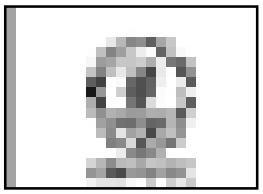
Mine Plan

APPLICANT

West Bengal Power Development Corporation Limited



3/C, LA-BLOCK, FLOOR-II, SECTOR-III, SALTLAKE CITY

KOLKATA-700 098

Revised Mining Plan (1st Revision)

For

Barjora North Coal Mine

(lease area 260.14 ha)

Barjora Coalfield, Bankura District

West Bengal

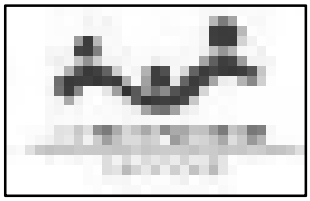
Prepared by

Vijay Kumar Singh

RQP. (No. 34012/ (03)/2014- CPAM; Dt. 29.05.2015)
Hill top, Mahalla-Chandwe,
Kanke Road, Ranchi-834008
Jharkhand

VOLUME 1
AUGUST, 2017

CONSULTANT
United Exploration India Private Limited



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1.1 The Company:

Office of the nominated Authority constituted under section 6 of the Coal Mines (Special provisions) second Ordinance, 2014 issued Allotment Order under Clause no. (c) of sub rule 7 and sub-rule (1) of rule 13 with following details:

In re: Barjora (North) Coal Mine ("the mine") particulars of which is specified in **Annexure-I.**

Order No. : 103/7/2015/NA.

Date: March 31, 2015.

In favour of: The west Bengal Power Development Corporation Limited incorporated in India under the Companies Act, 1956 with Corporate identity number U 40104WB1985SGC039154 whose registered office is at 3/C, LA-Block, Sector-III, Salt Lake, Kolkata, West Bengal – 700 098, India ("the allottee"). The company is State Government undertaking. The address for Correspondences for the west Bengal Power Development Corporation Limited (WBPDCL) is given below:

The West Bengal Power Development Corporation Ltd. (WBPDCL)
Bidyut Unnayan Bhaban.
Plot No. 3/C, LA-Block ,
Sector–III , Floor- IInd.
Salt Lake City.
Kolkata – 700098.

1.2 Location of the End Use Plants:

The coal of Barjora North Mine is for Utilisation in: End Use Plants situated at;

1. STPS, Santaldih, Purulia district.
2. KTPS, Mecheda, Purba Medinipur district.
3. BKTPP, Bakreswar, Birbhum district.
4. BTPS, Tribeni, Hoogly district.
5. SgTPP, Manigram, Murshidabad district.

Details of the end use plant capacities and configuration are given hereafter in Table no. 1.1.

Table No. 1.1

Detail configuration and Plant Capacities of the thermal power stations of West Bengal Power Development Corporation Limited.

S. L. No.	Name of Specified End Use Plants	Address	Configuration	Capacity	Existing or Proposed
1.	Santaldih Thermal Power Station.	Santaldih, Purulia, West Bengal – 723146.	2 x 250 MW	500 MW.	Existing.
2.	Kolaghat Thermal Power Station.	Mecheda, Medinipur, West Bengal – 721137.	6 x 210 MW	1260 MW.	Existing.
3.	Bakreswar Thermal Power Plant.	Birbhum, West Bengal –731104.	5 x 210 MW	1050 MW.	Existing.
4.	Bandel Power Station.	Tribeni, Hoogly, West Bengal – 712503.	4 x 60 =240 MW 1 x 210 = 210 MW	450 MW.	Existing.
5.	Sagardighi Thermal Power Plant; Unit 1 & 2.	Manigram, Murshidabad, West Bengal – 742237.	2 x 300 MW	600 MW.	Existing.
	Sagardighi Thermal Power Plant – Unit 3 & 4.	Manigram, Murshidabad, West Bengal – 742237.	2 x 500 MW	1000 MW.	Existing.

1.3 Coal Requirement for the End Use Plants:

The annual coal requirement for these units is given below in table no. 1.2.

Table No. 1.2

Coal requirement for the existing power plants of WBPDCL.

The above table shows normative calculation of coal requirement based on the average GCV of coal on G-9 Grade. However, due to change in operational environments of the power plants, PLF's may vary which may result in changes in the coal requirement.

1.4 Coal Supply for the plants:

As can be seen from the table no. 1.2, the coal requirement for the end use plants of WBPDCL comes to 19.45 MTPA considering G-9 grade of coal. At present coal is being sourced from the different subsidiaries of CIL through linkages as well as through e-auction.

It is envisaged to supply coal of 3.0 MTPA from this mine to the different operational end use plants of WBPDCL. Remaining requirement of coal will be fulfilled either from the other mines or through existing coal linkages with CIL. The existing linkages will remain operational for the power plants.

1.5 Coal Beneficiation:

No ROM coal beneficiation is envisaged.

1.6 Mineral Which Applicant intends to Mine:

Intended mineral to be mined is Coal.

1.7 Name and Address of RQP preparing Revised Mining Plan:

Vijay Kumar Singh
Hill Top, Mahalla - Chandwe.
Kanke Road, Ranchi – 834008.
Mobile No.: +91-8226865342.
Email id: vijay7143@gmail.com
Registration No. : 34012/03/2014- (CPAM). Dt. 29th May, 2015. (Renewal).
Valid Till: 28th May, 2025.
RQP certificate issued by Ministry of Coal Attached as **Annexure-3.**

1.8 Name of the Prospecting Agency:

Geological Report of Barjora Coal Block was prepared by Central Mining Planning & Designing Institutes Limited by its Regional Institute-I, Asansol.

2.1 Approval of Earlier Mining Plan:

The earlier mining plan was prepared by Shri. S. C. Chatterjee, (Registration No. 38011/4/2002 CA dt. 17.10.2002; valid for 10 years) and approved by Ministry of Coal vide their letter no. 47011/4/2003-CA-I; dt. 24-08-2006. Copy of the Mining Plan approval letter is furnished as **Annexure-4.**

2.2 Need for Revised/Modified Mining Plan:

To obtain/ transfer the Environmental Clearance for Barjora North Coal mining project granted to prior Allottee M/S DVC-Emta Coal Mines Limited vide MOEF's letter no. J-11015/312/2007-1A.II (M); dt 13/03/2008 (furnished in **Annexure -5**), WBPDCL applied to MOEF & CC for transfer of the same to restart the production. In this regard, Ministry of Coal Vide their letter no. Nil, dt. November, 2016, (furnished in **Annexure-6)** stated that MOEF & CC has advised to submit separate mining plan for forest and non forest areas of Barjora North Coal Mine.

This revised mining plan is thus proposed for mining operation within 260.14 ha of leasehold land (non forest area).

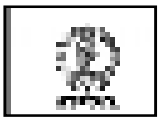
2.3 Details of the Approved Mining Plan(as per item 4 of checklist):

Details of earlier approved mining plan is furnished below in Table no. 2.1.

Table No. 2.1

Details of the earlier mining plan.

S.L.No.	Particulars	Descriptions/ Comments
a.	Date of approval	Mining Plan approved by MOC,GOI on 24th August, 2006, vide their letter no. 47011/4/2003-CA-I; for total allotted block area of 800 ha.
b.	Conditions, if any	Provided in Table no. 2.2.
c.	Scheduled year of start of production	Actual year of Production commencement is 2011 by previous allottee. Present applicant i.e. M/S WBPDCL will start within three months of receipt of clearances from authorities.
d.	Proposed year of achieving the targeted production	4th year (after the start of mine.)



<table>
<tr><th>S.L.No.</th><th>Particulars</th><th>Descriptions/ Comments</th></tr>
<tr><td>e.</td><td>Date of actual commencement of mining operations, if operations already started</td><td>Year 2011. Mining operation continued till 31st March, 2015 by previous allottee. Since then it is stopped.</td></tr>
<tr><td>f.</td><td>Likely date of mining operations, if operations not yet started & reasons for non-commencement of operations.</td><td>Production started in the year 2011.</td></tr>
<tr><td>g.</td><td>Planned production and actual levels achieved in last 3years (Coal in Mte, OB in MM3, SR in M3/te).</td><td>Planned production was 11.37 MTES as in the per the calendar program of the approved mining plan for first four years of mine life. Actual production was 6.11 Mte during this period.
<table>
<tr><th></th><th></th><th colspan="2">Planned</th><th colspan="5">Actual Coal Production "Mte"</th></tr>
<tr><th></th><th>Calendar Year</th><th>Coal</th><th>OB</th><th>UG</th><th>OC</th><th>Total Mte</th><th>OB MM3</th><th>SR</th></tr>
<tr><td>Y-1</td><td>2010-11</td><td>0.77</td><td>3.18</td><td rowspan="5">NA</td><td rowspan="5">6.11</td><td rowspan="5">6.11</td><td rowspan="5">27.56</td><td rowspan="5">4.51</td></tr>
<tr><td>Y-2</td><td>2011-12</td><td>1.6</td><td>7.04</td></tr>
<tr><td>Y-3</td><td>2012-13</td><td>3</td><td>12.02</td></tr>
<tr><td>Y-4</td><td>2013-14</td><td>3</td><td>15.52</td></tr>
<tr><td>Y-5</td><td>2014-15</td><td>3</td><td>15.24</td></tr>
</table>
Coal: Opencast- 6.11 Mte.
OB: 27.56 Mcum.
SR: 4.51 M3/ te.</td></tr>
<tr><td>h.</td><td>Reasons for difference between the planned and actual production levels</td><td>Not known from prior allottee.</td></tr>
</table>

2.4Compliance Conditions imposed if any with Approval of Mining Plan:

The approval of mining plan of Barjora North Coal block involves the conditions imposed by Ministry of Coal vide their letter no. 47011/4/2003-CA; dt. 24.08.2006 (**Annexure-4**) is given in table no. 2.2.

Table No. 2.2: Compliance Status of the Conditions imposed in the approval of the mining plan.

S.L. No.	Conditions Imposed	Compliance Status
1.	If the detailed geology of the proposed external OB dump area is not available to the effect that such area is non coal bearing, the mining company shall explored by drilling additional boreholes under the supervision of CMPDIL before placing overburden dump there and should coal occurrence reported within 300 meter depth, a revised mining plan should be submitted with alternative external dump site.	No external dumping has been undertaken and neither it is proposed in this revised mining plan.
2.	Deduction of 7 Mt reserves which has been excluded on account of bands should also be included in extractable reserves unless the exclusion is vetted by CMPDIL.	The matter has been taken up with CMPDIL and request letter submitted for carrying out the exercise. Outcome of the exercise will be intimated to MOC with due addendum if required. Letter submitted to CMPDIL is furnished in **Annexure- 4A.**
3.	The approval of the mining plan is without prejudice to the requirement of approvals from competent / prescribed authority under the relevant rules/regulations etc.	Shall be complied with.

2.5 Mining Operations:

The mine has already commenced operation in the year 2011 and till the re-allotment to the West Bengal Power Development Corporation Limited, prior allottee have produced about 6.11 Million tons of coal and about 27.56 Million Cum of overburden. The complete activity was restricted within the leasehold non forest area of 260.14 ha. Commencement of mining operation done with due approval from office of the Coal Controller, Kolkata vide their letter no. CC/Tech/opn. Perm/Barjora (North)/DVC EMTA/10-11; dt. 25.01.2011 and is furnished in **Annexure no. 7.**

3.1 Location of the Coalfield:

The Barjora Coalfield (Latitudes 23°23'N to 23°28' N and Longitudes 87°12'E to 87°18'18"E) identified by the Geological Survey of India during 1951-54 is located on south of the Damodar river outside the known limits of the Raniganj coalfield.

3.1.1 Location of the Block:

The Barjora North Block of Barjora Coalfield lies South of Damodar River. The bounding coordinates as per vesting order (with corrigendum 01 as furnished in **Annexure 1A**) is as given below:

Latitude: 23°25'59.238" N – 23°27'42.094"N
Longitude: 87°13'17.106"E – 87°15'26.268"E

The area is covered under survey of India Toposheet nos. F45 D3 (earlier 73 M/3) and F45 D7 (earlier 73 M/7) in RF – 1:50,000.

The block administratively falls under the jurisdiction of Barjora Police Station of Bankura district in the West Bengal state.

The certified geological block boundary as per the vesting order is also furnished in **Plate No. 2.**

3.1.2 Block boundary:

Barjora North block boundary is demarcated along the following limits-

North: An arbitrary line passing 20m north of borehole no. BOR/MA/047 and 60m north of Borehole no. BOR/MA/60.

East: Fault F1-F1 and incrop of Seam-I in the eastern side.

South: 2000 (s) grid line which is also the northern boundary of Barjora South Block.

West: Incrop of Seam-V in the area north of fault F3-F3 and in-crop of Seam-I in the area south of fault F3-F3.

A general location map of the Barjora North Coal block with respect to India and West Bengal is depicted in Figure No. 3.1.

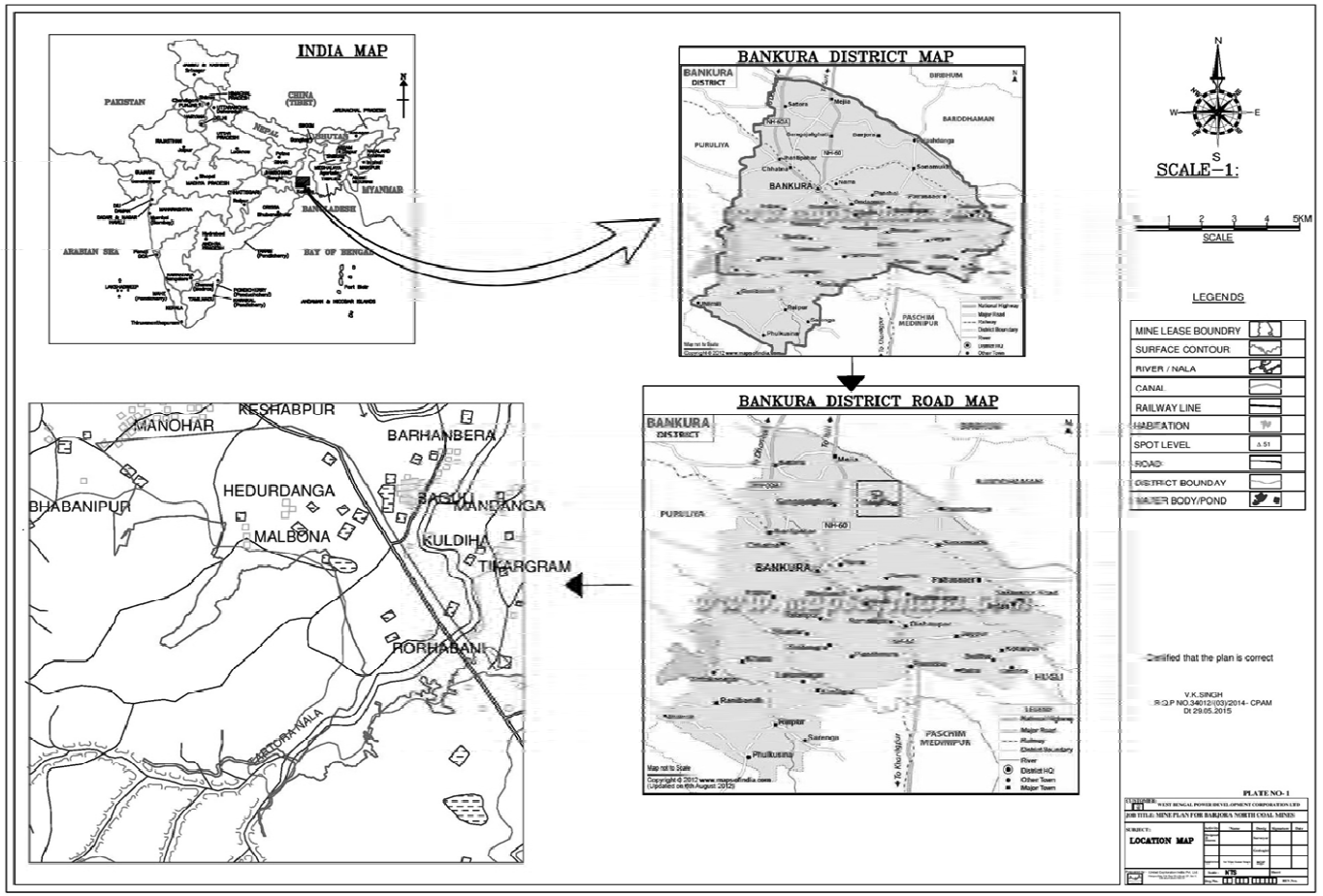


Figure No. 3.1: General Location Map of Barjora North Coal Block.

3.1.3 Lease Boundary:

Mining lease has been granted for 260.14 ha of non forest land against the applied area of 663.00 ha.

The northern boundary of the lease area merges with the geological block boundary.

The eastern boundary of the lease is guided by the western edge of the metalled road joining Barjora and Mejia.

The southern and western boundary is guided by the existing forest land and the industrial land of WBIDC.

Corner points for the mining lease boundary have been further worked out and furnished below in Table No. 3.1.

Table no. 3.1

Corner Points for the Leasehold boundary for 260.14 ha.

Point No.	Latitudes	Longitudes
01	23°27'40.911"N	87°14'24.501"E
02	23°27'35.524"N	87°14'37.254"E
03	23°26'45.888"N	87°15'10.753"E
04	23°26'30.091"N	87°15'3.16"E
05	23°26'17.805"N	87°14'40.952"E
06	23°26'15.398"N	87°14'26.508"E
07	23°26'11.783"N	87°14'16.661"E
08	23°26'17.486"N	87°14'14.628"E
09	23°26'19.652"N	87°14'21.701"E
10	23°26'21.403"N	87°14'28.479"E
11	23°26'31.598"N	87°14'36.543"E
12	23°26'40.919"N	87°14'41.987"E
13	23°27'5.059"N	87°14'35.452"E
14	23°27'11.847"N	87°14'31.455"E
15	23°27'11.243"N	87°14'24.596"E
16	23°26'56.795"N	87°14'5.556"E
17	23°26'46.331"N	87°13'54.509"E
18	23°26'48.838"N	87°13'52.292"E
19	23°26'54.754"N	87°13'58.659"E

Point No.	Latitudes	Longitudes
20	23°27'8.148"N	87°14'7.533"E
21	23°27'17.32"N	87°14'8.057"E
22	23°27'17.56"N	87°14'4.496"E
23	23°27'18.881"N	87°13'59.988"E
24	23°27'19.545"N	87°13'52.361"E
25	23°27'18.629"N	87°13'46.021"E
26	23°27'9.101"N	87°13'40.707"E
27	23°27'19.582"N	87°13'40.487"E
28	23°27'26.362"N	87°13'46.057"E
29	23°27'36.627"N	87°13'36.132"E

Fig. 3.2 shows the geological block boundary and the mining lease boundary and the same has been furnished in **Plate No. 2A.**

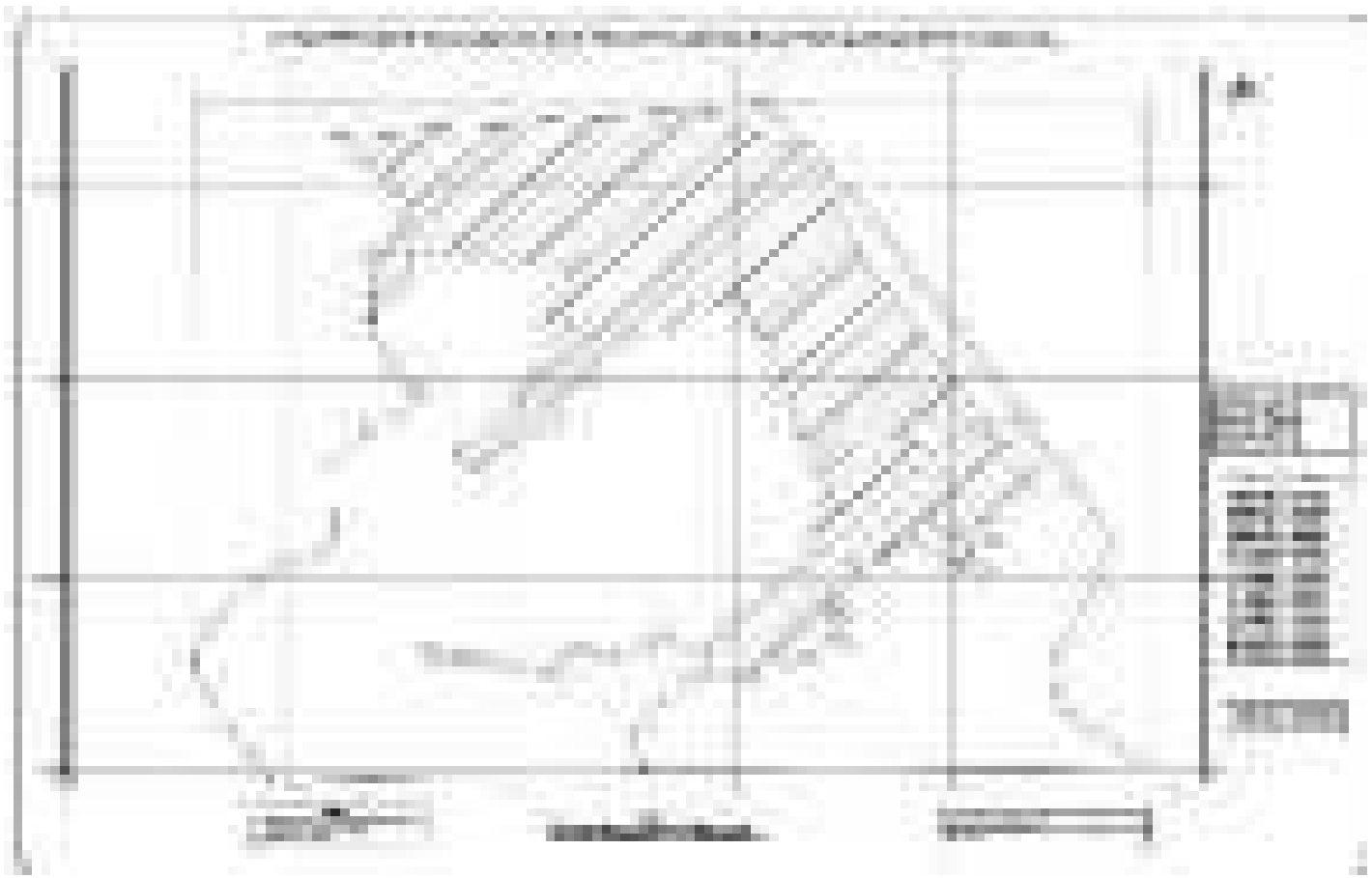


Figure No. 3.2: Figure showing the Geological Block Boundary and Mining Lease boundary of Barjora North Coal Mine.

3.2 Physiography and Drainage:

The area is characterized by gently undulating topography with the elevation ranging from 70m to 106 m above mean sea level. The general slope of the terrain is towards east and north-east direction.

The main drainage of the area is controlled by the Damodar River which flow about 5 kms. north of the coalfield. Tartora nallah with a north-easterly flow forms the main drainage within the block with seasonal surface flow.

However, Tartola nallah is not going to be affected in this proposed mining plan.

3.3 Climate:

The temperature in winter broadly remains within 15°c to 22°c and in the summer the temperature varies from 25°c to 43°c. The annual rainfall is around 1380 mm as per IMD data for the region as obtained from the nearest Meteorological Station at Durgapur.

3.4 Communication & Accessibility:

The nearest railway station from Barjora Coalfield is Durgapur at a distance of 10 km, located on the Howrah – Delhi main line of Eastern Railway.

Barjora Block is connected to Durgapur by a metalled road via Durgapur Barrage. An all-weather metalled road connecting Barjora (lying on the Durgapur-Bankura State Highway - 9) and Saltora passes almost along the north-eastern boundary of the Barjora Coalfield.

3.5 Availability of Power supply:

All HEMM proposed for this project, are diesel operated equipment. Hence, quarry power requirement is only for quarry lighting and haul road lighting, besides catering to the electrical load requirement for Workshop, pumping and office. Required power will be drawn from WBSEDCL.

3.6 Availability of water supply:

Accumulated water in the mine pit will be utilized for the plantation, water sprinkling and other workshop usage while water for domestic need will be catered through existing tube wells in the mine site.

3.7 Ownership/ Occupancy of land:

This revised mining plan involves the leasehold area of 260.14 ha. This is all non forest land which has already been purchased by prior allottee and transferred to WBPDCL by virtue of the vesting order no. 103/07/2015/NA; dt. 31st March, 2015.

3.8 Involvement of Forest land:

The Barjora north coal block covering 800 ha is comprising about 357.16 ha of forest land. However, this revised mining plan is being limited to leasehold area of 260.14 ha of non forest land as directed by Ministry of Coal, vide their letter no. nil, dt. November, 2016. **(Annexure-6).**

3.9 Present land use details:

Mining operation has been carried out by prior allottee in the non forest area within the leasehold area of 260.14 ha.
About 103.42 ha of land was excavated out of which about 39.49 ha has already been backfilled after de-coaling. Balance void area consists of 63.93 ha of land. A soft dump cover about 5.86 ha land while mine infrastructure including office and coal stack yard cover about 12.61 ha of land.

Total unutilized land within the leasehold area of 260.14 Ha comes about 114.75 ha. Mining activity in this Modified period will be restricted within 260.14 ha.

The table no. 3.2 given present land uses of 260.14 ha of the mining plan area.

Table No. 3.2

Present Land Use pattern of the 260.14 ha of non forest leasehold area.

S. L. No.	Land Use Category	Pre Mining (ha)
1	Mined out Voids .	63.93
2	De-coaled waste filled Area	39.49
3	Soil & Sub soil Storage Area	5.86
4	Infrastructure areas	9.11
5	Other Built Up areas	5.61

6	Safety Zone	17.89
7	Coal Stack Yard	1.25
8	Office and VT Centre	3.50
9	Road	2.55
10	Access Trench	0.65
11	Water Body	1.67
	* **Sub Total =**	**151.51**
12	Unutilised Areas	108.63
	Total =	**260.14**

3.11 Need for Shifting of 220 KV Mejia-Barjora Power Line:

An existing 220 kv power line belonging to Damodar Valley Corporation (DVC) passes through the eastern and northern part of the Barjora North Coal Block. The same needs to be diverted to have smooth and safe mining operation in this Modified period. WBPDCL has already applied to DVC for diversion of this line, vide their letter no. WBPDCL/Director (Mining)/166; dt. 6th January, 2017. The copy of the letter is furnished in **Annexure-8.**

4.0 Geology & Exploration:

The Barjora North Coal Block of Barjora Coalfield is distributed over villages, namely Manohar, Baguli, Ghutgoria, Sitarampur, Sarjora, Tikargram and Barpukhuria villages. The coalfield was named after major village Barjora in the area which administratively falls under the Bankura district of West Bengal and confined within the southern side of the Damodar River. The coalfield appears to be a detached and localized depression within the archean metamorphics in which Lower Gondwana sedimentaries were accumulated and preserved, which at present, has formed an outlier on crystalline metamorphic basement.

