The observed values at all the monitoring locations are found to be within permissible limits.

NOISE LEVEL DATA

Name of the Company: **Bharat Coking Coal Limited** Year : **2016-17.**

Name of the Cluster: **Cluster -IV** Month: **Oct, 2016.**

Name of the Stations & Code :

1. **Govindpur village (N7)**
2. **Chotudih (N37)**
3. **Block IV (N6)**
4. **Nichitpur (N8)**[1]

Sl. No.	Station Name/Code	Category of area	Date	Noise level dB(A)LEQ	*Permissible Limit of Noise level in dB(A)*
3	**Block IV (N6)**	**Industrial area**	27.10.2016	61.4	*75*
4	**Nichitpur (N8)**	**Industrial area**	20.10.2016	59.4	*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, +Night Time: 10.00 PM to 6.00 AM.**

[1] Report released by Shri Indranil De, Manager (Env), CMPDI, RI-1, Asansol, Signed……  …….Dated 22.02.2017. Job No. 110310

NOISE LEVEL DATA

Name of the Company: **Bharat Coking Coal Limited** Year : **2016-17.**

Name of the Cluster: **Cluster -IV** Month: **Nov, 2016**

Name of the Stations & Code :

1. **Govindpur village (N7)**
2. **Chotudih (N37)**
3. **Block IV (N6)**
4. **Nichitpur (N8)**[2]

Sl. No.	Station Name/Code	Category of area	Date	Noise level dB(A)LEQ	**Permissible Limit of Noise level in dB(A)*
1	**Govindpur village (N7)**	**Industrial area**	28.11.2016	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, +Night Time: 10.00 PM to 6.00 AM.**

[2] Report released by Shri Indranil De, Manager (Env), CMPDI, RI-1, Asansol, Signed……  …….Dated 22.02.2017. Job No. 110310

NOISE LEVEL DATA

Name of the Company: **Bharat Coking Coal Limited**

Year : **2016-17.**

Name of the Cluster: **Cluster -IV**

Month: **Dec, 2016**

Name of the Stations & Code :

1. **Govindpur village (N7)**
2. **Chotudih (N37)**
3. **Block IV (N6)**
4. **Nichitpur (N8)**[3]

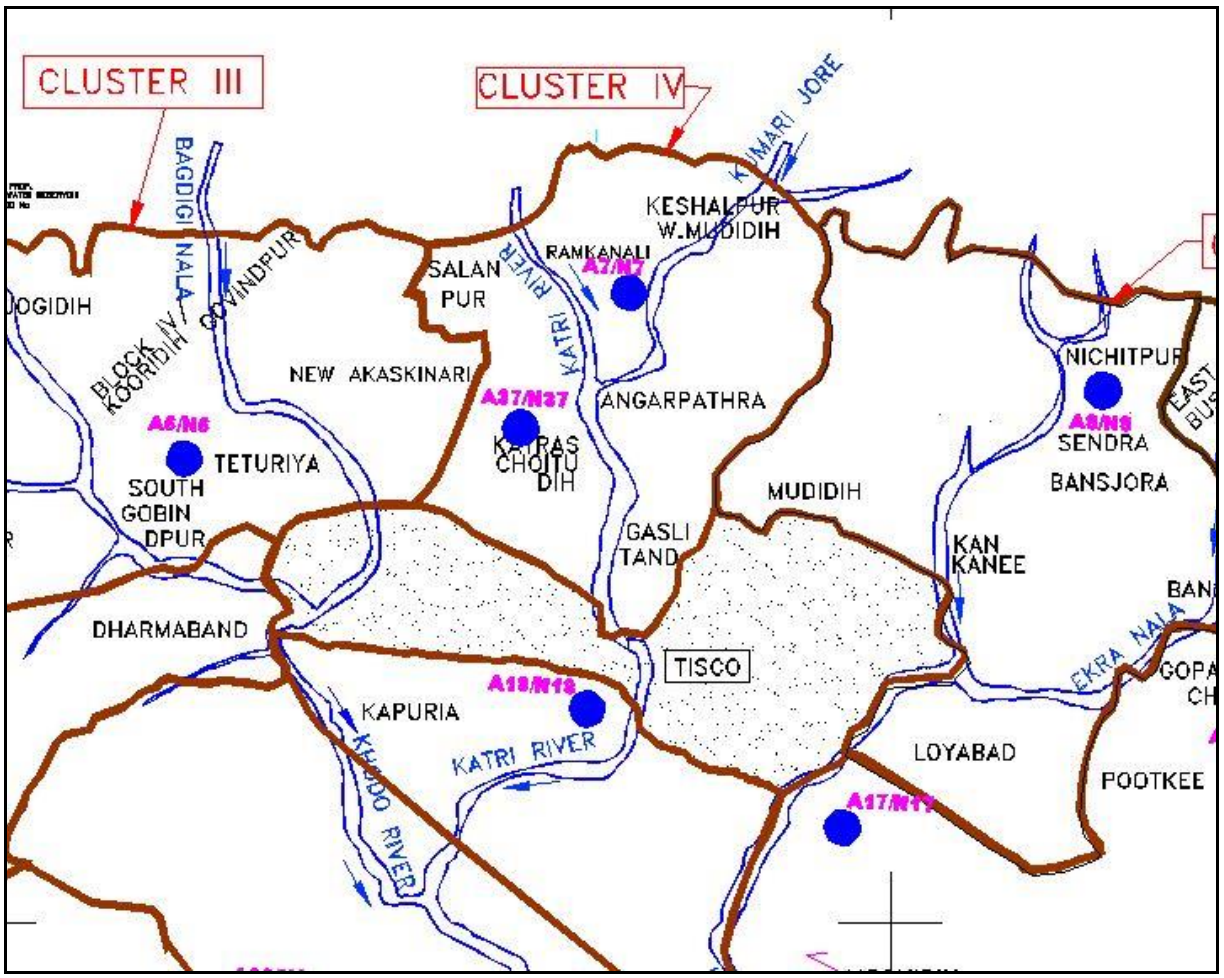
Sl. No.	Station Name/Code	Category of area	Date	Noise level dB(A)LEQ	**Permissible Limit of Noise level in dB(A)*
1	**Chotudih (N37)**	**Industrial area**	01.12.2016	61.3	*75*
2	**Chotudih (N37)**	**Industrial area**	20.12.2016	62.1	*75*

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.

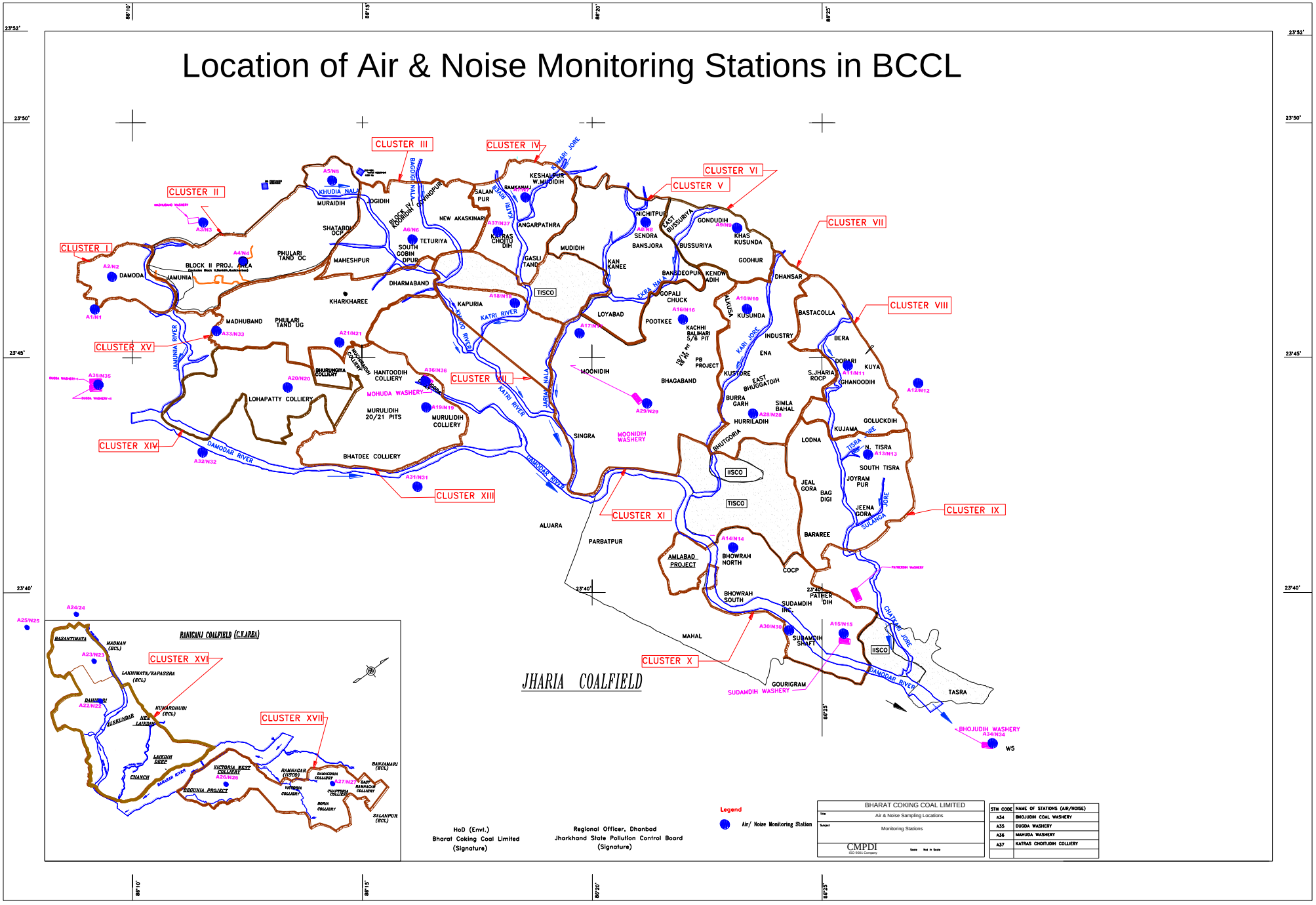
*** Day Time: 6.00 AM to 10.00 PM, +Night Time: 10.00 PM to 6.00 AM.**

[3] Report released by Shri Indranil De, Manager (Env), CMPDI, RI-1, Asansol, Signed……  …….Dated 22.02.2017. Job No. 110310

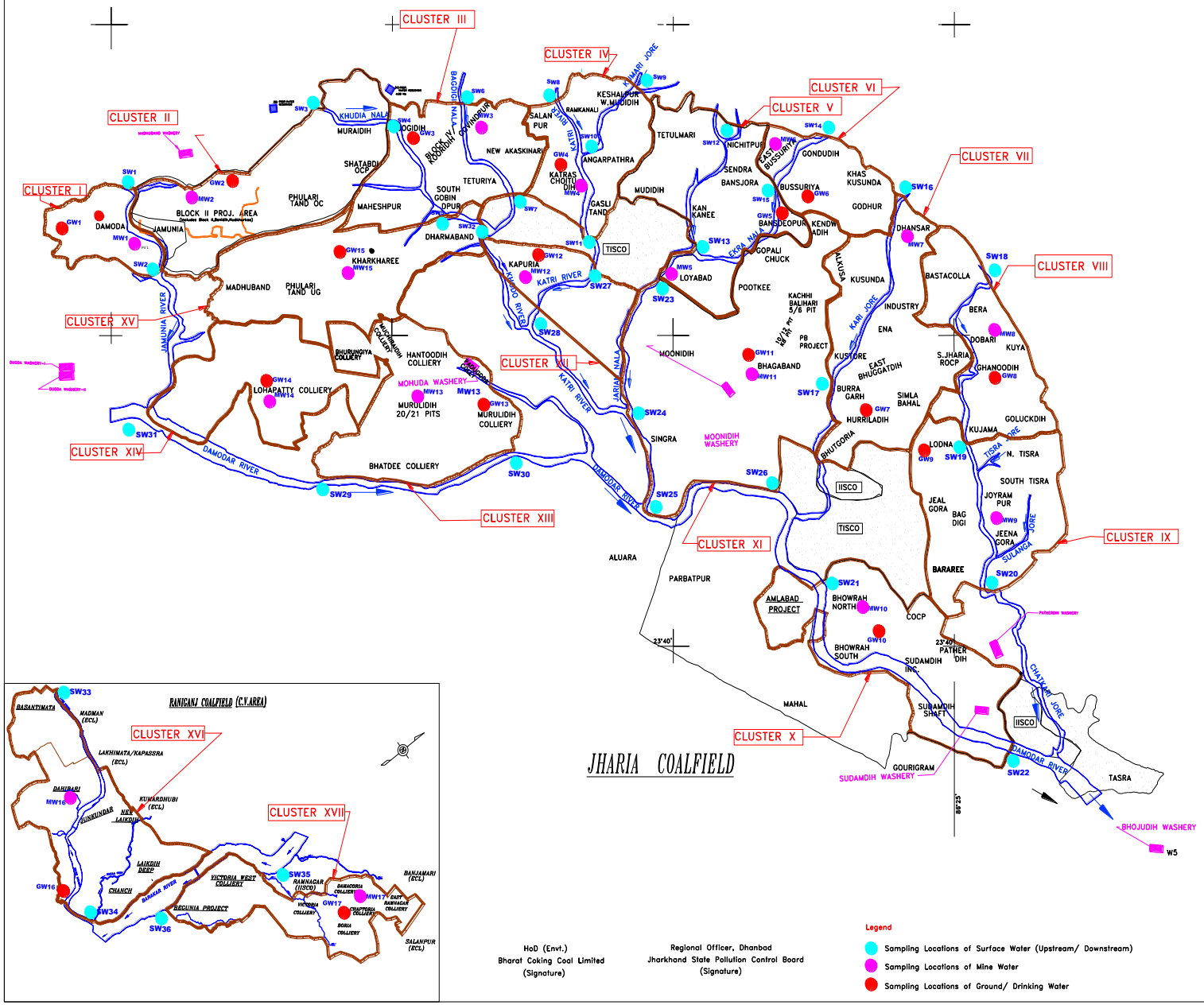
Fig: Noise Level Monitoring Location of Cluster IV



Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

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

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

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

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

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

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

CLUSTER IV GROUP OF MINES

(Amalgamated Keshalpur and West Mudidih (Mixed), Amalgamated Angarpathra Ramkanali (UG), Katras Choitudih (OC) Salanpur (Mixed) and Gaslitand (OC))

Normative Production : 2.851MTPA
Peak Production : 3.706 MTPA
Lease Hold Area : 1123.79 Ha

Bharat Coking Coal Limited

(March, 2017)

Prepared by

Environment Division

Central Mine Planning & Design Institute Limited

CMPDI (HQ)

Gondwana Place

Kanke Road, Ranchi-834008

CONTENTS

Chapter – I

Introduction

1.1 Genesis:

MOEF provided Environmental Clearance to the various mines of the Cluster – IV vide letter No.. J-11015/212 /2010-IA.II (M) Dated: 6th February, 2013.

As per the Environmental Clearance Conditions given by the Ministry of Environment & Forest Clause No. (xvii)- "A study should be initiated to analyse extent of reduction in pollution load every year by reducing road transport of coal". Therefore the present study has been carried out to quantify the pollution load due to coal transportation.

1.2 Methodology:

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

1.3 General Information about Cluster – IV group of mines:

1.3.1 Brief Description:

Cluster-IV group of mines of BCCL is a group of five mines consisting of opencast and underground mines of the Bharat Coking Coal Limited in the Dhanbad District of Jharkhand state. BCCL is the proponent of the cluster and it is under the administrative control of Coal India Limited. All the mines in the cluster are taken over mine from their owner after Nationalization and were reorganized to form five mines. The five mines have been clustered to form Cluster-IV mines of Bharat Coking Coal Limited under the 'Cluster Concept' approved by MoEF.

1.3.2 Nature and Size of the Cluster:

The Cluster IV consists of two mixed mines (UG & OC), two UG mines and one closed mine proposed to be worked out by opencast mine.

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

Table 1.1: Details of the Mines of Cluster – IV

Name of Mine	Production (MTY)		Leasehold Area (ha)
	Normative	Peak	
Salanpur Colliery	0.15	0.195	177.49
Katras Choitudih Colliery	0.22	0.286	228.00
West Mudidih Colliery & Keshalpur Colliery	2.19	2.847	325.00
Angarpathra Colliery & Ramkanali colliery	0.291	0.378	254.64
Gaslitand Colliery	0.00	0.00	138.66
Total	**2.851**	**3.706**	**1123.79**

1.3.3 Impact of Fire Control on Ambient Air Quality:

A total of 358270 Sq, M area is under active fire in Cluster IV. It will be tackled by digging out burning coal and quenching fire at a total cost of Rs 34.99 Crores. Coal recovered will be sent to the consumers. In – situ mine fire generates dust and other pollutants. The fire control will lead to reduction of pollution load and improvement of background pollution level.

1.3.4 Impact of Resettlement on Ambient Air Quality:

A total of 7012 nos. of households will be shifted for implementation of Jharia Action Plan (JAP) for which a sum of Rs.26274.00 lakhs has been sanctioned. The reduction in number of households within the leasehold area of Cluster IV will lead to reduction in generation of air pollutants due to reduction in movement of man & materials apart from decrease in consumption of coal as a domestic fuel.

1.4 Meteorological Data

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

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

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

The maximum temperature recorded was 39.3^{0}C and the minimum was 6.2^{0}C. The daily average relative humidity values were in the range of 32.2 to 65.0%. The sky was mostly clear during the study period. The average atmospheric pressure value has been found to be around 732.3 mm Hg. Total 94.5mm rainfall was recorded during the study period. The average rainfall during the season was found to be 1.04 mm.

