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MINING PLAN & MINE CLOSURE PLAN

FOR

SIARMAL OPENCAST PROJECT

(CAPACITY : 50.0 MTY)

IB-VALLEY COALFIELD

MAHANADI COALFIELDS LIMITED

(TEXT & PLATES)

RQP: SANJAY KUMAR BHAR, NO. 34011/(22)/2005-CPAM, Dtd. 02.12.2010
Under Rule 22(C) of Mineral Concession Rules 1960

DECEMBER, 2017

CENTRAL MINE PLANNING & DESIGN INSTITUTE LIMITED
(A Subsidiary of Coal India Ltd.)
REGIONAL INSTITUTE-VII
BHUBANESWAR - 751013.

MINING PLAN & MINE CLOSURE PLAN
FOR
SIARMAL OCP (50 Mty)

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GENERAL INFORMATION

1	NAME AND ADDRESS OF THE APPLICANT	:	MAHANADI COALFIELDS LIMITED, JAGRUTI VIHAR, BURLA, SAMBALPUR-768020 (ORISSA)
2	STATUS OF THE APPLICANT	:	CENTRAL PUBLIC SECTOR UNDERTAKING (A SUBSIDIARY OF COAL INDIA LTD.) A GOVT. OF INDIA UNDERTAKING REGISTERED UNDER COMPANIES ACT, 1956
3	MINERAL WHICH THE APPLICANT INTENDS TO MINE	:	COAL
4	NAME, ADDRESS OF PERSON WHO PREPARED MINING PLAN	:	SHRI SANJAY KUMAR BHAR CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED, REGIONAL INSTITUTE-VII, PLOT NO – E4, AT – SAMANTAPURI (NEAR GANDHI PARK), BHUBANESWAR-751013 (ORISSA). RQP REF.NO.-No. 34011/(22)/2005-CPAM, DTD. 2nd DEC. 2010 for CMPDI assignments.
5	NAME AND ADDRESS OF PROSPECTING AGENCY	:	CENTRAL MINE PLANNING & DESIGN INSTITUTE LIMITED, REGIONAL INSTITUTE-VII, PLOT NO – E4, AT – SAMANTAPURI (NEAR GANDHI PARK), BHUBANESWAR-751013 (ORISSA).

SUMMARISED DATA

1.	**General**	
	Name and address of the applicant Company	Mahanadi Coalfields Limited Jagruti vihar, Burla Dist: Sambalpur (Odisha) - 768020
	Name and address of the Block Allottee	MAHANADI COALFIELDS LIMITED (MCL)
	Relationship between the applicant and allottee company	MCL is a subsidiary of Coal India Ltd. which is a Govt. of India Undertaking.
	Status of the Applicant Company : Central /Public Sector Undertaking/State Government Undertaking/JV Company/ Pvt. Company/Public Co/Others (Specify)	Central Public Sector Undertaking.
	Name of the Coal Block together with name of Coalfield & State where located	Siarmal & Siarmal Extension block and Banapatra block in the Gopalpur Sector, Ib Valley Coalfield, Odisha.
	Date of allotment	MCL Block
	End Use of Coal/Lignite as per Approval by the Competent Authority	Basket linkage.
	ROM Quantity proposed to be produced as per Mining Plan	50 Mt per year
	Norms adopted for calculating ROM quantity requirement in case it differs from the quantity indicated in the Allotment Order.	Not Applicable
	Beneficiation required – Yes/No	Beneficiation will be taken up at a later stage
	Requirement of Beneficiated Coal & expected availability thereof.	Washing of total ROM coal, washed coal yield will be tentatively around70%.
	Period for which Mining Lease has been granted/is to be renewed/ is to be applied for.	Land acquired under CBA(A&D), Act, 1957
	Date of Expiry of earlier Mining Lease, if any	N/A
	RQP who has prepared the Mining Plan Name Address Phone No/Fax/Email ID Registration No & date till valid Date of grant/Renewal of RQP Status Validity	 S.K.Bhar, Chief Manager, Central Mine Planning and Design Institute limited, RI-VII, Plot No E4 (Near Gandhi Park), At: Samantapuri Bhubaneswar-751013 Phone No. 0674-2391962(o) E-Mail- sk.bhar@coalindia.in RQP NO. 34011/(22)/2005-CPAM Dtd. 02.12.2010.