The coalfield was initially regionally explored by Geological Survey of India (G.S.I) during the period March, 1956 to November, 1957 and a total of 26 nos. of boreholes were drilled over an area of 59.0 Sq. km. existence of 9 carbonaceous horizons were established during the investigations.

The block was further taken up for detailed investigation when search of open-castable reserve were in great need to cater the need of Mejia Power Plant. The detail exploration has been taken up by CMPDI during the period September 82 to September, 87. A total meterage of 10,060.60 meter drilling have been done to complete total 96 nos. of boreholes. Out of 96 boreholes, 64 boreholes were falling within the Barjora North Coal Block, while remaining was falling in Barjora South Coal Block. The total meterage done within Barjora North Coal Block was 6299.60 meter. Overall borehole density within the Barjora North Coal Block comes to 8.0/ Sq. km. Out of the 64 boreholes within the block area, 25 number of boreholes are falling within the leasehold area of 260.14 ha with an overall borehole density of 9.61 BH/Sq. KM. List of boreholes falling within the leasehold area is depicted below.

BOR/MA/047	BOR/MA/063	BOR/MA/071	BOR/MA/076	BOR/MA/058
BOR/MA/060	BOR/MA/033	BOR/MA/015	BOR/MA/017	BOR/MA/068
BOR/MA/025	BOR/MA/059	BOR/MA/028	BOR/MA/074	BOR/MA/016
BOR/MA/066	BOR/MA/038	BOR/MA/039	BOR/MA/054	BOR/MA/014
BOR/MA/024	BOR/MA/065	BOR/MA/010	BOR/MA/027	BOR/MA/045

Graphic lithologs of the boreholes falling within the leasehold area are depicted in **plate no. 6E, 6F & 6G.**

The geological plan and section of the block along with the borehole locations is furnished in **Plate no. 3**&**Plate no. 7** respectively. Geological plan of the lease area is furnished in **Plate No. 3A.**

The detailed sub surface investigations carried out by the CMPDIL in Barjora North Coal Block established a thickness of around 160 m for the sedimentary of Barakar formation contained therein.

Based on the regional and detailed exploration within the Barjora North Coal Block G.S.I and CMPDIL, the stratigraphic sequence of Barjora Coalfield is furnished below in table no. 4.1.

Table No.4.1

Stratigraphic Sequence of Barjora Coalfield.

Age	**Formations**	**Lithology**
Recent	Alluvium/Soil	Loose to sub-consolidated, light to reddish brown soil and sandy soil.
Quaternary	Laterite	Brown to dark brown, porous heterogeneous assemblage of iron and manganese rich materials.
Unconformity		
Permian/Lower Gondwana	Barren measures	Dark grey/Ironstone shale.
	Barakar formation	Sandstone, shale, carb. Shale and coal seams.
	Talchir Formation	Greenish shale, carb. Shale and argillaceous sandstone, greenish in colour.
Unconformity		
Pre-cambrian	Archeans	Granite, gneiss with mica schists, quartzite etc.

4.1 Description of the Formations:

4.1.1 Alluvium and Laterites:

Extensive lateritic cover in the form of thin capping associated with loose masses of sub-rounded quartz gravels and gritty sandstone occurs in Barjora Coalfield. The alluvial cover along with the weathered/detrital mantle, which is extensive and thick at places, varies by loose sand/clay as well as oxidized (iron rich) reddish sandstone. The feldspathic content being largely removed, the formation appears soft and friable. This is observed in course of drilling operation when the alluvial / detrital cover was recovered as sludge. Exfoliation is very commonly found on the eroded surface in the weathered zone, due to iron leaching from the iron rich brownish sandstone.

4.1.2 Barren Measures:

This formation is underlying the weathered mantle and has been encountered in only one borehole – BOR/MA/025 from which it becomes obvious that the formation has a restricted development in this coal basin and may occur only in patches overlying the Barakar formation. This formation is represented by thick dark grey to ironstone shale but barren of any well-defined coal seams.

4.1.3 Barakar Formation:

The litho units of Barakar Formation have been exposed in the nulla cuttings and Bad Lands while exploration, whereas the rocks are well exposed as on date in the working faces. Thick sandstones and coal measures are well observed in the worked out faces of the mining areas. The Barakar formation comprises of fine, medium, coarse to very coarse grained feldspathic sandstone, dominantly grey to white in colour along with micaceous and grey shale, carbonaceous shale, shaly coal, coal seams and occasional conglomerate beds.

4.1.4 The Talchir:

Distinctive litho units of Talchir beds were intersected in a number of boreholes in the Barjora Coalfield. The maximum thickness intersected is 6.37 meter. The Talchirs have not been encountered in all the boreholes which intersected

metamorphic. As such, apparently it has been preserved in localized patches with limited lateral extent. This formation consists of brown and greenish shale, greenish sandstone with unaltered feldspars.

4.2 Geological Structure of Barjora North Coal Blocks:

4.2.1 Dip & Strike:

In absence of sufficient rock exposures within the block, the dip and strike of the beds were derived from sub-surface data. The strike and dip of the beds are depicted in the floor contour plans furnished in **Plate No. 6A & 6B** respectively for seam-V and Seam-I.

Strike of the beds roughly trend in N- S direction with local variation and swings from NE- SW to NW-SE at places. However, dip directions are broadly to the east and west in the western and eastern limbs of the block respectively. The strike of the beds is largely parallel to the basement contours with an axis being aligned similarly. However, a distinct shallowing up of the dips as well as marginal variation in the basin axis alignment is seen in shallower sediments. The bed dips normally between 2^0 to 7^0 though higher dips, i.e. up to 15^0 have been observed within sediments in the south-eastern corner of the block.

4.2.2 Faults:

Three numbers of faults F1-F1, F2-F2 & F3- F3 have been identified in and around the block. These faults have either been taken from the previous records or interpreted on the basis of data generated during this phase of investigation. Fault F1-F1 (Trending NW-SE) has down throw towards south- west. Fault F2- F2 trending (E-W) delineates the southern boundary of Sector C of the block with down throw 5 – 20 m south. The other fault F3- F3 (trending almost E-W) forming southern boundary of Sector-B of the block has down throw varying 45 – 55 m towards north. Details of faults are given in the Table No.4.2.

Table No. 4.2
Description of Faults

S. L. No.	Nomenclature	Strike of Fault	Down throw direction	Throw amount(m)	Linear extent	Remarks
1.	F1- F1	NW-SE	South westerly	Not Known.	1.8 Km	On the basis of GSI Borehole.
2.	F2- F2	E-W	Southerly	5 – 20	2.2 Km	Seam-V faulted in BH No. BOR/MA/043 and reduction in parting between Seam I/II/III & seam-V in BH no. BOR/MA/011.
3.	F3- F3	E-W	Northerly.	45- 55	2.2 Km	Seam V faulted in BH No. BOR/MA/073.

4.2.3 Sector Divisions:

Based on the occurrence of faults especially F2-F2 and F3-F3, the block has been subdivided into three sectors namely sector-A, Sector-B and Sector-C. The above mentioned faults have formed a trough in the north central part which is termed as Sector-B. The southern section termed as Sector-A while the northern part is termed as Sector-C.

4.3 Geophysical Investigations:

Six numbers of boreholes were Geophysically logged with SPR, Natural Gamma and Density parameters by CMPDIL RI-I. Geophysical logging was mostly done in the boreholes where core loss was substantial.

4.4 Sequence of Coal Seams:

The details in respect of coal seams of the area under report as per the published Geological Report, as per correlation considering Seam-I/II/III and Seam-V (with its splits V Bottom & top) as single units are provided in table no. 4.3.

Table no. 4.3

Sequence of Coal Seams at Barjora North Coal Block.

Seam	Thickness Range(m)	Parting Range (m)	Remarks
IX	0.26-2.78 (Avg. 1.43)		Impersistent, occurs only in north-eastern part of the block.
Paring		4.70-11.50 (Avg. 7.29m)	
VIII	0.30-2.94 (Avg. 1.26m)		Forms an enclosure in the southern part of Sector-A occurs impersistently in the area north of fault F3-F3 .
Parting		3.20-29.70 (Avg. 16.18m)	
VII	0.55-4.72 (Avg. 2.11m)		Splits locally around borehole no. 073. Thickness of top section is 1.02 and bottom section is 1.75m with only 1.92m parting in between the two splits.
Parting		4.70-24.50 (Avg. 13.52m)	
VI	0.25-4.42 (Avg. 1.51m)		Impersistnent Workable only in Sector-A between borehole no.003 to 004 in east-west approximately.
Parting		1.80-29.40 (Avg. 13.74m)	
V	1.70-6.29 (Avg. 3.88m)		Splits into top and bottom seams in considerable portion of the area. The top section shows a variation in thickness from 0.65m to 4.26m while the bottom section varies from 0.56m to 3.80m in thickness. The parting between the two ranges 0.00 to 8.00m.

Parting		1.90-14.40 (Avg. 8.38m)	
IV	0.20-1.30 (Avg. 0.67m)		Highly impersistent and has workable thickness only in one borehole.
Parting		4.90-21.40 (Avg. 14.21m)	
I/II/III	4.42-6.34 (Avg. 5.39m)		Splits into two to three section (I, II & III) in major part the area but occurs as a combined unit in the central part of the area. The thickness of split sections as recorded in boreholes is as follows :
Parting		1.90-19.70 (Avg. 7.11m)	
Local	0.35-2.48 (Avg. 0.96m)		Impersistent has attained workable thickness only in 9 boreholes.

Seam-III	0.42-3.42-m
Parting	0.00-20.20M
Seam-II	0.28-2.75m
Parting	0.00-9.00m
Seam-I	0.50-5.00m

4.4.1 Seam Descriptions:

A description of individual coal seams as per the above sequence is being discussed below with their salient features.

Seam – IX:

This seam is the youngest horizon found within Barjora North Coal block and confined in the north eastern part – especially in the sector C. The seam occurs at shallowest depth of 6.13 meter in Borehole no. BOR/MA/051 while it occurs at a depth of 40.78 meters in the borehole no. BOR/MA/027.

Salient Features of the coal seam is being furnished in Table No. 4.4.

Table No. 4.4

Salient Features of Seam IX.

1	Seam Name	Units	Seam -IX
2	Borehole Intersections	Nos.	6
3	Depth Range	M	
i	Shallowest		15.14
ii	Deepest		40.16
4	Seam Thickness in Meters	M	
i	Minimum		0.26
ii	Maximum		2.78
iii	Average		1.43
iv	Average above 1.0 Meter		1.83
5	Parting with Overlying Seam in meters	M	
i	Minimum		-
ii	Maximum		-
ii	Average		-
6	Immediate Roof		Sandy Shale & Shaly Sandstone
7	Immediate Floor		Sandstone.
8	Dirt Bands	Nos.	1 to 2
	Range of Thickness of individual Bands (m)	M	0.09 - 0.75
	Range of Cumulative Thickness (m)		0.09 -0.89
	No. of Boreholes where seam is devoid of dirt bands(% of Total Boreholes.)	%	2 (33%)
	Lithology		Shale, Carb. Shale.
9	Quality Parameters (Incl. of Calculated Values) - I_{100} basis		
	Moisture %	Wt.%	5.3 -6.8
	Ash%	Wt.%	35.60 -55.10
	V.M. %	Wt.%	22.7
	UHV - Kcal/Kg - Minimum	Kcal/Kg	689
	UHV - Kcal/Kg - Maximum	Kcal/Kg	3049
	Grade Range - UHV Based.		F-G
	Grade Range - GCV Based		G-13

1	Seam Name	Units	Seam -IX
	Usual Grade		G
10	Net Proved+Indicated reserve in Million Tons	MT	
	Opencast		0.2713
	UG		0.5136
	Total		0.7849

Thickness range of Seam IX has been shown graphically in figure no. 4.1.

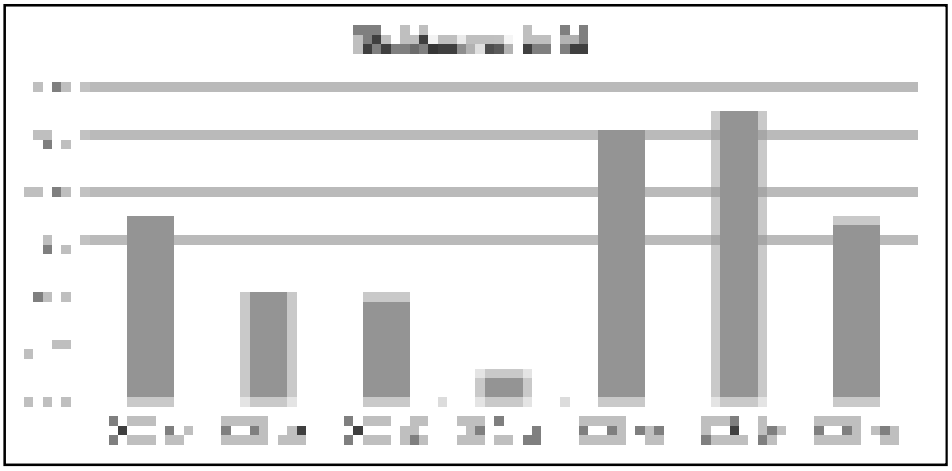


Figure.4.1: Thickness variation of Seam IX.

From the above graphical representation, it is evident that seam IX has developed erratically within Barjora North Coal Block.

Seam-VIII:

The in-crop of this seam has formed a closure along the central part while seems to be pinched out in the northern and eastern part of the block. The seam has attained a maximum thickness up to 2.94 meter and found to be occur in a depth range of 6.13 mete bgl to 46.09 m bgl. Salient feature of the seam is furnished below in Table no. 4.5.

Table No. 4.5

Salient Features of Seam-VIII.

1	**Seam Name**	**Units**	**Seam - VIII**
2	Borehole Intersections	Nos.	15
3	Depth Range	M	
i	Shallowest		6.13
ii	Deepest		46.09
4	Seam Thickness in Meters	M	
i	Minimum		0.3
ii	Maximum		2.94
iii	Average		1.26
iv	Average above 1.0 Meter		1.7
5	Parting with Overlying Seam in meters.	M	
i	Minimum		4.7
ii	Maximum		11.5
ii	Average		7.29
6	Immediate Roof		Sandy Shale & Fine grained SST.
7	Immediate Floor		Shale and Sandstone.
8	Dirt Bands	Nos.	1 to 2
	Range of Thickness of individual Bands (m)	M	0.05 -0.39
	Range of Cumulative Thickness (m)		0.08 -0.55
	No. of Boreholes where seam is devoid of dirt bands(% of Total Boreholes.)	%	6 (40%)
	Lithology		Carb. Shale
9	Quality Parameters (Incl. of Calculated Values) - I_{100} basis		
	Moisture %	Wt.%	4.0 -6.0
	Ash%	Wt.%	39.0 -56.0
	V.M. %	Wt.%	23
	UHV - Kcal/Kg - Minimum	Kcal/Kg	620
	UHV - Kcal/Kg - Maximum	Kcal/Kg	2690
	Grade Range - UHV Based.		F - Ungraded
	Grade Range - GCV Based		G-13
	Usual Grade		G
10	Net Proved + Indicated reserve in Million Tons.	MT	

1	Seam Name	Units	Seam - VIII
	Opencast		1.8015
	UG		0.0771
	Total		1.8786

Seam thickness variation of seam-VIII is depicted in figure no. 4.2.

igure No. 4.2: Thickness variation of seam VIII within Barjora North Coal Block.

Seam-VII:

This seam founds to be occur along with its in crop region in all the sectors of Barjora North Coal Block while in few boreholes it has been found to be deteriorated to carbonaceous shale. Total number of intersections within the block is 37. The seam has attained a thickness range of 0.55 m to 4.72 meter while depth range belongs to 3.20 m bgl to 29.70 bgl. Salient features of seam VII has been described in table no. 4.6.

Table No. 4.6

Salient Features of Seam VII.

1	Seam Name	Units	Seam - VII
2	Borehole Intersections	Nos.	37
3	Depth Range	M	
i	Shallowest		9

1	Seam Name	Units	Seam - VII
ii	Deepest		76.38
4	Seam Thickness in Meters	M	
i	Minimum		0.55
ii	Maximum		4.72
iii	Average		2.11
iv	Average above 1.0 Meter		2.18
5	Parting with Overlying Seam in meters	M	
i	Minimum		3.2
ii	Maximum		29.7
ii	Average		16.18
6	Immediate Roof		Varied Grains Sandstones.
7	Immediate Floor		Shale & Shaly Sandstone.
8	Dirt Bands	Nos.	1 to 7
	Range of Thickness of individual Bands (m)	M	0.04 -1.0
	Range of Cumulative Thickness (m)		0.07 -01.37
	No. of Boreholes where seam is devoid of dirt bands(% of Total Boreholes.)	%	9 (24%)
	Lithology		Carb. Shale, Shale & fine grained Sandstone.
9	Quality Parameters (Incl. of Calculated Values) - I_{100} basis		
	Moisture %	Wt.%	3.7 -8.0
	Ash%	Wt.%	29.70 -52.0
	V.M. %	Wt.%	27.7
	UHV - Kcal/Kg - Minimum	Kcal/Kg	1075
	UHV - Kcal/Kg - Maximum	Kcal/Kg	3946
	Grade Range - UHV Based.		E - Ungraded.
	Grade Range - GCV Based		G-12
	Usual Grade		F-G
10	Net Proved+Indicated reserve in Million Tons	MT	
	Opencast		5.37
	UG		1.72
	Total		7.05

Seam thickness variation is depicted in figure no. 4.3.

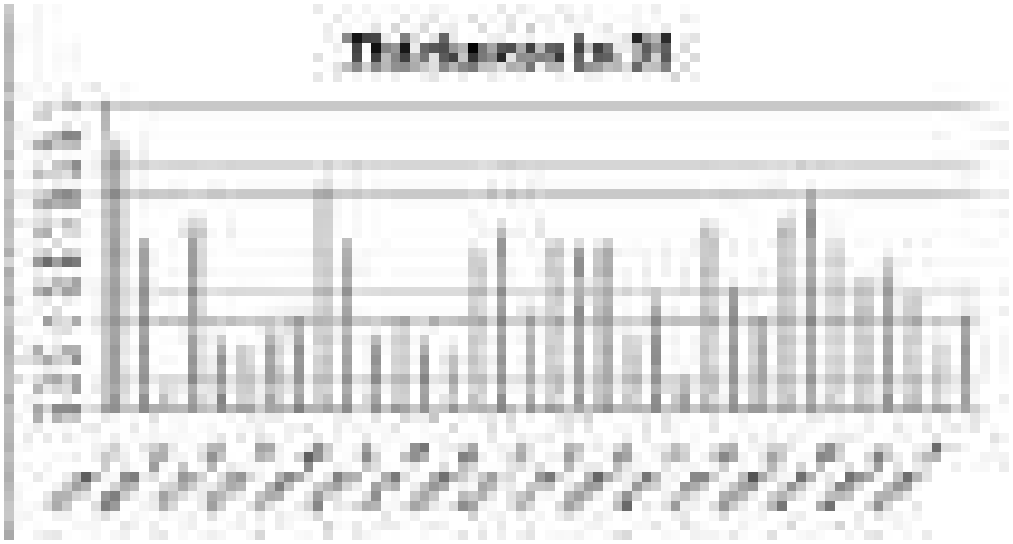


Figure 4.3: Seam Thickness variation of Seam VII.

Seam VI:

The seam occurs mostly as a single unit and well distributed in Sector-A. this seam has not developed in the sector-C. The seam thickness varies from 0.25 m to 4.42 m. total number of seam intersection found to be 32. Salient features of the coal seam are being furnished in table no. 4.7.

Table no. 4.7

Salient Features of Seam VI.

1	**Seam Name**	**Units**	**Seam - VI**
2	Borehole Intersections	Nos.	32
3	Depth Range	M	
i	Shallowest		17.2
ii	Deepest		75.89
4	Seam Thickness in Meters	M	
i	Minimum		0.25
ii	Maximum		4.42
iii	Average		1.51
iv	Average above 1.0 Meter		2.39
5	Parting with Overlying Seam in meters	M	
i	Minimum		4.7
ii	Maximum		24.5
ii	Average		13.52

1	Seam Name	Units	Seam - VI
6	Immediate Roof		Sandstone & Carb Shale.
7	Immediate Floor		Sandstone & Shale.
8	Dirt Bands	Nos.	1 to 4
	Range of Thickness of individual Bands (m)	M	0.03 -0.32
	Range of Cumulative Thickness (m)		0.05 -1.43
	No. of Boreholes where seam is devoid of dirt bands(% of Total Boreholes.)	%	17 (53%).
	Lithology		Carb. Shale, Shale, fine grained Sandstone.
9	Quality Parameters (Incl. of Calculated Values) - I_{100} basis		
	Moisture %	Wt.%	3.8 -6.6
	Ash%	Wt.%	32.10 -48.10
	V.M. %	Wt.%	23.3 -25.80
	UHV - Kcal/Kg - Minimum	Kcal/Kg	1738
	UHV - Kcal/Kg - Maximum	Kcal/Kg	3780
	Grade Range - UHV Based.		E - G
	Grade Range - GCV Based		G-12
	Usual Grade		F
10	Net Proved + Indicated reserve in Million Tons.	MT	
	Opencast		7.22
	UG		-
	Total		7.22

Seam thickness variation is being shown in Figure no. 4.4.

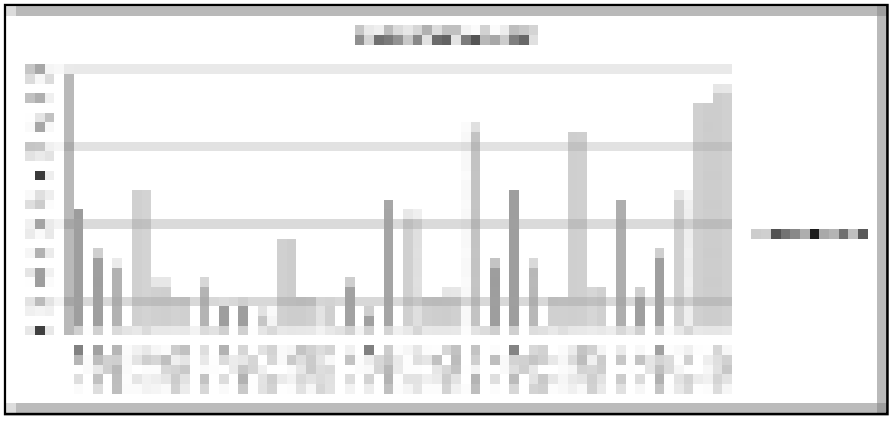


Figure No. 4.4: Graphical Representation of the Seam thickness variation of Seam VI.

Seam-V (Combined):

This seam is the most potential coal seam of this block along with its splits. Also V-combined occurs as a single unit mostly in the Sector-A & B. sector-C is having the in crop of the seam. Thickness of this seam varies from 1.70 m to 6.29 m while depth of occurrence varies from 12.96 m to 112.20 m. salient feature of this seam is being furnished in table no. 4.8.

Table no. 4.8

Salient Features of Seam V (Combined).

1	**Seam Name**	**Units**	**Seam - V-Combined**
2	Borehole Intersections	Nos.	29
3	Depth Range	M	
i	Shallowest		12.96
ii	Deepest		112.2
4	Seam Thickness in Meters	M	
i	Minimum		1.7
ii	Maximum		6.29
iii	Average		3.88
iv	Average above 1.0 Meter		3.88
5	Parting with Overlying Seam in meters.	M	
i	Minimum		1.8
ii	Maximum		29.4
ii	Average		13.74
6	Immediate Roof		Sandstone, Shale.
7	Immediate Floor		Carb Shale & Shale.
8	Dirt Bands	Nos.	1 to 5
	Range of Thickness of individual Bands (m)	M	0.04 -0.80
	Range of Cumulative Thickness (m)		0.04 -1.46
	No. of Boreholes where seam is devoid of dirt bands(% of Total Boreholes.)	%	3 (10%)
	Lithology		Carb shale, Shale and Fine Grained Sandstone.

1	Seam Name	Units	Seam - V-Combined
9	Quality Parameters (Incl. of Calculated Values) - I_{100} basis		
	Moisture %	Wt.%	3.7 -6.3
	Ash%	Wt.%	30.70 -54.1
	V.M. %	Wt.%	22.20 -27.40
	UHV - Kcal/Kg - Minimum	Kcal/Kg	924
	UHV - Kcal/Kg - Maximum	Kcal/Kg	3822
	Grade Range - UHV Based.		E -Ungraded
	Grade Range - GCV Based		G-12
	Usual Grade		E-G
10	Net Proved + Indicated reserve in Million Tons.	MT	
	Opencast		25.9328
	UG		6.2167
	Total		32.1495

The reserve figures mentioned above comprise of all splits of Seam-V together.

Seam V-combined has been remodeled into Seam V Top and V Bottom for with zero parting wherever V Combined was considered in the geological report. This is being done to simplify the software model.

Seam- V-Top & V-Bottom:

Thickness variation of Seam V-Top and V-Bottom are furnished in figure no. 4.5 and 4.6 respectively.

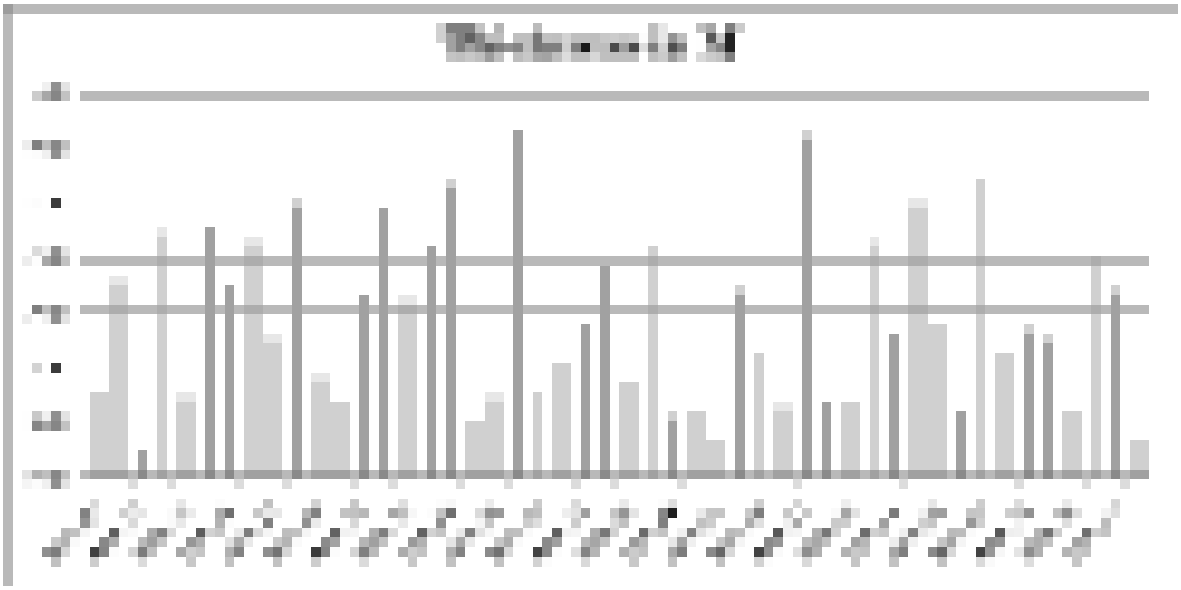


Figure no. 4.5: Graphical Representation of Seam Thickness variation of Seam V-Top.