Table 1.2: SEASONAL WIND DISTRIBUTION
Period: 01st JAN.'2016 – 31st MAR.'2016

Wind Direction	Wind Velocity (m/s) & Duration (%)				
	< 0.5	0.6 -1.5	1.6 -3.5	>3.5	Total
N		1.61	0.78	0.00	2.38
NNE		0.83	0.37	0.00	1.19

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

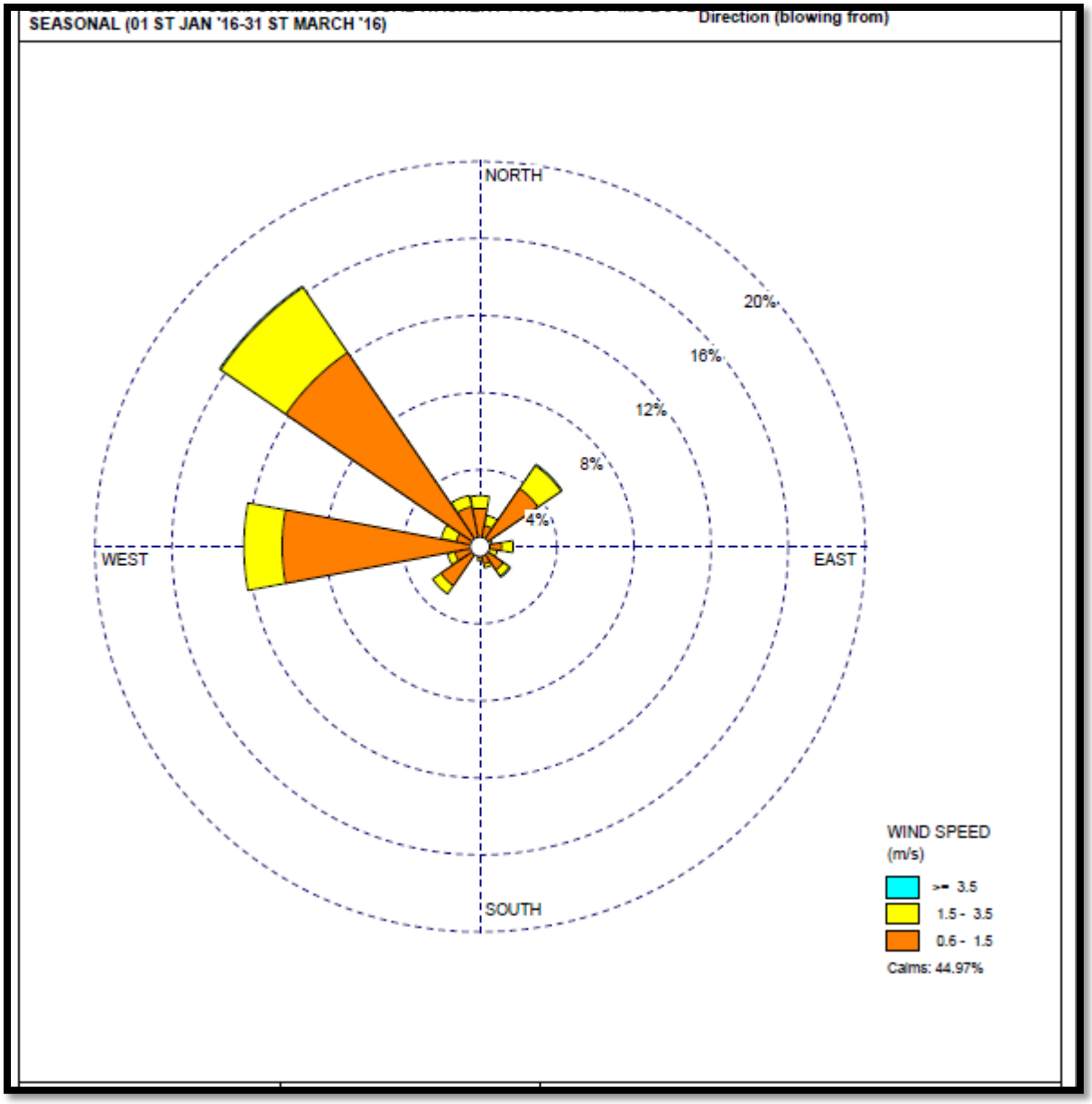


Figure No.-1.1 Wind Rose diagram for the period 1St Jan to 31St March 2016

Chapter – II

Fugitive Dust Generation Due To Movement of Coal

2.1 Introduction

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

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

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

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

2.2 Movement of Coal

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

2.2.1 Amalgamated Keshalpur and West Mudidih Colliery (AKWMC) :

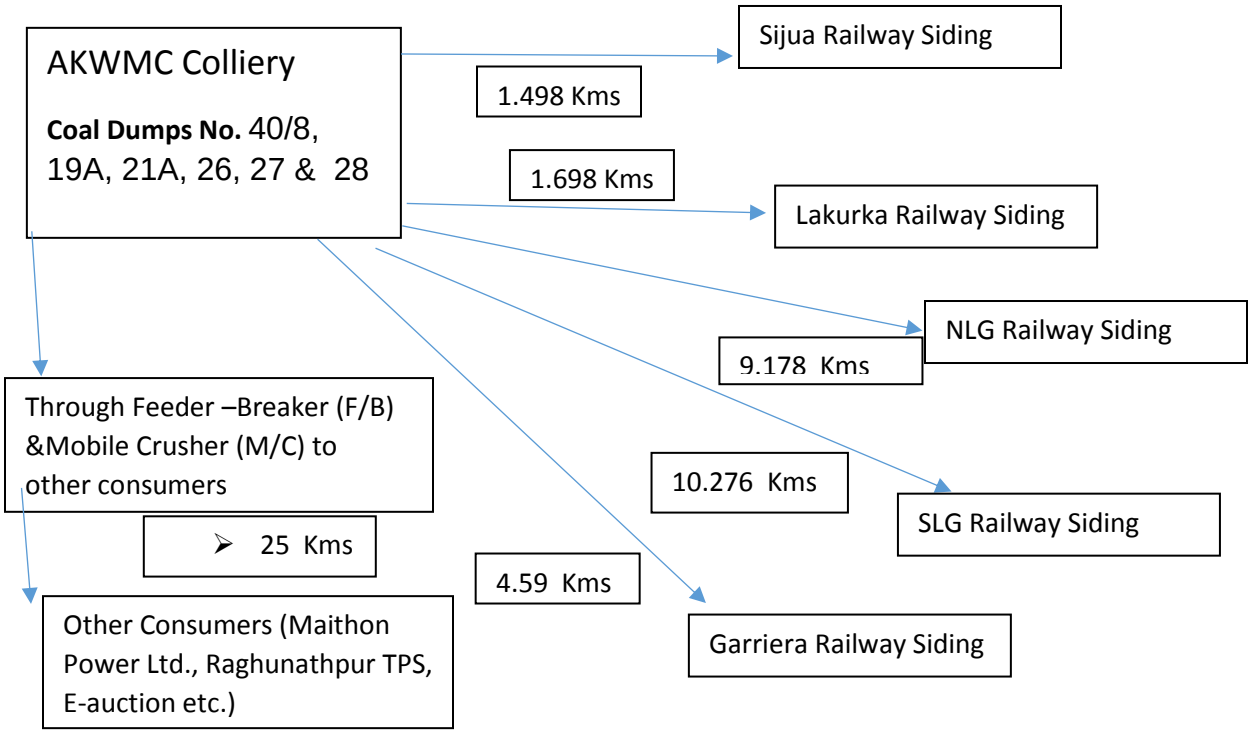


Table: 2.1 Dust Generation (Kg/day)

Name of the Mine	Year	Location	Distance from Face to Siding	Coal Transferred (TPA)	Daily Coal Production (TePD)	Capacity of the Dumper	Vehicle Kilometer Travelled	Emission Rate for PM 10 (kg/VKT)	Pollution Load * Dust Generated Per Day (Kg/day)
AKWMC	13-14	Sijua Siding	1.498	5292.600	16.000	30.000	1.598	0.530	0.847
	13-14	Lakurka Siding	1.698	5292.600	16.000	30.000	1.811	0.530	0.960
	13-14	NLG Siding	9.178	5292.600	16.000	30.000	9.790	0.530	5.189
	13-14	SLG Siding	10.276	5292.600	16.000	30.000	10.961	0.530	5.809
	13-14	Garerria Siding	4.595	5292.600	16.000	30.000	4.901	0.530	2.598
	13-14	New F/B	1.120	106733.000	323.000	15.000	48.235	0.530	25.564
	13-14	M/C	1.635	106734.000	323.000	15.000	70.414	0.530	37.319
								Total For 13-14 =	**78.286**
	14-15	Sijua Siding	1.498	790809.000	2396.000	30.000	239.281	0.530	126.819
	14-15	Lakurka Siding	1.698	790809.000	2396.000	30.000	271.227	0.530	143.750
	14-15	NLG Siding	9.178	790809.000	2396.000	30.000	1466.033	0.530	776.997
	14-15	SLG Siding	10.276	790809.000	2396.000	30.000	1641.420	0.530	869.952
	14-15	Garerria Siding	4.595	790809.000	2396.000	30.000	733.975	0.530	389.007
	14-15	New F/B	1.120	170269.500	516.000	15.000	77.056	0.530	40.840
	14-15	M/C	1.635	170269.500	516.000	15.000	112.488	0.530	59.619
								Total For 14-15 =	**2406.984**
	15-16	Sijua Siding	1.498	796377.800	2413.000	30.000	240.978	0.530	127.718
	15-16	Lakurka Siding	1.698	796377.800	2413.000	30.000	273.152	0.530	144.770
	15-16	NLG Siding	9.178	796377.800	2413.000	30.000	1476.434	0.530	782.510
	15-16	SLG Siding	10.276	796377.800	2413.000	30.000	1653.066	0.530	876.125
	15-16	Garerria Siding	4.595	796377.800	2413.000	30.000	739.182	0.530	391.767
	15-16	New F/B	1.120	328264.500	995.000	15.000	148.587	0.530	78.751
	15-16	M/C	1.635	328264.500	995.000	15.000	216.910	0.530	114.962
								Total For 15-16 =	**2516.604**

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

Total fugitive dust (PM-10) generated during 2013-14, 2014-15 and 2015-16 due to road transportation of coal is 78.3 kg/day, 2407.0 kg/day & 2516.6 kg/day respectively. The corresponding values of daily coal production and daily dust generation per tonne are 726 te/day, **0.11 kg/te** (13-14), 13012 te/day, **0.18 kg/te** (14-15) and 2516 te/day, **0.18 kg/te**.

2.2.2 Amalgamated Angarpathra Ramkanali Colliery (AARC):

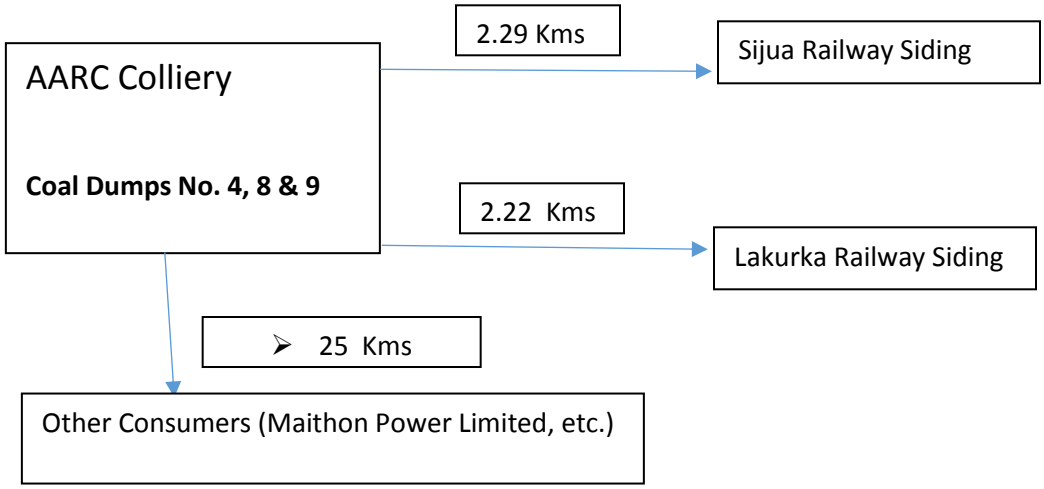


Table: 2.2 Dust Generation (Kg/day)

Name of the Mine	Year	Location	Distance from Face to Siding	Coal Transferred (TPA)	Daily Coal Production (TePD)	Capacity of the Dumper	Vehicle Kilometer Travelled	Emission Rate for PM 10 (kg/VKT)	Pollution Load * Dust Generated Per Day (Kg/day)
AARC	13-14	Sijua Siding	2.290	3341.000	10.000	30.000	1.527	0.530	0.809
	13-14	Lakurka Siding	2.220	3341.000	10.000	30.000	1.480	0.530	0.784
	13-14	Others	25.000	76065.000	231.000	15.000	770.000	0.530	408.100
								Total For 13-14 =	**409.694**
	14-15	Sijua Siding	2.290	0.000	0.000	30.000	0.000	0.530	0.000
	14-15	Lakurka Siding	2.220	0.000	0.000	30.000	0.000	0.530	0.000
	14-15	Others	25.000	57721.000	175.000	15.000	583.333	0.530	309.167
								Total For 14-15 =	**309.167**
	15-16	Sijua Siding	2.290	0.000	0.000	30.000	0.000	0.530	0.000
	15-16	Lakurka Siding	2.220	0.000	0.000	30.000	0.000	0.530	0.000
	15-16	Others	25.000	46390.000	141.000	15.000	470.000	0.530	249.100
								Total For 14-15 =	**249.100**

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

Total average fugitive dust (PM-10) generated during 2013-14, 2014-15 and 2015-16 due to road transportation of coal is 409.7 kg/day, 309.2 kg/day & 249.1 kg/day respectively.

The corresponding values of daily coal production and daily dust generation per tonne are 251 te/day, 1.63 kg/te (13-14), 175 te/day, 1.76 kg/te (14-15) and 141 te/day, 1.76 kg/te.

2.2.3 Katras Choitudih Colliery(KCC):

It started coal production from 1st April, 2015.

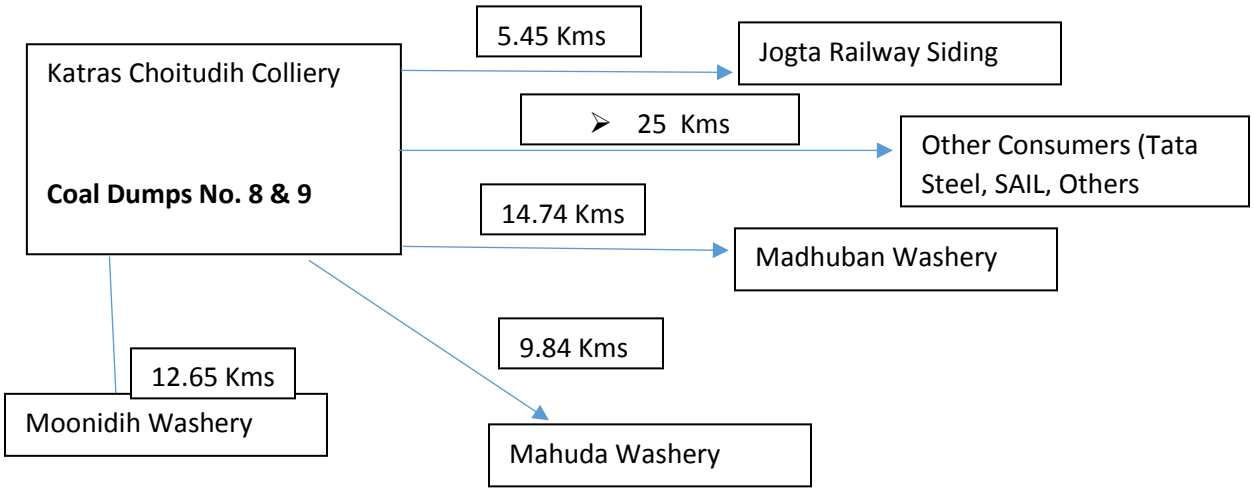


Table: 2.3 Dust Generation (Kg/day)

Name of the Mine	Year	Location	Distance from Face to Siding	Coal Transferred	Daily Coal Production (Te)	Capacity of the Dumper	Vehicle Kilometer Travelled	Emission Rate for PM 10 (kg/VKT)	Pollution Load * Dust Generated Per Day (Kg/day)
Katras	15-16	Jogta Siding	5.45	37465	113.530303	30	41.249343	0.53	21.86215202
	15-16	Mahuda Washery	9.84	100427	304.3242424	20	299.4550545	0.53	158.7111789
	15-16	Madhuban	14.74	100427	304.3242424	20	448.5739333	0.53	237.7441847
	15-16	Moonidih	12.65	100428	304.3272727	20	384.974	0.53	204.03622
	15-16	Others	25	30000	90.90909091	15	303.030303	**0.53**	**160.6060606**
								Total for 15-16=	**782.9597962**

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

Total average fugitive dust (PM-10) generated during 2015-16 due to road transportation of coal is 783.0 kg/day.

The corresponding values of daily coal production and daily dust generation per tonne during 2015 -16 are 1117.4 te/day and **0.70 kg/te.**

2.2.4 Salanpur Colliery:

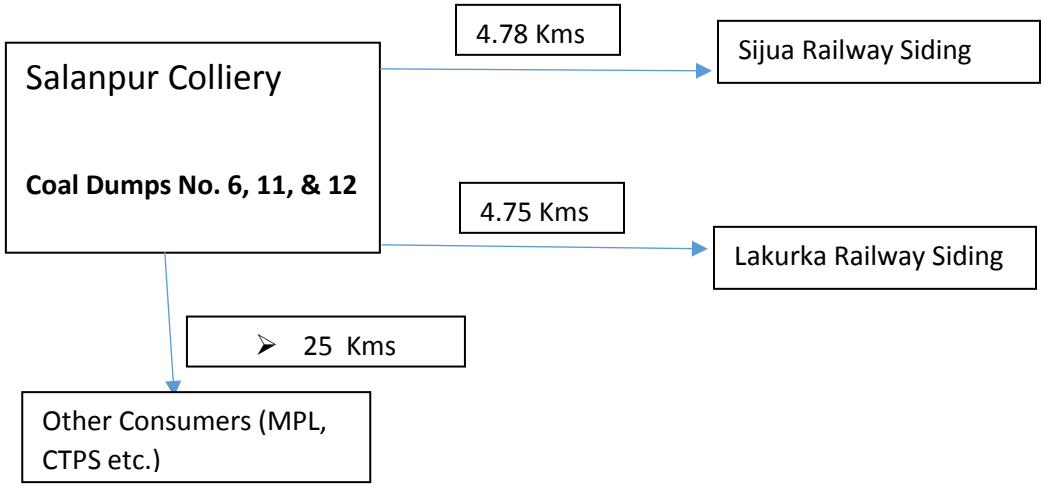


Table: 2.4 Dust Generation (Kg/day)

Name of the Mine	Year	Location	Distance from Face to Siding	Coal Transferred (TPA)	Daily Coal Production (TePD)	Capacity of the Dumper	Vehicle Kilometer Travelled	Emission Rate for PM 10 (kg/VKT)	Pollution Load * Dust Generated Per Day (Kg/day)
Salanpur	13-14	Sijua Siding	4.780	6125.000	19.000	30.000	6.055	0.530	3.209
	13-14	Lakurka Siding	4.750	6125.000	19.000	30.000	6.017	0.530	3.189
	13-14	Others	25.000	44849.000	136.000	15.000	453.333	0.530	240.267
								Total For 13-14 =	**246.664**
	14-15	Sijua Siding	4.780	0.000	0.000	30.000	0.000	0.530	0.000
	14-15	Lakurka Siding	4.750	0.000	0.000	30.000	0.000	0.530	0.000
	14-15	Others	25.000	118257.000	358.000	15.000	1193.333	0.530	632.467
								Total For 14-15 =	**632.467**
	15-16	Sijua Siding	4.780	0.000	0.000	30.000	0.000	0.530	0.000
	15-16	Lakurka Siding	4.750	0.000	0.000	30.000	0.000	0.530	0.000
	15-16	Others	25.000	133823.000	406.000	15.000	1353.333	0.530	717.267
								Total For 14-15 =	**717.267**

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

Total average fugitive dust (PM-10) generated during 2013-14, 2014-15 and 2015-16 due to road transportation of coal is 246.7 kg/day, 632.45 kg/day & 717.3 kg/day respectively.

The corresponding values of daily coal production and daily dust generation per tonne are 174 te/day, 1.42 kg/te (13-14), 358 te/day, 1.76 kg/te (14-15) and 406 te/day, 1.76 kg/te.