D. Information regarding earlier approved Mining Plans, if any.	NOT APPLICABLE
E LOCATION	
a) Location of the Block Taluka/ Village/ Khasra/ Plot / Block Range / etc. District / State	Himgir tahsil, Sundergarh district, Odisha
b) Name of the Coalfield/ Coal belt	Ib Valley Coalfield
c) Particulars of adjacent blocks: North, South, East, West	North- Chaturdhara and Basundhara West blocks separated by Basundhara river/nala. South- Prajapara block. East- Kulda block separated by chattajhor nala West- Rampia & Dip side of Rampia.
d) Area of the Allotted Block i Geological block area	→ 14.67 Sq.km
e) Reference no. of plan of block boundary issued by CMPDI/ SCCL/ NLC (A copy of the Plan also to be annexed)	The Mining Plan is based on "Geological Reports on Siarmal & Siarmal Extension block and Banapatra block, Ib-River coalfield Dist. Jharsuguda, Odisha" prepared by CMPDI,RI-7 in March,2008 & November,2009 respectively.
f) Whether the lease boundary/ required boundary is same as demarcated by CMPDI/ SCCL/ NLC for delineating block/sub- block	Mine excavation area falls within geological block but other infrastructure is outside geological block
g) Existing mining Lease Area in case of existing mines,	Not applicable
h) Applied/ required Lease Area(Project area) as per the Mining Plan under consideration (hectares)	Proposed lease area for mining: 2290.45 Ha Area for colony, R&R, Railway siding will be additionally needed
i) Whether the applied lease area falls within the allotted block	Mine excavation area falls within allotted block, however external overburden dump has been located on dip side block Prajapara which also belongs to MCL, some more land is required outside block for locating infrastructure/office and despatch arrangement.
j) Area of lease which falls outside the block/sub- block delineated by CMPDI/SCCL/NLC.	8.23 Sq.Km of additional land will be required outside block area which will be used for infrastructure, ext. OB dump. (excl land for colony, R&R)
k) Details of outside area: - Whether forms part of any other coal block - Whether it contains any coal/lignite reserves - Purpose for which it is required, e.g. roads/ OB dumps/ service buildings/ colony/ safety zone/ others (specify)	External dumps are proposed in Prajapara bock, which is dipside of present geological block and is owned by MCL only, dumps will have to be rehandled while extending the mine into dipside block area. Other infrastructure are located in non coal bearing area which does not belong to any coal block

l) Whether some part(s) of the allotted block has not been applied for mining lease. - Total area in Ha. of such part(s). - Total reserves in such part(s). - Brief reasoning for leaving such part(s),	Total of geological block has been applied for mining.
m) Type of Land involved in Hectares -Forest Land -Non Forest Land	349.709 Ha, 1940.745 Ha (another 290 Ha of non forest land will be required for colony,railway,resettlement)
n) Broad Land Use Pattern (Forest, Township, Industrial, Agricultural, Grazing, Barren etc.)	Agricultural, Forest, Village and Barren.
o) Proximity of public road / railway line/major water body if any and approximate distance	Nearest rail head Himgir —35 km by road Sundergarh town is at a distance of 46km by road. Basundhara river forms northern boundary.
p) Latitude and longitude	Latitude 22°01'19"-22°03'59.99"N and Longitude 83° 37'09" – 83°42'59.58" E in Survey of India topo-sheet no.-64N/12 on RF 1:50,000.