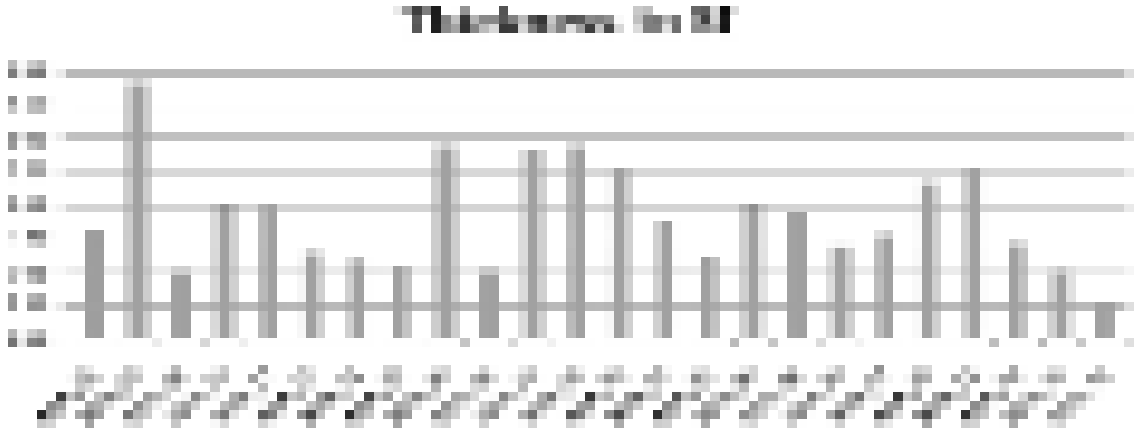


Figure No. 4.6: Graphical Representation of Seam Thickness variation of Seam V-Bottom.

Seam-IV:

This seam occurs impersistently as a thin band just below seam V. the seam has several occasions merged with either seam V-Bottom or V-combined seam. The seam has attained a workable thickness in only

one boreholes out 16 occurrences as per Geological report. Salient features of the seam has not been furnished thus.

Seam-III, II & I:

The lower packet of Barjora North coal block comprise of three sections namely – Seam-III, Seam-II & Seam-I. three seams occur as a combined seam along the central part while found completely pinched off in the south western sector and part of northern sector. Cumulative thickness range attains more than 8 meter in the central part. However, the split behavior found to be erratic and often either two seams found to be coalesced in different combination in different parts of the block. Salient features of Seam-III, II & I is furnished in table no. 4.9.

Table No.4.9

Salient Features of Seam-III, II & I.

1	Seam Name	Units	Seam - III	Seam - II	Seam - I
2	Borehole Intersections	Nos.	30	22	36
3	Depth Range	M			
i	Shallowest		17.16	27.02	23.49
ii	Deepest		137.5	135.33	148.39
4	Seam Thickness in Meters	M			
i	Minimum		0.42	0.28	0.5
ii	Maximum		3.42	2.75	5.06
iii	Average		1.46	1.3	1.91
iv	Average above 1.0 Meter		1.82	1.76	2.25
5	Parting with Overlying Seam in meters	M			
i	Minimum		4.9	0	1.9
ii	Maximum		21.4	20.2	19.7
ii	Average		14.21	4.84	7.11
6	Immediate Roof		Shale, Shaly Sandstone & Carb.Shale	Sandy Shale, shale & Alternate Shale-	Shale, Sandy Shale & Shaly Sandstone.

1	Seam Name	Units	Seam - III	Seam - II	Seam - I
				Sandstone	
7	Immediate Floor		Shale, Medium Grained Sandstone & Carb.Shale	Shale, Coarse Grained Sandstone & Shaly Sandstone	Mostly sandy shale and coarse grained sandstone.
8	Dirt Bands	Nos.	1 to 4	1 to 2.	1 to 5
	Range of Thickness of individual Bands (m)	M	0.04 -0.55	0.02 -0.36	0.04 -0.52
	Range of Cumulative Thickness (m).		0.06 -1.0	0.03 -0.68	0.08 -1.44
	No. of Boreholes where seam is devoid of dirt bands(% of Total Boreholes.)	%	10 (33%)	11 (50%).	16 (44%).
	Lithology		Carb. Shale, medium grained Sandstone and Sandy Shale.	Carb. Shale, shale and Coarse Grained Sandstone.	Mostly carb. Shale, Shale & Medium grained Sandstone.
9	Quality Parameters (Incl. of Calculated Values) - I_{100} basis				
	Moisture %	Wt.%	3.4 -6.5	4.2 -7.5	3.7 -6.9
	Ash%	Wt.%	21.40 -48.0	27.4 -48.4	23.0 -51.50
	V.M. %	Wt.%	25.1 -30.0	23.50 - 27.60	27.0 -29.60
	UHV - Kcal/Kg - Minimum	Kcal/Kg	1793	1572	1282
	UHV - Kcal/Kg - Maximum	Kcal/Kg	5105	4525	4939
	Grade Range - UHV Based.		C -G	D-G	D- Ungraded.
	Grade Range - GCV Based		G-10	G-10	G-10
	Usual Grade		F- G	E-G	E - F

Total geological reserve (Proved + Indicated) for these combined seams found to be 36.3563 million Tons.

Seam thickness variations for all sea III & seam I has been depicted in figure nos. 4.7 & 4.8 respectively.

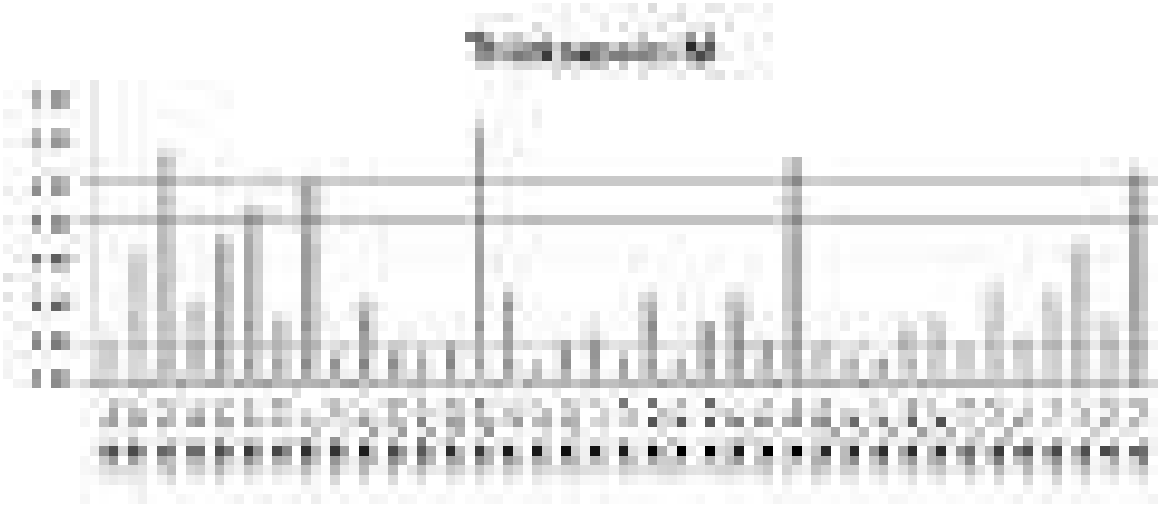


Figure No. 4.7: Graphical Representation on thickness variation of Seam-III Combined and Seam III in Barjora North Coal Block.

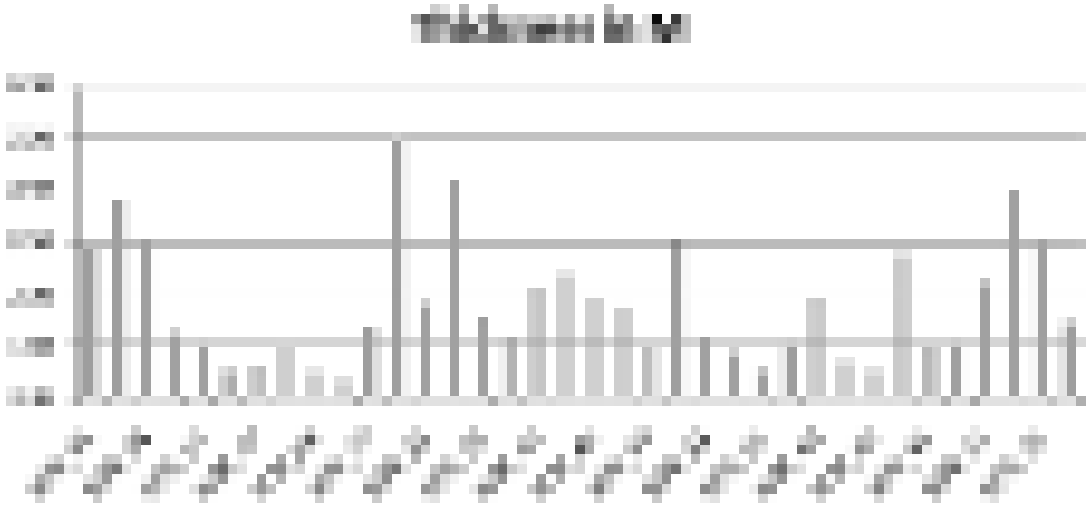


Figure No. 4.8: Graphical Representation on thickness variation of Seam-I in Barjora North Coal Block.

From the above seam descriptions and figures, it reveals that seam thickness, split behaviors' and pinching off of a particular seam is very common in Barjora North Coal Block of Barjora Coalfield and this has to be dealt with proper planning in the operational stage to have optimum coal recovery from the block.

4.5 Seam Quality:

4.6.1 Proximate Analysis:

As per the Geological Report of Barjora North Coal Block quality as defined in UHV based grading system.

The seam-wise usual range of grade including bands up to 100mm (i.e. I_{100} basis) varies from E to G. However, these grades are expected to be improved considerably during mining by surface miners by selective removal of in-seam bands.

The specific gravity for estimation of reserves has been considered as 1.6 instead of 1.7 to minimize the quantity of reserves. Which may not be available due to erratic behavior of seams (both in thickness and quality).

Seam wise quality as given in the geological report of CMPDI is summarized in table no. 4.10.

Table No. 4.10

Seam wise summarized proximate analysis figures of Barjora North Coal Block.

Coal Seam	Proximate Analysis at 60% RH & 40°C			U.H.V	Grade	Usual Grade
	M%	Ash %	VM%	(K. Cal /kg.)		
IX	5.3-7.4(5.3-6.8)	30.5-45.2(35.6-55.1)	22.7	1931-3670 (689-3049)	E-G(F- Unger)	F-G (G)
VIII	4.8-6.8(4.0-6.0)	31.9-49.4(39.0-56.0)	23.0	1420-3559(620-2690)	F-G(F- Unger)	F-G(G-Unger)
VII	4.3-8.0(37-8.0)	28.2-43.2(29.7-52.0)	27.5-27.7(27.7)	2055-4111 (1075-3946)	E-G(E- Unger	E-F(F-G)
VI	4.2-7.1(3.8-	27.0-	23.3-	2248-4318	D-G	E-F

	6.6)	42.5(32.1-48.1)	28.8(23.3-25.8)	(1738-3780)	(E-G)	(F)
V(Comb)	4.2-6.5 (3.7-6.3)	30.0-48.5(30.7-54.1)	23.2-27.4 (22.2-27.4)	1627-3987 (924-3822)	E-G (E-Unger)	E-F (F-G)
V Top	5.3-7.6 (4.1-7.6)	28.2-45.6(28.2-53.7)	21.9-28.2 (21.9-28.2)	1870-3960 (924-3960)	E-G (E-Unger)	E-F(E-G)
V Bottom	4.2-8.8 (3.8-8.8)	21.4-49.3 (21.4-49.6)	24.2-27.4 (23.5-27.4)	1517-5032 (1517-4732)	C-G (D-G)	D-F (F-G)
IV	(4.6)	(44.7)	(22.9)	(2097)	(G)	-
I/II/III	5.8-6.3 (5.1-5.7)	27.0-31.5 (32.3-39.7)	25.6-25.9 (25.0)	3739-4305 (2718-3656)	D-F (E-F)	D-E (E-F)
II/III	(3.8)	(41.5)	--	(2649)	(F)	--
III	4.2-7.2 (3.4-6.5)	21.4-37.8 (21.4-48.0)	26.8-30.0 (25.1-30.0)	2994-5105 (1793-5105)	C-F (C-G)	D-F (F-G)
I/II	4.8-6.6 (4.4-6.0)	25.5-36.9 (31.2-48.6)	26.0	3145-4663 (1572-3780)	D-F (E-G)	D-F (F)
II	4.3 - 7.6(4.2-7.5)	26.0 - 38.2(27.4-48.4)	23.5-27.6(23.5-27.6)	2769-4525 (1572-4525)	D-F (D-G)	F (E-F)
I	4.2-8.1 (3.7-6.9)	22.3-39.9 (23.0-51.5)	26.2-29.6 (27.0-29.6)	2814-5039 (1482-4939)	C-F (D- Unger.	D-E (E-F)

Note : 1) Ex-band values are show without brackets.

2) 1-100 values are show within brackets.

3) Ungr indicates Ungraded.

4.6.2 Special tests:

Special tests carried out in respect of coal seam encountered coal seams encountered in boreholes of Barjora North Coal Block area Ash fusion Temperature (18 Samples), HGI (18 Samples), Ultimate Analysis (2 samples). Results of these analysis tests are given in Table No. 4.11.

Table No.4.11

Details of the Special Tests carried out at Barjora North Coal Block.

Borehole No.	**Depth (m)**		**M**	**Degree in Centigrade**				
	From	**To**	**Thickness**	**IDT**	**HT**	**FT**	**HGI**	**Remarks**
Seam- VIII								

BOR/MA/028	22.94	23.92	0.98	1320	1400	1400	60	EX-BAND
Seam- VII								
BOR/MA/028	35.62	36.77	1.15	1400	1400	1400	57	Part Special Teat team.
BOR/MA/036	25.75	27.1	1.35	1330	1400	1400	67	Part Seam.
Seam-VI								
BOR/MA/036	37.75	38.93	1.18	1400	1400	1400	69	Part Seam.
Seam- V								
BOR/MA/028	68.55	73.43	4.88	1290	1400	1400	62	Ex-Band, Seam V Combined.
BOR/MA/036	62.36	63.79	1.43	1290	1400	1400	70	INBAND - SEAM VT
BOR/MA/040	33.55	35.65	2.1	1400	1400	1400	71	SEAM V-T
BOR/MA/040	40.8	41.8	1	1400	1400	1400	59	V B TOP SPLIT INCL. 0.15 M CARB. SHALE AT TOP.
	42.96	44.41	1.72	1350	1400	1400	67	VB SPLIT.
SEAM I/II/III								
BOR/MA/028	87.6	88.65	1.05	1400	1400	1400	-	EX. NC BAND SEAM-III
	93.35	95.66	2.31	1400	1400	1400	73	IN BAND SEAM II PART.
	100.2	102.5	2.36	1380	1400	1400	65	IN BAND SEAM -I PART
BOR/MA/036	83.63	84.65	1.02	1400	1400	1400	58	SEAM-III
	85.92	87.22	1.3	1350	1400	1400	71	SEAM-III
	94.4	95.4	1	1400	1400	1400	61	EX-BAND SEAM-LOCAL
BOR/MA/040	65.29	66.85	1.56	1260	1370	1400	63	SEAM III PART.
	70.2	71.86	1.68	1400	1400	1400	68	SEAM III
	72.53	73.66	1.43	1400	1400	1400	74	SEAM-I

4.6.3 Re-computed Coal Grades – as per new norms:

The Geological report and the earlier mining plan were prepared before the commencement of the GCV based grading system which was adopted since the year 2012. As a result, in both the reports, emphasis was not given to GCV based grading systems and even GCV's has not been determined systematically during the exploration. In absence of such systematic data, GCV values were derived from the available UHV and Ash% values and are furnished in the subsequent tables.

The formulae used to calculate the GCV values are given below:

GCV = {(UHV+3645)-75.40*M}/1.466

Seam Overall analysis data on I_{100} basis has been considered for GCV value determination and grade estimation as per new system. Total number of samples considered for the exercise is 172.

Seam-IX:

Though occurrence of seam IX found to be very limited in few boreholes, attempt has been made to establish the grade as per new system and is furnished below in Table no. 4.12.

Table No. 4.12

Re-calculated GCV and Grade of Seam-IX.

Borehole No.	Seam Name	Moisture%	Ash%	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/016	IX	6.8	35.6	3049	4566.17	G-11
BOR/MA/027	IX	5.8	43.3	2124	3935.20	G-13
BOR/MA/038	IX	5.3	45.2	1931	3803.55	G-13
BOR/MA/060	IX	4.4	55.1	689	2956.34	G-16
BOR/MA/076	IX	5.4	46.8	1696	3643.25	G-14
Total Number of Samples		**5**				
Minimum Value		4.40	35.60	689.00	2956.34	
Maximum Value		6.80	55.10	3049.00	4566.17	
Mean Average		5.54	45.20	1897.80	3780.90	
Usual Grade		G-13				
Standard Deviation		0.87	7.01	848.45	578.75	

Seam – VIII:

Seam overall analysis data for Seam-VIII are not much however, attempt has been made to classify the coal based on the available I100 data. Estimation details are furnished in table No. 4.13.

Table No. 4.13

Re-calculated GCV and Grade of Seam-VIII.

Borehole No.	Seam Name	Moisture %	Ash %	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/016	VIII	4	56	620	2909.28	G-16
BOR/MA/022	VIII	5.1	46.4	1793	3709.41	G-13
BOR/MA/028	VIII	5.4	43.7	2124	3935.20	G-13
BOR/MA/048	VIII	5.7	42.1	2240	4014.32	G-12
BOR/MA/051	VIII	4.6	51.1	1213	3313.78	G-15
BOR/MA/054	VIII	5.2	45.5	1903	3784.45	G-13
BOR/MA/059	VIII	5.2	45.5	1903	3784.45	G-13
BOR/MA/060	VIII	5.3	45.9	1834	3737.38	G-13
BOR/MA/071	VIII	6	39	2690	4321.28	G-12
BOR/MA/075	VIII	4.6	50.9	1241	3332.88	G-15
BOR/MA/076	VIII	4.3	53.5	924	3116.64	G-16
Total Number of Samples		**11**				
Minimum Value		4.00	39.00	620.00	2909.28	
Maximum Value		6.00	56.00	2690.00	4321.28	
Mean Average		5.04	47.24	1680.45	3632.64	
Usual Grade		G-13				
Standard Deviation		0.60	5.10	614.22	418.98	

Seam-VII:

Number of available data is sufficient to judge the quality of seam VII on overall basis. Based on the I100 data, GCV estimation done and is furnished on table No. 4.14.

Table No. 4.14

Re-calculated GCV and Grade of Seam-VII.

Borehole No.	Seam Name	Moisture%	Ash%	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/002	VII	6.30	33.10	3463.00	4591.41	G-10
BOR/MA/011	VII	3.70	45.60	2097.00	3505.32	G-13
BOR/MA/014	VII	5.80	34.50	3339.00	4527.39	G-10
BOR/MA/015	VII	6.10	32.30	3601.00	4628.96	G-9
BOR/MA/016	VII	5.00	33.40	3601.00	4587.82	G-10

Borehole No.	Seam Name	Moisture%	Ash%	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/022	VII	4.80	32.30	3780.00	4797.35	G-9
BOR/MA/024	VII	6.40	38.40	2490.00	3958.55	G-12
BOR/MA/025	VII	4.80	48.00	1614.00	3345.58	G-14
BOR/MA/027	VII	5.60	36.70	3063.00	4267.12	G-11
BOR/MA/028	VII	4.90	45.20	1986.00	3553.04	G-13
BOR/MA/034	VII	6.20	29.70	3946.00	4905.44	G-8
BOR/MA/035	VII	5.40	44.00	2083.00	3572.92	G-13
BOR/MA/036	VII	6.50	31.30	3684.00	4608.43	G-9
BOR/MA/040	VII	5.50	49.90	1235.00	3040.76	G-15
BOR/MA/043	VII	5.20	45.10	1959.00	3632.35	G-13
BOR/MA/047	VII	5.10	45.60	1903.00	3372.99	G-13
BOR/MA/048	VII	6.20	38.60	2718.00	4049.31	G-11
BOR/MA/049	VII	5.00	48.30	1542.00	3538.20	G-14
BOR/MA/051	VII	8.00	31.40	3463.00	4801.63	G-9
BOR/MA/058	VII	4.60	48.60	1558.00	3549.11	G-14
BOR/MA/059	VII	6.10	41.90	2276.00	4038.88	G-12
BOR/MA/060	VII	6.90	32.80	3431.00	4826.74	G-10
BOR/MA/062	VII	5.20	46.80	1724.00	3662.35	G-14
BOR/MA/063	VII	4.40	51.80	1144.00	3266.71	G-15
BOR/MA/065	VII	4.70	52.00	1075.00	3219.65	G-15
BOR/MA/068	VII	6.00	41.80	2304.00	4057.98	G-12
BOR/MA/069	VII	5.60	40.00	2607.00	4264.67	G-12
BOR/MA/071	VII	5.30	39.90	2662.00	4302.18	G-12
BOR/MA/074	VII	6.50	33.60	3366.00	4782.40	G-10
BOR/MA/075	VII	7.60	31.45	3145.00	4631.65	G-11
BOR/MA/076	VII	6.10	37.80	2842.00	4424.97	G-11
BOR/MA/001	VII	5.60	49.00	1365.00	3417.46	G-14
Total Number of Samples		**32**				
Minimum Value		3.70	29.70	1075.00	3040.76	
Maximum Value		8.00	52.00	3946.00	4905.44	
Mean Average		5.66	40.34	2533.31	4054.04	
Usual Grade		**G -12**				
Standard Deviation		0.91	7.03	878.40	578.68	

Seam-VI:

Seam overall data of 18 numbers of samples has been considered for GCV calculation and grade estimation for seam-VI. The calculations are furnished in Table no. 4.15.

Table No. 4.15

Re-calculated GCV and Grade of Seam-VI.

Borehole No.	Seam Name	Moisture%	Ash%	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/001	VI	5	41.3	2511	3273.40	G-12
BOR/MA/002	VI	4.9	35.7	3297	4539.89	G-10
BOR/MA/003	VI	5	32.1	3780	4725.35	G-9
BOR/MA/004	VI	5.7	34.8	3311	4489.72	G-10
BOR/MA/022	VI	4.6	41.1	2593	4018.53	G-12
BOR/MA/029	VI	6.6	32.4	2518	4167.62	G-12
BOR/MA/035	VI	6	37.1	2952	4500.00	G-11
BOR/MA/036	VI	4.2	43.3	2345	4085.95	G-12
BOR/MA/048	VI	4.2	46.9	1848	3746.93	G-13
BOR/MA/049	VI	4.6	40.2	2718	4340.38	G-11
BOR/MA/051	VI	4.9	39.2	2814	4405.87	G-11
BOR/MA/058	VI	4.2	43.6	2304	4057.98	G-12
BOR/MA/060	VI	5.7	42.5	2248	4019.78	G-13
BOR/MA/062	VI	3.8	48.1	1738	3671.90	G-13
BOR/MA/068	VI	5.1	33.6	3559	4914.05	G-9
BOR/MA/072	VI	5.3	31.1	3877	5130.97	G-9
BOR/MA/074	VI	4.6	39.5	2814	4405.87	G-11
BOR/MA/075	VI	4.9	42.8	2317	4066.85	G-12
Total Number of Samples		**18**				
Minimum Value		3.80	31.10	1738.00	3273.40	
Maximum Value		6.60	48.10	3877.00	5130.97	
Mean Average		4.96	39.18	2752.44	4253.39	
Usual Grade		G-12				
Standard Deviation		0.71	5.07	614.78	450.84	

Seam- V (Combined):

Seam overall analysis of 29 samples has been considered for GCV determination and grade estimation for Seam V within Barjora North Coal Block. Details are furnished in Table No. 4.16.

Table No. 4.16

Recalculated GCV and Grade of Seam V (Combined).

Borehole No.	Seam Name	Moisture%	Ash%	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/001	V-COM	5.8	37.5	2925	4183.27	G-11
BOR/MA/002	V-COM	5.3	33.6	3532	4623.04	G-9
BOR/MA/004	V-COM	4.8	43.2	2276	3792.01	G-12
BOR/MA/008	V-COM	5.8	40.1	2582	3949.30	G-12
BOR/MA/011	V-COM	6.3	36.3	3021	4223.04	G-11
BOR/MA/014	V-COM	5.1	43.5	2193	3719.96	G-12
BOR/MA/015	V-COM	5.1	42.2	2373	3842.74	G-12
BOR/MA/016	V-COM	5.2	43.9	2124	3667.75	G-12
BOR/MA/022	V-COM	5.5	42.9	2221	3718.49	G-12
BOR/MA/024	V-COM	5.7	34.9	3297	4442.17	G-10
BOR/MA/027	V-COM	4.5	47.5	1724	3430.90	G-17
BOR/MA/028	V-COM	5.5	39.6	1724	3379.47	G-13
BOR/MA/029	V-COM	6	39.1	2676	4003.14	G-11
BOR/MA/033	V-COM	4.7	45.1	2028	3627.98	G-13
BOR/MA/035	V-COM	6.9	27.6	4139	4954.80	G-8
BOR/MA/038	V-COM	5.5	43.6	2124	3652.32	G-13
BOR/MA/039	V-COM	6.1	30.7	3822	4779.71	G-9
BOR/MA/044	V-COM	4.7	39.4	2814	4164.13	G-11
BOR/MA/045	V-COM	4.7	43.4	2262	3787.60	G-12
BOR/MA/047	V-COM	5.1	40.2	2649	4031.01	G-11
BOR/MA/048	V-COM	6.4	36.2	3009	4209.71	G-10
BOR/MA/054	V-COM	5.6	38.2	3187	4372.28	G-10
BOR/MA/059	V-COM	5.9	39.9	2580	3942.80	G-11
BOR/MA/064	V-COM	3.7	54.1	924	2926.34	G-15
BOR/MA/065	V-COM	5	42.6	2331	3819.24	G-12
BOR/MA/066	V-COM	4.2	49.3	1517	3305.13	G-14

Borehole No.	Seam Name	Moisture%	Ash%	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/069	V-COM	5.6	38.5	2814	4117.84	G-11
BOR/MA/076	V-COM	5.4	43.9	2097	3639.05	G-13
BOR/MA/077	V-COM	5.3	42.4	2317	3794.26	G-12
Total Number of Samples		**29**				
Minimum Value		3.70	27.60	924.00	2926.34	
Maximum Value		6.90	54.10	4139.00	4954.80	
Mean Average		5.36	40.67	2526.97	3934.46	
Usual Grade		**G-12**				
Standard Deviation		0.68	5.37	687.63	442.50	

Seam- V- Top:

Seam overall analysis of 21 samples has been considered for GCV determination and grade estimation for Seam V within Barjora North Coal Block. Details are furnished in Table No. 4.17.