2.2.5 Gaslitand Colliery:

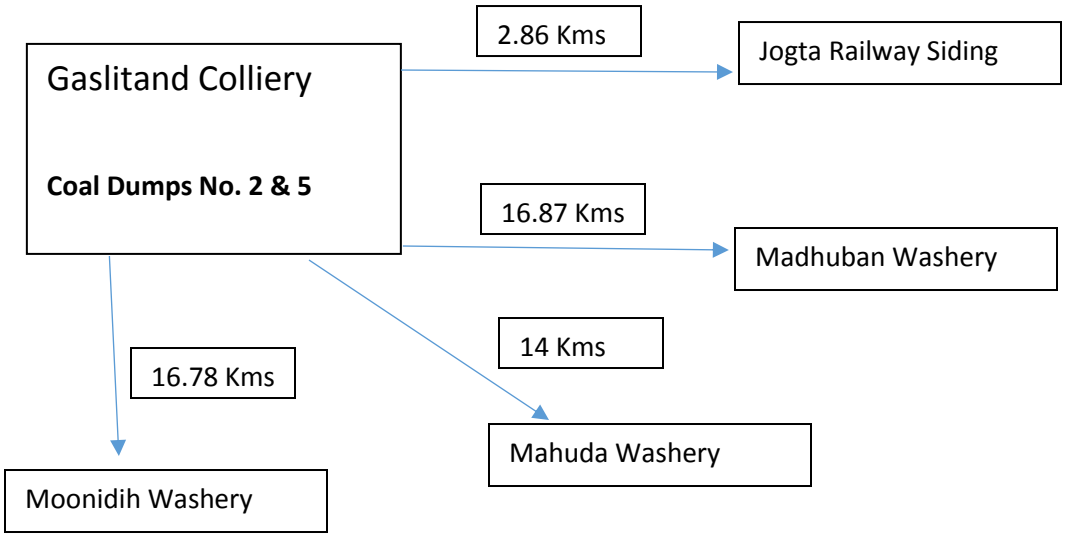


Table: 2.5 Dust Generation (Kg/day)

Name of the Mine	Year	Location	Distance from Face to Siding	Coal Transferred	Daily Coal Production (Te)	Capacity of the Dumper	Vehicle Kilometer Travelled	Emission Rate for PM 10 (kg/VKT)	Pollution Load * Dust Generated Per Day (Kg/day)
Gaslitand	13-14	Jogta Siding	2.86	34575.00	105.00	30.00	20.02	0.53	10.611
	13-14	Mahuda Washery	14.00	55868.00	169.00	20.00	236.60	0.53	125.398
	13-14	Madhuban	16.87	55868.00	169.00	20.00	285.10	0.53	151.105
	13-14	Moonidih	16.78	55869.00	169.00	20.00	283.58	0.53	150.298
		Total For 13-14 =							**437.412**
	14-15	Jogta Siding	2.86	39976.00	121.00	30.00	23.07	0.53	12.227
	14-15	Mahuda Washery	14.00	7958.00	24.00	20.00	33.60	0.53	17.808
	14-15	Madhuban	16.87	7957.00	24.00	20.00	40.49	0.53	21.459
	14-15	Moonidih	16.78	7957.00	24.00	20.00	40.27	0.53	21.344
		Total For 14-15 =							**72.838**
	15-16	Jogta Siding	2.86	75006.00	227.00	30.00	43.28	0.53	22.939
	15-16	Mahuda Washery	14.00	64007.00	194.00	20.00	271.60	0.53	143.948
	15-16	Madhuban	16.87	64007.00	194.00	20.00	327.28	0.53	173.457
	15-16	Moonidih	16.78	64007.00	194.00	20.00	325.53	0.53	172.532
		Total For 15-16 =							**512.876**

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

Total average fugitive dust (PM-10) generated during 2013-14, 2014-15 and 2015-16 due to road transportation of coal is 437.4 kg/day, 72.8 kg/day & 512.9 kg/day respectively.

The corresponding values of daily coal production and daily dust generation per tonne are 612 te/day, 0.714 kg/te (13-14), 193 te/day, 0.377 kg/te (14-15) and 809 te/day, 0.63 kg/te.

2.3 Optimum Coal Transportation scheme in the Present Scenario:

Phase – I (for 10 + 05 Years)

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

2.4 Conceptual Plan of Proposed Integrated Coal Transportation Network for Cluster – IV

Phase – II (after 15 Years):

As suggested by the EAC Members, BCCL shall implement conveyor –cum-rail transport to avoid movement of trucks within the cluster for coal transportation in Phase –II which shall start after 15 years from now. Loading of coal by pay–loaders shall be discontinued. A conceptual plan for coal transportation for the Phase – II has been presented in Table 2.6.

During 2015-16, the combined daily coal production form all 05 mines of Cluster – IV was 16528.4 tones resulting in 4778.8 kg of daily fugitive dust generation. The dust (PM-10) generation rate at present is 0.29 kg/te. As a result of replacement of existing road transportation of coal by Conveyor to railway siding will result in reduction of fugitive dust generation to the extent of 972 kg/day for daily coal production of 3351.5 tonnes (1.106MTY) during Phase –II.

Table 2.6: Proposed Infrastructure for Coal Transportation (phase – II)

Cluster	Mines in Operation in Phase - II	Peak Production	Proposed Transport Infrastructure in Phase – II
IV	Salanpur Colliery	0.195 MTY	Coal transport by Conveyor to Railway Siding
	Katras Choitudih Colliery	0.286 MTY	
	Amalgamated Keshalpur – West Mududih Colliery UG	0.247 MTY	
	Amalgamated Angarpathra Ramkanali Colliery UG	0.378 MTY	
	Total	1.106 MTY = 3351.5 te/day	

2.5 Conclusion:

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

Phase – I: (2013-14 to 2028 -29) :

1. During Phase – I, business as usual (BAU) scenario will prevail and the existing road cum rail transport network system will be used for coal dispatch to the consumers. During 2015-16, the combined daily coal production form all 05 mines of Cluster – IV was 16528.4 tones resulting in 4778.8 kg of daily fugitive dust generation. The dust (PM-10) generation rate at present is 0.29 kg/te. The increase

in coal production will cause corresponding increase in fugitive dust generation due to coal transportation by road.

2. The generation of fugitive dust due to transportation of coal by road can be further reduced by enforcing covering of loaded trucks, periodical removal of loose materials lying on the road surface and black topping of coal transportation roads.
3. Avenue plantation, effective wetting of the road surface and proper maintenance of roads will further result in mitigation of the impact of road generated dust on ambient air quality.
4. Better road condition, by the use of Mechanical Sweeper or vacuum cleaner dust generation may be minimized.

Phase – II :(From 2029-30 Onwards):

1. As a result of replacement of existing road transportation of coal by Conveyor to railway siding will result in reduction of fugitive dust generation to the extent of 972 kg/day for daily coal production of 3351.5 tonnes (1.106MTY) during Phase –II.

2. During Phase –II, dust load will further reduce due to quenching of mine fire and domestic coal consumption after resettlement of general population dwelling within the command area of cluster –IV, as a result of implementation of Jharia Action Plan. It will result in significant improvement in ambient air quality.

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

Table: 2.7 Coal Production Vs. Dust Generation due to Road Transportation

Year	Coal Production (Te/day)	Dust Generation(Kg/Day)
2015-16 (By Road transportation)	16528.4	4778.8
2029-30 (By Road transportation)	3351.5	972
2029-30(By Conveyor Transportation)	3351.5	0

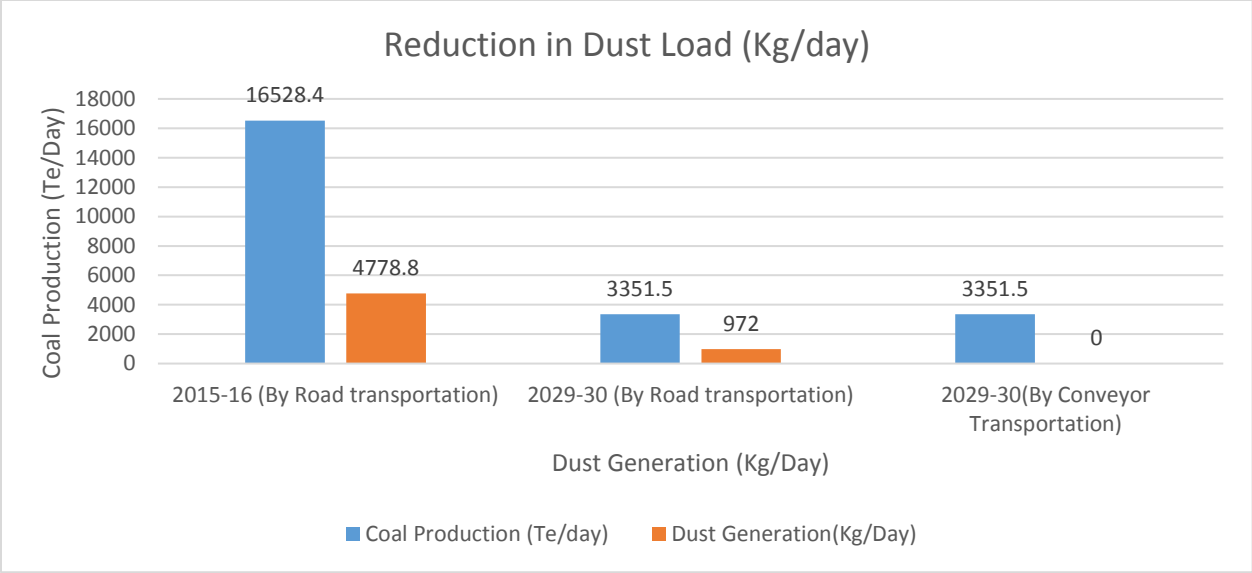


Figure 2.1: Presentation of reduction in dust generation due to replacement of Road transportation by Conveyor system.

DETAILS OF THE REPORT

Sl No.	ITEMS	INFORMATIONS
1	Geographical Area	Jharia Coalfield (JCF): 453 sq. km. Raniganj Coalfield (RCF part): 19.64 sq. km. (Cluster-XVI area only)
2	Major Physiographic Units	Dissected Pediplain with surface Reduced Level (RL) varies from 160 m to 220 m above mean sea level (AMSL) in JCF and 100 m to 140 m AMSL in RCF.
3	Drainage System	Damodar River is the master drainage flowing along western boundary of the JCF. Jamunia River, Khudia River, Katri River, Jarian Nala, Ekra Jore, Kari Jore, Kashi Jore, Chatkari Jore and their tributaries are flowing through the JCF area. Damodar River, Barakar River is the master drainage of the part of RCF area (CV Area).
4	Annual Rainfall	JCF and part of RCF area – 1509 mm (2016) (Dhansar Mine Rescue Station rainfall data)
5	Geological Formations	Gondwana Formation
6	Aquifer System	Top Unconfined/Phreatic Aquifer – average thickness 25 m Semi-confined to confined Aquifer – average thickness 50–200 m
7	Hydrogeological properties	Unconfined Aquifer (Damoda BJ Section & Block-III): Hydraulic Conductivity – upto 0.50 m/day Transmissivity – 10 - 42 m^2/day Semi-confined to confined Aquifer (Sitanala & Kumari Block): Hydraulic Conductivity – 0.0006-1.44 & 0.05-0.0027 m/day Transmissivity – 0.06 – 0.573 m^2/day
8	Groundwater Level Monitoring Network	Out of total 254 no of monitoring stations 64 nos located within core mining area and rest comes within Buffers zone. 60 Nos. of Groundwater monitoring well (Dug Wells) network is established by CMPDI to record groundwater level data in and around the Core Zone of JCF and 4 Nos. of Groundwater monitoring well (Dug Wells) in RCF (CV Area).
9	Groundwater Levels Below Ground Level (bgl)	JCF area: Pre-monsoon – 0.78 to 16.73 m (Avg. 5.64 m bgl) in ‘2016 Post-monsoon – 0.30 to 12.43 m (Avg. 3.19 m bgl) in ‘2016 RCF area (part): Pre-monsoon – 3.61 to 10.65 m (Avg. 6.24 m bgl) in ‘2016 Post-monsoon – 0.90 to 6.50 m (Avg. 3.18 m bgl) in ‘2016
10	Groundwater Quality	Potable
11	Proposed Piezometers	New piezometers (23 nos.) have been proposed to monitor impact of coal mining on groundwater regime within the coalfield area (JCF & part of RCF) for maximum depth upto 290 m to monitor deeper aquifers.

1.0 INTRODUCTION

1.1 CLIMATE, TEMPERATURE & 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.

The annual rainfall in the area is 1509 mm (Dhansar Mine Rescue Station, 2016) has been considered in year 2016 given in **Annexure-I**. IMD stations nearby the Coalfield area are Dhanbad, Baghmara and Asansol. The mean non-monsoon rainfall in the area is 15% and the monsoon rainfall is 85% of total annual rainfall. Rainfall is the primary source of groundwater recharge.

1.2 GEOMORPHOLOGY

Northern part of the JCF area is covered with hills and thin forest. In general the altitude varies from 160 m above mean sea level (AMSL) in Sudamdih area to 220 m AMSL in Barora area. Pediplains are developed over sedimentary rocks or Gondwana formation consisting of Sandstone, Shale, coal, etc. Dissected pediplains are developed over Gondwana formations found in Jharia, Baghmara, Katras areas etc. However, in RCF (part) areas the altitude varies from 100 m to 140 m AMSL. The general slope of the topography is towards south, i.e. Damodar River.

1.3 DRAINAGE

The drainage pattern of the area is dendritic in nature. The drainage system of the area is the part of Damodar sub-basin. All the rivers that originate or flow through the coalfield area have an easterly or south easterly course and ultimately joins Damodar River, the master drainage.The drainage of the JCF is mainly controlled by Jamuniya River (5th order), Khudia nala (3rd order), Katri River (4th) and Chatkari nala (3rd order) flowing from north to south and joins Damodar River. Whereas, Barakar River and Khudia River are controlling the drainage pattern of RCF (part) and joins Damodar River in the south. Damodar River is the main drainage channel and flows from west to east along the southern boundary of JCF and RCF.

The drainage map of the JCF and part of RCF has been prepared on topographic map of scale 1:50000 (**Figure No-1**). The watershed of all tributary rivers (Jamuniya River to Barakar River) falls within the north-western part of Damodar sub-basin which comes under Lower Ganga Basin.

Besides, a large number of ponds/tanks are distributed in and around JCF, out of which one prominent lake is located at Topchanchi in the north-west part. Two reservoirs, Maithon dam in Barakar River and Panchet dam in Damodar River near to Chanch Victoria Area of BCCL (part of RCF) are the main source of water supply to the nearby area. Jharia Water Board, Damodar Water Supply Scheme and Mineral Area Development Authority (MADA) are supplying water to the various coalfield area from Maithon dam, Damodar River, Jamunia River, Topchachi Lake, etc.

2.0 GROUNDWATER SYSTEM

2.1 GEOLOGY OF THE AREA

The Jharia Coalfield covers an area of 453 sq. km. located in Dhanbad District, Jharkhand. The non-coal bearing Talchir Formation is exposed in patches along the northern fringe of the Coalfield. The Barakar Formation which overlies the Talchir is covering the most part of the Jharia Coalfield and having an area of 218 sq. km. This is successively overlain by the non-coal bearing Barren Formation which is mainly exposed in the central part of the Coalfield. This, in turn, is overlain by the Raniganj formation (Coal Bearing horizon) in the south-western part of the Coalfield and covers an area of 54 sq. km.

Chanch-Victoria Area which is located in the western part of Raniganj Coalfield. The Raniganj coalfield represents the eastern most coal basin in the Damodar Valley Region and located in Burdwan District, West Bengal. The Coalfield is almost elliptical in shape and covers an area of about 1530 sq. km. out of which only 35 sq. km. comes under leasehold area of BCCL out of which 19.64 sq. km is the study area (Cluster-XVI only). The coal bearing formations of the area belongs to Barakar Formation of the Lower Gondwana.

2.2 HYDROGEOLOGY OF THE STUDY AREA

The permeable formations mainly composed of sandstone behave as aquifer units. The coal seam and shales developed in the area act as impermeable beds i.e. aquiclude. The aquifer materials of Gondwana Formation are constituted of fine to coarse grained sandstone having primary porosity of intergranular void space. The secondary porosity formed due to presence of faults, fracture, joints, etc. Sandstone of Gondwana formations in JCF and RCF are very hard, compact and cemented sandstone and forming less potential aquifer, particularly the deeper aquifer system. The secondary porosity along with primary porosity forms a conduit system making these formations good aquifers for movement and storage of ground water.

2.3 AQUIFER DISPOSITION

The aquifer system for shallow and deeper aquifer has been established through hydrogeological studies, exploration, surface and subsurface geophysical studies in the JCF and RCF (part) covering all geological formations. The aquifer can be divided into two zones – Un-confined/Phreatic (shallow) and Semi-confined to confined (deeper) aquifer.

PHREATIC/UN-CONFINED AQUIFER

The top aquifer occurred above the top most coal seam/shale bed is called un-confined or water table aquifer and it consists of relatively permeable formation such as weathered sandstone and loose soil. The thickness of the un-confined aquifer is varies from few meters to 50 m. This un-confined aquifer is more potential than deep seated semi-confined to confined aquifer.

SEMI-CONFINED TO CONFINED AQUIFER

The semi-confined to confined aquifer consisting of sandstone bed is sandwiched with coal seams/shale beds and multiple aquifer system developed due to presence of multiple numbers of coal seams/shale beds. With the presence of intercalated shale and carbonaceous shale beds and reduction in permeability with depth, the lower aquifers are poor in potential.

2.4 AQUIFER PARAMETERS

PHREATIC/UN-CONFINED AQUIFER – The wells are tested by CMPDI for determination of aquifer parameters in Damuda (BJ Section) and Block-III area of JCF. The hydraulic conductivity of the un-confined aquifer is 0.50 m/day as computed from pumping tests on the wells. The transmissivity of the unconfined aquifer ranges from 10.68 m^2 /day to 41.48 m^2 /day.

SEMI-CONFINED TO CONFINED AQUIFER – Below the un-confined aquifer, the sandstone partings in-between impervious layers of shale and coal seams is designated as semi-confined / confined aquifers. The sandstones in these aquifers are fine to coarse grained, hard and compact with very low porosity. Mostly groundwater occurs in the weak zones formed due to weathering, fracture, faults, which create the secondary porosity. The hydrogeological parameter has been determined by CMPDI in Sitanala Block by conducting aquifer performance test (APT). The hydraulic conductivity (K) of semi-confined aquifer in Barakar Formation ranges from 0.0006 m/day to 1.44 m/day. The hydrogeological parameter has also been determined at Kumari OCP Block in the central JCF by conducting aquifer performance test. The hydraulic conductivity (K) of semi-confined aquifer in Barakar Formation in this area ranges from 0.0027 m/day to 0.05 m/day.

3.0 GROUNDWATER LEVEL MONITORING

To collect the representative groundwater levels in the study area, CMPDI has established a monitoring network of total 254 monitoring stations out of which 64 located within core zone and rest comes within Buffer zone. 60 dug wells within JCF and 04 dug wells within RCF (part) area (Details of the Hydrograph stations & water level are given in **Annexure-IIA** & **IIB**) spread over the entire BCCL leasehold area, **Figure No-1**. Water level monitoring in 254 hydrograph stations has been done in pre-monsoon as well as in post monsoon whereas in 64 stations monitoring done in quarterly (February, May, August and November month of each year) basis.