F	**GEOLOGY AND EXPLORATION**			
a)	Name of the Geological Block and area	Siarmal & Siarmal Extension block and Banapatra block 14.67 Sq.km		
b)	Name of the Geological Report (GR) with year of preparation	"Geological Reports on Siarmal & Siarmal Extension block and Banapatra block, Ib-River coalfield Dist. Jharsuguda, Odisha" prepared by CMPDI,RI-7 in March,2008 & November,2009 respectively.		
c)	Name of the agency which conducted exploration and prepared GR	GSI, CMPDI & DG (O) G.R. prepared by CMPDI Ltd.		
d)	Period of conducting exploration	September 1985 to April 2006		
e)	Details of drilling (by all agencies)	**Block**	**Agency**	**No. of BHs**
		Siarmal & Siarmal Extension block and Banapara block	CMPDI GSI DG (O)	494 4 5
f)	No. of boreholes drilled within the blocks	503		
g)	Overall borehole density within the block (no./ sq. km)	34 BH/ Sq.Km		
h)	Area covered by 'detailed' exploration within the block	14.67 Sq.Km		
i)	Area covered by 'detailed' exploration outside the block (hectares) - No. of boreholes drilled outside the block. - Bore hole density for outside area (no./sq. km)	Not Applicable		
j)	Whether entire lease area has been covered by 'detailed' exploration.	Yes		

k)	Whether any further exploration is required or suggested and timeframe in which it is to be completed	No
l)	Number of coal/lignite seams/horizons Thickness range of coal seams (for >1m only) Minimum & maximum depth of coal seams (for Ib Bottom seam which is lowest)	3 seams/16 section – General Thickness Range(in m) Laj-IV 1-17 Laj-III 1-6 Laj-IIT3 1-3 Laj-IIT2 1-3 Laj-IIT1 14-27 Laj-IIB 2-12 Laj-I 1-18 Rampur V 1-8 Rampur IV 4-18 Rampur IVB 1-4 Rampur III 2-12 Rampur II 1-9 Rampur I 1-15 Ib Top 1-7 Ib Mid 1-10 Ib Bottom 1-4 Minimum depth - 90 m Maximum depth - 360 m
m)	Gross Calorific Value (GCV in K Cal/kg) or Useful Heat Value(UHV in K.Cal/Kg), of coal as per GR : Range	Seam name – GCV Laj-IV 3349 – 5469 (G7-G14) Laj-III 3350 – 5545 (G7-G14) Laj-IIT3 3491 – 4805 (G9-G13) Laj-IIT2 3505 – 6034 (G5-G13) Laj-IIT1 3410 – 5304 (G7-G13) Laj-IIB 2405 – 5188 (G8-G17) Laj-I 3130 – 4594(G10-G14) Rampur V 2650 – 5504 (G6-G17) Rampur IV 3074 – 4710 (G9-G15) Rampur IVB 3076 – 4510(G10-G15) Rampur III 3584 – 5930 (G5-G13) Rampur II 3435 – 5739 (G6-G13) Rampur I 3220 – 5624 (G8-G14) Ib Top 3057 – 5905 (G4-G15) Ib Mid 3197 – 6350 (G4-G14) Ib Bottom 4225 – 6225 (G4-G11)
n)	Quality (Grade) of coal as per GR : Range Mean	C To G (GCV G4-G17) 45.61% F & 27.38% G (Weighed average GCV G11)
o)	Total Net geological reserves considered	1895.43 Mt
p)	Additional reserves established (if any for running mine)	N/A
q)	Depletion of reserves (in case of running mine)	NA
r)	Extractable reserves by Opencast mining	1547.82 Mt (Mineable reserve)
G.	**MINING**	
a)	Proposed method of mining (Opencast for OB & coal separately with dragline/shovel/ surface miners/ manual/ etc.)	Shovel-Dumper & Surface miner-front end loader-dumper
b)	Targeted capacity in mtpa when the mine is fully developed and the year in which proposed to be achieved	50.0 Mty Ninth year of production