Table No. 4.17

Recalculated GCV and Grade of Seam V (Top).

Borehole No.	Seam Name	Moisture%	Ash%	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/002	V-TOP	5.6	33.5	3504	4588.51	G-9
BOR/MA/005	V-TOP	5.9	42.8	2179	3669.26	G-13
BOR/MA/013	V-TOP	6.4	33.5	3394	4472.33	G-10
BOR/MA/017	V-TOP	5	41.6	2469	3913.37	G-11
BOR/MA/031	V-TOP	6.7	34.2	3255	4362.09	G-9
BOR/MA/035	V-TOP	7.1	30.2	3753	4681.21	G-8
BOR/MA/036	V-TOP	5.8	33.1	3477	4559.81	G-9
BOR/MA/040	V-TOP	6.4	39	2635	3954.60	G-11
BOR/MA/042	V-TOP	5.4	46.7	1710	3375.06	G-13
BOR/MA/048	V-TOP	6.4	36.2	3009	4209.71	G-10
BOR/MA/049	V-TOP	5.3	45.6	1870	3489.35	G-12
BOR/MA/053	V-TOP	4.2	49.3	1517	3305.13	G-13
BOR/MA/058	V-TOP	6	37.3	2925	4172.99	G-10
BOR/MA/059	V-TOP	5.7	42.7	2227	3712.29	G-11

Borehole No.	Seam Name	Moisture%	Ash%	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/060	V-TOP	5.3	45.5	2298	3781.30	G-11
BOR/MA/062	V-TOP	7.6	28.2	3960	4796.70	G-8
BOR/MA/063	V-TOP	5.2	45.8	1862	3489.03	G-12
BOR/MA/068	V-TOP	6.2	40.1	2511	3880.30	G-11
BOR/MA/072	V-TOP	5.3	42.7	2276	3766.29	G-11
BOR/MA/074	V-TOP	5.8	43.5	2097	3618.47	G-12
BOR/MA/075	V-TOP	6	35.7	3145	4323.06	G-9
Total Number of Samples		**21**				
Minimum Value		4.20	28.20	1517.00	3305.13	
Maximum Value		7.60	49.30	3960.00	4796.70	
Mean Average		5.87	39.39	2670.14	4005.76	
Usual Grade		**G-11**				
Standard Deviation		0.76	5.91	711.54	455.50	

Seam-I, II & III:

As discussed earlier, the lower packet consists of three seams namely Seam-III, II & I are found to be coalesce and pinched off and often difficult to distinguish within this block. Though reporting has been done on the basis of combined seam, for better understanding of the coal seam distributions, three seams have been identified and quality aspects have been analysed. Details of individual seams have been furnished in table nos. 4.18, 4.19 & 4.20 respectively.

Table No. 4.18

Recalculated GCV and Grade of Seam III.

Borehole No.	Seam Name	Moisture%	Ash%	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/001	III	5.2	35	3352	4505.40	G-10
BOR/MA/002	III	3.6	45.6	2110	3740.49	G-13
BOR/MA/004	III	3.8	47.7	1793	3513.97	G-13
BOR/MA/009	III	5.2	35.9	3228	4420.82	G-10
BOR/MA/014	III	5	31.9	3808	4826.74	G-9
BOR/MA/028	III	5.2	36	3214	4411.27	G-10
BOR/MA/031	III	4.4	35.9	3339	4537.68	G-10
BOR/MA/036	III	6.1	21.4	5105	5654.88	G-6

Borehole No.	Seam Name	Moisture%	Ash%	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/038	III	5.4	26.4	4512	5286.38	G-7
BOR/MA/040	III	6.3	32.1	3601	4618.68	G-9
BOR/MA/049	III	6.4	36.4	2994	4199.48	G-10
BOR/MA/051	III	6.6	35.2	3131	4282.65	G-11
BOR/MA/052	III	6.5	35.6	3088	4258.46	G-10
BOR/MA/065	III	4.4	36.7	3201	4443.55	G-10
BOR/MA/072	III	3.7	43.4	2400	3933.17	G-12
BOR/MA/074	III	3.4	47.8	1834	3562.51	G-13
BOR/MA/075	III	4.3	39.6	2842	4203.81	G-11
BOR/MA/077	III	3.4	48	1807	3544.09	G-13
BOR/MA/079	III	4.7	34.6	3477	4616.38	G-10
Total Number of Samples		**12**				
Minimum Value		3.40	21.40	1807.00	3544.09	
Maximum Value		6.60	48.00	5105.00	5654.88	
Mean Average		5.10	36.43	3166.00	4383.67	
Usual Grade		**G-10**				
Standard Deviation		1.26	7.82	963.34	619.25	

Table No. 4.19

Recalculated GCV and Grade of Seam II.

Borehole No.	Seam Name	Moisture%	Ash%	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/001	II	4.7	48.4	1572	3316.93	G-14
BOR/MA/002	II	4.9	26.8	4525	5320.97	G-7
BOR/MA/014	II	5.6	34.9	3311	4456.86	G-10
BOR/MA/028	II	5.3	35.1	3325	4481.84	G-10
BOR/MA/036	II	5.7	28.5	4180	5044.49	G-8
BOR/MA/040	II	5.8	38.2	2828	4117.11	G-11
BOR/MA/044	II	4.3	29	4305	5201.76	G-8
BOR/MA/051	II	6.2	38.2	2769	4056.29	G-11
BOR/MA/055	II	7.5	27.4	4083	4885.74	G-8
BOR/MA/065	II	6.1	29.6	3973	4882.71	G-8
BOR/MA/074	II	4.7	47.9	1641	3364.00	G-13
BOR/MA/075	II	4.2	36.8	3242	4481.80	G-10

Total Number of Samples	**12**				
Minimum Value	4.20	26.80	1572.00	3316.93	
Maximum Value	7.50	48.40	4525.00	5320.97	
Mean Average	5.42	35.07	3312.83	4467.54	
Usual Grade	**G-10**				
Standard Deviation	0.94	7.40	981.47	659.32	

Table No. 4.20

Recalculated GCV and Grade of Seam I.

Borehole No.	Seam Name	Moisture%	Ash%	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/001	I	4.3	45.4	2041	3657.42	G-13
BOR/MA/004	I	3.7	51.5	1282	3170.55	G-15
BOR/MA/005	I	5.2	41.1	2511	3931.73	G-12
BOR/MA/014	I	5.1	34.1	3490	4604.68	G-9
BOR/MA/017	I	5	29.3	4167	5071.62	G-8
BOR/MA/022	I	5.9	24.3	4732	5410.74	G-6
BOR/MA/027	I	4.7	39.7	2773	4136.17	G-11
BOR/MA/028	I	4.4	41.9	3811	4859.65	G-9
BOR/MA/035	I	4.2	37.5	3145	4415.63	G-10
BOR/MA/036	I	4.1	49.2	1545	3329.37	G-14
BOR/MA/038	I	5.7	23	4939	5562.22	G-6
BOR/MA/040	I	6.2	31.8	3656	4661.34	G-9
BOR/MA/043	I	4.9	36.5	3187	4408.28	G-10
BOR/MA/044	I	5.3	39.7	2690	4048.69	G-11
BOR/MA/045	I	4	34.2	3518	4680.35	G-9
BOR/MA/046	I	5.3	29.3	4125	5027.54	G-8
BOR/MA/050	I	5.6	25	4699	5403.66	G-7
BOR/MA/051	I	4.6	41.1	2566	4000.11	G-12
BOR/MA/052	I	4.2	39.9	2814	4189.85	G-11
BOR/MA/059	I	5.6	28.4	4208	5068.73	G-8
BOR/MA/060	I	6.9	39.2	2651	3939.80	G-12
BOR/MA/064	I	4.2	46.1	1959	3606.63	G-13
BOR/MA/70	I	5.8	27.3	4332	5143.03	G-7
BOR/MA/074	I	4.1	47.2	1821	3517.64	G-13

Borehole No.	Seam Name	Moisture%	Ash%	UHV (Kcal/Kg)	GCV (Kcal/Kg)	Grade
BOR/MA/075	I	4.3	44.5	2166	3742.69	G-13
BOR/MA/077	I	5.3	34.5	3408	4538.46	G-10
Total Number of Samples		**26**				
Minimum Value		3.70	23.00	1282.00	3170.55	
Maximum Value		6.90	51.50	4939.00	5562.22	
Mean Average		4.95	36.99	3162.92	4389.48	
Usual Grade		**G-10**				
Standard Deviation		0.79	7.99	1030.05	678.76	

Discussion on the Coal Grade and Deposit Characteristics:

While observing the seam wise coal grades after being recalculated empirically, it is found that, wide variations even within a single seam is existing. Even, almost all the seams are found to be falling in a wide range rather than a narrow grade range. Frequency distribution table of all the data of Seam Overall (172 nos.) shows that around 80% of the analytical data confined within a range of G-9 to G-13. Also, individual seams are lying in same range except few discrete coal samples in the lower packet seems to be high on range. On the other hand, few low grade data also observed where seam has deteriorated to ungraded coal mostly on the younger horizons of this block.

Thus the deposit may be declared to be within a range of G-9 to G-13 which corresponds well when compare with the Geological Report where it was declared as Grade F-G based on UHV.

Graphical representation of the frequency distribution and percentage of occurrence has been shown in figure 4.9.

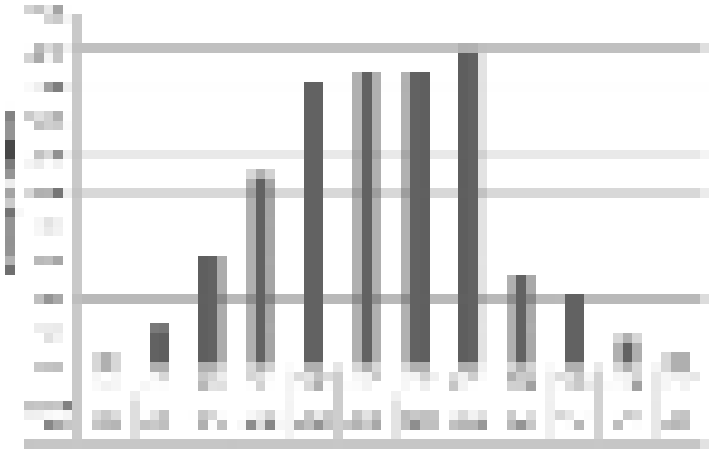


Figure 4.9: Graphical representation of Frequency distribution of all seams based on Grade of Barjora North Coal mine.

4.6.4 Ultimate Analysis:

Samples from three number of boreholes were selected for carrying out ultimate analysis covering the major workable coal seams of Barjora North Coal Block. Summarized analysis results are furnished in table no. 4.21.

Table No. 4.21

Ultimate Analysis results for the coal samples of Barjora North Coal Block.

Seam Name	Borehole No.	From	To	Thickness	CO2%	P%	C%	H%	N%	S%	O%
VIII	BOR/MA/028	22.94	23.92	0.98	0.44	0.152	80.54	5.36	1.98	0.88	11.24
VII	BOR/MA/028	35.62	36.77	1.15	0.32	0.470	81.01	5.30	2.06	0.96	10.67
	BOR/MA/036	25.75	27.10	1.35			81.09	5.08	1.96	0.83	11.04
VI	BOR/MA/036	37.75	38.93	1.18			80.98	5.10	1.93	0.76	11.25
V	BOR/MA/028	68.55	73.43	4.88	0.54	0.990	81.60	5.25	1.97	0.89	10.29
	BOR/MA/036	62.36	63.79	1.43			80.93	5.22	1.84	0.91	11.10
	BOR/MA/040	33.55	35.65	2.10	0.45	0.370	81.41	5.13	1.98	0.95	10.53
		40.80	41.80	1.00	0.75	0.460	81.44	4.96	2.21	0.83	10.56
		42.69	44.41	1.72	0.41	0.320	80.87	5.30	2.04	0.77	10.16
III	BOR/MA/028	87.60	88.65	1.05	0.40	0.390	82.06	5.01	2.00	0.77	10.16
	BOR/MA/036	83.63	84.65	1.02			81.12	5.15	1.95	0.81	10.97
	BOR/MA/040	65.29	66.89	1.60	0.53	0.870	82.01	5.15	2.18	0.92	9.74

Seam Name	Borehole No.	From	To	Thickness	CO2%	P%	C%	H%	N%	S%	O%
II	BOR/MA/028	93.35	95.65	2.30	0.22	0.430	82.62	5.13	1.92	0.91	9.42
	BOR/MA/036	85.92	87.22	1.30			82.43	5.06	1.92	0.74	9.85
	BOR/MA/040	70.20	71.88	1.68	0.25	0.630	82.46	5.28	2.12	0.81	9.33
I	BOR/MA/028	100.15	102.51	2.36	0.60	0.280	82.40	5.21	1.90	0.73	9.76
	BOR/MA/040	72.53	73.66	1.13	0.48	0.119	82.94	5.16	1.98	0.78	9.14

4.6 Seam Wise Geological Reserve:

The erratic nature of coal seams and rapid variation in their lay and disposition make assessment of resources of Barjora North bit problematic and difficult. However, for reserve estimation, following considerations' have made as per the geological report.

- For reserve estimation purpose, the area has been divided into three sectors – mostly by the presence of Faults. Three sectors are named as Sector-A, Sector-B & Sector-C.
- Based on analytical data carbonaceous /non-carbonaceous litho units were delineated as:

Litho units:	**Range of Ash%+Moisture%**
Shale	> 75%
Carb. Shale	>55% to < 75%.
Shaly Coal	>40% to < 55%.
Coal	< 40%.

- All combustible and non-combustible dirt bands upto 1 meter have been included in the coal seams.
- Quality parameters considered for reserve estimation purpose is I_{100} basis.
- Due to inadequate data and erratic nature of the coal seams, grade wise reserve estimation has not been attempted.
- In absence of systematic seam wise relative density values, 1.60 is considered for reserve estimation.

Based on the above considerations, geological net proved and indicated reserves have been estimated for each sector after considering probable losses due to unforeseen geological disturbances.

Seam wise Geological reserve along with its UHV based grades and computed GCV based (usual) grades are provided in table no. 4.22.

Table No. 4.22

Grade Wise - Seam wise Geological Reserves (Proved + Indicated) of Barjora North Coal Block.

Seam Name	Geological Reserve (Mtes)	Avg. UHV (Kcal/Kg)	Avg. GCV (Kcal/Kg).	Avg. Grade (As per GCV based Grading System)
IX	0.78	1897.80	3495.96	G-13
VIII	1.87	1680.45	3373.61	G-14
VII	7.05	2533.31	3923.33	G-12
VI	7.22	2752.44	4108.72	G-11
V	32.14	2526.97	3934.46	G-12
III	36.35	3166.00	4383.67	G-10
II		3312.83	4467.54	G-10
I		3162.92	4389.48	G-10
Total =	**85.4**			

Seam wise sector wise geological reserve has been depicted in table no. 4.23 below.

Table No. 4.23
Summarized Sector wise Geological Reserves of Barjora North Coal Block.

Seam Name	Sector-A		Sector-B		Sector-C		Total		Avg. Grade
	Area	Reserves	Area	Reserves	Area	Reserves	Area	Reserves	
Seam-IX	-	-	-		0.3565	0.7849	0.3565	0.7849	G
Seam-VIII	0.3114	0.9302	0.1388	0.3000	0.3002	0.6484	0.7504	1.8786	G-UNGR
Seam-VII	1.1073	3.7622	0.4500	1.1231	0.8411	2.2106	2.3984	7.0959	F-G
Seam-VI	2.0270	6.8276	0.1844	0.3983	0.0000	0.0000	2.2114	7.2259	F-G
Seam-V	3.4842	18.4306	0.6313	4.1007	1.5263	9.1014	5.6418	31.6327	F-G
Seam-I/II/III	2.1903	17.3637	0.2197	1.5729	0.2107	1.3517	2.6207	20.2883	E-F
Seam-I+III	0.1741	0.8972					0.1741	0.8972	F-G
Seam-I+II	0.9211	4.3335	0.4421	0.0909	0.0784	0.2185	1.4416	4.6429	F
Seam-I	1.3492	3.1973	0.0675	0.1458	0.3466	2.1942	1.7633	5.5373	E-F
Total = Seam-I+II+III	4.6347	25.7917	0.7293	1.8096	0.6357	3.7644	5.9997	31.3657	E-F
Total=	**11.5646**	**55.7423**	**2.1338**	**7.7317**	**3.6598**	**16.5097**	**17.3582**	**79.9837**	**F-G**
Net Indicated Reserve									
Seam-V			0.1269	0.5168			0.1269	0.5168	
Seam-I/II/III	0.7387	4.5303	0.1254	0.4603			0.8641	4.9906	
Total =	**0.7387**	**4.5303**	**0.2523**	**0.9771**				**5.5074**	
TOTAL GEOLOGICAL RESERVE - PROVED+INDICATED									
Total proved & Indicated		**60.2726**		**8.7088**		**16.5097**		**85.4911**	

4.7 Mineable Reserve as per Earlier Mining Plan:

As per the approved mining plan of Barjora North Coal Block, the estimated mineable reserve was 61.10 Million tons. Detail calculation for deriving the mineable reserve is being furnished in Table No. 4.24.

Table No. 4.24

Estimation of Mineable Reserve as per earlier Approved Mining Plan of Barjora North Coal Block.

Sl No.	Particulars	Coal reserves (Mt.)
1.	Net geological reserves considering 10% geological loss.	85.49 Mt.
2.	Less Geological Reserves to account for exclusion of incombustible dirt bands (presently considered within Net Geological Reserves).	8.55 Mt.
Net Available Geological Reserves (1-2)		76.94 Mt.
3.	Reserves blocked vertically below existing infrastructure (Cosmic Ferro Alloy Steel Factory) & Ghutgaria village and the 100m barrier zone.	4.59 Mt
4.	Reserves blocked within 45m surface barrier left from the existing road (between connecting Barjora and Mejia).	1.10 Mt.
5.	Reserves blocked within 7.5m surface barrier left from the Barjora Block Boundary.	2.06 Mt.
6.	Reserves Blocked within quarry batters .	4.87 Mt.
Net Available Quarriable/mineable coal reserves (1 – 2 – 3 – 4 – 5 – 6)		64.32 Mt.
7.	Less 5% Mining loss	3.22 Mt.
Net Available Extractable Coal Reserves		**61.11 Mt.**

As per the information obtained from the prior allottee, the mine has produced about 6.11 Million Tons of coal since commencement of production in 2011 till end of March, 2015.

Thus as per the approved mining plan and earlier production by prior allottee, the remaining coal reserves in this mine comes around 55 Million Tons.

4.8 Reserve within the Non-Forest Area:

4.8.1 Geological Reserve:

Based on the Geological report and the primary level of information supplied along with the Geological Report, geological modeling work has been carried out through software and coal reserves estimated accordingly. Seam wise coal reserves as estimated within the leasehold area of 260.14 ha is being furnished in table no. 4.25.

Table No. 4.25

Geological Reserve of the Leasehold area of 260.14 ha.

Seam Name	Gross Insitu Reserve (Mte)	Net Insitu Reserve (Mte)
IX	1.23	1.10
VIII	0.99	0.89
VII	4.26	3.83
VI	1.47	1.33
VT	8.75	7.87
VB	2.63	2.37
V	0.27	0.24
III	3.74	3.36
II	1.61	1.45
I	3.78	3.40
Total =	**28.72**	**25.85**

About 10% deductions have been made towards unforeseen geological disturbances to arrive upon net in-situ geological reserve from the gross in-situ geological reserve.

4.8.2 Mineable reserve:

Mineable reserve of the leasehold area has been derived after considering the mining benches and an active pit area. A pit has been considered up to floor of Seam-I with 38^0 slope from the surface elevation and individual bench slopes considered as 70^0. Bench heights

have been limited to 10 meter. Width in non-working benches considered as 10 meter and working benches considered as 30 meters. Estimation of mineable reserve (depleted reserve) from the gross in-situ geological reserve has been shown in the table No. 4.26.

Table No. 4.26

Mineable Reserve of the Leasehold area of 260.14 ha.

S L No.	Particulars	Coal reserves (Mt.)
1.	Net geological reserves considering 10% geological loss.	28.72 Mt.
2.	Less Geological reserve on account of unforeseen losses.	2.87 Mt.
Net Available Geological Reserves (1-2)		25.85 Mt.
4.	Reserves blocked under unapproachable areas due to shape of lease boundary.	2.12 Mt.
5.	Reserves blocked within 7.5m surface barrier left from the Barjora Block Boundary.	2.06 Mt.
6.	Reserves Blocked within quarry batters.	3.07 Mt.
Net Available Quarriable/mineable coal reserves (1 – 2 – 3 – 4 – 5 – 6)		18.60 Mt.
7.	Less 5% Mining loss	0.93 Mt.
	Mined out reserves by previous allottee.	6.11 Mt.
Net Available Extractable Coal Reserves		**11.56 Mt.**

4.8.3 Seam wise Mineable reserve:

Seam wise reserves have been estimated within the created pit through software modeling (later verified through sectional methods) and details of the same are furnished in Table no. 4.27.

Table No. 4.27

Seam wise extractable reserve (Depleted reserve) in the mining lease area of 260.14 ha.

Average stripping ratio for the life of the mine comes about to 1: 5.69 (Coal in tons: OB in cum).

4.9 Need for Further Exploration:

The exploration of this block is well covered with 64 boreholes with the density of 8 BH/Sq. Km as well as the leasehold area is covered with 25 boreholes with a density of 9.61 BH/Sq. km.

However, production support drilling will be carried out as and when required to ascertain the coal thickness and coal quality, etc. as per the annual working plans.

5.1 Introduction:

This chapter deals with the planning for mining activities within the allotted leasehold area of 260.14 ha. Selection of mining technology, phasing of equipment, along with target schedule of production etc. are being discussed in this chapter. The technology described in the previous approved mining plan, will be adopted and continued. An excavation schedule has been worked out for this mining plan for the allotted lease area (Non Forest area) of 260.14 ha, in compliance with the direction of MOC, Govt. of India vide their letter no. 103/7/2015/NA, dt. 18th November, 2016 furnished in **Annexure-6.**

Based on the existing conditions in the lease area, modification with respect to production schedule, internal dumping schedule etc. have been done and discussed subsequently in this chapter to cover mining within 260.14 ha of lease area.

5.2 The proposed mine (260.14 ha):

Mine boundary of the Barjora North Coal Mine has been firmed on the basis of considerations laid down by Ministry of Coal (vide their letter nil; dt. November, 2016 for Allotment order No.103/07/2015;) for transfer of Environmental clearance for Barjora North Coal Block from MOEF & CC. This mining plan for non-forest area has to be prepared by WBPDCL for commencement of mining activities in leased area.

1. The mining lease area, as granted by Government of West Bengal is involving 260.14 ha of non-forest land within Barjora North Coal block. It is to be noted that the same mining lease have been transferred to WBPDCL from previous allottee for 260.14 ha.
2. Corrigendum 01; dt. 07.03.2017 of the vesting order issued by Nominated Authority (NA) vide no. 103/75/NA; dt. 31st March, 2015.
3. Present surface lay out and mined out (De- Coaled) & backfilled areas are lying within the lease area.

5.3 Boundary of proposed Mine area:

i. In north, the mine boundary will be up-to the northern boundary of lease area.

ii. In South, the boundary will be mostly guided by the forest boundary and northern boundary of WBIDC area.

iii. Eastern boundary will be the zone along the existing metalled road joining Barjora – Mejia along lease area alignment.

iv. Western boundary will be along the lease boundary, covering sector c of the lease area.

5.4 Lease Area:

Leasehold area of 260.14 ha has been considered for the preparation of this mining plan.

The mining lease document is being furnished in **Annexure-2.**

5.5 Present surface conditions – in the lease area:

At present land use pattern of the lease area is given below in table no. 5.1.

Table No. 5.1

Present land use pattern of the lease area of Barjora North Coal Block.

S. L. No.	Land Use Category	Pre Mining (ha)
1	Mined out Voids .	63.93
2	De-coaled waste filled Area	39.49
3	Soil & Sub soil Storage Area	5.86
4	Infrastructure areas	9.11
5	Other Built Up areas	5.61
6	Safety Zone	17.89
7	Coal Stack Yard	1.25
8	Office and VT Centre	3.50
9	Road	2.55
10	Access Trench	0.65
11	Water Body	1.67
	* **Sub Total =**	**151.51**
12	Unutilised Areas	108.63
	Total =	**260.14**

The present land use is shown in Plate no. 4.

5.6 The Objective of Mining Plan:

The objective of this mining plan is to restart mining operation in the granted lease area. Efforts have been made towards estimation of the geological reserves and mineable reserve within the lease area where mining operation is to be resumed. Geological reserve has been estimated based on the borehole

information provided in the Geological report. Seam wise geological reserve has been furnished in Table no. 4.25 of chapter-4.

A pit has been considered up to floor of Seam-I and mineable reserve has been estimated based on the 38^0 slope from the pit top and individual bench slopes considered as 70^0. Bench heights have been limited to 10 meters for working benches. The bench width in non-working benches consider goes upto 20 meter and working benches upto 30 meters. Seam wise reserves have been estimated within the proposed pit through software modeling (later verified through sectional methods) and details of the same is furnished in Table no. 5.4.

The considered area for pit development comprises only the unworked areas within the lease area.

5.6.1 Coal reserves in the lease area:

Estimation of mineable and extractable coal reserves from the gross in-situ geological reserves has been furnished in table no. 5.2 below.