Depth to water level of the water table depict the inequalities in the position of water table with respect to ground surface and is useful in delineating recharge / discharge areas, planning of artificial recharge structure and shows the overall status of the groundwater level in the area. Historical groundwater level (GWL) of entire JCF and part of RCF with fluctuation, GWL of Non-mining / Mining areas and GWL of the Cluster of Mines of BCCL are shown in this report to assess the effect of Coal mining activity in the groundwater regime in and around the Coalfield area.

Mining is a dynamic phenomenon. The mining activity creates dis-equilibrium in environmental scenario of the area and disturbs the groundwater conditions/regime in particular. The impact on shallow water regime due to mining activity can be broadly viewed as under:

- Historical GWL with annual fluctuation over the years
- GWL scenario in Non-mining and Mining area (OC/UG mines)
- GWL scenario of Cluster of mines of BCCL

**Construction of piezometers within Jharia Coalfield and part of Raniganj Coalfield to monitor groundwater level of deeper aquifers is already in progress.*

3.1 HISTORICAL GROUNDWATER LEVEL

Historical GWL of JCF and part of RCF are given from 2005 to 2016 of CMPDI monitoring stations (total 64 stations within Coalfield area). Pre-monsoon water level within JCF varies from 0.07 m to 19.27 m bgl with an average varying from 4.92 m to 6.29 m. The post-monsoon water level varies from 0.10 m to 15.88 m bgl with an average varying from 2.72 m to 4.48 m. The annual water level fluctuation varies from 0.02 m to 16.15 m bgl with an average varies from 1.54 m to 3.17 m.

Within RCF (part) pre-monsoon water level varies from 1.70 m to 10.50 m bgl with an average varying from 4.57 m to 7.59 m. The post-monsoon water level varies from 1.55 m to 9.58 m bgl with an average varying from 2.63 m to 5.11 m. The annual water level fluctuation varies from 0.54 m to 6.60 m bgl with an average varies from 0.89 m to 3.87 m.

Table No – 1: Historical Groundwater Level

Period		(Water level in metre below ground level)								
		Pre-Monsoon (April/May)			Post-Monsoon (Nov/Dec)			Fluctuation		
		From	To	Average	From	To	Average	From	To	Average
JCF	2005	0.07	19.08	6.29	0.84	12.13	3.20	0.12	12.45	3.21
	2007	0.40	19.27	5.66	0.35	8.21	2.87	0.02	16.15	2.96
	2008	0.45	18.35	5.42	0.35	14.20	3.62	0.03	9.22	2.45
	2010	0.85	14.47	5.24	0.10	15.88	4.48	0.02	5.55	1.54
	2012	1.27	18.68	5.58	0.15	7.80	2.72	0.08	13.45	2.96
	2013	0.70	19.20	5.65	0.45	8.35	2.77	0.29	15.88	3.17
	2014	0.70	16.28	4.92	0.75	14.98	3.27	0.25	10.15	2.17
	2015	1.38	17.20	6.00	0.45	14.58	3.92	0.28	7.62	2.15
	2016	0.78	16.73	5.64	0.30	12.43	3.19	0.23	6.35	2.88
RCF (part)	2008	5.02	10.50	7.59	2.85	4.90	3.71	1.82	6.60	3.87
	2010	2.20	8.85	4.74	2.78	9.58	4.63	0.68	1.10	0.89
	2011	3.57	8.02	4.98	2.50	6.21	3.75	0.55	1.90	1.23
	2012	3.10	7.34	4.59	1.55	7.00	3.66	0.05	2.78	0.94
	2013	1.70	9.87	6.54	2.90	8.85	4.71	1.02	5.54	2.84
	2014	3.27	6.48	4.57	2.13	3.03	2.63	0.54	3.45	1.94
	2015	3.38	9.52	5.33	2.68	8.20	5.11	1.06	1.32	1.81
	2016	3.61	10.65	6.24	0.90	6.50	3.18	1.63	4.40	3.06

3.2 GROUNDWATER LEVEL SCENARIO IN NON-MINING/MINING AREA

Depth to water level (DTW) range in different formations with respect of mining and non-mining areas is summarized in the Table No-2.

Table No – 2: Depth to water table

Formation	***Area***		***DTW (bgl, m) [Year-2016]***		***Average GWL (m)***	
			Pre-monsoon	***Post-monsoon***	***Pre-monsoon***	***Post-monsoon***
Sedimentary (Gondwana)	Non-mining		0.78 to 7.37	0.30 to 4.645	5.12	3.23
	Mining	OC	1.30 to 10.20	0.70 to 9.08	5.30	3.55
		UG	1.50 to 16.73	1.10 to 12.43	7.21	4.89
Metamorphics	Peripheral part of the Coalfield		0.50 to 14.00	0.30 to 11.30	7.25	4.50

The study revealed that water table is in shallow depth and there is no significant stress in the water table due to coal mining activity. Mining and Non-mining areas shows barely any difference in water table condition in the JCF and RCF (part) area. The average hydraulic gradient of the water table within mining and non-mining areas is given in Table No-3. Flat hydraulic gradient has been observed within Non-Mining, Underground mines and Metamorphics areas w.r.t, Opencast mining areas. Relatively steep gradient near active opencast mining areas may be due to coal mining activity in addition with less rainfall in recent years within the study area.

Table No – 3: Average hydraulic gradient

Sl. No	***Formation***	***Area***		***Average hydraulic gradient***
1	Sedimentary (Gondwana)	Non-Mining		1.5×10^{-3} to 3.5×10^{-3}
2		Mining	OC	7.75×10^{-3} to 11.82×10^{-3}
3			UG	2×10^{-3} to 5×10^{-3}
4	Metamorphics	Peripheral part of the Coalfield		1.0×10^{-3} to 3.0×10^{-3}

3.3 QUARTERLY GROUNDWATER LEVEL, CLUATER OF MINES (BCCL)

3.3 A Monitoring of Ground Water Levels of Cluster-I

Cluster-I (Damuda Group of Mines) consisting of Damoda (BJ and Gutway section) UG, Damoda (Albion section) OCP, proposed Damoda (B.J.section) OCP and Closed Gutway OCP of Barora Area of BCCL. It is located in the extreme western part of JCF in Bokaro district of Jharkhand.

The present leasehold area of Cluster-I is 575 Ha. The Damoda block area is marked by more or less flat and gently undulating topography. The RL varies from 179 m to 208 m AMSL and the general slope of topography is towards east. Jamuniya River, Kari Jore, Podo Jore and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Jamuniya River.

4 hydrograph stations (**B-15, B-21A, B51 and B-53**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April and August & November‘2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb’16	Apr’16	Aug’16	Nov’16
1	B-15	Bera Basti	0.55	1.85	0.40	0.55
2	B-21A	Dugdha	6.45	5.55	1.45	4.50
3	B-51	Taranga	3.20	4.90	1.03	3.18
4	B-53	Karmatanr	3.47	4.62	-	1.37
Average WL (bgl)			***3.42***	***4.23***	***0.96***	***2.40***

Ground Water Level (in bgl) varies from 0.55 to 6.45 m during February’16, 1.85 to 5.55 m during April’16, 0.40 to 1.45 m during August’16 and 0.55 to 4.50 m during November‘16 within the Core Zone of Cluster-I area.

3.3 B Monitoring of Ground Water Levels of Cluster-II

Cluster-II consists of seven mines namely; Block-II mixed mine (OCP & UGP), Jamunia OCP, Shatabdi OCP, Muraidih mixed mine (OCP & UGP) and Phularitand OCP is under administrative control of Block-II Area and Barora Area of BCCL. It is located in the extreme western part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-II is 2025.71 Ha. The Damoda block area is marked by more or less flat and gently undulating topography. The RL varies from 176 m to 235 m AMSL. Jamuniya River, Khudia River and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Jamuniya River and Khudia River.

5 hydrograph stations (**B-1, B-59, B-60, B-61A and B-62A**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November‘2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb’16	Apr’16	Aug’16	Nov’16
1	B-1	Muraidih	2.53	3.58	1.43	1.93
2	B-59	Khodovaly	1.40	4.40	0.65	0.50
3	B-60	Bahiyardih	6.78	9.36	1.48	5.03
4	B-61A	Kesargora	5.36	6.58	1.09	3.87
5	B-62A	Sadiyardih	6.85	9.30	2.85	4.95
Average WL (bgl)			***4.58***	***6.64***	***1.50***	***3.26***

Ground Water Level (in bgl) varies from 1.40 to 6.85 m during February, 3.58 to 9.36 m during April, 0.65 to 2.85 m during August and 0.50 to 5.03 m during November‘2016 within the Core Zone of Cluster-II area.

3.3 C Monitoring of Ground Water Levels of Cluster-III

Cluster-III consists of nine mines namely, Jogidih UG, Maheshpur UG, South Govindpur UG, Teturiya UG, Govindpur UG, New Akashkinaree mixed mine (OC & UG) and Kooridih/Block-IV mixed mine (OC & UG) under the administrative control of Govindpur Area of BCCL. This Cluster of mines is located in western part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-III is 1420.0 Ha. The area is plain with gentle undulation with RL varies from 160 m to 208.80 m AMSL. The general slope of the area is towards south. Khudia River, Baghdihi Jore, Katri River and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Khudia River.

5 hydrograph stations (**A-12, A-25, A-29, B-14 and B-60**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November‘2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb’16	Apr’16	Aug’16	Nov’16
1	A-12	Jamua	1.70	2.50	0.35	0.70
2	A-25	Sinidih	4.78	7.43	1.40	4.58
3	A-29	Dharmaband	3.95	5.92	1.54	6.96
4	B-14	Mathadih	1.92	2.44	1.26	0.47
5	B-60	Sonardih	6.31	10.33	2.21	5.03
Average WL (bgl)			***3.73***	***5.72***	***1.35***	***3.65***

Ground Water Level (in bgl) varies from 1.70 to 6.31 m during February, 2.50 to 10.33 m during April, 0.35 to 2.21 m during August and 0.70 to 6.96 m during November‘2016 within the Core Zone of Cluster-III area.

3.3 D Monitoring of Ground Water Levels of Cluster-IV

Cluster-IV consists of six mines namely, Salanpur UG, Katras-Choitudih UG, Amalgamated Keshalpur & West Mudidih OC, Amalgamated Keshalpur & West Mudidih UG, Amalgamated Angarpathra & Ramkanali UG and closed Gaslitand UG of Katras Area of BCCL. It is located in the north-central part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-IV is 1123.79 Ha. The area has a general undulating topography, with an overall gentle south-westerly slope. The RL varies from 182 m to 216 m AMSL. Katri River, Kumari Jore and its tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Katri River.

5 hydrograph stations (**A-26, A28A, B-63, B-64 and B-65A**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November‘2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb’16	Apr’16	Aug’16	Nov’16
1	A-26	Malkhera	5.78	8.93	2.83	4.48
2	A28A	Lakarka	2.15	3.35	1.22	1.47
3	B-63	West Mudidih	1.35	2.44	0.95	
4	B-64	Keshalpur	1.35	2.35	0.35	0.55
5	B-65A	Jhinjipahari	5.20	7.15	1.40	2.68
Average WL (bgl)			***3.17***	***4.84***	***1.35***	***2.30***

Ground Water Level (in bgl) varies from 1.35 to 5.78 m during February, 2.35 to 8.93 m during April, 0.35 to 2.83 m during August and 0.55 to 4.48 m during November‘2016 within the Core Zone of Cluster-IV area.

3.3 E Monitoring of Ground Water Levels of Cluster-V

Cluster-V consists of twelve mines namely; Tetulmari OC & UG mine, Mudidih OC & UG mine, Nichitpur OC, Sendra Bansjora OC & UG, Bansdeopur OCP (proposed) & UG, Kankanee OC & UG and closed Loyabad UG under the administrative control of Sijua Area of BCCL. This Cluster of mines is located in northern part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-V is 1957.08 Ha. The area has a general undulating topography, with an overall gentle south westerly slope. The RL varies from 210 m to 170 m AMSL. Jarian Nala, Nagri Jore, Ekra Jore and its tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Jarian Nala and Ekra Jore.

4 hydrograph stations (**A-3, A-16, A-27 and D-23**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November‘2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb’16	Apr’16	Aug’16	Nov’16
1	A-3	Sijua	3.02	4.87	0.20	0.47
2	A-16	Ekra	4.40	5.85	1.75	3.15
3	A-27	Tetulmari	2.40	4.85	0.40	1.80
4	D-23	Jogta	3.51	5.70	2.35	1.63
Average WL (bgl)			***3.33***	***5.32***	***1.18***	***1.76***

Ground Water Level (in bgl) varies from 2.40 to 4.40 m during February, 4.85 to 5.85 m during April, 0.20 to 2.35 m during August and 0.47 to 3.15 m during November‘2016 within the Core Zone of Cluster-V area.

3.3 F Monitoring of Ground Water Levels of Cluster-VI

Cluster–VI consists of four coal mines; East Bassuriya OC, Bassuriya UG, Gondudih Khas-Kusunda OC, Godhur Mixed Mines (OC and UG) are under the administrative control of Kusunda Area of BCCL. This Cluster of mines is located in central part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-VI is 876.55 Ha. The area has a general undulating topography with general slope towards south. The RL varies from 180 m to 240 m AMSL. Ekra Jore, Kari Jore and their tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Ekra Jore and Kari Jore.

2 hydrograph stations (**D-25 and D-30**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November‘2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb’16	Apr’16	Aug’16	Nov’16
1	D-25	Godhur	2.10	2.40	0.25	1.90
2	D-30	Borkiboa	3.32	4.45	1.10	3.20
Average WL (bgl)			***2.71***	***3.43***	***0.68***	***2.55***

3.3 G Monitoring of Ground Water Levels of Cluster-VII

Cluster-VII consists of fourteen mines namely; Dhansar mixed mine, Kusunda OCP, Viswakarma OCP, Industry UG (closed), Alkusa UG, Ena OCP, S.Jharia/Rajapur OCP, Burragarh UG, Simlabahal UG, Hurriladih UG, Bhutgoria UG, Kustore UG (closed) and E.Bhuggatdih UG (closed) under the administrative control of Kusunda Area and Kustore Area of BCCL. This Cluster of mines is located in east central part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-VII is 2127.70 Ha. The area has a general undulating topography with general slope towards south. The RL varies from 172 m to 221 m above M.S.L. Kari Jore, Chatkari Jore and its tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Kari Jore and Chatkari Jore.

7 hydrograph stations (**D-3, D-4, D-33, D-34, D-47, D-55 and D-80**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November‘2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb’16	Apr’16	Aug’16	Nov’16
1	D-3	Dhansar	2.10	2.35	1.20	1.90
2	D-4	Jharia	1.01	1.21	0.41	1.36
3	D-33	Kustore	1.00	2.50	0.20	1.95
4	D-34	Kusunda	0.75	2.30	0.22	0.30
5	D-47	Parastanr	3.05	3.18	3.35	2.95
6	D-55	Hariladih	2.72	2.52	1.62	3.62
7	D-80	Bastacolla	3.63	6.55	2.05	4.15
Average WL (bgl)			***2.04***	***2.94***	***1.29***	***2.32***

Ground Water Level (in bgl) varies from 0.75 to 3.63 m during February, 1.21 to 6.55 m during April, 0.20 to 3.35 m during August and 0.30 to 4.15 m during November‘2016 within the Core Zone of Cluster-VII area.

3.3 H Monitoring of Ground Water Levels of Cluster-VIII

Cluster-VIII consists of ten mines namely; Bastacolla mixed mines (OC & UG), Bera mixed mines (OC & UG), Dobari UG, Kuya mixed (OC & UG), proposed Goluckdih (NC) OC, Ghanoodih OC and Kujama OC under the administrative control of Bastacolla Area of BCCL. This Cluster of mines is located in eastern part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-VIII is 1200.41 Ha. The area has a general undulating topography with general slope towards south and south-west. The ground elevation in the area ranges from 175 m to 221 m AMSL. Chatkari Jore, Tisra Jore and its tributaries controlling the drainage pattern of the area. The area comes under the watershed of Chatkari Jore.

4 hydrograph stations (**D-8, D-43, D-49 and D-51**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November‘2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb’16	Apr’16	Aug’16	Nov’16
1	D-8	Alokdiha	4.65	8.00	2.70	3.43
2	D-43	Alagdih	4.17	8.20	1.90	3.35
3	D-49	Galucdih	2.00	2.45	0.28	1.72
4	D-51	Chankuiya	8.80	11.15	3.58	6.45
Average WL (bgl)			***4.91***	***7.45***	***2.12***	***3.74***

Ground Water Level (in bgl) varies from 2.0 to 8.80 m during February, 2.45 to 11.15 m during April, 0.28 to 3.58 m during August and 1.72 to 6.45 m during November‘2016 within the Core Zone of Cluster-VIII area.

3.3 I Monitoring of Ground Water Levels of Cluster-IX

Cluster-IX consists of eight mines namely; North Tisra/South Tisra Expansion OCP, Lodna UG, Bagdigi UG, Bararee UG and Joyrampur UG and Jealgora UG (closed) are under the administrative control of Lodna Area of BCCL. This Cluster of mines is located in eastern part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-IX is 1942.12 Ha. The topography of the area is undulating with gentle slope towards south. The RL varies from 221 m to 188.44 m AMSL. Chatkari Jore, Tisra Jore, Sulunga Jore and its tributaries controlling the drainage pattern of the area. The area comes under the watershed of Chatkari Jore.

6 hydrograph stations (**D-5, D-7, D-39, D-40A, D-41 and D-74**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November‘2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb’16	Apr’16	Aug’16	Nov’16
1	D-5	Jiyalgora	7.54	9.40	2.20	6.40
2	D-7	Golden Pahari	5.63	7.53	1.63	4.03
3	D-39	Tilaboni	2.15	2.18	1.55	2.65
4	D-40A	Khapa Dhawra	0.70	1.40	0.45	0.85
5	D-41	Joyrampur	1.30	1.30	0.45	1.52
6	D-74	Bhulan Bararee	5.95	7.73	2.60	5.00
Average WL (bgl)			***3.88***	***4.92***	***1.48***	***3.41***

Ground Water Level (in bgl) varies from 0.70 to 7.54 m during February, 1.30 to 9.40 m during April, 0.45 to 2.60 m during August and 0.85 to 6.40 m during November‘2016 within the Core Zone of Cluster-IX area.

3.3 J Monitoring of Ground Water Levels of Cluster-X

Cluster-X consists of ten coal mines and one coal Washery namely; Bhowrah North mixed mines (UG & OC), Bhowrah South mixed mines (UG, 3 Pit OCP, Chandan OCP), Patherdih Mixed mines (UG, Chandan OCP), Sudamdih incline UG mine, Sudamdih Shaft UG mine, Amlabad UG (Closed) and Sudamdih Coal Washery under the administrative control of Eastern Jharia Area of BCCL. This cluster of mines is located in the eastern part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-X is 2057.47 Ha. The area has an undulating topography with gentle slope towards south and south east. The RL varies from 185 m to 150.0 m AMSL. Gaurkuthi Nala and few seasonal streams are controlling the drainage pattern of the area. The area comes under the watershed of Damodar River.