By Opencast : Year :	
c) Life of the mine Opencast workings : Overall :	38 Years (@ 50 Mty) excluding construction period
d) Calendar programme for normative production (year wise) along with OB removal has been furnished in chapter-5.	
e) Whether the proposed external OB dump site is coal/ lignite bearing: - If so, whether coal/lignite below waste disposal area is extractable.	Yes, will be rehandled while extending the mine towards dip side block.
f) Whether negative proving for coal / lignite in the proposed site for OB dump/ infrastructure has been done.	Normal exploration has been carried out
g) Proposed configuration of HEMM for OC (Coal & OB) & Major Equipment for OC.	Suggested HEMM: **Var-I(departmental):** Hydraulic Shovel (20-23 cum) Hydraulic Shovel/backhoe(10-12 cum) Rear Dumper(190-205t & 100t) Surface Miner 3800mm drum dia. Elec RBH Drill (250mm & 160 mm) Dozer (850/410 HP) Front end loader(10-12 cum) Var-II: by outsourcing agency with similar size of HEMM
h) Mode of entry for underground mines (shaft, incline, adit,):	Underground mining is not proposed
i) Operations that are proposed to be outsourced	Total outsourcing variant (Variant –II) of the PR has been sanctioned, as per this variant all the major activities related to coal extraction & OB removal and other auxiliary activities will be done through outsourcing means(coal movement from pit bottom to washery by belt conveyor will be done through departmental basis. Blasting is proposed to be done departmentally)
j) Proposed coal evacuation facilities Along Face Face to Surface Surface to end use plants	 Rear Dumpers Reclaim feeder-shiftable belt conveyor Belt conveyor – to washery/ train loading system

<table>
<tr><td colspan="3">H. END USE OF COAL/ LIGNITE</td></tr>
<tr><td colspan="2">a) Capacity of the approved end use plants
b) Coal/ lignite requirement for end use plant with grade/quality
c) %age of end use requirement to be met from this mine</td><td>This mine has been planned to meet the demand of the future thermal power stations and dispatched through basket linkage.</td></tr>
<tr><td colspan="2">d) If washing / beneficiation of the coal/ lignite is planned to be conducted on site or adjacent to the extraction area, briefly describe the nature of the beneficiation and recovery rate.</td><td>Wet process – float separation by Jig
Recovery 70%</td></tr>
<tr><td colspan="2">e) Proposed Use of Rejects/Middlings</td><td>Not decided, either for power generation through FBC technology or selling to customers</td></tr>
<tr><td colspan="3">I. ENVIRONMENTAL MANAGEMENT</td></tr>
<tr><td>a) Existing land use pattern</td><td colspan="2">Existing :
Forest land 349.709 Ha
Non-forest land 1940.745 Ha
Total : 2290.45 Ha</td></tr>
<tr><td>b) Land area indicating the area likely to be degraded due to mining, dumping, roads, workshop, washery, township etc.</td><td colspan="2">Excavation area 1546.32 Ha
Safety zone 18.59 Ha
External dump 386.08 Ha
Infrastructure 42.82 Ha
Embankment 28.30 Ha
Blasting danger zone 268.34 Ha
other infrastructure & future expn. area
TOTAL MINE LEASE AREA : 2290.45 Ha

Another 290 Ha of non-forest land may be required additionally for R& R, colony & railways if same is not available in existing area of MCL</td></tr>
<tr><td>c) Surface features over the block area</td><td colspan="2">Basundhara river, Telendra/ Chaturdhara & Chattajor nullah around periphery of block</td></tr>
<tr><td>d) No. of villages/Houses to be shifted</td><td colspan="2">5villages, tentatively 2645 families</td></tr>
<tr><td>e) Additional Population to be affected by</td><td colspan="2">No additional population will be affected due to this project.</td></tr>
<tr><td>f) Monitoring schedules for different environmental components after the commencement of mining and other related activities.</td><td colspan="2"><table>
<tr><td>For air quality</td><td>Two days in a month at each station (once in a fortnight).</td></tr>
<tr><td>For water and effluent quality</td><td>Once in a month for each station (for drinking water quality), once in a fortnight (for 4 parameters) and once in a year (23 parameters) (for effluent quality)</td></tr>
<tr><td>For ground water level monitoring</td><td>4 times in a year (i.e. April/May, August, November & January)</td></tr>
<tr><td>For noise level</td><td>Once in a day-time and once in a night-time in fortnight from each station.</td></tr>
</table></td></tr>
</table>