Table No. 5.2

Estimation of Mineable and Extractable Coal Reserves within the leasehold area of 260.14 ha.

It is to be noted that about 2.12 Mt of coal is getting blocked because forest boundary does not allow approach to those reserves. Similarly, due to faults F2-F2 and F3- F3, a trough has got formed and due to narrow width of trough, down thrown coal deposits have become unapproachable. Batter loss accounts to about 3.07 Mt of coals.

5.6.2 Seam wise reserves of the leasehold area:

Seam wise coal reserves within the leasehold area is furnished in table no. 5.3 below.

Table No.5.3

Seam wise extractable coal reserves within leasehold area of Barjora North Coal Mine.

Seam Name	Mineable reserve in Million Tons	Waste Volumes in Million Cum
Seam - IX	0.45	12.59
Seam - VIII	0.38	5.41
Seam - VII	2.56	19.49
Seam - VT	5.57	18.26
Seam - VB	1.23	4.49
Seam - III, II, I	1.37	5.61
Total =	**11.56**	**65.85**

Effective stripping ratio part is about 5.70 cum/te.

As discussed earlier, grade for these individual seams within the conceptual pit boundary on the lease area has not been considered separately and will be same as the general seam wise grade depicted in figure no. 4.9.

5.7. Geo mining parameters:

During the revised mining plan period, excavation will be confined in the sector-C. The mine opening has been suggested from the North – West corner near the Bore hole no BOR-47. The geo-mining parameters are given in table No. 5.4.

Table No. 5.4

Geo-Mining Parameters.

Geo-mining Parameters	**Year - 1**	**Year-3**	**Year-5**	**Year - 7**
Quarry Area – Ha.	33.23	53.25	75.68	87.58
Floor Area- Ha.	17.08	44.79	50.39	71.58
No. of working benches – Nos.	3	6	6	5
Ultimate pit depth-Meter.	82.5	105.5	128	145
Floor of seam.	Seam-V	Seam-I	Seam-I	Seam - I
Strike length – Meter.	604	710	954	395
Dip-rise length – Meter.	624	774	1106	1333
Dump-A (Existing mined out voids and partially backfilled) in the Sector A). Mcum. (Cumulative).	4.93	18.56	21.13	21.13
Dump-B (Existing Dump site in mined out voids of Sector-C). Mcum. (Cumulative).	-	3.93	20.30	20.30
Dump-C1 & C2 (Concurrent Backfilling in Sector-C). Mcum. (Cumulative).	-	1.16	4.92	24.42

5.8 Description of Mining System:

Opencast mining method is selected in view of varying thickness of coal seams. The mechanized opencast method is described below.

Drilling and Blasting

The uppermost layer of soil (about 3 – 8 m) is soft and will not require drilling and blasting. So it will be dozed and ripped by the dozer and ripper attachment. It will be kept separately in temporary top soil dump for the reclamation purpose. The total area of 5 Ha has been earmarked for top soil dump in the north-east corner of the project area. The remaining hard overburden and partings are to be drilled and blasted before excavation. Rotary blast hole drills of 250mm drill diameter has been proposed for O.B. benches and more than 10 m inter-seam partings and Rotary blast hole drills of 150-160 mm dia has been proposed for other inter seam parting blasting.

A tentative blast pattern of 6.5 m spacing and 5 m burden is proposed for 10 m bench. Considering mining in adjoining block, optimum blast pattern will

have to be arrived at for horizons of different thickness after necessary field trials to determine parameters viz., peak particle velocity, maximum charge per delay etc.

Overburden Excavation:

The rock overburden and thick inter-burden below top soil will be excavated by 6 cum Diesel hydraulic shovels in conjunction with 50T - 60T rear dumper. Whereas the thin parting between the seams will be removed by deploying 3 - 4 cum hydraulic shovel and 35 T rear dumper.

Coal Mining: Surface Miner

It is envisaged to deploy surface miner for coal excavation. In this technology blasting is not required for excavation of coal. Surface miner will be provided for production of coal of uniform size i.e. 100 mm size. The inseam bands of +30sm size can also be removed separately. Due to utilization of selective mining the grade of the coal could improved. In this technology the coal face will be clean and wear & tear of dump trucks will also reduce. No crushing unit would be required in this method.

Overburden Removal: Shovel – Dumper System

As is well known, the combination of Shovel and Dumper technology offers convenient mining operations, to deal with sudden occurrence of unworkable and poor quality zones and offers flexibility for easy up gradation. During the initial year of quarry operation a temporary road will be developed near the access trench by dressing the top soil and some leveling of the undulating surfaces. The overburden from lower branches will be connected by ramps to the central dump road, which is connected with the old quarry void, during the first two years of mine operation. By then central flank road will be developed gradually along with the mine advancement. Internal dumping will start after the end of 2nd Year of mine operation.

The thickness of top & sub soil varies from 6 -10 meter within the planned excavation area. The top soil dump has been managed in the eastern part of Sector-C during previous operation as per approved mining plan and the same will be continued in this period as well. Once backfilling of the de-coaled area is completed and stabilized, this newly generated top soil will be spread over the stabilized dumps for biological/agro reclamation. Top & sub soil removal

is being planned by 3 – 4 cum shovel in this planned period coupled with 35 T rear dump trucks.

Though equipment is provided separately under overburden and coal, the same shovel working in coal or O.B may excavate the parting or coal seam below and above a particular horizon depending on work load and location.

5.9 Mining System & Stages of Mining:

To finalize the mining system, the following geo-mining conditions were considered:

- Multiple coal seams
- Strike length.
- Presence of coal seams of variable thickness.
- Variable thickness of OB/Parting.
- Gradient of coal seams around 8^{o}.
- Proposal for 100% internal dumping.

Based on the above factors Mining System has been developed.

The top OB benches would be worked in horizontal slicing method. Horizontal slicing method will also be adopted for coal extraction by surface miner. Inter-seam partings will be dealt along inclined faces.

5.9.1 Stages of Mining:

Construction activity:

As Barjora North Coal Mine was being operated till 31st March, 2015 by prior allottee, and the lease has already been transferred to WBPDCL, for 260.14 ha of non forest land, no further land acquisition is envisaged for this modified mining plan.

Office areas, magazine, stores etc. are available at site, thus the mine can resume its operation without further construction of the same.

However, project specific workshop needs to be developed by WBPDCL, before commencement of the operation at Barjora North Coal Mine.

Nearby locality is almost urban to semi-urban in nature and considerations for residential colony has not been considered by WBPDCL.

Rehabilitation and Resettlement have already been complied by prior allotte as per approved R & R Plan. However, if any left out families

found within the leasehold area, WBPDCL will implement approved R & R policy.

The Mine Layout:

The mine is geologically divided into three major sectors namely, Sector –A, Sector – B, Sector – C. The sector description is given in the Chapter – IV of this report.

Considering the working only for the leased area, it has been assessed that the present mine working can be taken up in sector –C only. The working in the Sector-A was taken up by the prior allotte and after the mine working, the mine voids were also used as a dump area for the overburden. The existing mine voids and dump area shall be utilized for dumping for the present working. Sector B has also been worked out and internal dumping was done in this area. Mine infrastructures like pit office, workshop, weigh bridge, temporary coal stack yard has been proposed in this area. The Mine Lease boundary along with proposed mine infrastructure has been drawn and shown in the **Plate no -9**

The mine working will start from the North West of the Mine. The access trench will be placed near the Bore hole no BOR – 47 and Bore hole no BOR-24. The mine will progress from North to south till the fault plane F2-F2". And gradually mine will be developed towards South – East along the dip.

During the initial year of quarry operation a temporary road will be developed near the access trench by dressing the top soil and some leveling of the undulating surfaces. The overburden from lower branches will be connected by ramps to the central haul road, which is connected with the old quarry void, during the first two years of mine operation, and central flank road will be developed gradually along with the mine advancement along the seam gradient. Internal dumping will start after the end of 2nd Year of mine operation.

Previous Allottee has worked in the Eastern section of the lease area. Top Soil was stacked in the North East part of the coal block. Overburden were dumped in the voids of the mine working in Sector – A.

It is proposed that the old mine void, which is still in bgl depth, will be utilized for the initial year dumping which will continue till the end of 2nd year of mine operation. Top soil will be stacked in the old Top soil stack yard only. Old mine dump will also be utilized in subsequent year in a sequence to accommodate all the overburden.

The top soil will be spread over the filled up mine void in a progressive way.

In the present mine plan all the mine voids and old dumping within the mine lease hold area will be utilized for backfilling in the sequence. No external OB dump area has been proposed in this mine Plan.
Year wise mine operation along with area of operation are detailed below:

Opening of Mine Field:

The in-crop of Seam V (Com) occurs all along the western side of coal blocks in Sector C. An access trench no AT1 will start near the borehole no BOR - 47at level of +73m. It will touch the floor of seam V at +23.5m. The coal seam occurs at a depth of about 50 to 60 m. The main haul road will be driven down at 6% gradient towards south- east along the floor. This will advance towards further east while working bench will advance towards south east. The initial length of the access trench will be about 290m.

1st Year of Mine Operation:

It is proposed to have an access trench in the North west side of the mine. The Surface RL in this area is +72 to +75. The box cut of about 10m will be developed in this area towards south. This will continue till the fault plan of F2 –F2'. To achieve the seam floor the access trench will further move towards north after reaching the southern safety zone batter limit and will continue till it touches floor of seam V near the northern boundary limit. After that it will further move towards south again along the floor of the mine. The approach road will be developed and will continue to further develop the main haul road in the south along the batter limit of the block boundary.

The total area of excavation will be 33.12 ha including 10.58 ha for box cut.
The mine will be working in the Seam –I floor to Seam V Top roof. The total coal excavation will be 0.77 M.te and 4.93 M.cum of Overburden will be removed. The stripping ratio will be 6.40 cum/te.

The overburden will be backfilled in the old mine working in sector. A. Detailed mine working has been shown in the plate no **Plate no 13.**

3rd Year of Mine Operation:

During the 3rd year of mine operation the top soil will be stacked in the top soil stack yard. The mine will produce 2.25 M.Te of coal and corresponding OB removal will be 11.30. The stripping ratio for this year of mine operation will be 5.02 cum/te. The cumulative coal production will be 4.52 M.tes and corresponding overburden removal will be 23.65 M.cum. The internal

dumping will also start in the present working leaving the safety barrier of 110 m from the mine working. The internal dumping in the present working will be 1.60 M.cum with a level of +25. The total area of excavation will be 54.25 ha.

The mine will be working in the Seam –I floor in the bottom to and Seam VII roof. Mine working along with dump location has been shown in the plate no 14.

By end of 3rd year, pa portion of backfilled area in Sector- A will start getting sterile from south side. Plantation will be undertaken in the sterile area.

5th Year of Mine Operation:

During the 5th year of mine operation the top soil will continue to be stacked in the top soil stack yard. The mine will achieve its peak rated capacity of production in the 4th year of mine operation. Due to space congestion and batter position production level in this year will be only 2.25 M.tes and corresponding Overburden removal will continue to be at 11.35 M.cum. The stripping ratio will be 5.04 cum/te. The internal dumping will continued and part of OB will be back filled in old mine working and old dump area of mine sector – A.

The mine will be working in the Seam –I and Seam V Top. The total coal excavated till this year will be 9.77 M.te and cumulative overburden removal will be 46.35M.cum. The average stripping ratio will be 4.74 cum/te.

The total area of excavation will be 75.68 ha. Detailed mine working has been shown in the plate no 15.

By end of 5th year, total of about ha of backfilled area gets sterile in Sector A. this will be covered by plantation.

7th Year (Final year) of Mine Operation:

During the 7th year of mine operation the top soil will be stacked in the newly top soil stack yard developed near the mine infrastructure area. The mine will achieve its complete mine production. During the last year of mine operation it will produce 0.64 m.tes of coal and the corresponding overburden will be 8.15 M.cum. The stripping ratio will be 12.73 cum/te. A total effort has been made for the maximum recovery of the coal. Due to space congestion and batter position further production from this mine area will not be possible. The internal dumping will continued along with the reclamation activity in the old dump area of mine sector – A.

The mine will be working in the Seam –I and Seam V Top. The total coal excavated till this year will be 11.56 M.te and cumulative overburden removal will be 65.85 M.cum. The average stripping ratio will be 5.70 cum/te.
The total area of excavation will be 87.58 ha. Detailed mine working has been shown in the plate no 16.

5.10 Transportation:

For OB removal, it is envisaged to deploy 60T rear dumpers in conjunction with 6.0 Cum hydraulic shovels and 50T rear dumpers with 4.5 / 5 Cum Shovels for the entire life of the mine. For Coal extraction, 2200& 1900 series Surface Miners has been proposed to work in coal in conjunction with 25T rear dump trucks by winrowing method of mining using dozer and pay loaders.
Partings between various seams and top overburden would be transported along the benches and then through ramps to various dump location within the mine lease area in the excavated area, old dump and de-coaled area.

5.11 Production schedule:

The Barjora North Coal mine has commenced production in the year 2011 and till 31st March, 2015, the mine has produced about 6.11 Million Tons of Coal. The calendar program is given below in Table no. 5.5.

Table No. 5.5

Calendar program for Coal excavation & OB removal

Year	Coal (Mt)	OB (Mcum)	SR	Coal (Mt)	OB (Mcum)	Avg. SR
Year-1	0.77	4.93	6.40	0.77	4.93	6.40
Year-2	1.50	7.42	4.95	2.27	12.35	5.44
Year-3	2.25	11.30	5.02	4.52	23.65	5.23
Year-4	3.00	11.35	3.78	7.52	35.00	4.65
Year-5	2.25	11.35	5.04	9.77	46.35	4.74
Year-6	1.15	11.35	9.87	10.92	57.70	5.28
Year-7	0.64	8.15	12.73	11.56	65.85	5.69
Total	**11.56**	**65.85**	**5.70**			

5.12 Proposed HEMM with phasing :

Detail equipment list for this mining plan is given below in table no. 5.5 Separate equipment configuration has been suggested for coal and OB. The numbers are indicative based on the planned parameters. However,

depending upon the actual site conditions, numbers may increase or decrease at any specific period of operation as well as specific equipment may be used interchangeably in between coal and OB as and when required basis.

Table No. 5.6

Proposed HEMM Configuration for this mining plan.

PHASING OF EQUIPMENT

S.NO.			Total	Year on Year Production / Population						
				Yr-1	Yr-2	Yr-3	Yr-4	Yr- 5	Yr-6	Yr-7
	Coal (mt)		**11.56**	0.77	1.50	2.25	3.00	2.50	1.00	0.54
	Overburden (M.Cum)		**65.85**	4.93	7.42	11.30	11.35	11.35	11.35	8.15
A:	**OB Removal Equipment**	Capacity		**Yr-1**	**Yr-2**	**Yr-3**	**Yr-4**	**Yr- 5**	**Yr-6**	**Yr-7**
			Total	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**
1	Diesel Hyd. Shovel	6 cu.m.	**1**	0	0	1	1	1	1	1
2	Diesel Hyd. Shovel	4.5 / 5 Cum	**6**	2	3	5	6	6	6	5
3	Diesel Hyd. Shovel	3 - 4 Cum	**2**	2	2	2	2	2	2	2
4	Rear Dumper (Rock Body)	50 T - 60T	**49**	14	21	42	49	49	49	42
5	Rear Dumper (Rock Body)	35 T	**14**	14	14	14	14	14	14	14
6	Diesel RBH Drill	250mm	**6**	4	6	6	6	6	6	6
7	Diesel RBH Drill	160 mm	**6**	4	6	6	6	6	6	6
8	Dozer	320 HP	**5**	3	4	5	5	5	5	5
9	Dozer with ripper attachment	436 HP	**3**	2	3	3	3	3	3	3
10	F.E. Loader	5-6 cum	**3**	3	3	3	3	3	3	3
B	**COAL Equipment**									
1	Surface Miner	CM 2200	**2**	1	1	2	2	2	2	1
2	Surface Miner	CM 1900	**1**	0	1	1	1	1	1	1
3	Wheel Dozer	405 HP	**2**	1	1	2	2	2	2	2
4	F.E Loader	2.5 CUM	**3**	1	2	2	3	3	2	1
5	Tipper	25T	**32**	15	25	25	32	32	20	10
6	Water Sprinkler.	28kL	**3**	2	3	3	3	3	3	3
C:	**COMMON Equipment**									
1	Diesel Hyd. Shovel	0.9-1.2 cu.m.	**1**	1	1	1	1	1	1	1
2	Crane	35 T	**1**	1	1	1	1	1	1	1
3	Crane	10 T	**1**	1	1	1	1	1	1	1
4	Tyre Mounted Crane	20 T	**1**	1	1	1	1	1	1	1
5	F.E Loader	1.5 cum	**1**	1	1	1	1	1	1	1

6	F.E Loader	0.5 cu.m.	**1**	1	1	1	1	1	1	1
7	Wheel Dozer	450 HP	**2**	1	1	2	2	2	1	1
8	Grader	145-150 HP	**2**	1	2	2	2	2	2	2
9	Grader	280 HP	**2**	1	2	2	2	2	2	2
10	Water Sprinkler.	28 KL	**3**	2	3	3	3	3	3	3
11	Fuel Truck	110 HP	**3**	1	2	3	3	3	3	3
12	Fire Truck	110 HP	**2**	1	2	2	2	2	2	2
13	Tipping Truck	10t	**2**	1	2	2	2	2	2	2
14	Tyre Handler		**2**	1	2	2	2	2	2	2
15	Vibratory Compactor		**2**	1	2	2	2	2	2	2
16	Maintenance Van		**2**	1	2	2	2	2	2	2

5.13 Waste and Top Soil Management:

5.13.1 Top Soil Management:

The process of mining starts from scrapping of top soil. Average topsoil in the proposed area of excavation found to be around 0.98 meter. Year wise proposed top soil excavation is furnished in table no. 5.7.

Table no. 5.7
Year Wise Top Soil Excavation

Production Year	Top Soil in MM^3
1st Year	0.32
2nd Year	0.42
3rd Year	0.52
4th Year	0.64
5th Year	0.74
6th Year	0.80
7th Year	0.85
Total	**4.29**

This stored top soil will be spread over the reclaimed areas 3rd year onward. Year wise top soil spreading will be done as furnished in table no. 5.8.

Table No. 5.8

Year Wise Top soil Spreading Schedule.

		Top Soil used " MM3"				
Stage	**Top soil Removal MM3**	**Embankment**	**Spreading over the Backfilled area**	**Spreading over OB dump Area**	**Using Green Belt Area**	**Total Utilised TS**
1st Year	0.32		-			-
2nd Year	0.42		-			-
3rd Year	0.52		0.56			0.56
4th Year	0.64		0.92			0.92
5th Year	0.74		1.12			0.95
6th Year	0.8		1.24			0.95
7th Year	0.85		0.45			0.91

Post spreading of top soil, the area will be reclaimed biologically.

5.13.2 Minimising area of coverage:

The first guiding principle of designing an overburden dump is to minimize use of land area for dump accommodation. Keeping this in mind an attempt has been made to implement zero external dumping which is in continuation to the earlier mining process. An area of about 39.49 ha has already been backfilled and dumping in the initial years of this planned period will also be continued in the same. Concurrent backfilling is envisaged from the 3rd of operation.

5.13.3 Stability of Dump:

The second guiding principle is slope stability of the dumps. Initially dumping will be continued in the already de-coaled area to accommodate about 22.49 MBCM of OB till 3rd year of operation. Within this time period, sufficient voids are expected to be created in the northern patch of the mining area where de-coaling is envisaged. Concurrent backfilling will be done in keeping safe distance of more than 100 meter within the working areas. A flat slope of less than 28^{o} will be maintained all throughout the backfilled areas.

5.13.4 Control of pollution arising from dumps:

Thirdly, in pre mining stage itself, garland drain around dump area will be created, to arrest seepage waters from dump. A toe wall of 2.5 meter height and 2 meter width will be erected along the periphery of the bottom tier at

surface level. The slopes and the berms will be vegetated. Gullies will be provided to guide water from higher deck to lower deck. These are some of the measures to control pollutions from dumps.

5.13.5 **Nature of waste rock:**

The bulk of the overburden rock are represented by sandstone and shale contributing cover 50% of the waste rocks, followed by their intermediate varieties, carbonaceous shale, thin coaly horizons and clays. Additionally the block is mostly covered by soil/ weathered mantle which constitutes a part of the overburden strata.

5.14 **Sequence of Dumping:**

Dumping of Overburden in this period has been planned in both the existing internal dump as well concurrent backfilling within the mined out pits Proposed to be excavated. Quantum of internal and concurrent backfilled OB volumes is furnished in table no. 5.9.

Table No. 5.9

Details of Overburden dumping

Year	Dump-A (Existing mined out voids in the Sector C).	Dump-B (Existing Dump site in mined out voids of Sector-A)	Dump-C (Concurrent Backfilling in Sector-C).	Total Volume in Mcum.
1.	4.93	-	-	5.93
2.	7.42	-	-	7.42
3.	6.21	3.93	1.16	14.3
4.	2.57	7.62	1.16	15.35
5.	-	8.75	2.60	11.35
6.	-	-	11.35	11.35
7.	-	-	8.15	8.15
Total	**21.13**	**20.3**	**24.42**	**65.85**

Stage dumping plans is being shown as given below:

1st Year – Plate No. 13.
3rd Year- Plate No. 14.
5th Year – Plate No. 15.
7th Year – Plate No. 16.

6.1 Drilling:

Drilling and blasting would be required in OB benches before excavation by shovel. As per general strata conditions, 50% of rocks taken in category III and balance 50% in category IV for drilling and blasting.

6.2 Overburden Blasting details:

Top OB of soil & sub soil will be excavated directly while drilling & blasting will be required from the hard strata. 250 mm blasthole drilling will be carried out for the thick inter-burden while 160 mm blasthole drill will be utilized for thinner inter-burdens.

6.3 Blasting requirements:

Particulars	Requirements
Estimated peak rated annual OB including main burden and partings at 5.70 m3/T stripping ratio.	11.35 Mcum.
Max. weekly OB removal (52 weeks)	218269.23 Cum
Type of explosives – slurry/emulsion	Bulk explosives
Powder factor – assumed – Overburden.	0.3 Kg/Cum
Weekly explosives requirement (maximum at PRC).	65.48 Tons.
Suggested pattern for drilling	Spacing: 6-8 meter Burden: 7-8 meter

Drilling shall be suitably distributed in all OB benches to provide requisite workload for each shovel.

6.4 Storage of explosives:

It is envisaged that blasting operation will be carried out by SMS (site mix slurry) and will be transported to the mine site by the explosives agency. Magazine will be required only for storage of detonators, detonating fuse, cast boosters, cord relays etc. a cluster of 2 magazines, each of 5 Te capacities is proposed for storing detonating fuses, detonators and other explosives for secondary blasting.

6.5 Ground level vibrations:

Vibrations due to blasting may cause damage to the nearby structures if appropriate control measures are not adopted.

Flyrock is another possible damage causing outcome of blasting. There are many factors which influence flyrocks. These are like long explosive columns with inadequate stemming column, improper burden, loose material or pebbles near holes and long water columns in the holes.

6.6 Suggested measures to minimize ground vibrations:

The following control measures have been envisaged to reduce ground vibration within statutory limits:

a. The peak particle velocity (PPV) of ground vibration will be kept below 10mm/s for 8-25 hz frequency range through optimally controlled blasting techniques, after necessary field trials.
b. Drilling and charging pattern will be formulated, with less explosives charge etc, after field trials.
c. Use of suitable initiating sequence and millisecond detonators.
d. Reduction of amount of explosives charged per day optimally.
e. To contain fly rocks, stemming column will not be less than burden of the hole. Blasting area will also be muffled, if necessary, to stop fly rocks propagation.
f. Blasting will not be carried out when strong winds are blowing towards habitation areas. Blasting will be done during midday time and never at night.
g. Surrounding villages within 1 km radius of blasting will be regularly inspected for any visual cracks on walls and feedbacks will be gathered to investigate thee reasons for these and for reassessing the charge per delay from time to time.
h. Vibration study will also be carried out at appropriate times to firm up most ideal and optimal blasting parameters.
i. Controlled blasting to avoid tension cracks which may endanger the stability of bench slopes in the mine.
j. Short delay detonators to be used in preference to detonating fuse.
k. In case of using detonating fuse, it should be covered with 750 mm thick cover of sand or drill cuttings.

l. Proper care and supervision during blasting by a competent and experienced persons.

By adoption of the above measures, it will be ensured that the ground level vibration due to blasting are maintained within the limits prescribed by DGMS. The Circular No. 7 dt. 29-08-1997 of DGMS giving permissible safe peak particle velocity (PPV) is given in the following table no. 6.1.

Table no. 6.1

Permissible Peak Particle Velocity (PPV) at the foundation level of structures in mining areas in mm/sec.

Type of structure	Dominant excitation frequency – hz.		
	< 8 hz	8 -25 hz	>25 hz
A. Building structures not belonging to the owners.			
Domestic houses/ structures (Kutcha brick and cement)	5	10	15
Industrial buildings (RCC and framed structures)	10	20	25
Objects of historical importance	2	5	10
B. **Building belonging to the owner with limited span of life.**			
Domestic houses/ structures (Kutcha brick and cement)	10	15	25
Industrial buildings (RCC and framed structures)	15	25	50

7.0 Introduction

Barjora North Block is envisaged to be mined by opencast mining method. The maximum depth envisaged during proposed planned period of 7 years is 145 m on the floor of seam-1. No artificial ventilation system will be required to establish for this depth. Natural ventilation will drive out the blasting fumes and polluted air out of the mine.

However, during subsequent years also, no artificial ventilation arrangement will be required.

8.1 Introduction:

The planning of de-watering of the mine has been done in such a way that as far as possible the working faces and haul roads remain dry. The layout of the quarry, provides suitable gradient along the quarry floors and the benches to facilitate self-drainage of water to the lowest level of the quarry towards the eastern side.

The maximum rain water intake will be during the period of about four months (June to September) in a year. During dry season, say October to May, seepage from strata is expected to be moderate and the same can be dealt by running a few number of pumps provided for monsoon pumping. During this period repair & overhauling of the pumps will be done by rotation.

The southern section of the quarry face is proposed to act as the mine sump. The rain water inflow into the quarry workings will gravitate into this sump by natural drainage. The quantity of water inflow during a day of peak rainfall in monsoon in excess of sump capacity will be handled by the main pumps.

Although there is a fair variation from year to year, the average annual rainfall is around 1380 mm per annum as per data collected from Durgapur. As described in the approved mining plan, maximum rainfall in a day has considered as 170 mm.

8.2 Basic Considerations:

The following considerations have been made for calculating the pumping requirement and selection of pump for this interim period.