4 hydrograph stations (**A-19, D-35, D-36 and D-77**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November‘2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb’16	Apr’16	Aug’16	Nov’16
1	A-19	Bhowrah	4.75	8.10	1.35	4.40
2	D-35	Patherdih	7.22	9.52	2.53	6.45
3	D-36	Sudamdih	0.46	0.78	0.25	0.95
4	D-77	Amlabad	3.75	4.60	2.49	2.90
Average WL (bgl)			***4.05***	***5.75***	***1.66***	***3.68***

Ground Water Level (in bgl) varies from 0.46 to 7.22 m during February, 0.78 to 9.52 m during April, 0.25 to 2.53 m during August and 0.95 to 6.45 m during November‘2016 within the Core Zone of Cluster-X area.

3.3 K Monitoring of Ground Water Levels of Cluster-XI

Cluster–XI consists of eight coal mines and one coal Washery namely; 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 Pootkee Balihari Area and Moonidih UG & Moonidih Washery are under the administrative control of Western Jharia Area of BCCL. This Cluster of mines is located in central part of Jharia Coalfield in Dhanbad district of Jharkhand.

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.

5 hydrograph stations (**A-17, A-18, A-20, A-32 and D-34**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November‘2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water below (bgl in meters)			
			Feb’16	Apr’16	Aug’16	Nov’16
1	A-17	Kachi Balihari	2.31	2.44	0.37	2.69
2	A-18	Baghaband	0.74	1.14	1.84	0.89
3	A-20	Gorbudih	4.60	7.49	1.07	3.50
4	A-32	Baludih	2.99	4.75	0.65	2.10
5	A-34	Bhatdih	4.54	4.75	1.55	4.45
Average GW (bgl)			***3.04***	***4.11***	***1.10***	***2.73***

Ground Water Level (in bgl) varies from 0.74 to 4.60 m during February, 1.14 to 7.49 m during April, 0.37 to 1.84 m during August and 0.89 to 4.45 m during November‘2016 within the Core Zone of Cluster-XI area.

3.3 L Monitoring of Ground Water Levels of Cluster-XIII

Cluster-XIII consists of one operating mine i.e. Murulidih 20/21 pits UG mine and six abandoned mines (Bhurungiya Colliery, Muchraidih colliery, Hantoodih colliery, Padugora colliery, Murulidih colliery, Bhatdee colliery) of Western Jharia Area of BCCL. It is located in the south-western part of Jharia Coalfield in Dhanbad district of Jharkhand.

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

5 hydrograph stations (**A-22, A-23, A-33, B-25 and B-48**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November‘2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb’16	Apr’16	Aug’16	Nov’16
1	A-22A	Nagdah Basti	2.00	3.25	0.40	1.75
2	A-23	Machhayara	8.83	11.87	2.99	8.13
3	A-33	Mahuda Washery	3.43	5.75	0.60	2.60
4	B-25	Mahuda More	4.53	7.90	1.79	2.55
5	B-48	Mahuda	5.35	9.35	2.03	4.60
Average GW (bgl)			***4.83***	***7.62***	***1.56***	***3.93***

Ground Water Level (in bgl) varies from 2.00 to 8.83 m during February, 3.25 to 11.87 m during April, 0.40 to 2.99 m during August and 1.75 to 8.13 m during November‘2016 within the Core Zone of Cluster-XIII area.

3.3 M Monitoring of Ground Water Levels of Cluster-XIV

Cluster-XIV consists of two mines namely; Lohapatty UG and Lohapatty Opencast Patch (proposed). These are under the administrative control of Western Jharia of BCCL. This Cluster of mines is located in western part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-XIV is 1577.22 Ha. The topography of the area is undulating with slope towards south west. The maximum RL is 224 m in the north-eastern part whereas the minimum RL is 170 m above mean sea level on the south-western part of the area. Jamunia River and its tributaries are controlling the drainage of the area. The area comes under the watershed area of Jamunia River.

3 hydrograph stations (**B-23, B-24 and B-67**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November'2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb'16	Apr'16	Aug'16	Nov'16
1	B-23	Lohapatti	3.32	6.81	1.09	2.41
2	B-24	Telmuchu	6.33	10.63	1.73	4.28
3	B-67	Simatanr	7.45	9.53	3.47	4.30
Average GW (bgl)			***5.70***	***8.99***	***2.10***	***3.66***

Ground Water Level (in bgl) varies from 3.32 to 7.45 m during February, 6.81 to 10.63 m during April, 1.09 to 3.47 m during August and 2.41 to 4.30 m during November'2016 within the Core Zone of Cluster-XIV area.

3.3 N Monitoring of Ground Water Levels of Cluster-XV

Cluster–XV consists of four coal mines; Kharkharee UG and Dharmaband UG are under the administrative control of Govindpur Area and Madhuband UG & Phularitand UG are under the administrative control of Barora Area of BCCL. This Cluster of mines is located in western part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-XV is 1696.55 Ha. The topography of the area is undulating with slope towards south west. The maximum RL is 235 m in the Kharkharee mine area whereas the minimum RL is 165 m AMSL on the eastern & western part of the Cluster. Jamunia River and Khudia River are controlling the drainage of the area. The area comes under the watershed area of both Jamunia River and Khudia River.

3 hydrograph stations (**A-24, B-32A and B-61A**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November‘2016 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb’16	Apr’16	Aug’16	Nov’16
1	A-24	Pipratanr	12.80	16.73	2.48	12.43
2	B-32A	Madhuband	4.20	6.95	1.54	3.07
3	B-61A	Kesargora	5.48	6.58	1.09	3.87
Average GW (bgl)			***7.49***	***10.09***	***1.70***	***6.46***

Ground Water Level (bgl) varies from 4.20 to 12.80 m during February, 6.58 to 16.73 m during April, 1.09 to 2.48 m during August and 3.07 to 12.43 m during November‘2016 within the Core Zone of Cluster-XV area.

3.3 O Monitoring of Ground Water Levels of Cluster-XVI

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

The present leasehold area of Cluster-XVI is 1964.21 Ha. The topography of the area is undulating with slope towards south west. The area is plain with gently undulating with elevation varying from 100 m to 140 m AMSL. The general slope of the area is towards southeast. Barakar River and Khudia River are controlling the drainage of the area. The area comes under the watershed area of Barakar River.

4 hydrograph stations (**DB-22, DB-23, DB-24 and DB-25**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November'2016 and the Ground water level data is enclosed in the table below:

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

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

4.0 GROUNDWATER LEVEL SCENARIO

During the month of February'2016 the depth to water level (in bgl) within 15 nos Cluster of mines varies from 0.46 m to 12.80 m with an average varies from of 2.04 m to 7.49 m. During the month of April'2016 the depth to water level varies from 0.78 m to 16.73 m with an average varies from 2.94 m to 10.09 m. During the month of August'2016 the depth to water level varies from 0.20 m to 3.58 m with an average varies from 0.68 m to 2.12 m. During the month of November'2016 the depth to water level varies from 0.30 m to 12.43 m with an average varies from 1.76 m to 6.46 m. The summarized water level data of all clusters are given in **Table No – 4**.

Depth to water level (in bgl) values described that water level goes down to maximum 16.73 m during pre-monsoon'2016 and maximum upto 12.43 m during post-monsoon'2016. Un-confined aquifer is affected around 20 m to 30 m maximum close to active opencast mining areas, showing steep gradient towards mine void. Other than that, there is no mining effect in the water level within JCF area and RCF area (part). Historical water level data and hydrograph of permanent observation stations from CGWB shown in **Annexure–III**.

Monitoring groundwater (quantity & quality) to assess the present condition and resource has been done regularly in the coalfield areas. Well hydrographs (**Annexure–III**) are prepared and studied to identify potentially adverse trends so that appropriate action can be taken to protect groundwater resource. According to the hydrograph trend analysis of CGWB monitoring wells, no significant decline trend 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 (**Figure No–2**) with collection points details (dug wells) are given in **Annexure–IV**.

Table No–4: Groundwater level data Cluster-wise

Sl. No.	Cluster of BCCL	No. of Monitoring Wells	Water level fluctuation Below ground level (Feb, Apr, Aug & Nov'16)	Formation
1	I	4 nos.	0.40 to 6.45 m	Barakar
2	II	5 nos.	0.50 to 9.36 m	Barakar
3	III	5 nos.	0.35 to 10.33 m	Barakar
4	IV	5 nos.	0.35 to 8.93 m	Barakar
5	V	4 nos.	0.20 to 5.70 m	Barakar
6	VI	2 nos.	0.25 to 4.45 m	Barakar
7	VII	6 nos.	0.20 to 6.55 m	Barakar
8	VIII	4 nos.	0.28 to 11.15 m	Barakar
9	IX	6 nos.	0.45 to 9.40 m	Barakar
10	X	4 nos.	0.25 to 9.52 m	Barakar
11	XI	5 nos.	0.65 to 7.49 m	Barakar & Barren Measure
12	XIII	5 nos.	0.40 to 11.87 m	Raniganj
13	XIV	3 nos.	1.09 to 10.63 m	Raniganj
14	XV	4 nos.	1.09 to 16.73 m	Barakar & Barren Measure
15	XVI	4 nos.	0.53 to 10.65 m	Barakar

5.0 GROUNDWATER QUALITY

The ground water sample of the study area (15 nos. of Cluster of mines, BCCL) have been collected from dug wells and analysed. Fifteen ground water samples (GW-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15 & 16) were analysed quarterly (February, May, August and November'2016) at CMPDI (HQ), Ranchi. The water sampling details are given in **Annexure–IV** and Water sample locations are shown in **Figure No-2**. The water quality data are enclosed in **Annexure–VA, VB, VC and VD**.

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

During the month of February, May, August and November'2016:

The pH of the groundwater samples varies between 7.56 to 8.26 in February'16, 7.10 to 8.31 in May'16, 6.16 to 8.27 in August'16 and 7.85 to 8.57 in November'16. The pH is within the ISI standards of drinking water except in Cluster-VIII during November'16.

During the month of February, May, August and November'2016:

The mineral constituents dissolved in water constitute the dissolved solids. The total dissolve solids varies from 388 to 910 mg/l in February'16, from 370 to 1070 in May'16, from 320 to 1060 in August'16 and from 276 to 902 in November'2016. The TDS values are above the IS 10500 standards of drinking water.

During the month of February, May, August and November'2016:

During the month of February'16 the alkalinity of the water samples varies from 84 to 372 mg/l and are slightly above the stipulated standard of (200 mg/l) drinking water. The concentrations of calcium in the water samples vary from 40 to 122 mg/l and are slightly above the permissible limit (75 mg/l) of drinking water standards. The total hardness ranges between 156 to 616 mg/l and the value of total hardness in water samples are above the permissible limit (200 mg/l). The sulphate ranges between 66 to 178 mg/l 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 are found to be below the upper ISI limits for drinking water.

During the month of May'16 the alkalinity of the water samples varies from 80 to 504 mg/l and are above the stipulated standard of (200 mg/l) drinking water. The concentrations of calcium in the water samples vary from 42 to 133 mg/l and are slightly above the permissible limit (75 mg/l) of drinking water standards. The total hardness ranges between 176 to 724 mg/l and the value of total hardness in water samples are above the permissible limit (200 mg/l). The sulphate ranges between 52 to 230 mg/l and the value of sulphate in water sample are slightly above the permissible limit (200 mg/l). The Iron, Copper, Manganese, Lead, Zinc and Chromium concentration in the water samples are found to be below the upper ISI limits for drinking water.

During the month of August'16 the alkalinity of the water samples varies from 80 to 432 mg/l and are above the stipulated standard of (200 mg/l) drinking water. The concentrations of calcium in the water samples vary from 46 to 110 mg/l and are slightly above the permissible limit (75 mg/l) of drinking water standards. The total hardness ranges between 172 to 496 mg/l and the value of total hardness in water samples are above the permissible limit (200 mg/l). The sulphate ranges between 60 to 224 mg/l and the value of sulphate in water sample are slightly above the permissible limit (200 mg/l). The Iron, Copper, Manganese, Lead, Zinc and Chromium concentration in the water samples are found to be below the upper ISI limits for drinking water.

During the month of November'16 the alkalinity of the water samples varies from 32 to 408 mg/l and are slightly above the stipulated standard of (200 mg/l) drinking water. The concentrations of calcium in the water samples vary from 34 to 115 mg/l and are slightly above the permissible limit (75 mg/l) of drinking water standards. The total hardness ranges between 120 to 780 mg/l and the value of total hardness in water samples are above the permissible limit (200 mg/l). The sulphate ranges between 41 to 260 mg/l 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 are found to be below the upper ISI limits for drinking water.

6.0 STAGE OF GROUNDWATER DEVELOPMENT

The groundwater is mainly utilized for domestic needs and for irrigation purposes. The groundwater abstraction is mainly through dug wells and bore wells. The stage of groundwater development in Dhanbad district is 55.80%. The highest stage of development is in Dhanbad (143%) and Jharia (112%) blocks and lowest stage of development is in Nirsa (30%) block. The Gondwana sandstones in general, are known to constitute good aquifers at many places. However, the yield potential of the area adjoining to active mines in the coal belt is poor. The active mines often act as groundwater “sinks”. In contrast, the water logged abandoned mines and pits act as potential sources of groundwater. As per the assessment done by Central Ground Water Board (CGWB), Patna in 2011, the Block wise data of Dhanbad district is given below:

Table No–5: Block-wise Stage of Groundwater development

Sl No.	Administrative Unit	Stage of GW Development	Category
1	Baghmara	60%	safe
2	Baliapur	31%	safe
3	Dhanbad	143%	**Over- exploited**
4	Gobindpur	64%	safe
5	Jharia	112%	**Over- exploited**
6	Nirsa	30%	safe
7	Tundi	48%	safe
8	Topchachi	62%	safe

Table No–6: Cluster-wise Groundwater development scenario

Cluster/ Area	Adminis-trative Blocks/Stage Of GW Develo-pment	Total Water demand (cum/day)				Avg. GW level (bgl in m) 2016		GW level declining trend 2005-2016		Remarks
		Mine Discharge	Surface Water Source	Total Use (Domestic +Industrial +Others)	Excess Or other use	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
Cluster-I	Bermo 44%	2950	NIL	2123	827	4.23	2.40	NO	NO	-
Cluster-II	Baghmara 60%	8350	Jamunia river	7265	1085	6.64	3.26	NO	NO	-
Cluster-III	Baghmara 60%	10,960	NIL	7290	3670	5.72	3.65	NO	NO	-
Cluster-IV	Baghmara 60%	5900	MADA (Damodar river)	5900	NIL	4.84	2.30	NO	NO	
Cluster-V	Baghmara 60%	11,025	MADA	9214	1811	5.32	1.76	YES	NO	Excess water stored into abandoned UG
Cluster-VI	Dhanbad 143%	4150	MADA (Damodar river)	4150	NIL	3.43	2.55	YES	YES	Artificial recharge structure needed
Cluster-VII	Dhanbad 143%	14,920	MADA	14,639	281	2.94	2.32	NO	NO	
Cluster-VIII	Jharia 112%	9320	MADA	5474	3846	7.45	3.74	NO	NO	Excess water stored into abandoned UG & FF
Cluster-IX	Jharia 112%	12,980	MADA	9714	3266	4.92	3.41	NO	NO	Excess water stored into abandoned UG & FF
Cluster-X	Jharia 112%	11,825	Damodar river	6525	5300	5.75	3.68	YES	NO	Excess water stored into abandoned UG & OC
Cluster-XI	Dhanbad 143%	31,530	MADA & DVC	18,825	12,705	4.11	2.73	NO	YES	Excess water used F.P
Cluster-XIII	Baghmara 60%	4774	Damodar river	4115	659	7.62	3.93	NO	NO	-
Cluster-XIV	Baghmara 60%	2600	DVC	1875	725	8.99	3.66	NO	NO	
Cluster-XV	Baghmara 60%	6200	Jamunia river	4147 +1800 (ponds)	253	10.09	6.46	NO	YES	Excess water store into surface bodies
Cluster-XVI	Nirsa 30%	3380	DVC (Barakar river)	2450	930	6.24	3.18	NO	NO	

7.0 CONSERVATION MEASURES & FUTURE STRATEGY

- BCCL has installed 25 Pressure Filter Plant of total capacity of 4.16 MGD to meet drinking water requirement nearby the area. At present 63 Water Treatment Plants are operational having capacity of 16.16 MGD within Jharia Coalfield area. Further installation of 28 more Pressure Filter Plants with the capacity of 5.84 MGD are in progress.

- BCCL participated in development of low cost technology for drinking water in a CSIR project along with CIMFR, Dhanbad and a pilot plant of 4000 Liters/hour is functional at PB Project site of BCCL. Similar plant has been proposed at other sites of BCCL.

- A scheme entitled 'Scheme for multi-purpose utilization of surplus mine water of Barora Area, Block II and Govindpur Area of BCCL' was prepared with a view to harness the excess water discharge to take care of the persistence problem of water scarcity in the nearby villages. In the scheme, two water reservoirs of capacity 27 MG and 17 MG have been proposed in the non-coal bearing area for storage of 3250 GPM and 2000 GPM surplus mine water which will be fed through pipe line by mine discharge at mines of Barora, Block-II and Govindpur Area.

- Roof-top rainwater harvesting (RWH) will be taken up in the project area using the administrative buildings. 138 no. of quarters having roof-top area of about 14950 sq. m. is already prepared to harvest rainwater and around 13150 cum/annum of water is going to be recharged the nearby groundwater system through RWH structures. Proposal already made to facilitate this kind of RWH structure at suitable locations i.e. Lodna Area, Kusunda Area (Jawahar Nagar, Matkuria, Coal Board Colony), Sijua Area (Nichitpur and Tetulmari Colony) within Jharia Coalfield to augment groundwater recharge.

- After cessation of mining, with plenty rainfall and abundant ground water recharge, the water levels will recoup and attain normalcy. Thus, the impact of mining on groundwater system may be considered as a temporary

phenomenon. The abandoned mine workings (UG) behave as water pool and improves the resources availability in the coalfield area.

- Utilization of treated mine water discharge by both industry and local people in the mine influence area. The excess mine water can be used to recharge groundwater system through connecting pipeline to abandoned dug wells. Utilization of mine water for irrigation use will also enhance the ground water recharge potential through artificial recharge in the area.

- Increase vegetative cover by plantation in the mine area under land amelioration measures. This will contain the surface run-off and increase the groundwater recharge.

- Creation of awareness among workers and local peoples about Rain water harvesting and artificial recharge will be given priority. This aspect is usually covered during the Environmental Week celebrated every year (5 to 12 June).

- Monitoring of water quality of mine water discharge, local River/nala and domestic water source (dug well/hand pump wells) will be continued under routine monitoring (February, May, August & November).