J. PROGRESSIVE AND FINAL MINE CLOSURE PLAN (DETAILS FURNISHED IN CHAPTER-11)	
a) Estimated total capital expenditure for mine closure activities	
b) Major closure Activities with proposed Capital expenditure	
Preparation of survey and disposal reports Subsidence Area study Disposal of P&M items Subsided Area (Technical & biologically reclaimed) Dismantling of Industrial Structure (Like substation / water treatment plant / / ETP / STP, etc.) Leveling & gradient Fencing of subsided area Cleaning of coal stock and infrastructure area Disposal / Dismantling of Residential colony Plantation and landscaping on subsided/backfilled area Plantation over cleaned land of infrastructure Environmental monitoring Permanent lighting arrangement in and around mine periphery	The total mine closure amount to be deposited in escrow account is Rs.61474.4870 lakhs alongwith interest. (Cost base November, 2017)
Total	

K. OTHERS	
a) Base date of Mining Plan.	**December, 2017**
b) Calendar year from which the production will start	Subject to approval of EMP & Mining plan and land acquisition
c) Results of any investigation carried out for scientific mining, conservation of minerals and protection of environment; future proposals.	Not Applicable
d) Signature of RQP Date Place	 Bhubaneswar

Chapter - 1

INTRODUCTION

1.1 BACKGROUND

The Siarmal & Siarmal Extension and Banapatra blocks are located in north-western central part of Ib River coalfield of Odisha, known as Gopalpur sector. This coalfield is the southern middle part of lower Gondwana basin of Son Mahanadi Valley and occupies an area of about 1460 sq.km. with potential coal bearing area of around 1050 sq.km. The Ib River coalfield lies in between latitude 21°31' to 22°14' North and longitude 83°32'00" to 84°10'00" East and falls mainly in Sundergarh, Jharsuguda and Sambalpur districts of Odisha. (Ref Plate no. GEN-I for location map of Odisha coalfields and GEN-II for geological blocks of IB Valley coalfield)

The proposed Siarmal OCP has been formulated within Siarmal & Siarmal Extension block and Banapatra (also known as Western Extension of Siarmal) block in the Gopalpur Sector of Ib-valley coalfield. Both are virgin blocks. The Mining plan is based on Geological Reports of Siarmal & Siarmal Extension Block and Banapatra Block and project report of Siarmal OCP. The proposed mine area lies in the south of Basundhara West OCP (7.0 Mty) on the southern side of Basundhara river. Basundhara West OCP is an ongoing project. To its east lies the sanctioned Kulda OCP (10 Mty). Kulda OCP was sanctioned in January,2005 by Govt. of India. Coal production from this mine has been 9.99 Mt in 2016-17. Rampia/Dip Extension of Rampia Block lies to the west of proposed Siarmal OCP.

1.2 BACKGROUND IN CHRONOLOGICAL ORDER ABOUT MINING COMPANY

a) Coalfield discovered in 1837.
b) G.S.I surveyed & mapped in 1855.
c) First mining started by state PWD department in Hingula block in 1875 & was subsequently discontinued due to poor quality coal.
d) Handidhua colliery was started by M/s. Villiers Ltd in 1921.
e) Deulbera colliery was started by B.N railways in 1926.
f) Talcher colliery was started by MSM railways in 1927.
g) NCDC was formed & Deulbera & Talcher colliery came under it in 1956.

h) NCDC opened South Balanda OC in 1960.

i) NCDC opened Nandira U/G in 1962.

j) NCDC opened Jagannath OCP in 1971.

k) After nationalisation in 1973, CMAL was formed in 1973.

l) The coalfield came under the administrative control of CCL in 1975.

m) Came under SECL which was formed in 1986.

n) Came under MCL which was formed in 1992.