- Excavated mine area and its depth.
- Geographical location of the project.
- General climatic conditions, surface features of the terrain beyond the boundary of the mine.
- Calendar plan of excavation of quarry.

- Geological characteristics of OB and coal seams.
- Meteorological data of nearest rain-gauge stations.
- Catchment areas, mined out areas beyond excavation, spoil dump area etc., maximum depth of the quarry during this interim period.
- Water garland drains shall be developed in advance for each stage of mine working so that rain water is collected by the garland drains and get diverted to the adjoining Tartora nallah.
- Desired location at surface where quarry water can be discharged after due settlement and considering the surface drainage system.
- Maximum rainfall per day (170mm continuous rainfall for 24 hours).
- Pumping requirement has been assessed on the basis that the make of water on the day of maximum rainfall will be pumped out in following five days.
- Within the quarry, the faces shall be so laid that water from the working areas shall flow into the sump by gravity. From the sump, the water would be pumped out to the surface and will flow into the surface drainage system.
- Concurrent backfilling will be done in the de-coaled areas of the quarries.
- For the purpose of pumping calculation, effective pumping hours per day has been adopted as 18.
- Adequate reserve pumping capacity has been provided.

8.3 Assessment of Volume of water for pumping:

For the Barjora North block in particular, the total average rainfall is about 1380 mm of which 90 % precipitation is during rainy season. For rainwater estimates for pumping purpose, a high of 170 mm of rainfall in a day has been considered. The volume of rain water entering to the mine and accumulating in the quarry

has been estimated on the basis of direct catchment area, maximum daily precipitation and the run-off coefficient. An additional 20% additional make of water has been considered to account for ground water seepage and aquifer water.

Volume of rain water entering to the mine and accumulating in the quarry (make of water) has been assessed on the basis of the following formula:

$$Q = A \times H \times \partial \ m^3/day$$

Where, A - Catchment area in m^2

H - Maximum daily precipitation in mm

∂ - Run-off co-efficient

The run-off co-efficient (∂) has been considered as below:

For mined out area	:	0.60
For area beyond excavation	:	0.15
For internal dumped area	:	0.10

The maximum broken area within this interim period is envisaged in the fifth year of operation and estimation for make of water done on the quarry parameters for fifth year only.

Following parameters were considered:

Maximum broken area :	87.58 ha
Internal dump area:	65.85 ha
Other catchment area:	150 ha.

Net area calculated for make of water in pit – 87.58 ha + 150 ha – 65.85 ha = 171.73 ha

Or say, 1717300 sq. meter.

Make of water within pit = (87.58-65.85) x 10000 x 0.17 x 0.60= 22164.60 m^3

Make of water for other catchment areas = 150 x 10000 x 0.17 x 0.15 = 38250 m^3

Total accumulated water in pit = 604146.60 m^3

Additional 20% water for ground water and seepages = 21,726 m^3.

Total water estimated for pumping requirement= 82140.60 m^3.

8.4 Pumping Capacity & Pump selection:

Main Pumps

The pumping capacity has been designed in such a way that the maximum water can be pumped out in 5 days with 18 hours of pumping per day.

Requirement of pumps

Year	Total required pumping capacity	Depth of excavation from surface	Specification of Pump	Basic Strength
	(cum/hr)	(m)		(No.)
Up to 7th year	915.00	145.00	300 cum/hr cap. 180 m head, around 350 – 400 HP diesel operated pumps will be fitted.	4

Requisite accessories will be fitted with these pumps to make it operational. Sufficient quantity of accessories will be maintain as inventory to deal with worse case scenario not only to continue the production but also to avoid happenings of disasters.

9.1 Despatch:

Coal will be dispatched to the trucks either to Bankura Railway Station at a distance of around 35 – 40 km or to Durgapur railway station at a distance of around 10- 12 km from project location by road. Coal will reach to end use plants by railway. Railway sidings are available in each of the end use plants. Distance of the different end use plants with respect to Bankura and Durgapur railway stations are given below in table no. 9.1.

Table No. 9.1

Distances of different End Use plants of WBPDCL from Barjora North Coal Block.

Name of End Use Plants	Distance from Bankura Railway Station.	Distance from Durgapur Railway Station.
Santaldih TPS	76	105
Kolaghat TPS	172	218
Bakreswar	161	58
Bandel	274	171
Sagardighi TPP, Unit 1 & 2	367	264
Sagardighi TPP, Unit 3 & 4	367	264

Figure no. 9.1 shows the map of different end use plants along with Barjora North Coal Block superimposed in the administrative map of West Bengal.

9.2 Coal handling Arrangement:

Coal will be produced through surface miner, thus primary crushing units are not proposed at mine end. Secondary crushing whatever required will be done at Plant end. Produced coal size will vary within (-200) mm range.

Existing infrastructure on ground such as platform for coal stack will be utilized for ground stocking of coal.

Coal will be loaded onto trucks through pay loaders for despatching out of the mine areas.

9.3 Quality Control:

Segregation of coal and bands will be done at mining face once the surface miner cut the coal surface. Selective mining methodology will be adopted to mine only the coal surface while stone bands will be removed through drilling & blasting. In case of thin dirt bands, manual vigilance will be adopted not to stack the material along with the coal stack yard.

9.4 Seam wise Quality:

The Seam-I/II/III contains of both combustible and non-combustible dirt bands. Generally 10% to 14% dirt bands are present. Quality of ROM will improve to primary grades upto G-11, due to selective mining by Surface miner as coal and stone shale bands will be worked separately.

Seam V is also consisting of dirt bands mainly of combustible nature to the tune of 12- 15%. The overall ROM grade with stone band is G-13. Adoption of Surface Miner Technology will result in quality enhancement for Seam –V for existing G-13 to G14 to primarily G-11 grades.

Seam VI/VII/VIII/IX is thin in-seam band contributing to as high as 20% of reserves in some cases. Hence, in these seams selective mining by adoption of Surface Miner Technology will improve the coal quality as stone bands will be selectively removed from the coal seams.

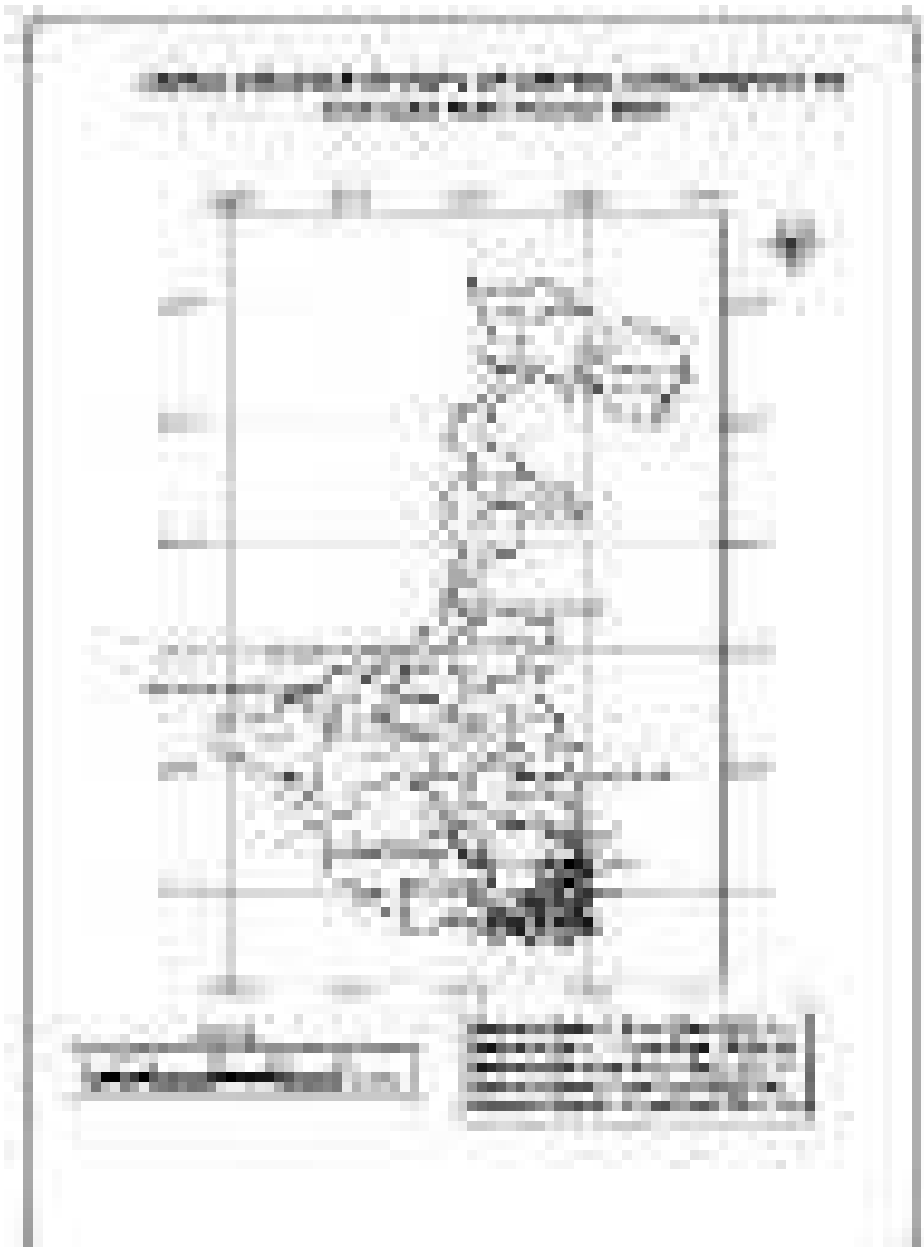


Figure No. 9.1: Distance of different End Use Plants of WBPDCL with respect to Barjora North Coal Block .

10.1 General:

Man Power requirements are assessed on the basic design criteria for a production of 3.0 MTPA and comes to about 477 . Break-up of total manpower requirement for the Barjora North Opencast Mine is given below in table no.10.1

Table 10.1

Break-up of total manpower requirement at PRC.

Sl. No	Particulars	Strength (no)
1.	O.B. Direct	178
2.	Coal Direct	78
3.	Reclamation/Environment	9
4.	Excavation	54
5.	E & M	35
6.	Supervision & Safety	32
7.	Survey	5
8.	Medical & sanitation	6
9.	Common including engineering & Planning staffs.	80
	Total	**477**

Standard norm of manpower calculation has been used for arriving at the manpower requirement in respect of HEMM operation and maintenance.

10.2 Output per manshift (OMS):

Total manpower = 477.

Total man shifts (considering 300 working days) = 143100.

Output per man shift (OMS) = 20.96 (considering peak rated capacity of 3.0 MTPA).

10.3 Services proposed to be outsourced:

The following services are proposed to be outsourced for better management and results and improved efficiency in daily operations.

a. Surface Transport
b. Sizing & Shale Picking
c. Maintenance of HEMM
d. Security Services
e. Canteen Services
f. Rest house services
g. Sweepers.

Considering the provisions for outsourcing, manpower in the project has been proposed.

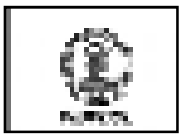
10.4 Automation:

Efficient management and control of project depend upon the management of information system. Availability of accurate information at proper time is backbone for decision, implementation and control. In Barjora North Opencast Mine emphasis has been given on the use of modern information technology and other modern system as a tool to the management. Provisions have been made for the following:

1. Computer hardware and software for mine planning and design, maintenance,inventory control, data management, etc.
2. INTERNET, WAN/LAN support for integrated information system.
3. Surface Mine Communication System for monitoring, control of line function, etc.
5. Modern survey equipment (TOTAL STATION) compatible with computer system.

10.5 Manpower Training:

In order to achieve higher productivity in mining operations, various tools of automation has been proposed. To successfully implement and use the envisaged level of automation proper training in each aspect of automation i.e. success in achieving higher productivity and efficiency will greatly depend on the training imparted. It is also proposed that suitable time bound up-gradation of hardware and software along with annual maintenance contracts, training contracts,



periodic exposure to technical enhancement is provided. A suitable feedback evaluation system is proposed to evaluate the efficiency of the automation proposed and its modification if required.

However, the benefits of automation can be assessed only if, proper management actions in real time frame is taken based on MIS information.

11.1 Introduction:

Extraction of coal through opencast mining is generally taken to be safe compare to underground mining. The following however are considered areas of danger in opencast mining.

- Accidents on OB and coal benches due to failure.
- Failure of dump slopes.
- Flooring of the mine.
- Blasting in opencast mines.
- Fire in OB dump/Coal Yard/Coal benches.
- Accidents due to lack of proper space for movement for men and equipment in mine.

Opencast mining needs are:

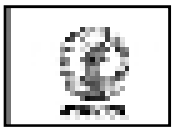
- Coal bench top must be cleaned off before drilling & blasting is taken up.
- Coal blasting has to be well controlled for unwanted spread over OB benches.
- While cleaning toe of coal bench by shovel, the operator has to take special care so that minimum coal is picked up along with OB for disposal to the OB dump.

11.2 Failure of Benches of OB and Coal:

Bench height of OB and Coal must match with the bucket reach of the shovel so that it can pick up all loose materials from the coal / Ob benches. This reduces chances of accidents due to fall of loose materials. The blasting of OB and Coal faces must be dressed with bucket as shovel and dumpers reach the vertical face.

11.3 Failure of Dump Slopes:

The internal dump has been benched at 20 meter height. Although individual OB bench slopes at its natural angle of repose i.e 37^0 the overall slope has been reduced to 27^0 by leaving a 30 meter wide berm between two successive benches.



This reduces the chances of OB slope failure and subsequent damages. The dumps once sterile should be stabilized by bio reclamation.

11.4 Flooding of the Mine:

Flooding is envisaged from the proposed diverted nallah which flows along the south- central part of the Barjora North Coal Block. However, during this modified interim period of five years, diversion of nallah is not envisaged as the mining sequence is not going to affect the nallah.

11.5 Blasting in Opencast Mines:

Blast design can be made carefully so that we get the fragmentation with desired features. By regulating the burden, spacing, column of explosives and stemming of blast holes and specific combination of explosives, any danger of fly rocks can be controlled. During blasting safety precautions of removing people out of danger zone shall be ensured. Detail safety precautions during blasting is being discussed in chapter no. 6 of this document.

11.6 Fire in Coal Benches/Coal Stack Yard:

Spontaneous heating of coal may cause fire in its coal benches, coal yards etc. however, in the instant mine the work area is small and therefore, benches would remain during most of the operational period. Hence, chances of fire are rare. Never the less, if any coal benches are to remain idle for a period more than two months, the same shall be properly dressed and cleaned from loose coal or fines at the time of stoppage.

There would not be any sizeable coal in the stock yard as coal will continuously be dispatched to linked power houses of WBPDCL. All of the end use plants are located within less than 400 km from the project site via Durgapur and Bankura railway sidings. Thus regular coal evacuation on first in first out basis will be followed to prevent old stockings of coal in the coal stackyard. However, provision of pumped water supply, with permanently laid pipe lines shall be ensured, in the coal stock yards to meet in eventuality.

11.7 Accidents due to lack of proper space in movement in Mine:

Workers around shovel, dumper, dozer, drill and cranes must be warned to keep out of blind area so that operator may be able to see them clearly. Audiovisual alarms be used for pre warning person around this machine. To overcome

shortage of space, strict discipline will have to be inculcated in workmen and supervisors.

11.8 Disaster management Plan:

The disaster is an event which takes place without warning and confronts in an unforeseen manner. The following disasters can be imagined in the proposed project:

- Bench failure
- Dump failure
- Flooding of the mine

11.8.1 Bench Failure:

The benches in the overburden rocks are proposed upto 10 meter height 30 meter width. On these 30 meter horizontal benches, regular movement of dumpers and shovels takes place. Any sudden failures of the vertical face would cause dangerous situations to the top horizontal bench and would move large quantity of debris to the lower horizontal benches, thereby causing serious mishap to the equipment and persons deployed at both the horizontal bench. Following actions can be taken to avert this mishaps or disaster:

i. Thorough inspection of the surface of the horizontal benches to detect sign of cracks, slips or fault lines. The failure along these fault lines or slips are sudden and can result into disaster.
ii. Study of fault plane taking geo-investigation details and marking the same on the working plans. This will help to plan blasting in the faulted area so that the fault planes are taken care scientifically.
iii. Benches to be continuously monitored through survey to detect any impending movement of the bench which might result into bench failure.

11.8.2Dump Failure:

The OB dump, till they have been stabilized and become old or settled, is likely to fail and cause disaster. Failures can be averted by:

i. Designing the height of internal dump within 20 meters have been planned to avoid dump failures.
ii. Terracing of the dump will be done in each stage.
iii. Keeping dumps so graded at the top that water does not accumulate at the top.
iv. Ensuring that soil or sub soil does not get mixed up at deeper levels – say below 10 meter from proposed dump tops with rocks during dump formation.
v. The dump should be having only hard rocks below 10 meters from their surface level.
vi. Concurrent backfilling should be planned with sufficient lag distance in between the dump toes and working faces.
vii. Soil or sub soil to be put only on sterile dump top which are ready for bio reclamation.

11.8.3 Flooding:

The flooding is rare phenomenon in life of a mine. However, since the mine area is involving a tartola nala which needs to be diverted in the later phase of mining, a proper safeguarding in future course is required. During this modified planned period of five years, the nallah is not going to be affected by the proposed mining activities and flooding is not envisaged. However, in later phases, when the nallah will be diverted, a proper embankment has to be constructed all along the diverted parts which may affect the mining activity.

11.8.4 Disaster Management preparation:

Each coal mine prepare and emergency operational plan to be activated in case of major accidents or disasters. This plan is to be vetted by DGMS and is governed by the provision of the mine act 1952. This is to be prepared and submitted for approval by DGMS just after opening a mine. It is to be stated that, in case of any disaster, DGMS is the organization which is first to be informed. The emergency plan for disaster management is executed under guidance of best grade of the industry and senior officers of the regulator, the Directorate General of Mines Safety, GOI.

11.9 Coal Conservation:

Estimated Mineable reserve within the leasehold area of 260.14 ha comes about to 18.60 M te. At present.

Table No. 11.1

Estimation of Mineable Reserve & Extractable reserve

S L No.	Particulars	Coal reserves (Mt.)
1.	Net geological reserves considering 10% geological loss.	28.72 Mt.
2.	Less Geological reserve on account of unforeseen losses.	2.87 Mt.
Net Available Geological Reserves (1-2)		**25.85 Mt.**
3.	Reserves blocked under unapproachable areas due to shape of lease boundary.	2.12 Mt.
4.	Reserves blocked within 7.5m surface barrier left from the Barjora Block Boundary.	2.06 Mt.
5.	Reserves Blocked within quarry batters.	3.07 Mt.
Net Available Quarriable/mineable coal reserves. (1 – 2 – 3 – 4 – 5)		18.60 Mt.
6.	Less 5% Mining loss.	0.93 Mt.
7.	Mined out reserves by previous allottee.	6.11 Mt.
Net Available Extractable Coal Reserves		**11.56 Mt.**

The recovery percentage of coal from this leasehold area comes to about 68.36 % as blocked reserve in quarry batters and safety zone are occupying much of the deposit. About 7.25 Mt of coal will be blocked in the unapproachable areas, quarry batters, and safety zone.

12.1 Introduction:

The maintenance of all major equipment is proposed to be done by manufacturer. They will be provided space for maintenance in the HEMM (Excavation) workshop. Regular maintenance and repair of other plant and machinery can be carried out at E&M workshop. The project store shall be attached to the E&M workshop. The proposed E&M workshop and project store will be facilitate the maintenance and repair requirement of mining, mechanical, electrical, transport and other auxiliary equipment and storage of spare-parts, sub-assemblies and consumables.

In general, two-shift working has been envisaged for the workshop with only essential maintenance facilities in the 3rd shift and one shift working for project store.

12.2 Equipment maintenance planning:

Facility planning of workshop and project store has been done based on a comprehensive maintenance and repair programme to achieve the high level of availability, reliability and longer life.

Maintenance and repair load of unit workshop has been assessed on the basis of annual operating time, inter-repair period, life of the equipment / assemblies/ sub-assemblies, weight and size of the equipment / assemblies/ sub-assemblies, man- hours required per repair etc. Space requirement for maintenance and repair activities, parking facilities of HEMM and other equipment, washing of equipment and assemblies, requirement of open and covered storage space etc have also been considered. The size of Excavation workshop cum Project store has been given in Table 12.1 below.

Table 12.1

Layout dimensions of Excavation workshop & E&M workshop cum project Store.

Particular	Size (m x m)	Area (m^2)
A. Excavation workshop	180 x 50	9000
B. E&M Workshop cum project store	150 x 50	7500
C. Mine office and common Facilities	50 x 40	2000

A typical layout diagram of workshop is given in figure no. 12.1. However, project specific workshop will be designed separately before commencement of operation.

12.3 Scope of Work:

12.3.1 Excavation/ Workshop:

- Preventive maintenance.
  a) Daily maintenance, routine lubrication and bi-weekly washing of equipment.
  b) Technical inspection and running repair of transport equipment and checking of tyres.
  c) Daily and fast filling of diesel at fuel delivery station for transport equipment and at site for field equipment.
  d) Dismantling , opening and refitting of tyres.
  e) Incidental minor repairs of assemblies and sub-assemblies of mining and mechanical equipment, i.e dumper, dozer, shovel, drill etc.
- Scheduled Maintenance.
- Medium repair and replacement of assemblies and sub-assemblies.
- Mobile repair team with crew and facilities to cater the maintenance of minor repair needs of field equipment at site.

12.3.2 E& M Workshop

- Minor repair, medium repair and replacement of components, assemblies and sub-assemblies of pumps and electrical equipment.
- Bi-weekly washing of LMVs and washing of equipment assemblies and sub-assemblies as and when required.
- Periodical lubrication
- Repairs and replacement of components/ assemblies for LMV.
- Minor and medium repair of switchgears, motors, self-starters and other electrical equipment.
- Battery charges facilities and re-conditioning of batteries.

12.4 Facilities:

Following facilities have been provided in the excavation workshop and E&M workshop for maintenance and repair of equipment as envisaged in the scope of work:

12.4.1 Excavation Workshop

- Mechanized washing on specially constructed platform for dumpers and dozers.
- Daily maintenance bays for dumpers and dozers.
- Schedule inspection and lubrication bays for dumpers and dozers.
- Schedule maintenance, medium repair and minor repair facilities for dumpers and dozers.
- Minor repair and replacement of sub-assemblies and assemblies of shovels, drills and other field equipment at site by mobile repair team.
- Medium repair of overhauling of sub-assemblies and assemblies of field equipment.
- Machining section.
- Electrical and auto repair section.
- Engine section.
- Repair of hydraulics especially Surface miner.
- Radiator repair section.
- Welding and structural section.
- Tyre section.
- Condition monitoring section.
- Shovel repair section.
- Drill repair section.
- Dozer repair shop.
- Pavements for dumper and dozer parking.
- Overhead and u/g water reservoirs.
- Supporting facilities like computer room, electronics room, charge stores, tool room, offices, pump room, cycle stand, canteen, security post, fire fighting facilities, ventilation system etc.
- Material handling facilities
- Machine tools, general and special purpose tools, diagnostic tools, master tool kits etc.

- Refueling station with pump and other necessary accessories.
- Mobile repair and servicing unit.

12.4.2 E&M Workshop

- E&M maintenance and repair unit for maintenance and minor repair of CHP equipment, pumps, electrical equipment and other installations.
- Machining section, mechanical section and structural section, electrical and auto section etc.
- Washing platform for LMVs.
- Maintenance and repair shop for LMVs.
- Machine tools, general and special purpose tools, diagnostic tools, master tool kits etc for electrical and mechanical equipment.
- Supporting facilities like charge store, tool store, toilet, offices etc.

12.5 Workshops and projects stores layout:

The maintenance and repair bays and other facilities for dumpers and other HEMM have been designed based on the prevailing standard norms and OEM's /Equipment Manufacturer's recommendations.

Excavation workshop unit has been planned for maintenance and repair work of all major HEMM.

Excavation Workshop

The area of excavation workshop unit will be 9000m². This workshop has been designed to cater to the needs of dumpers upto 100 T capacity. Detail description of major functional shops are given in the table 8.2 below.

Table No- 12.2
General Plan for Layout for HEMM Workshop**.**

Major Shops	No. of Bays	Bay size (m x m)	Shop size(mx m)	Bracket height (m)	EOT crane capacity(t)
Dumper repair complex	12	10 x 18	60 x 40	11.5m	25/5 t-1 nos. 10/2 t-1 no.
Dozer and Face equipment repair complex	2	10 x 12	40 x 30	8.5 m	15/2 t-1 no.

E&M Workshop

It is proposed to deploy 5 nos. of trucks, 5 nos. of buses, 12 nos. of jeeps/cars/vans and a large nos. of pumps, transformers and other electrical equipment.

The maintenance and repair bays and other maintenance facilities required for LMVs, pumps and other electrical and mechanical equipment have been provided based on the prevailing standards and OEM's recommendations.

The overall area of E&M workshop will be 7500 m². Sizes of major functional shops of E&M workshop are given in the table 8.3 below.

Table 12.3

General Plan for layout for E&M Workshop.

Major shops	**No. of bays**	**Bay size**	**Shop size**	**Bracket height (m)**	**EOT crane capacity (t)**
E&M repair complex	**-**	**-**	**20 m x 40 m**	**6 m**	**5t -1 no**
LMV repair complex			**15 m x 10 m**	**6 m**	**-**

Project store

The project store will be integrated with the E& M workshop facilities for efficient and coordinated movement of material, equipment and sparses to and from the stores. An area of 15 m x 55 m has been provided for the stores in the E& M workshop.

The storage capacity for the stores is envisages for 30-45 days consumption of materials. Due consideration we have to be given for proper working environment, cleanness and safety measures. Proper equipment and material handling facilities have also been provided.

The size of main sheds/ buildings of the project store are given table no. 12.4 below.

Table No. 12.4: General Plan for layout of project store.