Annexure – I

Rainfall Data (in mm) At Dhansar (Rescue station) Observatory Station, State Sec Deptt of Coord, BCCL

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
January	34.20	0.00	0.00	5.80	0.00	0.00	7.60	17.6	0.0	12.40	23.80	3.0
February	22.80	0.00	22.00	4.80	0.00	12.20	0.00	13.4	32.0	36.80	0.0	20.60
March	41.80	34.40	37.80	17.80	1.60	7.60	18.0	1.0	3.0	21.80	6.20	5.50
April	32.20	33.80	0.00	18.40	2.20	9.20	11.40	9.0	33.90	2.60	76.20	0.0
May	33.00	87.60	78.70	18.00	112.00	64.30	121.60	6.60	190.40	79.80	35.80	99.40
June	193.00	214.20	167.20	216.10	72.80	206.20	344.20	52.0	244.20	217.60	122.10	181.60
July	542.00	477.70	545.00	433.48	269.20	199.40	163.40	328.20	192.80	305.30	407.60	248.80
August	107.80	246.30	426.40	183.80	192.80	212.60	452.0	315.10	364.40	315.60	244.40	456.70
September	185.60	172.00	351.40	297.80	333.00	230.10	374.0	367.70	304.70	178.0	145.20	443.60
October	39.20	0.00	52.00	85.80	98.20	45.30	41.80	11.60	233.60	6.40	25.60	50.40
November	0.00	1.00	0.00	0.00	10.20	3.4	0.00	61.60	0.0	0.0	0.0	0.0
December	2.00	0.00	0.00	0.00	0.00	----	0.00	18.0	0.0	0.0	6.20	0.0
Annual	1233.60	1267.00	1680.50	1281.78	1092.00	991.90	1534.20	1201.80	1599.0	1176.0	1093.10	1509.60

Annexure – IIA

Details of Hydrograph Stations (Dug Wells)

Well No	Location	M.P. (agl) in m	Well Dia in m	Well Depth (m bmp)	R.L. (G.L) (m)	Formation	Owner	Utility
A-3	Sijua	0.53	3.00	5.20	203	Barakar	Govt.	Domestic
A-12	Jamua	0.80	1.90	3.30	202	Barakar	Govt.	Domestic
A-16	Ekra, Kalali More	0.45	3.10	6.50	205	Barakar	Govt.	Domestic
A-17	Kachi Balihari	0.56	1.60	5.30	182	Barakar	Govt.	Domestic
A-18	Bhagabandh	0.61	1.45	3.37	182	Barakar	Govt.	Domestic
A-19	Bhaura	0.54	3.15	11.65	162	Barakar	Govt.	Domestic
A-20	Gorbhudih	0.43	3.30	8.30	181	BM	Govt.	Domestic
A-22	Nagdah, Niche tola	0.00	1.40	9.50	171	Raniganj	Govt	Irrigation
A-23	Machhyara	0.43	1.85	12.40	203	Raniganj	Govt	Domestic
A-24	Pipra Tanr	0.22	1.80	19.55	208	Raniganj	Govt	Domestic
A-25	Sinidih	0.22	2.00	11.30	203	Barakar	Govt	Domestic
A-26	Pasitanr (Malkera)	0.32	1.80	9.65	198	Barakar	Govt	Domestic
A-27	Chandor	0.60	2.50	5.50	221	Barakar	Govt	Domestic
A-28A	Lakarka 6 no.	0.65	1.30	5.25	199	Barakar	BCCL	Domestic
A-29	Aambagan (Gobindpur)	0.10	2.60	9.15	186	Barakar	Govt	Domestic
A-32	Baludih	0.55	2.30	6.85	182	BM	Govt	Domestic
A-33	Mahuda	0.75	2.00	10.80	195	BM	BCCL	Domestic
A-34	Bhatdih	0.55	3.50	24.50	162	Raniganj	BCCL	Domestic
B-1	Muraidih	0.47	1.80	5.35	212	Talchir	Govt	Domestic
B-14	Mathadih	0.76	2.15	3.75	201	Barakar	Govt	Domestic
B-15	Bera Basti	0.55	1.60	2.50	221	Talchir	Dhanu Roy	Domestic
B-21A	Dugdha	0.55	2.10	10.35	220	Metamorphics	Govt	Domestic
B-23	Lohapati	0.26	3.60	10.85	204	Raniganj	Govt	Domestic
B-24	Telmuchu	0.67	4.35	10.83	207	Raniganj	Govt	Domestic
B-25	Mahuda More	0.10	2.45	8.45	205	Raniganj	Govt	Domestic
B-32A	Madhuband	0.80	4.30	8.60	205	Barakar	BCCL	Domestic
B-48	Mahuda	0.65	2.10	11.50	181	Raniganj	Mosque	Domestic
B-51	Taranga	0.00	2.50	5.75	215	Metamorphics	Bisun	Irrigation
B-53	Karmatanr	0.58	2.70	13.25	195	Barakar	Govt	Domestic
B-53A	Karmatanr-Damoda OCP							
B-59	Khodovaly	0.60	2.40	9.30	202	Barakar	BCCL	Domestic
B-60	Bahiyardih	0.77	3.00	15.60	196	Barakar	BCCL	Domestic
B-61A	Kesargora	0.48	2.00	11.20	201	Barakar	BCCL	Domestic
B-62A	Sadariyadih	0.15	3.10	9.50	188	Barakar	Govt	Domestic

Annexure – IIA

Details of Hydrograph Stations (Dug Wells)

Well No	Location	M.P. (agl) in m	Well Dia in m	Well Depth (m bmp)	R.L. (G.L) (m)	Formation	Owner	Utility
B-63	West Mudidih	0.60	1.70	3.35	196	Barakar	BCCL	Domestic
B-64	Keshalpur	0.65	1.10	3.40	195	Barakar	BCCL	Domestic
B-65A	Jhinjipahari	0.95	2.20	12.40	196	Barakar	Shiv Temple	Domestic
B-67	Simatanr	0.55	2.20	11.80	198	Raniganj	Govt	Domestic
D-3	Dhansar	0.60	1.70	8.70	217	Barakar	Govt	Domestic
D-4	Jharia	0.59	1.90	5.73	218	Barakar	Govt	Domestic
D-5	Jiyalgora	0.70	2.80	10.55	183	Barakar	Govt	Domestic
D-7	Golden Pahari	0.67	2.85	10.05	201	Barakar	BCCL	Domestic
D-8	Alokdiha	0.35	1.75	7.57	201	Metamorphics	BCCL	Domestic
D-23	Jogta (Sindra)	0.40	3.10	7.25	205	Barakar	BCCL	Domestic
D-25	Godhar More	0.60	2.75	5.60	219	Barakar	Govt	Domestic
D-30	Borkiboa	0.70	2.00	5.60	221	Talchir	H.Kumbhakar	Domestic
D-33	Kustore-4	0.55	1.85	3.45	196	Barakar	BCCL	Domestic
D-34	Kusunda-7	0.60	1.50	3.45	201	Barakar	BCCL	Domestic
D-35	Patherdih	0.40	2.00	11.20	160	Barakar	BCCL	Domestic
D-36	Sudamdih	0.90	2.00	6.20	141	Barakar	BCCL	Domestic
D-39	Tilabani	0.85	2.00	5.90	178	Barakar	BCCL	Domestic
D-40A	Khapra Dhaora	0.55	1.95	3.70	180	Barakar	Panchayat	Domestic
D-41	Joyrampur	0.50	1.80	4.00	180	Barakar	BCCL	Domestic
D-43	Alagdih	0.45	2.20	8.90	200	Metamorphics	Govt	Domestic
D-47	Parastanr	0.45	3.20	23.80	206	Barakar	BCCL	Domestic
D-49	Goluckdih	0.55	1.80	6.15	192	Barakar	BCCL	Domestic
D-51	Chankuiya	0.55	3.70	11.90	197	Barakar	BCCL	Domestic
D-55	Hariladih	0.48	2.80	11.80	184	Barakar	Govt	Domestic
D-74	Bhulan Barari	0.10	1.60	12.80	173	Barakar	Govt	Domestic
D-77	Rohoniatanr	0.40	3.15	6.70	156	Barakar	Govt	Domestic
D-80	Bastacolla	0.70	2.50	24.95	219	Barakar	Govt	Domestic
DB-22	Nichebasti	0.67	2.40	10.65	121	Barakar	Govt	Domestic
DB-23	Dahibari OC	0.70	2.30	8.00	-	Barakar	BCCL	Domestic
DB-24	Dahibari	0.60	3.60	13.70	125	Barakar	BCCL	Domestic
DB-25	Palasya	0.37	1.55	5.25	127	Barakar	Govt	Domestic

MP: Measuring Point **R.L.: Reduced Level** **W.L.: Water Level m: Meter**

Abn.: Abandoned **b.g.l.: Below Ground Level** **a.g.l.: Above Ground Level**

G.L.: Ground Level **bmp: Below Measuring Point** **BM: Barren Measure**

Annexure – IIB

Historical Water Level data of Hydrograph Stations

Well No	Water level below ground level (bgl) in meters														
	May, 08	Nov, 08	May, 10	Nov, 10	May, 11	May, 12	Nov, 12	May, 13	Nov, 13	May, 14	Nov, 14	May, 15	Nov, 15	May, 16	Nov, 16
A-3	4.67	4.52	4.71	3.57	4.77	4.25	1.87	4.47	4.45	4.67	2.37	3.70	3.42	4.87	0.47
A-12	2.95	1.25	2.82	1.60	2.80	2.80	1.30	3.00	1.17	2.45	1.4	3.00	2.68	2.50	0.70
A-16	4.99	1.58	4.17	1.90	5.80	3.53	1.60	3.80	3.35	5.5	2.9	5.55	4.17	5.85	3.15
A-17	2.54	2.36	2.39	2.37	2.24	2.52	2.34	2.32	1.54	2.19	1.91	3.79	2.64	2.44	2.69
A-18	2.51	1.04	2.49	0.94	2.49	2.59	0.90	2.87	0.91	1.76	1.19	2.84	1.29	1.14	0.89
A19	9.76	2.81	3.61	2.81		9.61	2.46	7.46	4.46	3.00	2.75	3.05	2.75	7.81	4.11
A-20	0.52	1.43	7.42	1.87	7.87	7.17	1.57	6.47	0.67	3.97	2.55	4.59	2.93	7.49	3.50
A22A						1.90	1.05	1.79	1.00	1.50	2.0	3.20	1.96	3.25	1.75
A-23	10.01	5.37	10.67	11.07	11.92	9.87	4.75	10.57	5.82	8.76	6.82	11.3	9.37	11.87	8.13
A-24	18.35	9.13	14.47	15.88	18.28	18.68	5.23	16.01	3.25	16.28	14.98	17.2	14.5	16.62	12.43
A-25	7.12	4.53	7.23	5.10	6.83	10.23	4.43	10.23	2.98	7.03	5.28	7.78	5.85	7.43	4.58
A-26	5.53	4.13	7.77	3.95	9.18	8.76	4.28	7.56	4.28	7.71	4.58	7.73	3.18	8.93	4.48
A-27	1.60	1.20	1.98	1.42	3.00	2.13	1.10	1.62	1.25	1.63	1.55	4.40	3.95	4.85	1.80
A28A	2.92	3.25	3.29	2.73	3.90	2.90	2.45	3.35	2.45	3.29	1.91	4.35	3.60	3.35	1.47
A-29	2.85	1.50	3.80		5.50	9.30	1.42	6.95	1.67	3.3	2.35	4.55	4.60	5.92	6.96
A-32	1.20	1.72	1.95	1.35	2.30	2.19	1.10	2.45	1.95	3.15	2.45	4.41	2.13	4.75	2.10
A-33	1.55	2.73	3.03	1.85	3.07	5.25	1.25	4.13	1.80	4.08	1.57	4.91	1.97	5.75	2.60
A-34	3.05	2.85	2.85	3.77	2.90	6.95	2.90	6.21	2.50	4.45	4.45	8.40	4.81	4.75	4.45
B-1	2.73	1.73	2.43	1.73	1.78	2.08	1.73	1.53	1.83	2.43	1.81	3.28	2.75	3.58	1.93
B-14	2.89	3.02	1.35	1.09	2.49	1.34	1.42	1.74	1.45	3.24	4.44	2.94	2.29	2.44	0.47
B-15	1.37	0.37	1.40	1.38	1.37	1.27	0.45	1.20	0.55	0.95	1.45	1.50	0.45	1.85	0.55
B21A	8.75	4.79	9.15	5.65	7.60	9.00	5.05	8.01	4.95	9.54	3.7	7.37	4.65	5.55	4.50
B-23	5.19	2.22	6.14	3.56	9.14	3.71	1.74	5.27	1.39	6.57	2.74	7.86	4.29	6.81	2.41
B-24	10.51	5.21	9.45	4.95	10.33		3.09	8.88	2.83	9.40	2.21	10.0	5.78	10.63	4.28
B-25	7.95	2.60	5.88	7.00	8.35	8.35	2.60	7.08	2.15	5.82	5.15	6.88	-	7.05	1.70
B32A	7.50	3.36	6.50	4.32	7.80	7.75	3.22	6.25	2.68	8.33	2.05	7.55	3.32	6.95	3.07
B-48	3.70	3.50	4.10		5.75	5.43	3.85	4.69	3.20	6.38	4.35	7.90	5.42	9.35	4.60
B-51	3.90	2.38	3.94	2.38	3.95	3.60	2.05	3.35	2.49	2.09	1.98	4.65	3.40	4.90	3.18
B-53		1.32	1.77	1.72	1.67	6.97	1.42	4.15	1.12	3.39	-	5.58	2.82	4.70	1.45
B-59	3.95	0.45	6.75	1.00	8.25	6.90	0.60	7.56	0.30	2.65	1.0	4.12	1.60	4.40	0.50
B-60	6.13	5.28	10.56	5.24	11.44	10.18	5.13	11.29	5.23	9.82	4.59	9.21	5.28	10.33	5.03
B61A	10.62	2.49	4.96	3.36	10.72	5.42	2.40	8.17	2.02	6.93	3.57	6.15	4.52	6.58	3.87
B62A	8.12	5.95	8.37	7.90	8.85	7.85	4.90	7.73	4.63	8.83	5.85	9.10	5.21	9.30	4.95