Major sheds	Shop size	Covered area	Height	EOT crane capacity (t)
Store shed	15 m x 30 m	450m²	8m	5t-1 no.
POL store	15 m x 15 m	225m²	4.5m	-
Cement store	15 m x 15 m	150m²	3.5m	-

- Separate storage facility have been envisaged for the following items:

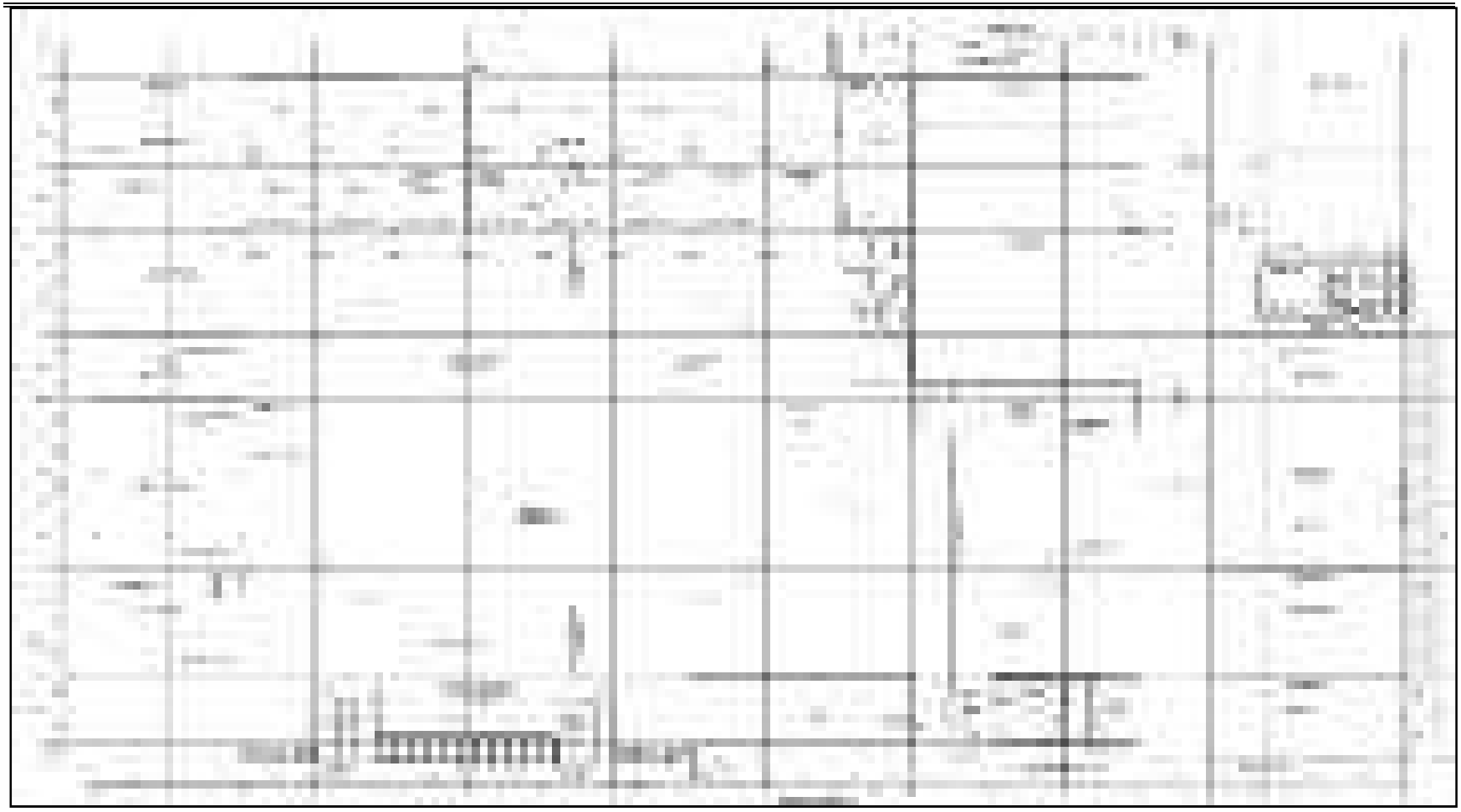
- Bulk consumables

- Light consumables.
- Spares and assemblies of HEMM
- Spares and assemblies of LMV.
- Electrical equipment like motor, generators, switch gears etc.
- Spares and assemblies of electrical equipment.
- Cables and beltings.
- Chemicals, paints etc.
- Rubber materials.
- Stationary and office material.
- Float assemblies.
- POL etc.

12.6 Plant & equipment for workshop:

The selection of plant and equipment (machine tools) for workshops has been done in accordance with the maintenance programme of various equipment, job wise requirement in respect of dimensions, nature of operations to be performed, frequency of such requirements and degree of precision.

Provision of E.O.T cranes , mobile cranes, tyre handler, fork- lift trucks , trolleys, electric hoist, chain pulling blocks, jacks etc . has been made for quick and effective handling of heavy materials and tyres within and outside the shops.



13.1 Mining Lease area:

The Barjora North Coal mine comprises of about 260.14 ha of land distributed over 6 nos. of villages. It administratively falls under the Barjora P.S of Bankura district, West Bengal.

13.2 Project Area:

This revised mining plan covers the whole leasehold area a project area of 260.14 ha. A village wise break up of260.14 ha of leasehold area is being given below in table no. 13.1.

Table No. 13.1

Village wise break up of lease area.

		All units in ha
Village Name	**Non Forest Land**	**Total Land**
Baguli	29.29	29.29
Baraphukhuria	83.57	83.57
Ghutgoria	28.97	28.97
Manohar	114.43	114.43
Saharjora	2.18	2.18
Tikargram	1.70	1.70
Total =	**260.14**	**260.14**

All activities under this proposed plan will be restricted to the already granted leasehold area only.

13.3 Present and Proposed Land use of the leasehold area:

At present, the leasehold area is having a worked out quarry areas, backfilled areas in the de-coaled sectors, mine infrastructure areas, and a soil and sub soil dump area.

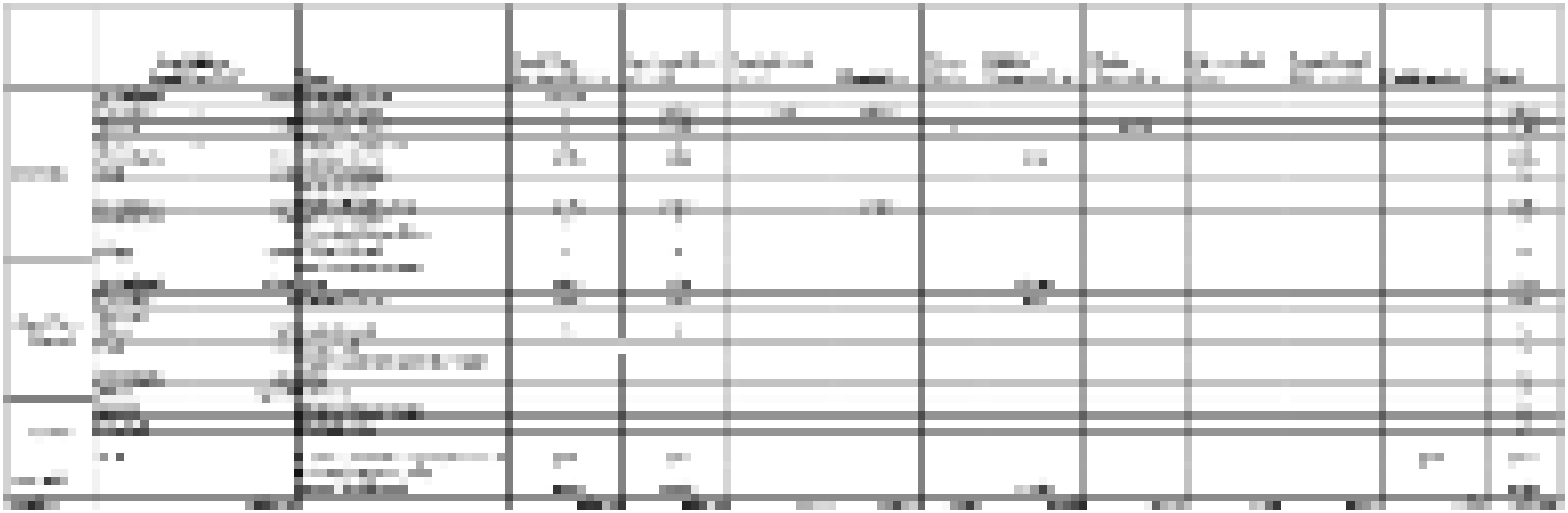
Breaking up of fresh areas is envisaged during this plan period for coal production and OB removal.

The present and proposed land use of the leasehold area of 260.14 ha is furnished in table no. 13.2 below.

Unutilized areas as shown in the table no. 13.2 are resultants of mostly unapproachable part of the leasehold areas and left out areas in between the mined out voids and planned active quarry area.

Table No. 13.2

Land use pattern of 260.14 ha in pre mining, during mining and post mine closure.



14.0 General:

As per statutory stipulations of Ministry of Environment & Forests and Climate Change (MoEF & CC) it is mandatory to prepare Environmental Impact Assessment & Environmental Management Plan report and get its clearance for mining a coal block before commencement of any activities.

Environment Impact Assessment study and Environment Management Plan for total 927.50 ha of project area of Barjora North Coal Mine is already in place and the project has obtained Environmental Clearance from Ministry of Environment & Forest in the year 2008 vide their letter no. No J- 11015/312/2007-1A. II(M); dt 13/03/2008. The approved EIA/EMP also covers the leasehold area of 260.14 ha lease area. This revised mining plan is prepared for the non forest leasehold area of 260.14 ha only. Impact assessment and mitigative measures are suggested in this mining plan section for the leasehold area of 260.14 ha.

14.1 Salient Features of the Leasehold area:

The mining activity in lease area of 260.14 ha shall be started by applicant on approval of this mining plan. This present Mining Plan envisages to produce about 11.56 Mtes of coal and 65.85 Mcum of Overburden in the planned period of seven years . Total area of operation will be limited within the leasehold area of 260.14 ha. Opencast Mining methodology will be followed with drilling & Blasting for Overburden excavation and Shovel-Dumper combination for OB removal. Coal winning will be done through Surface Miner.

In this present mining plan, dumping of waste has been planned partly over the existing internal dump, and partly in the mined out voids through concurrent backfilling. Final Mine Closure activities are envisaged post 7 productive years.

14.2 Baseline Information:

Environmental Impact assessment and Environment Management Plan is in place. Selective part of the report has been used in this mining plan for the description of environment, impact assessment and suggestive mitigative measures.

14.2.1 Existing Land Use:

The planned area of 260.14 ha is devoid of any forest land.

The present land use of the leasehold area is given in the table no. 5.1 in previous chapter and is reproduced below in table no. 14.1.

Table No. 14.1

Present Land Use of the leasehold area.

S. L. No.	Land Use Category	Pre Mining (ha)
1	Mined out Voids .	63.93
2	De-coaled waste filled Area	39.49
3	Soil & Sub soil Storage Area	5.86
4	Infrastructure areas	9.11
5	Other Built Up areas	5.61
6	Safety Zone	17.89
7	Coal Stack Yard	1.25
8	Office and VT Centre	3.50
9	Road	2.55
10	Access Trench	0.65
11	Water Body	1.67
	* **Sub Total =**	**151.51**
12	Unutilised Areas	108.63
	Total =	**260.14**

14.2.2 Water Regime:

The water resources of the region are mostly covered by Damodar river and its tributaries. The main drainage is also controlled by Damodar River which flows at distance of around 5 km from the block boundary towards north. Tartola Nala flowing almost along the central part of the block, flows in East north east direction. This nala has been proposed to be diverted in due course of time as suggested in the original approved mining plan. However, this nala will not affect in period of this mining plan.

The water quality was analysed by CIMFR, Dhanbad in their report " Environmental Study of Barjora North Block" dated June, 2014. To assess the water quality of the area, ground water and surface water samples were collected and analysed from 5

sampling locations. The analysis was carried out in the laboratory and results are presented in table 14.2 and 14.3.

Ground water samples were collected from the following places:

1. Malliara Village –(well Water) – W1.
2. Ghutgoria –(Well Water) – W2.
3. Raharabani – (Tube well water) – W3.
4. Bathanbera - (Well Water) – W4.

Ground water quality of the study area is depicted in Table no. 14.2 below.

Table No. 14.2

Ground water Quality of the Study Area (December, 2013)

S. L. No	Parameters	Station Code				IS: 10500
		W1	W2	W3	W4	
1	Colour, Hazen Units	Colour less	Colour less	Colour less	Colour less	Unobjectionable.
2	Odour	Unobjectionable.	Unobjectionable.	Unobjectionable.	Unobjectionable.	Unobjectionable.
3	Taste	Agreeable.	Agreeable.	Agreeable.	Agreeable.	Agreeable.
4	Turbidity NTU Max	2.5	1.2	0.98	1.7	5
5	Dissolved Solids – mg/l, Max.	354	328	385	409	500
6	pH Value.	7.25	7.21	7.30	7.24	6.5-8.5
7	Total Hardness (As Caco3), mg/l- Max.	252	222	267	224	300
8	Calcium (as Ca), mg/l- mx.	35.3	27.2	41.5	29.6	75
9	Magnesium (as Mg), mg/l- max.	22	18.3	22.6	23.5	30
10	Copper (as Cu.) – mg/l- max.	0.011	0.012	0.009	BDL	0.05
11	Iron (as Fe)- mg/l- max.	0.312	0.254	0.402	0.204	0.3
12	Manganese (as Mn), mg/l – max.	0.06	0.062	0.052	0.082	0.1
13	Chlorides (as Cl), mg/l- max.	20.3	18.4	22.6	28.2	250
14	Sulphate (as So4), mg/l – mx.	72.3	56.9	52.5	40.7	200
15	Nitrate (as NO3)	2.25	2.68	3.21	9.6	45

S. L. No	Parameters	Station Code				IS: 10500
		W1	W2	W3	W4	
16	Fluoride (as F), mg/l.	0.56	0.72	0.89	1.10	1.0
17	Phenolic compounds (as C_6H_5OH), mg/l- max.	BDL	BDL	BDL	BDL	0.001
18	Mercury (as Hg), mg/l-max.	BDL	BDL	BDL	BDL	0.001
19	Cadmium (as Cd), mg/l- max.	BDL	BDL	BDL	0.0015	0.01
20	Selenium (as Se), mg/l- max.	0.006	BDL	BDL	0.003	0.01
21	Arsenic (as As), mg/l- max.	BDL	0.005	BDL	0.007	0.05
22	Cyanide (as Cn), mg/l- max.	BDL	BDL	BDL	BDL	0.05
23	Lead (as Pb), mg/l- max.	0.006	BDL	BDl	0.008	0.01
24	Zinc (as Zn), mg/l- max.	0.029	0.065	0.069	0.112	5
25	Arionic detergents (as MBAS), mg/l- max.	ND	ND	ND	ND	0.2
26	Chromium (as Cr^{6++}), mg/l- max.	0.007	0.005	BDL	0.009	0.05
27	Polynuclear aromatic Hydrocarbon (PH), mg/l- max.	ND	ND	ND	ND	0
28	Mineral oil, mg/l- max.	BDL	BDL	BDL	BDL	0.01
29	Residual, free chlorine, mg/l- min.	0.12	0.11	0.09	0.13	0.20
30	Pesticides	Absent.	Absent.	Absent.	Absent.	Absent.
31	Radioactive materials a. Alpha emitters . 29uc/ml -	ND	ND	ND	ND	$10^{-8} – 10^{-7}$

S. L. No	Parameters	Station Code				IS: 10500
		W1	W2	W3	W4	
	30max. b. Beta emitters . uc/ml-max.					

Water quality of the nearby wells and tubewell show that there is no significant impact of mining on water quality of region. TSS, TDS, Oil & Grease, COD, Trace Metals and other parameters are found within their respective leasehold limits. Natural water resources in the study area are mainly Damodar river and its tributaries. The main drainage of the area is controlled by the Damodar river which flows about 5 km north of the coal mine.

14.2.3 Air Regime:

While preparation of the environment Impact Assessment and Environment Management Plan for Barjora North Coal Project, two season data been obtained. Total nine sample locations were monitored. Two out of nine were falling in the core zone while 7 nos of sampling locations were in the buffer zone. The summarized result of the AAQ monitoring is being furnished in table no. 14.3.

Table No. 14.3

AAQ monitoring results (Summarised) within core and buffer zone.

	Parameters (microgram/m3)				
Location	**RPM**	**SPM**	**So2**	**Nox**	**Zone**
Hidurdanaga	39.7	110.6	8.0	7.1	Core
Roharabani	34.7	81.8	7.6	6.9	Core
Brindabanpur	35.4	79.90	6.80	5.8	Buffer
Ramkrishnapur	45.3	139.90	11.30	13.60	Buffer
Gobindapur	48.6	148.8	10.50	12.4	Buffer
Jagannathpur	34.3	93.7	9.40	10.4	Buffer
Kulladih	40.0	113.80	10.9	11.2	Buffer
Palasdanga	37.0	108.40	8.70	10.4	Buffer
Radhakrishnapur	35.9	108.50	28.4	10.60	Buffer

14.2.4 Ambient noise level:

Ambient noise monitoring done in nine locations which include two sampling locations in the core zone and seven sampling locations in the buffer zone. Detailed analysis of the noise reveals that there is no noticeable impact of noise in the surrounding environment. All the study sites in the residential areas exhibited a noise level well within the corresponding threshold limit value as prescribed by CPCB, both during day and night.

Table 14.4

Ambient Noise level data as per EIA- EMP of Barjora North Coal Mine.

Monitoring location	**Avg. leq values in dB (A)**		**Remark**
	Day	**Night**	
Hidurdanaga	53.2	39.5	Core zone
Roharabani	50.7	42.1	Core zone
Brindabanpur	53.4	44.10	Buffer zone
Ramkrishnapur	48.5	39.2	Buffer zone
Gobindapur	51.2	40.3	Buffer zone
Jagannathpur	50.9	40.7	Buffer zone
Kulladiha	49.6	38.6	Buffer zone
Palasdanga	50.2	38.7	Buffer zone
Radhakrishnapur	51.6	40.5	Buffer zone

14.2.5 Flora and Fauna:

Part of the core zone consists of forest area and vegetation growth is evident. Details of the flora and fauna list as described in the approved EIA- EMP report. However, the proposed area of operation in this modified period will be confined to the non forest area only.

14.2.6 Climatic Conditions:

Meteorological study of the area depicts the weather condition of a typical summer months and the climate of the area is dry humid and sub-tropical. It is characterized by hot and dry summer from March to May, rainy season from June to September, and winter spreading from November to February. The average annual relative humidity is about 60.6%. winter temperature fluctuates between 15°C to 22°C and summer temperature fluctuates from 25°C to 43°C. Annual rainfall is around 1380 mm as described in the EIA- EMP report.

14.2.7 Human Settlements:

The proposed mining area within the leasehold of 260.14 h doesn't have any human settlement as prior allottee already completed R & R as per approved plan. However, if any R & R is found to be implemented in due course, WBPDCL shall be implementing as per approved R & R plan.

14.2.8 Historical monuments:

There are no historical monuments and archaeological sites within the proposed area of operation.

14.3 Environmental Impact Assessment:

An essential step in Environmental Impact assessment (EIA) is to identify all potential environmental impacts (both beneficial and adverse), resulting from project activities. Assessed impacts due to project activities are discussed herewith.

14.3.1 Impact on land use:

Part of the leasehold are of 260.14 ha has already broken for mining activities by prior allottee. Detail of the existing land use pattern of the lease area discussed in table no. 14.1. During this planned period, further area will be added under quarry while part of the mined out areas will be backfilled. Post production mine will undergo final closure activities. The production operation will be suspended at the end of 7th year while closure and plantation activities will continue for another 3 years.

14.3.2 Impact on water quality:

Washing of coal has not been envisaged in this project. Thus pollution of surface water from the effluent discharged from washery gets ruled out.

The major sources of water pollution due to mining activities will be as follows:

a. Generation of industrial effluent water from workshops.
b. Mine discharge water to be pumped out from opencast.
c. Washouts from Overburden, coal stockpile etc.
d. Domestic effluents from office and townships.

At the end of the mine life, water body will be created in the left out voids and will be utilized for community use.

14.3.3 Impact on Surface water Regime:

The proposed mining area doesn't contain any seasonal or perennial nala which needs special attraction to deal with. No impact on surface water quality thus envisaged. The run off water from different catchment areas will be channelized to the discharged pit through garland drains and series of settling pits.

14.3.4 Impact on Air Environment:

The integrated mining operations in the leasehold area are likely to result in deterioration of air quality due to pollution arising from the operations. The principal sources causing air pollution in the area, i.e generation of dust due to mining and allied activities are envisaged as:

a. Drilling and blasting operation.
b. Loading and unloading operation.
c. Movement of HEMM, such as shovels, dumpers etc.
d. Overburden/coal transportation.
e. Wind erosion of dumps.

14.3.5 Vibration Levels (due to blasting)

Blasting pattern has been designed to minimize vibration levels. However, vibration levels will be studied once the blasting is done in the lease area to know the actual impacts and mitigation measures would be taken up accordingly.

14.3.6 Impact on socio economics:

As there is no involvement of R & R, socioeconomic impact will be only on the positive side by generating direct and indirect employment. Local people will be benefited due to implementation of this project.

Local people were benefited during the earlier mining operations carried out by prior allottee. Resuming of mining operation will be beneficial to the local community.

14.4 Environmental Management Plan:

To maintain ecological balance & to check harmful effects due to mining and allied activities, environmental control measures have to be taken to safeguard clean environment in process of mining.

14.4.1 Storage & preservation of Top soil:

To minimize adverse impacts on land, reclamation of degraded area should be resorted to. To achieve the same, top soil will be excavated and segregated separately. Top soil will be scrapped by dozer before the ground preparation for infrastructure or drilling and blasting or OB dumping is undertaken. Scrapped top soil will be transported to the top soil storage area designated in the north eastern corner of the leasehold area. As and when backfilled areas and main dump areas will be stabilized, the stored top soil will be spread over the dump to facilitate plantation and assist early bio-reclamation. Year wise top soil generation is furnished in table no. 14.5.

Table No. 14.5

Year Wise Top Soil Generation.

Production Year	Top Soil in MM^3
1st Year	0.32
2nd Year	0.42
3rd Year	0.52
4th Year	0.64
5th Year	0.74
6th Year	0.8
7th Year	0.85
Total	**4.29**

14.4.2 Proposal for reclamation of land affected by mining activities:

This mining plan is modified in nature and final layout of the dumps in a totality has been worked out. Within this period, stage dumping will be continued to be taken up in the existing dumping ground and part of the mined out areas will backfilled concurrently. Efforts were made to keep the dumps around ground level for technical and biological reclamation At the end of the period, dumping ground

will be converted to agricultural and plantation areas. Land reclamation will be done to the fullest extent except the areas where water harvesting will be carried out in the post closure period. Few infrastructure areas will be handed over the society for public use. Details of the land reclamation are given in table no. 14.6.

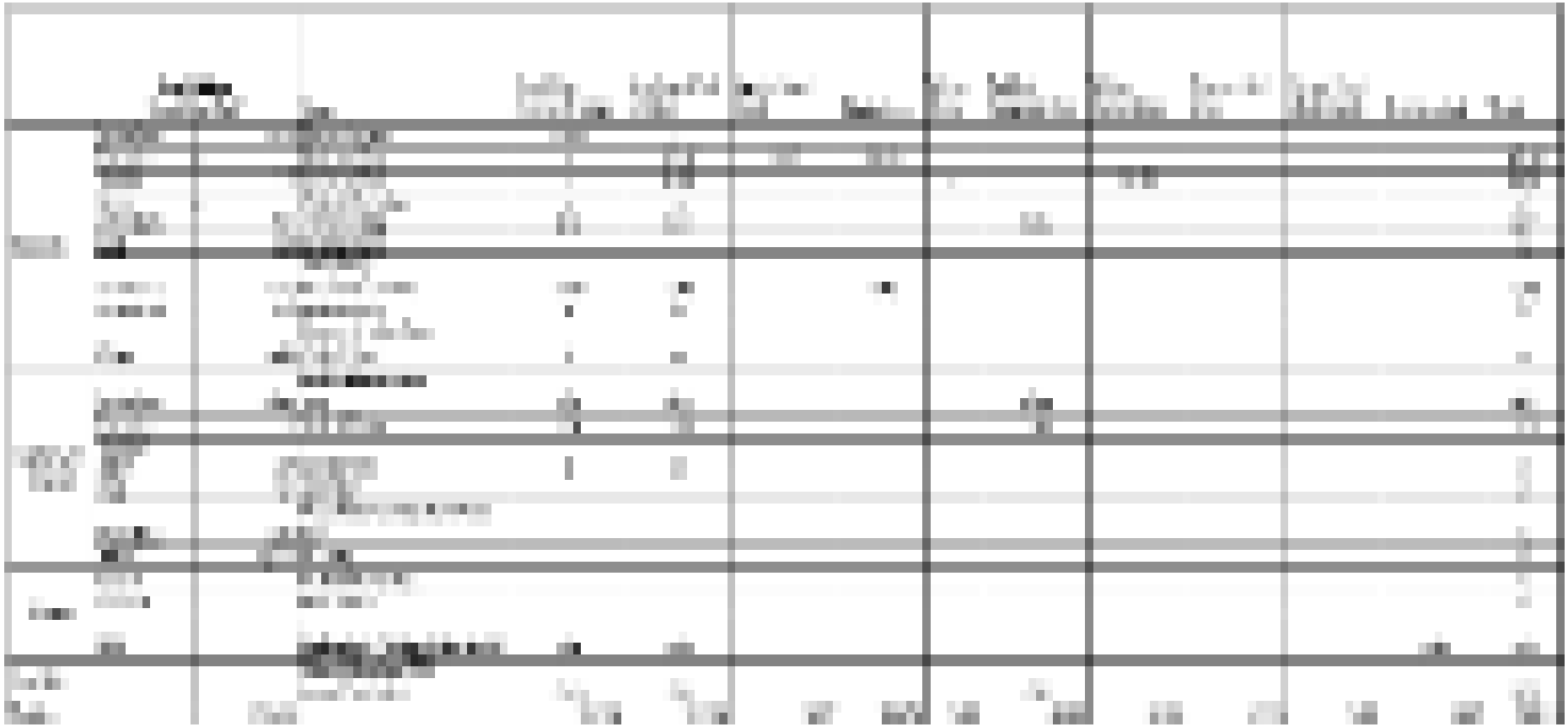
Table No.14.6

Year Wise mining areas and backfilling of mined out void area during the mining plan period of 7 years.

Land use pattern in pre mining, during mining and post mining including closure is shown in table no. 14.7.

Table No. 14.7

Table showing change in land use pattern due to course of mining.



Year wise area covered under block plantation including reclaimed areas are given below in Table no. 14.8.

Table No. 14.8

Year wise Plantation details

Year/ Stage	Excavation Area for OC / Reclaimed Area for UG.	Cumulative Plantation area " ha"						No. of Plantation
		Backfilled	Dump	Green Area	Infrastructure / Barren	Agri Land	Total	Plantation will be done @ 2500 saplings per ha.
1st Year	136.65	-		6.58				
3rd Year	156.67	25.00		7.23				
5th Year	179.10	54.55		4.08				
7th Year	191.00	57.35				19.57		
		136.9		**17.89**		**19.57**	**174.36**	

The above plantation areas doesn't cover avenue plantations.