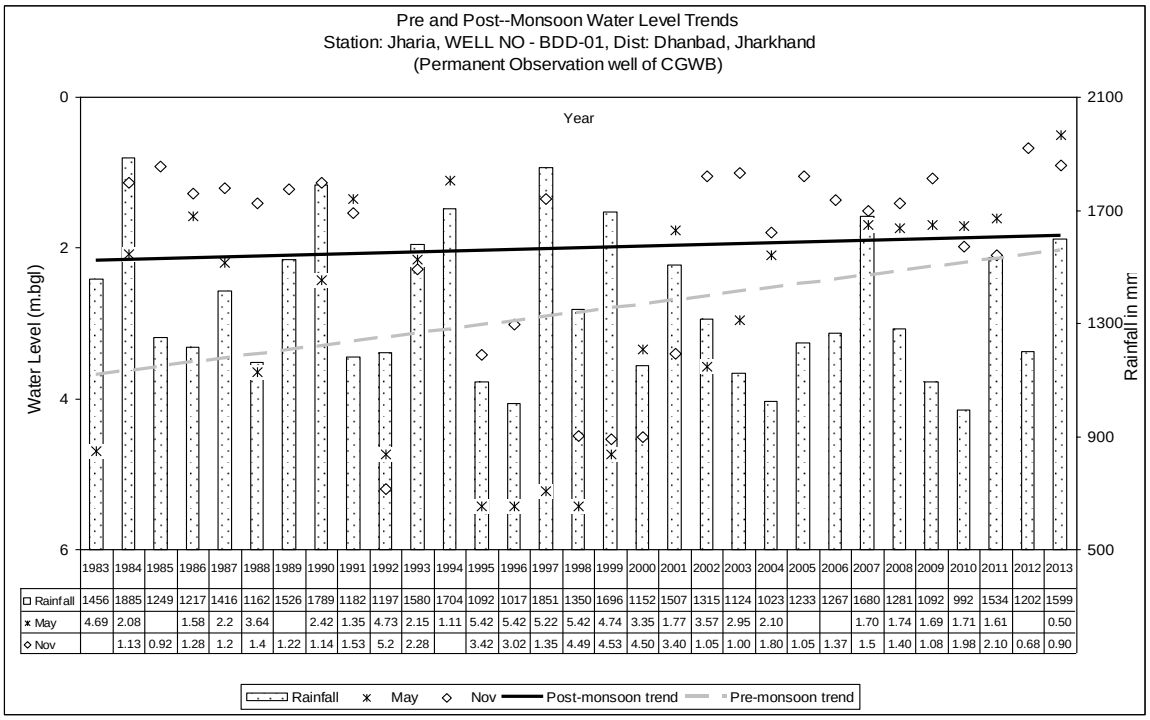
Annexure – IIB

Historical Water Level data of Hydrograph Stations

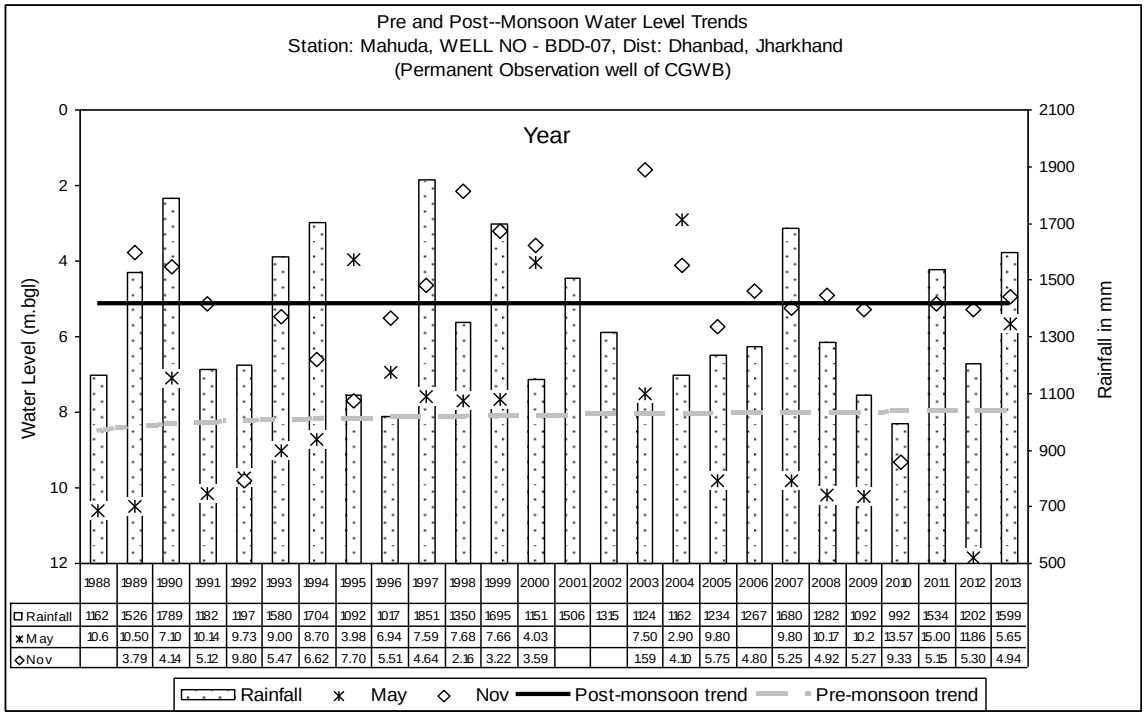
Well No	Water level below ground level (bgl) in meters														
	May, 08	Nov, 08	May, 10	Nov, 10	May, 11	May, 12	Nov, 12	May, 13	Nov, 13	May, 14	Nov, 14	May, 15	Nov, 15	May, 16	Nov, 16
B-63	1.57	0.50	1.03	1.00	1.05	1.09		1.32	0.80	1.22	0.92	2.46	1.40	2.44	-
B-64	0.77	0.75	0.79	1.05	0.85	1.05	1.00	1.35	0.85	0.7	1.15	1.38	0.95	2.35	0.55
B65A	11.53	3.35	11.45	3.39	9.65	11.45	1.73	10.11	1.82	10.45	2.4	7.82	5.87	7.15	2.68
B-67	8.75	6.85	11.00	10.69	11.25	8.55	6.50	9.73	5.31	9.80	3.72	9.23	5.53	9.53	4.30
D-3	3.25	2.20	3.15	2.55	2.55	2.93	1.80	3.45	1.68	2.54	2.11	4.25	2.25	2.35	1.90
D-4	3.13	1.41	2.61	1.46	1.51	1.94	0.91	2.41	0.98	1.23	0.91	2.41	1.27	1.21	1.36
D-5	9.40	7.85	9.05	6.65	9.05	9.50	6.45	9.32	4.59	9.0	7.8	9.37	8.33	9.40	6.40
D-7	9.23	5.23	9.23		9.33	6.08	5.83	7.19	4.63	5.28	5.53	8.25	5.61	7.53	4.03
D-8	6.70	1.87	6.85	6.73	7.75	6.15	3.75	6.65	2.85	7.73	-	6.24	4.38	8.00	3.43
D-23	2.20	1.70	5.85	4.85	6.80	6.00	3.30	6.60	1.20	6.38	2.4	6.55	3.48	5.70	1.63
D-25	4.70	4.75	5.10	2.30	4.70	5.20	3.65	4.26	3.45	4.42	2.9	4.48	2.45	2.40	1.90
D-30	4.70	1.37	2.90	2.23	5.10	3.88	1.80	4.38	3.08	4.17	3.3	4.55	3.15	4.45	3.20
D-33	0.45		0.94	0.70	0.95	2.85	0.35	1.80	0.45	1.72	0.35	2.25	1.10	2.50	1.95
D-34			2.85	2.65	2.85	2.35	2.50	2.50	2.13	2.80	0.30	2.55	1.45	2.30	0.30
D-35	6.25	4.90	7.30	6.15	8.20	8.05	5.55	7.70	4.10	6.94	6.15	9.80	7.90	9.52	6.45
D-36	2.22	0.35	0.85	0.10	1.95	1.55	0.15	1.28	0.80	1.82	0.75	1.66	1.13	0.78	0.95
D-39	4.95	3.85	4.75	3.40	5.05	5.05	3.65	3.98	2.50	5.03	2.25	5.00	2.61	2.18	2.65
D40A	1.97	2.07	2.50	1.65	1.95	2.45	1.70		2.25	2.35	2.45	3.07	2.45	1.40	0.85
D-41	1.70	1.65	1.60	1.55	1.55	1.50	1.50	1.72	1.35	3.20	1.35	2.65	2.32	1.30	1.52
D-43	8.20	3.33	7.95	4.95	7.65	7.05	4.00	6.23	4.05	6.0	4.75	6.61	5.05	8.20	3.35
D-47	4.10	3.60	2.95	2.75	4.35	1.95	2.12	2.60	2.97	8.0	2.37	9.60	3.60	3.18	2.95
D-49	2.77	1.75	1.40	1.81	1.55	1.60	1.65	1.30	1.45	2.51	1.65	3.55	2.35	2.45	1.72
D-51	10.65	7.57	11.03	8.93	10.85	10.00	7.85	8.94	8.35	9.60	9.05	10.48	9.15	11.15	6.45
D-55	2.57	2.42	4.62	2.44	5.97	1.93	1.82	3.90	1.45	1.95	2.07	6.15	1.57	2.52	3.62
D-74	4.32	3.80	4.04	3.80	4.05	4.95	3.60	4.55	3.41	5.0	4.0	10.05	7.20	7.73	5.00
D-77	6.38	5.30	6.40	6.30	6.30	6.50	4.75	4.79	5.10	6.23	6.0	6.44	5.60	4.60	2.90
D-80	16.55	4.10	19.20	3.05	17.45	14.20	3.35	15.25	3.32	13.3	3.15	10.97	3.35	6.55	4.15
RCF (part)		May, 10	Nov, 10	May, 11	Nov, 11	May, 12	Nov, 12	May, 13	Nov, 13	May, 14	Nov, 14	May, 15	Nov, 15	May, 16	Nov, 16
DB22		2.79	2.11	2.90	2.23	2.43	2.38	8.18	2.64	6.48	3.03	4.59	3.53	5.38	3.33
DB23		1.50	2.10	3.25	2.70	2.90	2.33	5.05	3.10	3.95	2.13	3.38	6.04	5.30	0.90
DB24		8.25	8.98						8.25	-	8.45	9.52	8.20	10.65	6.50
DB25		4.09	2.99	4.03	2.13	3.96	1.18	1.33	2.53	3.27	2.73	3.83	2.68	3.61	1.98

Annexure – III

HYDROGRAPHS OF CGWB PERMANENT OBSERVATION STATIONS



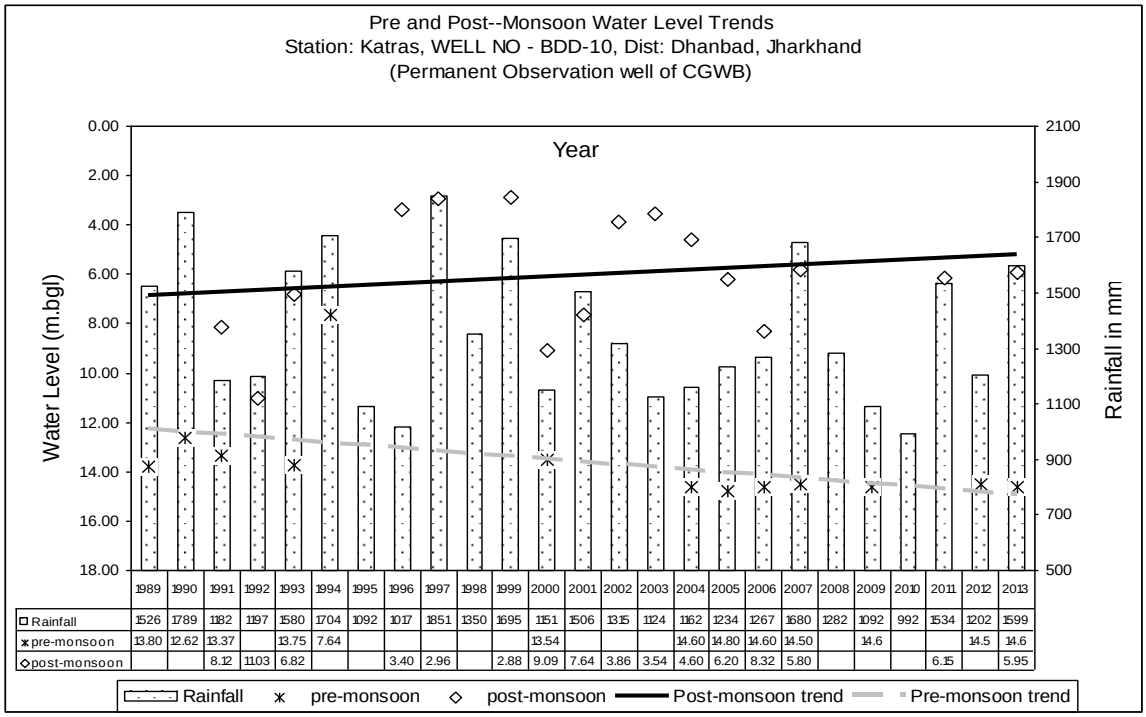
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Rainfall	1456	1885	1249	1217	1416	1162	1526	1789	1182	1197	1580	1704	1092	1017	1851	1350	1695	1152	1507	1315	1124	1023	1233	1267	1680	1281	1092	992	1534	1202	1599
May	4.69	2.08		1.58	2.2	3.64		2.42	1.35	4.73	2.15	1.11	5.42	5.42	5.22	5.42	4.74	3.35	1.77	3.57	2.95	2.10			1.70	1.74	1.69	1.71	1.61		0.50
Nov		1.13	0.92	1.28	1.2	1.4	1.22	1.14	1.53	5.2	2.28		3.42	3.02	1.35	4.49	4.53	4.50	3.40	1.05	1.00	1.80	1.05	1.37	1.5	1.40	1.08	1.98	2.10	0.68	0.90



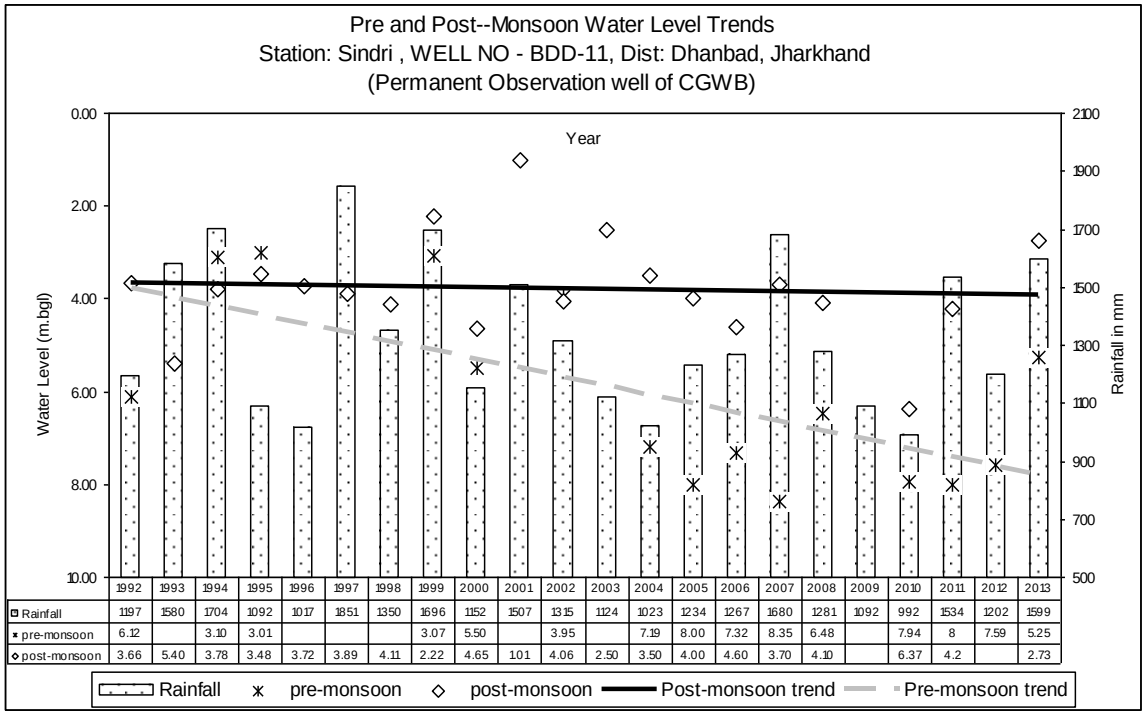
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Rainfall	1162	1526	1789	1182	1197	1580	1704	1092	1017	1851	1350	1695	1151	1506	1315	1124	1162	1234	1267	1680	1282	1092	992	1534	1202	1599
May	10.6	10.50	7.10	10.14	9.73	9.00	8.70	3.98	6.94	7.59	7.68	7.66	4.03			7.50	2.90	9.80		9.80	10.17	10.2	13.57	15.00	11.86	5.65
Nov		3.79	4.14	5.12	9.80	5.47	6.62	7.70	5.51	4.64	2.16	3.22	3.59			1.59	4.10	5.75	4.80	5.25	4.92	5.27	9.33	5.15	5.30	4.94

Annexure – III

HYDROGRAPHS OF CGWB PERMANENT OBSERVATION STATIONS



	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Rainfall	1526	1789	1182	1197	1580	1704	1092	1017	1851	1350	1695	1151	1506	1315	1124	1162	1234	1267	1680	1282	1092	992	1534	1202	1599
pre-monsoon	13.80	12.62	13.37		13.75	7.64						13.54				14.60	14.80	14.60	14.50		14.6			14.5	14.6
post-monsoon			8.12	11.03	6.82			3.40	2.96		2.88	9.09	7.64	3.86	3.54	4.60	6.20	8.32	5.80				6.15		5.95



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Rainfall	1197	1580	1704	1092	1017	1851	1350	1696	1152	1507	1315	1124	1023	1234	1267	1680	1281	1092	992	1534	1202	1599
pre-monsoon	6.12		3.10	3.01				3.07	5.50		3.95		7.19	8.00	7.32	8.35	6.48		7.94	8	7.59	5.25
post-monsoon	3.66	5.40	3.78	3.48	3.72	3.89	4.11	2.22	4.65	1.01	4.06	2.50	3.50	4.00	4.60	3.70	4.10		6.37	4.2		2.73

Annexure – IV

GROUNDWATER SAMPLE LOCATION DETAILS

Sampling month: February, May, August & November month of assessment year'2016

Sl No	Name of Cluster	Ground Water Sample	Dug well (CMPDI)	Location	Sampling Date			
					Feb'16	May'16	Aug'16	Nov'16
1	CLUSTER-I	GW-1	B-15	BERA VILLAGE	28/02	20/05	23/08	23/11
2	CLUSTER-II	GW-2	B-59	KHODOVALY VILLAGE	28/02	20/05	23/08	23/11
3	CLUSTER-III	GW-3	A-29	GOVINDPUR,AMBAGAN VILLAGE	28/02	20/05	23/08	23/11
4	CLUSTER-IV	GW-4	B-63	KESHALPUR, BATIGHAR	28/02	20/05	23/08	28/11
5	CLUSTER-V	GW-5	D-30	BORKIBOA VILLAGE	28/02	20/05	23/08	28/11
6	CLUSTER-VI	GW-6	D-25	GODHUR MORE	28/02	21/05	30/08	28/11
7	CLUSTER-VII	GW-7	D-80	DHANSAR MINE RESCUE STN.	29/02	21/05	30/08	28/11
8	CLUSTER-VIII	GW-8	D-49	NEAR GHANOODIH OC	29/02	21/05	30/08	28/11
9	CLUSTER-IX	GW-9	D-5	JEALGORA, NEAR P.O.	29/02	21/05	30/08	29/11
10	CLUSTER-X	GW-10	D-35	PATHERDIH RLY. COLONY	29/02	21/05	30/08	29/11
11	CLUSTER-XI	GW-11	A-32	MONNIDIH BAZAR	28/02	20/05	24/08	29/11
12	CLUSTER-XIII	GW-13	A-23	MACHHAYARA, BESIDE NH-32	28/02	20/05	24/08	28/11
13	CLUSTER-XIV	GW-14	B-23	LOHAPATTI VILLAGE	28/02	20/05	24/08	28/11
14	CLUSTER-XV	GW-15	B-32A	MADHUBAND VILLAGE	28/02	20/05	24/08	28/11
15	CLUSTER-XVI	GW-16	D-22	DAHIBARI,NICHE BASTI	29/02	21/05	30/08	29/11

Annexure – VA

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: February'2016

Stations: 1. Cluster-I (GW-1), Bera Village, Date: 28/02/2016
2. Cluster-II (GW-2), Khodovaly village, Date: 28/02/2016
3. Cluster-III (GW-3), Govindpur, Date: 28/02/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		1	2	3			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	1	1	2	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	70	79	51	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	130	96	50	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.94	1.11	0.57	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.05	0.06	0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	6	2	2	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.97	8.01	8.17	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	138	152	65	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	312	372	308	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	800	860	570	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	424	532	332	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2	3	3	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.015	0.017	0.016	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV.**

Annexure – VA

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: February'2016

Stations: 4. Cluster-IV (GW-4), Keshalpur Village, Date: 28/02/2016
5. Cluster-V (GW-5), Borkiboa village, Date: 28/02/2016
6. Cluster-VI (GW-6), Godhur, Date: 28/02/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		4	5	6			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	6	3	5	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	66	122	99	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	72	96	94	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.53	0.70	1.14	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.02	0.05	0.04	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	7	4	3	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.90	7.98	8.02	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	66	148	Acceptable	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	142	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{O3}),, mg/l, Max	172	176	364	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	460	900	890	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{O3}), mg/l, Max	236	616	528	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	7	3	7	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.013	0.020	0.017	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VA

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: February'2016

Stations: 7. Cluster-VII (GW-7), Dhansar, Date: 29/02/2016
8. Cluster-VIII (GW-8), Ghanudih, Date: 29/02/2016
9. Cluster-IX (GW-9), Jealgora, Date: 29/02/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		7	8	9			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	<1	3	<1	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	42	78	59	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	90	100	36	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.26	0.66	0.77	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.03	0.04	0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	16	9	5	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.93	8.06	8.26	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	76	88	78	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	152	244	228	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	388	650	420	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	156	408	256	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	<1	5	<1	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.045	0.024	0.018	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VA

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: February'2016

Stations: 10. Cluster-X (GW-10), Patherdih, Date: 29/02/2016
11. Cluster-XI (GW-11), Moonidih, Date: 28/02/2016
12. Cluster-XIII (GW-13), Machhayara, Date: 28/02/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		10	11	12			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	3	4	2	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	120	40	74	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	106	94	140	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.82	0.27	1.01	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.03	0.03	0.06	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	6	17	3	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.71	7.56	8.12	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	178	70	132	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	172	84	308	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.06	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	910	390	790	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	600	160	428	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	3	5	3	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.020	0.04	0.022	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VA

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: February'2016

Stations: 13. Cluster-XIV (GW-14), Lohapatti, Date: 28/02/2016
14. Cluster-XV (GW-15), Madhuband, Date: 28/02/2016
15. Cluster-XVI (GW-16), Dahibari, Date: 29/02/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		13	14	15			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	1	3	4	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	46	53	75	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	82	58	56	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.64	0.58	0.48	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.02	0.03	0.03	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	2	2	12	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.17	8.20	7.92	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	66	75	122	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	248	332	148	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	480	540	580	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	244	348	364	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2	4	6	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.012	0.01	0.149	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VB

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: May'2016

Stations: 1. Cluster-I (GW-1), Bera Village, Date: 20/05/2016
2. Cluster-II (GW-2), Khodovaly village, Date: 20/05/2016
3. Cluster-III (GW-3), Govindpur, Date: 20/05/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		1	2	3			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	5	2	6	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	77	80	96	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	102	56	60	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	1.10	0.73	0.72	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.06	0.07	0.04	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	4	5	4	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.78	8.04	7.81	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	172	230	98	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	336	236	360	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	1070	970	890	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	600	612	488	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	17	4	15	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.01	0.03	0.03	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV.**

Annexure – VB

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: May'2016

Stations: 4. Cluster-IV (GW-4), Keshalpur Village, Date: 20/05/2016
5. Cluster-V (GW-5), Borkiboa village, Date: 20/05/2016
6. Cluster-VI (GW-6), Godhur, Date: 21/05/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		4	5	6			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	2	2	2	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	77	96	83	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	80	96	122	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	1.30	1.04	1.06	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.03	0.05	0.03	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	7	3	6	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.80	8.13	7.49	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	135	156	Acceptable	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	110	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{O3}),, mg/l, Max	224	368	136	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	790	820	620	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{O3}), mg/l, Max	520	496	352	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	6	5	6	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.03	0.01	0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VB

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: May'2016

Stations: 7. Cluster-VII (GW-7), Dhansar, Date: 20/05/2016
8. Cluster-VIII (GW-8), Ghanudih, Date: 21/05/2016
9. Cluster-IX (GW-9), Jealgora, Date: 21/05/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		7	8	9			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	1	1	1	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	130	42	64	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	76	136	52	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.49	0.89	0.29	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.07	0.02	0.04	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	4	17	7	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.16	7.26	7.83	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	104	63	114	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	296	104	128	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	770	460	540	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	560	220	336	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	3	2	3	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.02	0.08	0.03	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VB

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: May'2016

Stations: 10. Cluster-X (GW-10), Patherdih, Date: 21/05/2016
11. Cluster-XI (GW-11), Moonidih, Date: 20/05/2016
12. Cluster-XIII (GW-13), Machhayara, Date: 20/05/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		10	11	12			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	2	2	1	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	54	133	88	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	134	60	38	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.55	0.25	0.65	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.03	0.08	0.03	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	17	7	4	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.10	7.89	8.31	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	61	126	90	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	80	264	504	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.06	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	410	980	480	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	176	724	328	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	5	7	4	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.05	0.06	0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VB

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: May'2016

Stations: 13. Cluster-XIV (GW-14), Lohapatti, Date: 20/05/2016
14. Cluster-XV (GW-15), Madhuband, Date: 20/05/2016
15. Cluster-XVI (GW-16), Dahibari, Date: 21/05/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		13	14	15			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	2	4	3	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	72	109	46	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	80	100	62	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.37	1.03	0.27	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.04	0.07	0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	4	5	11	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.13	7.68	7.74	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	52	167	60	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	404	148	168	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	450	990	370	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	284	640	224	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	6	13	7	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	0.02	0.04	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VC

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: August'2016

Stations: 1. Cluster-I (GW-1), Bera Village, Date: 23/08/2016
2. Cluster-II (GW-2), Khodovaly village, Date: 23/08/2016
3. Cluster-III (GW-3), Govindpur, Date: 23/08/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		1	2	3			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	2	2	3	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	88	64	53	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	70	62	122	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	1.01	1.11	1.06	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.05	0.06	0.05	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	7	12	8	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.26	8.01	7.64	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.002	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	123	224	118	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	212	208	324	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	0.046	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	700	820	780	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	428	424	496	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	3	4	6	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.01	0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV.**

Annexure – VC

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: August'2016

Stations: 4. Cluster-IV (GW-4), Keshalpur Village, Date: 23/08/2016
5. Cluster-V (GW-5), Borkiboa village, Date: 23/08/2016
6. Cluster-VI (GW-6), Godhur, Date: 30/08/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		4	5	6			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	5	4	2	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	56	80	110	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	38	188	154	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	1.34	1.24	1.08	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.04	0.08	0.09	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	6	18	15	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.16	7.79	8.02	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	90	144	Acceptable	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	168	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{O3}),, mg/l, Max	204	252	416	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	380	880	1060	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{O3}), mg/l, Max	172	432	452	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	12	10	4	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.01	0.01	0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VC

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: August'2016

Stations: 7. Cluster-VII (GW-7), Dhansar, Date: 30/08/2016
8. Cluster-VIII (GW-8), Ghanudih, Date: 30/08/2016
9. Cluster-IX (GW-9), Jealgora, Date: 30/08/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		7	8	9			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	2	1	1	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	50	46	92	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	54	52	66	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.37	0.38	1.23	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.04	0.03	0.05	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	0.043	0.059	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	20	18	14	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.55	6.16	7.99	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	62	60	124	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	128	80	280	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	320	340	670	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	176	200	400	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	3	2	2	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.07	0.06	0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VC

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: August'2016

Stations: 10. Cluster-X (GW-10), Patherdih, Date: 30/08/2016
11. Cluster-XI (GW-11), Moonidih, Date: 24/08/2016
12. Cluster-XIII (GW-13), Machhayara, Date: 24/08/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		10	11	12			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	7	3	4	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	82	64	94	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	92	58	68	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.66	0.84	1.09	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.06	0.07	0.05	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	35	4	16	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.12	7.95	7.47	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	110	82	108	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	188	356	268	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.06	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	740	640	700	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	488	456	476	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	15	7	7	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.01	0.02	0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VC

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: August'2016

Stations: 13. Cluster-XIV (GW-14), Lohapatti, Date: 24/08/2016
14. Cluster-XV (GW-15), Madhuband, Date: 24/08/2016
15. Cluster-XVI (GW-16), Dahibari, Date: 30/08/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		13	14	15			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	1	2	2	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	46	67	70	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	50	30	30	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.40	0.81	1.05	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.02	0.03	0.03	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	0.055	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	24	27	30	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	6.55	8.27	7.83	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.002	<0.002	<0.002	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	62	102	108	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	64	260	192	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	320	570	590	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	172	368	364	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2	3	4	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.10	0.01	0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VD

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: November'2016

Stations: 1. Cluster-I (GW-1), Bera Village, Date: 23/11/2016
2. Cluster-II (GW-2), Khodovaly village, Date: 23/11/2016
3. Cluster-III (GW-3), Govindpur, Date: 23/11/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		1	2	3			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	3	3	2	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	59.2	86.4	94.4	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	66	106	88	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.39	0.80	1.00	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	10.19	1.33	2.66	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.35	8.18	8.04	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.002	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	68	136	102	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	128	200	304	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	446	618	704	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	220	440	460	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	4	4	3	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.01	0.01	0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV.**

Annexure – VD

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: November'2016

Stations: 4. Cluster-IV (GW-4), Keshalpur Village, Date: 28/11/2016
5. Cluster-V (GW-5), Borkiboa village, Date: 28/11/2016
6. Cluster-VI (GW-6), Godhur, Date: 28/11/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		4	5	6			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	2	2	3	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	60.8	65.6	51.2	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	76	70	122	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.47	0.81	0.81	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	9.30	1.33	3.10	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.57	8.31	8.51	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	58	41	Acceptable	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	260	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{O3}),, mg/l, Max	156	240	252	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	446	466	834	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{O3}), mg/l, Max	250	260	540	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	4	3	4	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.02	0.02	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VD

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: November'2016

Stations: 7. Cluster-VII (GW-7), Dhansar, Date: 28/11/2016
8. Cluster-VIII (GW-8), Ghanudih, Date: 28/11/2016
9. Cluster-IX (GW-9), Jealgora, Date: 29/11/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		7	8	9			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	3	2	3	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	33.6	110.4	33.6	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	58	64	58	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.19	0.48	0.18	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	0.10	<0.02	0.10	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	9.30	7.09	7.53	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.90	7.93	7.85	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	63	132	63	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	32	228	32	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	278	602	276	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	120	440	120	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	4	4	4	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.13	<0.01	0.12	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VD

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: November'2016

Stations: 10. Cluster-X (GW-10), Patherdih, Date: 29/11/2016
11. Cluster-XI (GW-11), Moonidih, Date: 29/11/2016
12. Cluster-XIII (GW-13), Machhayara, Date: 28/11/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		10	11	12			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	2	3	2	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	112	105.6	115.2	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	64	82	100	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.48	0.51	0.47	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	0.06	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	7.53	2.66	11.96	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.06	8.04	8.11	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	134	230	60	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	220	408	204	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.06	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	602	902	618	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	440	780	480	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	4	3	2	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.01	0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VD

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: November'2016

Stations: 13. Cluster-XIV (GW-14), Lohapatti, Date: 28/11/2016
14. Cluster-XV (GW-15), Madhuband, Date: 28/11/2016
15. Cluster-XVI (GW-16), Dahibari, Date: 29/11/2016

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		13	14	15			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	2	3	3	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	59.2	65.6	76.8	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	68	42	60	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.25	0.34	0.28	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	0.055	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	12.40	0.89	1.77	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.42	8.21	8.02	0.2	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.002	<0.002	<0.002	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	55	90	170	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	124	264	76	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	424	518	428	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	230	370	300	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	4	4	4	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	0.03	0.03	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Abbreviations

AMSL: Above mean sea level

Avg.: Average

APT: Aquifer Pumping Test

BCCL: Bharat Coking Coal Ltd.

bgl: Below Ground Level

Buffer zone: periphery of the 10 km radius from the project boundary

Core zone: Project / mine / colliery boundary (leasehold area)

CMPDI: Central Mine Plan & Design Institute

DVC: Damodar Valley Corporation

DTW: Depth to water level

GW: Groundwater

IMD: Indian Meteorological Division

JCF: Jharia Coalfield

RCF: Raniganj Coalfield

MADA: Mineral Area Development Authority

MCM: Million Cubic Meter

MGD: Million Gallon per day

NTU: Nephlometric Turbidity unit

OC / UG: Opencast / Underground

OCP / UGP: Opencast Project / Underground Project

RL: Reduced Level

RWH: Rainwater Harvesting

FF: Fire Fighting

Bharat Coking Coal Ltd.
(A Subsidiary of Coal India Limited)
Office of the General Manager, Katras Area
P.O. Sijua, P.S.- Jogta, Dhanbad-828121
CIN: U1010JH1972GOI000918
Phone/Fax No.: 0326-2371213
Email ID: cgmkatras@bccl.gov.in

Ref. No. BCCL/KA-IV/ENV/2017/788

Date: - 05.06.2017

REMINDER

To,
The Regional officer
Jharkhand State Pollution Control Board
H.I.G.-1, Sardar Patel Nagar, Hirapur
Dhanbad-826001

Sub: - **Regarding relocating the Ambient Air Quality Monitoring station**

This is in reference to your letter no. 2650, dated 06.07.13 regarding approved locations depicted on the plan indicating Ambient air quality monitoring stations for clusters of BCCL and further ref. letter no. BCCL/DY. GM (Env.)/F-EMP/16/11(A), Dated 05.01.2016 regarding relocating the Ambient air quality monitoring stations for cluster IV of M/s BCCL.

In this regard, it is to be informed that an ambient air quality monitoring at one of the location i.e A-18 (Rudhi Basti) is not being carried out due to lack of security at the monitoring site and further a request was made to relocate the Ambient air quality monitoring stations for cluster IV of M/s BCCL vide reference letter no. BCCL/DY. GM (Env.)/F-EMP/16/11(A), Dated 05.01.2016 and subsequently reference letter no. BCCL/KA-IV/ENV/2017/7943, dated 25.02.2017 regarding approval of monitoring station as katras chautidih in place of Rudhi basti . But, we could not receive any response in this regard. Again you are requested to kindly acknowledge the same as desired.

Thanking you,
Enclosure: - As above

General Manager
Katras Area

Copy to: -

1. Dy. GM(Env.), BCCL
2. O/C

भारत कोकिंग कोल लिमिटेड
एक मिनी रत्न कंपनी
(कोलइंडियालिमिटेडकाएकअंग)
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: U10101JH197OI000918
Environment Department

Ref.No.BCCL/Dy.GM (Env.)/F-EMP/16/11(A) Dated 05-01-2016

To

Regional Officer

JSPCB, Dhanbad

Sub: Regarding relocating the Ambient Air Quality Monitoring station

This is in reference to your letter no.2650 dated 06.07.13 approving the locations depicted on plan indicating Ambient air quality monitoring stations for Clusters of BCCL. In this regard it is to be informed that at one of the Location i.e. A-18 (Rudhi Basti) which is Buffer zone station of Cluster IV, the monitoring at this location is not being carried due to safety and security problems. Therefore, to comply with EC conditions and ensure monitoring of a location instead of A-18 it is requested to relocate the station to some other suitable place.

This is for your kind information and necessary action

Yours Faithfully

Dy.GM (Env)

Bharat Coking Coal Ltd.
(A Subsidiary of Coal India Limited)
Office of the General Manager, Katras Area
P.O. Sijua, P.S.- Jogta, Dhanbad-828121
CIN: U1010JH1972GOI000918
Phone/Fax No.: 0326-2371213
Email ID: cgmkatras@bccl.gov.in

Ref. No. BCCL/KA-IV/ENV/2017/ 7943

Date: - 25.02.2017

To,
The Regional officer
Jharkhand State Pollution Control Board
H.I.G.-1, Sardar Patel Nagar, Hirapur
Dhanbad-826001

Sub: - **Regarding relocating the Ambient Air Quality Monitoring station**

This is in reference to your letter no. 2650, dated 06.07.2013 approving the locations depicted on plan indicating Ambient air quality monitoring stations for clusters of BCCL and further ref. letter no. BCCL/DY. GM (Env.)/F-EMP/16/11(A), Dated 05.01.2016 regarding relocating the Ambient air quality monitoring stations for cluster IV of M/s BCCL.

In this regard, it is to be informed that at ambient air quality monitoring at one of the location i.e A-18 (Rudhi Basti) is not being carried out due to safety and security problems and further a request was made to relocate the Ambient air quality monitoring stations for cluster IV of M/s BCCL vide reference letter no. BCCL/DY. GM (Env.)/F-EMP/16/11(A), Dated 05.01.2016. But, we could not receive any response in this regard. Hence, we have relocated the monitoring station i.e A-37 Chotudih in place of A-18 (Rudhi Basti).

Therefore, you are requested to kindly approve the relocated monitoring station as **A-37 Chotudih.**

Enclosure: - As above

25/02/17

Area Manager (Env.)
Katras Area

Copy to: -

1. General Manager, Katras Area
2. Dy. GM(Env.), BCCL

DEPARTMENT OF ENVIRONEMNAL SCIENCE & ENGINEERING
(CENTRE OF MINING ENVIRONMENT)
INDIAN INSTITUTE OF TECHNOLOGY (INDIAN SCHOOL OF MINES), DHANBAD – 826004

ESE/BCCL/ENV/01/2017-18

Date: 25.05.2017

Analysis Report of ambient air sample of BCCL Katras Area
Time 1: 18.04.2017 to 19.04.2017
Time 2: 02-05-2017 to 03-05-2017

	Pollutants	Concentration in Ambient Air								NAAQS Standards 2009 in Ambient Air	
		Ramkalani		Chatudih		Govindpur		Nichitpur			
		Time1	Time2	Time1	Time2	Time1	Time2	Time1	Time2		
1	Sulphur Dioxide (SO_2), µg/m³	24.12	23.06	27.06	25.06	22.45	30.75	21.64	22.36	24 Hours	80
2	Nitrogen Dioxide (NO_2), µg/m³	30.15	34.59	36.90	47.83	63.45	49.47	51.25	43.33	24 Hours	80
3	Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	88.20	86.36	95.8	94.88	96.3	98.87	98.9	99.31	24 Hours	100
4	Particulate Matter (Size less than 2.5µm) or PM2.5, µg/m³	55.30	55.17	55.12	58.11	56.47	56.43	59.95	59.8	24 Hours	60
5	Ozone (O_3) µg/m³	132	120	174	173	188	198	183	183	1 Hour	180
6	Lead (Pb) µg/m³	0.025	0.027	0.063	0.067	0.45	0.65	0.26	0.24	24 Hours	1
7	Carbon Monoxide(CO), mg/m³	0.229	0.115	1.26	1.031	1.603	1.718	0.916	0.802	1 Hour	4
8	Ammonia (NH_3), µg/m³	12.73	16.19	25.92	23.04	19.51	30.18	18.03	21.35	24 Hours	400
9	Benzene (C6H6), µg/m³	2.1	2.4	2.4	2.3	4.1	4.2	3.6	3.4	Annual	5
10	Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	0.60	0.62	0.60	0.70	0.95	0.90	0.85	0.85	Annual	1
11	Arsenic (As), ng/m³	0.021	0.019	0.023	0.02	0.045	0.042	0.032	0.031	Annual	6
12	Nickel (Ni), ng/m_3	0.045	0.044	0.052	0.053	0.074	0.076	0.058	0.056	Annual	20

Dr Manish Jain
AP/ESE

Dr Suresh Pandian E
AP/ESE

Dr. Manish Kumar Jain,
Associate Professor
Department of Environmental Science and Engineering
Centre of Mining Environment
Indian Institute of Technology (ISM), Dhanbad
Dhanbad-826004, Jharkhand

Dr. Suresh Pandian E
Assistant Professor
Dept. of Environmental Science & Engineering
(Centre of Mining Environment)
Indian Institute of Technology
(Indian School of Mines), Dhanba
Jharkhand-826004, Indi

Annexure-7

Sl. No.	Environmental Measures Activity at Cluster Iv for FY 2016-17	Cost Incurred (In Lakhs)	
		Capital	Recurring
1	Plantation from DFO	10.15	
2	Environmental Monitoring (Air, water and noise)		12
3	Subsidence Management		5
4	FRI Dehradun Monitoring Cost		2.138
5	Ecological Restoration		45
6	Fire covering/blanketing/fighting		468
7	Water Sprinkling		280
8	Water treatment plant		312
Total Cost Incurred (Manpower cost and Diesel cost is included)		**10.15**	**1124.138**
Grand Total		**1124.138 Lakhs**	

General Manager
Katras Area

30/5/17
AM(Env)
Katras Area

Sl. No.	Environmental Meaures Activity at Cluster Iv for FY 2015-16	Cost Incurred (In Lakhs)	
		Capital	Recurring
1	Plantation from DFO	20.6	
2	Environmental Monitoring (Air, water and noise)		2.255
3	Concrete pitching and embankment construction	700	
4	Construction/ Maintenance of toe wall	8.56	
5	Subsidence Management		12
6	FRI Dehradun Monitoring Cost		2.138
7	Ecological Restoration	4	126
8	Fire covering/blanketing/fighting		471
9	Water treatment plant		320
10	Water Sprinkling		235
Total Cost Incurred (Manpower cost and Diesel cost is included) (Manpower cost and Diesel cost is included)		733.16	1168.393
Grand Total		**1901.553 Lakhs**	

PO
GTC/ KCC

PO
AARC/ACWMC

PO
SPC

AFM
KATRAS AREA

General Manager
Katras Area

Sl. No.	Envirnmental Measures Activity at cluster Iv for FY 2014-15	Cost Incurred (In Lakhs)	
		Capital	Recurring
1	Scientific study for delineation of fire at Gaslitand Colliery		11.236
2	Scientific study for delineation of fire at J.K. Section		0.975
3	EMP Preparation	40	
4	Environmental Monitoring (Air, water and noise)		9.855
5	Subsidence Management		10.8
6	FRI Dehradun Monitoring Cost		0.855
7	Ecological Restoration	3.5	71.5
8	Fire covering/blanketing/fighting		455
9	Water treatment plant		312
10	Water Sprinkling		180
Total Cost Incurred (Manpower cost and Diesel cost is included)		43.5	**1052.221**
Grand Total		**1095.721 Lakhs**	

PO
GTC/KCC

PO
AKUHC/AARC

PO
SPC

AFM
KATRAS AREA

General Manager
Katras Area

CLUSTER - IV

ADMINISTRATIVE CONTROL : KATRAS AREA

PRODUCTION CAPACITY (T) : 2.851 MT (Norm), 3.706 MT (Peak)

EC Order issued vide OM No : J-11015/212/2010-1A.11 (M), Dated-06.02.2013

Name of Area	Production (T)		Lease Hold Area
	OC (MTe)	UG (MTe)	
Katras Area	2.886	0.306	1123.79

Concentration Values of Environmental Parameters Monitored

Water Parameters (mg/l)	Noise (dB)	Air Parameters (µg/m³)
pH - 8.5	61.3	NO_x - 24
TSS - 28		SO_2 12
COD - 24		PM_{10} - 86
Oil and Grease - <2		$PM_{2.5}$ - 45