14.4.3 Management of Water regime:

Management of water regime mostly comprising silt load, waste waters management arising due to mining activities. Following management plans are suggested:

- Construction of toe walls and garland drain around the existing OB dumps to catch the silt loads likely to come down from dumps.
- Providing bunds at suitable points in the garland drain around external dumps to allow settling of silt.
- Regular cleaning of the silt from these bund areas.
- Early plantation of the external dumps to prevent silt flowing from dumps.

- Mine water will be guided to siltation tanks and decanted water would be put to industrial uses in the mine. Siltation tanks shall be regularly cleaned.
- Maintaining proper gradient for drainage of water on the bench floors and construction of water drains using local material to prevent soil erosion and uncontrolled descent of water.
- Construction of garland drains of suitable size around mine area and external dump with proper gradients to prevent rain water entry into active mine area.
- Construction of settling and sedimentation ponds of adequate size to collect the mine discharge water to settle suspended solids. Treated water will be utilized for dust suppression and plantation use.
- Effluents from workshop, garage or wash areas will be treated through grease & oil traps and then in sedimentation ponds and recycled for use again.
- Separate effluent treatment plant for industrial water will be set up for proper treatment of these and for recycle in workshops etc. and reuse in green belt.

14.4.4 Management of air quality:

During the mining operations, impact on air quality will be effectively controlled both by preventive and suppressive measures listed below:

- Usage of drill bits of good conditions.
- Wet drilling to prevent dust generation.
- Well designed blast by effective stemming and use of milli second delay detonators – every blast should be properly designed to see that the optimum breakage occurs without generating fines.
- Avoiding blasting during high wind period.

- Conducting muffled blasting to avoid disturbances.
- Proper maintenance of haul roads.
- Development of extensive green belts/barriers around the mine, coal handling plants, workshops, along the roads, periphery of the mine, OB dumps etc.

With the above management plans, adverse impacts will be minimized.

14.4.5 Protective measures for ground vibration likely by blasting:

Loosening of rock mass will be done by the blasting of 6-8 meters deep and 160/250 mm dia blast holes. Milli second delay detonators have been envisaged to minimize the ground vibrations. Use of non electric detonators will be used wherever required. Blasting will be carried out in periodical manner so as to minimize the impact on the local habitants and the faunal species.

14.4.6 Socio-Economic benefits arising out of the project:

The activities involved in mining the proposed leasehold area will generate employment potential both directly and indirectly. Local people have employment opportunities as skilled, semi skilled and unskilled labourers. Resuming the mining operation at Barjora North will improve the socio economic conditions of the area. With the continuation of mining operation, employment opportunities, communication, medical facilities, schooling etc. will be improved further.

14.4.7 R & R Activities:

Prior allottee has already implemented R & R as per approved plan. However, if any further R & R is involved, WBPDCL shall implement R & R as per approved plan.

14.4.8 CSR Action Plan:

At present, the West Bengal Power Development Corporation Limited is preparing a comprehensive CSR action plan for the area. This plan involves the activities as listed:

- Improvement in medical and health care system.
- Improvement un-educational services.
- Infrastructural betterment through better roads, lighting and communicational systems.
- Betterment of drinking water facilities.
- Vocational training facilities for local eligible youth of local community to enable them to seek employment in suitable project operations and elsewhere.
- Improvement in irrigational facilities.

14.5 Monitoring schedule for the environmental activities:

The efficacy of management of environmental attributes, e.g- air, water, land and social activities is assessed by monitoring schedule for this components of environment. The physical attributes e.g. air, water, noise, etc. shall be guided by CPCB/SPCB norms and permissions. Progress on social upliftment shall be monitored by a team of project people, land loosers, and other local representatives of the area.

A tentative monitoring schedule is furnished in table no. 14.9 below.

Table No. 14.9

Monitoring Schedule

Monitoring parameters	**Frequency of sampling**
Air Quality	Once in fortnight
Water & Effluent Quality	Once a month
Ground water level monitoring	Once in season (4 season)
Noise level	Once in fortnight
Study of Flora & Fauna	No forest land involved in present lease area. Thus study not required.
Soil Quality	Once in a year.
Land Use Study	Once in every three years trough satellite imageries.

15.1 Introduction:

Final Mine closure plan in support with the Approved Mining Plan comprising 927.50 ha of project area for Barjora North Coal Mine has been approved by Ministry of Coal, vide their letter no. 34011/26/2016-CPAM; dt. 8.11.2016. Copy of the approval letter has been furnished in **Annexure-9.**

The mine closure plan covering the progressive and final closure for Barjora North Coal Mine covering 260.14 ha of lease area is discussed herewith as part of the mining plan for the same lease area.

15.1.1. Owner (Proponent):

Barjora North Coal mine (260.14 ha lease area) is owned by M/S "The West Bengal Power Development Corporation Limited (WBPDCL)".It is a Government of West Bengal undertaking. It has an existing installed capacity of 4860 MW with 5 (five Nos.) thermal power station.

15.1.2 Location:

The proposed coal mine is located in 6 (six) revenue villages of Barjora Tehsil in Bankura district of State of west Bengal. details are covered in chapter-3.

15.1.3 The present land use of the lease area:

The lease area covering 260.14 ha has following land uses in present stage. There is no forest land involved. Details of present uses are given hereunder in table no. 15.1. All project activities are covered within this lease area of 260.14 ha.

Table No. 15.1
Present land use of the leasehold area.

S. L. No.	Land Use Category	Pre Mining (ha)
1	Mined out Voids .	63.93
2	De-coaled waste filled Area	39.49
3	Soil & Sub soil Storage Area	5.86
4	Infrastructure areas	9.11
5	Other Built Up areas	5.61
6	Safety Zone	17.89
7	Coal Stack Yard	1.25
8	Office and VT Centre	3.50
9	Road	2.55
10	Access Trench	0.65
11	Water Body	1.67
	* **Sub Total =**	**151.51**
12	Unutilised Areas	108.63
	Total =	**260.14**

Present mining operation will also be confined in this leasehold boundary which forms lease for the proposed project area.

15.1.4 Likely Reasons for closure:

The mine is planned to be closed only after the exhaustion of recoverable coal reserves.

However, the following can be envisaged as some of the likely possible circumstances which may lead to premature closure of the mine:

- Safety: " Mine" may have to be closed down, under order of DGMS, on account of unexpected adverse geo-technical condition which may make continuation of the mining operations unsafe.

- Economy: "Mine" may be require to be closed down on account of some change in the economic environment at national/ international level.
- Regulatory and Policy issues: " Mine" may have to be closed down on account of Environmental and other regulatory considerations where the proponent is directed to do so by the concerned Govt. authorities.
- Social Pressure: " Mine" may be forced to be closed down on account of disturbances caused by the anti social elements and the situations may go beyond the control of administrative machinery of the State Govt. with complete breakdown of the law and order.
- Force Majeure: " Mine" may closed down on occurrences of circumstances leading to Force Majeure. These causes or circumstances could include acts of god, acts of war, hostilities (whether war be declared or not), blockage, invasion, insurrection, military or usurped power, riot, lockout, sabotage, restrictions in the use of power and other causes beyond the reasonable controls of the project authority.

Nevertheless, in the present scenario, in this planned mine, we do not foresee any of the above circumstances leading to mine closure operations. However, this conceptual Mine Closure Plan would be able to guide the closure activities even for such unforeseen situations and would help to tide over the problem.

15.1.5 Statutory Obligation:

At present this proposed mine with 260.14 ha of project area, does not have any statutory clearance except grant of lease to the applicant. The revised mining plan is being submitted for approval. After that environmental clearance will be sought. Thereafter other clearances will follow. As such presently there are no statutory approval which will lead to statutory obligations.

However, the applicant, M/S WBPDCL hereby undertakes to comply with all the statutory obligations which would arise after grant of various permissions/clearances to the applicant (WBPDCL) for running this mine.

15.1.6 Closure Plan Preparation:

The preparation of this mining plan including progressive mine closure plan is being prepared with due authorization of the owner (WBPDCL). The concerned matter is supported by a Board Resolution.

A final Mine Closure plan shall be prepared 5 years before the likely cessation of mining operations. However, a conceptual Mine Closure Plan has been prepared hereby for competent approval.

15.2 Mine Description:

15.2.1. Geology:

Details of the Geology are provided in chapter -4 of this mining plan.

15.2.1.1 Topography and Drainage:

Details are provided in chapter-3 of this mining plan. Please refer to page no. 5 of chapter-3.

15.2.1.2 Geology:

Details are provided in Chapter-4 of this mining plan.

15.2.2 Coal Reserves:

Details are provided in Chapter-4 of this mining plan.

15.2.3.Method of Mining:

Please refer to chapter-5 of this mining plan.

15.2.4 Choice of equipment for O.C. mining:

Details are provided in chapter-5 of this mining plan.

15.2.3.3 Calendar plan of production:

Details provided in chapter-5 of this mining plan. Calendar program for five years as per this revised mining plan is given in table no. 15.2.

Table no. 15.2

Calendar program for the planned period.

Year	Coal (Mt)	OB (Mcum)	SR	Coal (Mt)	OB (Mcum)	Avg. SR
Year-1	0.77	4.93	6.40	0.77	4.93	6.40
Year-2	1.50	7.42	4.95	2.27	12.35	5.44
Year-3	2.25	11.30	5.02	4.52	23.65	5.23
Year-4	3.00	11.35	3.78	7.52	35.00	4.65
Year-5	2.25	11.35	5.04	9.77	46.35	4.74
Year-6	1.15	11.35	9.87	10.92	57.70	5.28
Year-7	0.64	8.15	12.73	11.56	65.85	5.70
Total	**11.56**	**65.85**	**5.69**			

15.3 Mine Closure:

15.3.1 Progressive closure:

Activities which get completed during the productive life of mine and relate to land management and other environment management are termed as progressive closure. The following activities of progressive closure will be undertaken during 7 years of productive mine life.

Backfilling of the void areas will commence from the 1st year itself as mined out voids are available on ground.

i. Reclamation of mined out voids:

As such no waste will be dumped outside the leasehold area and from the very first day of development of this mine, internal dumping is envisaged. In the initial 2 (two) years of development, dumping will be done in the already mined out voids whereas concurrent backfilling is envisaged from

3rd year onward of production. Details of dumping strategy is furnished in table no. 15.3.

Table No. 15.3

Details of Dumping Strategy

Year	Dump-A (Existing mined out voids in the Sector C).	Dump-B (Existing Dump site in mined out voids of Sector-A)	Dump-C (Concurrent Backfilling in Sector-C).	Total Volume in Mcum.
1.	4.93	-	-	5.93
2.	7.42	-	-	7.42
3.	6.21	3.93	1.16	14.3
4.	2.57	7.62	1.16	15.35
5.	-	8.75	2.60	11.35
6.	-	-	11.35	11.35
7.	-	-	8.15	8.15
Total	**21.13**	**20.3**	**24.42**	**65.85**

ii. Green Belt & Green Block Plantation:

About 84.81 ha of backfilled area have been envisaged for complete reclamation. Reclamation of the mined out voids are planned from 3rd year onward while plantation on the barren lands and safety zone will be undertaken from the 1st year itself. Year wise plantation details are furnished in table no. 15.4 below.

Table no. 15.4

Details of the available areas for plantation during the plan period.

Year/ Stage	Excavation Area for OC / Reclaimed Area for UG.	Cumulative Plantation area " ha"						No. of Plantation
		Backfilled	Dump	Green Area	Infrastructure / Barren	Agri Land	Total	
1st Year	136.65	-		6.58				Plantation will be done @ 2500 saplings per ha.
3rd Year	156.67	25.00		7.23				
5th Year	179.10	54.55		4.08				
7th Year	191.00	57.35			**85.78**	19.57		
		136.9		**17.89**	**85.78**	**19.57**	**260.14**	

15.3.2 Final Mine Closure Plan:

After receipt of approval for this mining plan and getting E.C from MOEF & CC, mining will be resumed in this mine.

A final closure plan with required activities and funding shall be submitted to MOC, GOI, five years before the mine closes. However, the conceptual final mine closure is being covered under this plan.

15.3.3 Activities under Final Mine Closure Plan:

15.3.3.1 Water Regime

The proposed mining area is not dissecting any natural streams. The storm water and ground water intersected during the mining operation will be the source of water accumulation within the active mining pit. Accumulated mine pit water during the active mining period will be pumped while post mining operation,

there will be accumulated water in the left out voids. An area of about 34.53 ha of land will be converted to water body at the end of mine life. This area cant not reclaimed technically.

During operational phase, all waste water coming from mine or workshop shall be treated in suitably designed effluent treatment plant.

In post project phase the water accumulated in the lagoon shall be regularly sampled and analysed to monitor development of any acidity or toxicity in the accumulated water. As post seven years planned period, most of the broken areas will be backfilled and left out water bodies will be much less, development of toxic water is not anticipated.

The accumulated water will be utilised for the local community for agriculture and other usage. Regular monitoring of the water quality will be carried out as per the CPCB norms. Once the mine is closed, outside water shall be prevented to enter into the mined out pits which in turn will reduce the TDS and other solvents.

15.3.3.2 Air Regime:

Due to mining operation, the quality of air, especially the SPM/ RPM part in ambient air increases. Generally, the generation and emissions of gaseous pollutants like SO2 and NOx is not pronounced, to need control measures in coal mining sector. However, as dust is a by product of mining operations, increase in SPM is natural and control measures are put in place to minimize the impact and bring air quality within CPCB standards for coal mines during mine operations. For control of air pollution, in post project period, all the OB dumps, shall be covered with vegetation. This shall be completed within 3 years post mining activities. Other than dump stabilization by greening, and vacant land stabilization by vegetation growth no action for air quality control would be needed in post mining period.

15.3.3.3 Waste Management:

During the planned period of seven years, total volume of OBR comes to about 65.85 Mcum. The total generated waste will be accommodated internally through backfilling of mined out voids. Details of the waste management is being depicted in chapter no. 5 of this mining plan. An area of about 84.81 ha is planned to backfilled during this period. No external dumping is involved. Details of the dumping strategy is being furnished in table no. 15.4 below.

Table No. 15.5

Details of Dumping during the planned period.

Year	Dump-A (Existing mined out voids in the Sector C).	Dump-B (Existing Dump site in mined out voids of Sector-A)	Dump-C (Concurrent Backfilling in Sector-C).	Total Volume in Mcum.
1.	4.93	-	-	5.93
2.	7.42	-	-	7.42
3.	6.21	3.93	1.16	14.3
4.	2.57	7.62	1.16	15.35
5.	-	8.75	2.60	11.35
6.	-	-	11.35	11.35
7.	-	-	8.15	8.15
Total	**21.13**	**20.3**	**24.42**	**65.85**

During the planned period dumping will be carried out both in the existing mined out voids and the voids which are subject to be created during the planned period of seven years. About 87. 58 ha of land will be further broken whereas dumping will be carried out in total 124.30 ha. About 39.49 ha of existing dumping ground will be utlised for further dumping during this planned period. About 84.81 ha of backfilled land will be completely reclaimed at the end of the mine life including closure phase.

15.3.3.4 Top soil Management:

Soil including weathered mantle is the material to be used for reclamation of the OB dumps. The generated soil including weathered mantle in this planned period will be continued to store in the existing soil and sub soil dump. Top soil as generated during the planned period will be utilized in for spreading over the

reclaimed areas from 3rd year onward. Details of top soil generation and its spreading schedule is being furnished in table no. 15.6 below.

Table No. 15.6

Top Soil generation and Spreading Schedule.

		Top Soil used " MM3"				
Stage	**Top soil Removal MM3**	**Embankment**	**Spreading over the Backfilled area**	**Spreading over OB dump Area**	**Using Green Belt Area**	**Total Utilised TS**
1st Year	0.32		-			-
2nd Year	0.42		-			-
3rd Year	0.52		0.56			0.56
4th Year	0.64		0.92			0.92
5th Year	0.74		1.12			0.95
6th Year	0.8		1.24			0.95
7th Year	0.85		0.45			0.91

15.3.3.5 Management of Infrastructures:

Infrastructures consists of mine office, workshops, electrical transformers, weighbridge, VT center, rest shelters, etc. will be decommissioned. Only the mine office and the VT centers will be handed over to State Government for public use. the decommissioned areas will be covered by plantation during the post closure activities.

15.3.3.6 Disposal of Mining Machinery's:

This mine will be operated through Mine Developer and Operator (MDO). Machinery's will be shifted to other operational mines during the closure phase.

15.3.3.7 Safety of Mine Closure:

- Thorough inspection of the mine and OB dump areas for assessing the left over closure jobs of already reclaimed internal dump areas.
- Inspection of infrastructure and water body areas for their safe reclamation and abatement of any leftover dangers.
- Action required to make drainage and any fire areas safe for future period.
- Making 2 meter high fencing wall against excavated void area to prevent inadvertent entry as per requirement.
- Making safe approach road from surface to left out pit bottom for future uses, as void becomes a water body.
- Completing the survey of total reclaimed areas like mined areas, internal dumps, mine faces, quarry fencing and other areas to complete and update the Mine Plans under Coal Mine Regulation.

15.3.4 Economic Repercussions of Closure of the Mine:

As per the estimates, about 477 persons are likely to be deployed in the project for this planned period. The total number of employees will be distributed through mine developer as well as through direct role of WBPDCL.

15.3.4.1 Number of local residents employed in the mine during this planned period would likely to continue their service beyond this planned period towards monitoring of the mine during the closure and post closure phase as watch & yard and safety personnel. Few locals will also be engaged towards CSR activities for water distribution.

15.3.4.2 Compensation to be given to the employees for their sustenance and for their family:

Employees will be provided with full retiring benefits while closure of mines.

15.3.4.3 Satellite Occupations connected to the mining industry-continuation of such business:

People in the satellite occupations shall continue as such, as people in these occupations will have developed their expertise for various services, e.g, auto mechanic, welders, drivers, electronic repairing etc.

15.3.4.4 Continued engagement of employees in rehabilitated status of the mining area and other remnant activities:

Some locals may be on roll of the project at time of mine closure. Some of them shall be retained for carrying out mine closure operations. Major closure operation is bio reclamation of degraded land which would continue for about 3 years of cessation of mining operations. The locals could be deployed with the agencies carrying out these activities.

15.3.4.5 Expectation of society after the mine closure

For supporting the neighboring community (society), CSR activities would be taken up during the mining operations. Even after mine closure, it is proposed to have a corpus fund for sustaining some of the CSR activities.

15.3.5 Time scheduling for abandonment:

Tentative details of likely closing activities with manpower requirement as envisaged below has been estimated based on the present mine closure plan. Actual closing activities and manpower requirement may change during the preparation of Final Mine Closure Plan which will be prepared 5 years before the likely cessation of mining operation. A time schedule for abandonment along with tentative manpower requirement has been shown below in table no. 15.6.

Table No. 15.7

Time Scheduling for Mine Closure.

15.3.6 Abandonment cost:

The activities covered during the progressive closure will all be met by normal operational funds. The physical and biological reclamation of concurrent dumping areas and for green belts or block plantation is provided from the ongoing expenses.

Tentative closure cost as envisaged from the activities mentioned in table no. 15.6 is considered from the know how rates with base date of June, 2017. Activity wise cost schedule is provided in table no. 15.7 below.

Table No. 15.8

Estimated Fund Requirement for Closure Activities (Without Escalation- Base Year June, 2017).

Head		Unit	Qty	Rate Rs. / Unit	Amount Rs. Cr.	Remarks
Progressive Closure	Water Quality Management	LS	28	50000	0.14	Quarterly monitoring for seven years.
	Air Quality Management	LS	84	80000	0.67	Monthly monitoring for seven years.
	Waste Management	Mcum				Covered under mining cost as re-handling is not envisaged.
	Barbed wire fencing around dump	M	3750	375	0.14	
	Barbed wire fencing around the pit.	M	5500	375	0.21	
	Filling of voids- rehandling of crown dump	MM3				Covered under mining cost
	Top Soil management	MM3	4.29	15000000	6.44	Partial covered under Mining Cost

Head		Unit	Qty	Rate Rs. / Unit	Amount Rs. Cr.	Remarks
	Technical and Biological Reclamation of mined out of land and OB dump	ha	156.5	600000	9.39	
	Plantation over virgin area including green belt.	ha	17.89	200000	0.36	
	Manpower cost and supervision	PM	120	500000	6.00	
	Toe wall around the dump.	M				
	Garland Drain	M	3750	2160	0.81	
	Garland Drain around the dump.	M				
	Any Other Activities.					
Dismantling of Infrastructure & Disposal or rehabilitation of Mining Machinery	Dismantling of Workshop.	LS			0.25	MDO Cost.
	Rehabilitation of the dismantled facility.	LS			0.25	MDO Cost.
	Dismantling of pumps and pipes / Other Facilities	LS			0.15	MDO Cost.
	Dismantling of Stowing bunkers/ provisioning of pumps for borewell pumping arrangement.	LS	5	500000	0.25	
	Dismantling of UG equipment				0.00	Not Applicable.
	Rearranging water pipeline to dump top park / Agricultural land	LS			0.75	

Head		Unit	Qty	Rate Rs. / Unit	Amount Rs. Cr.	Remarks
	Dismantliung of power lines.	LS			0.50	
Safety & Security	Barbed wire fencing around dumps					Covered in Progressive Closure Cost.
	Barbed wire fencing around the pit.	M				Covered in Progressive Closure Cost.
	Barbed wire fencing with masonary pillars					
	Concrete wall with masonary pillar around the pit.	M				
	Securing air shaft and installation of borewell pump					
	Securing of Incline					
	Concrete wall fencing around the water body					
	Boundary wall around the water body					
	Stablisation (Viz. Benching, Pitching) of side walls of the water body.	LS	3	4200000	1.26	
	Toe wall around the dump.	M	3750	850	0.32	
	Garland drain					Covered in Progressive Closure Cost.
	Garland drain around the dump.					Covered in Progressive Closure Cost.
	Drainage channel from main OB dump.	M	1250	4000	0.50	Covered under mining cost.

Head		Unit	Qty	Rate Rs. / Unit	Amount Rs. Cr.	Remarks
Technical & Biological Reclamation of Mined out of land and OB Dump	Filling of void.	Ha	156.5		0.25	Majority of the void filling works are covered under mining cost.
	Top Soil management	MM3				Covered in Progressive Closure Cost.
	OB rehandling for backfilling.	MM3				Not Applicable.
	Terracing, Blanketing with soil, and vegetation of External OB dump	Ha				Not Applicable.
	Peripheral road, gates, view point, cemented steps on bank.	LS			0.75	
	Expenditure on development of agricultural land.	Ha	19.57	250000	0.49	
	Landscaping and plantation.	Ls				
Post Closure Management and Supervision	Power Cost	Ls			0.45	
	Post mining water quality management	Ls	12	50000	0.06	
	Post mining air quality management	LS	36	25000	0.09	
	Subsidence monitoring for five years.	Ls	3	1200000	0.36	
	Waste Management	Ls	3	3000000	0.90	
	Manpower cost and supervision.	Ls	36	800000	2.88	

Head		Unit	Qty	Rate Rs. / Unit	Amount Rs. Cr.	Remarks
Others	Enterprenuership development (Vocational/Skill development/training for sustainable income of affected people)	LS	10	2500000	2.50	
	Golden Handshake / Retrenchment benefits to OC employees.					
	Golden Handshake / Retrenchment benefits to UG employees.					
	One time financial grant to societies / Institutions/ Organisations which is dependent upon the project.	LS			0.50	
	Provide Jobs in other mine of the company.					
	Continuation of other services like running of schools etc.	LS	10	3600000	3.60	
Total					**41.21**	

15.3.7 Annual Closure Cost:

The annual closure cost has been calculated as per the guideline issued by MOC. As per the norms closure cost has been calculated based on the wholesale price index of June, 2017 as notified by Government of India.

Detail calculation for the ESCROW account is being shown in Table No. 15.9 below. Total amounts as per WPI, March 2017 comes about to 26.71 Crores including compounding@ 5%.

Table No. 15.9

Calculation for ESCROW account

WPI As on August 09	Aug_09	129.6
WPI as on base date "base date for the mining plan / Mine closure Plan"	June'2017	112.7
Escalation rate of closure cost		1.127
Rate of Compounding of annual closure cost		5%
Amount to be deposited into ESCROW account after compounding @ 5% Rs. In		27.93

	UG	OC
Base Rate of Closure Cost Rs. Cr./Ha	0.01	0.06
Closure Cost Rs. Cr/ Ha		0.0922
Lease Area		260.14
Amount to be deposited in ESCROW account Rs. In Crs		23.98
Amount already deposited in ESCROW account Rs. in Crs		0
Net amout to be deposited into ESCROW account Rs. In Crs.		23.98
Balance life of the project in Years		7
Annual Closure Cost		3.426

WPI base rate has been revised during 2011-12 with respect to Rs. 176.7052 considered as a base rate.
Base rate escalated by =176.7052/129.60 = 1.3634 with respect to 2009 cost.
Closure cost revised based on 2011-12= 0.06 x 1.3634 Crores/Ha = 0.0818 crores/ha

Year wise deposit and expenditures amount into ESCROW account is shown in Table no. 15.9.

Table No. 15.10

Year wise ESCROW Account. (Rs. In Crores)

Year	OC	Reimbursement
2017-18	3.43	-
2018-19	3.60	4.65
2019-20	3.78	4.65
2020-21	3.97	4.65
2021-22	4.17	4.65
2022-23	4.38	4.65
2023-24	4.60	4.65
Total =	27.93	27.90

As per the provisions of the mine closure plan, WBPDCL will open the ESCROW account with scheduled bank. The beneficiary of this account shall be Coal Controllers organization (on behalf of Central Government). The proponent shall deposit the amount detailed in table no. 15.9 on yearly basis. An agreement outlining the de detailed terms and conditions of operating the Escrow Account shall be finalized and executed. Release of funds may be sought from CCO while commencement of the mine closure activities.

15.3.7 Responsibility of Owners:

The mine owner, the WBPDCL, undertakes the responsibility of the mine closure as per the prevailing rules and regulations with respect to Mine Closure activities. Reclamation and rehabilitation works will be carried out as per the provisions of the Mining plan and Mine closure plan. Necessary fund arrangements will be

made by the Owner. Certificate to this extent has been provided by the authorized person of WBPDCL and is furnished in **Annexure- 19.**

Periodical reports to this extent will be submitted to the Coal Controllers Organisation stating the progress of the closure activities.

The mine owner will obtain a mine closure certificate from the coal controller to the effect that the protective, reclamation and rehabilitation works have been carried out by the mine owner in accordance with the mine closure plan/final mine closure plan for surrendering the reclaimed land to the concerned State Government.

Pre-feasibility Report