MAHANADI COALFIELDS LIMITED is a subsidiary of COAL INDIA LIMITED formed in 03.04.1992. It is the one of the largest coal producing company in Coal India Limited which has been already awarded Mini Ratna, Cat-I status. It has eleven areas in two coalfields of Odisha with 6 underground and 16 opencast mines. Total coal production of the company is 139.208 Mt in 2016-17 which was 23.14 Mt in 1992-93. There are 51 sanctioned mining projects (incl. 2 exhausted projects) in MCL with a capacity of 224.41Mty of coal. The total capital outlay of these projects is Rs.11670.677 Crs. & out of which 34 projects (capacity of 98.08 Mty) have been completed with a sanctioned capital investment of Rs.2823.78 Crs. Siarmal OCP, 50 Mty will be a new opencast mine in Basundhara area of Ib valley coalfield. The reserves of Ib-valley coalfield as per GSI as on 1.4.2016 are given below:

Table-1.1
Coal Reserves in Ib-valley coalfield as on 1.4.2016
(Reserves in million tonnes)

Depth (in meter)	Proved reserves	Indicated reserves	Inferred reserves	Total reserves
0-300	10083.24	4880.44	141.00	15104.68
300-600	1110.44	4140.39	4168.39	9419.76
600-1200	-	303.41	2.69	306.10
Total	**11193.68**	**9324.24**	**4312.62**	**24830.54**

Source CMPDI website, as on 01.04.2016

1.3 PROJECT OBJECTIVES AND TARGET BENEFICIARIES

The Ib-valley Coalfields is one of the two important coalfields of Odisha and forms a part of the Mahanadi Valley coalfields. Coal reserves of this coalfield are about 24.83 billion tonnes (as on 1.4.2016) of which about 15.10 billion tonnes lie within a depth range of 300m. Quality of coal varies from grade C to G (largely F), suitable for power generation.

The coalfield with an area of 1375 Sq.km is served by the Mumbai-Howrah main-line which passes through the central part of the coalfield. Jharsuguda, falling just outside the limits of the coalfield, is the nearest major railway station. The Chandikhole-Raipur section of National Highway (NH-200) passes through the coalfield. In addition, there are several arterial roads which criss cross the coalfield. The drainage in the coalfield is controlled by the Ib River. The Hirakud Dam across Mahanadi River is situated nearby with the back waters of the reservoir touching the south-eastern tip of the coalfield.

Gopalpur sector of Ib-valley coalfield forms the north western part of Ib River coalfield which is a greenfield area with huge mining potential. Detailed exploration was undertaken by CMPDI to assess the quarriable potentiality of coal seams with primary view of opening up of new mining projects to the extent possible. This sector has high potential for opencast mining operations including the proposed project namely Siarmal Opencast Project. This sector has been number of geological blocks (ref. Plate Gen-II) which are under different stages of exploration. All of them are virgin except Basundhara & Kulda blocks. At Basundhara coal production had commenced in 96-97 in Basundhara (East) OC project which was exhausted in 06-07. Mining operations in Basundhara (W) OC project (normative capacity : 7.0 Mty) have also started after the approval of the PR in October,2003. Mining operations in Kulda OCP (cap: 10 Mty) was started in 07-08 after approval of the PR in January,2005. Project capacity of Kulda OCP was later enhanced to 15 Mty.

Coal demand from Ib-valley coalfield has increased many times due to its strategic location with Howrah-Mumbai railway line passing through the coalfield. Coal of this coalfield is suitable for thermal power plants. The southern, western & central India power stations have to depend on Ib valley coalfield for their growth. Due to presence of Howrah-Mumbai in this coalfield, coal can be transported from this coalfield to western India power houses via rail route. Coal to Tamil Nadu Electricity Board is also supplied via rail-cum-sea route through Vishakhapatnam and Haldia ports. Necessary infrastructures for quick coal evacuation are being augmented in the region by the railways. Coal can easily move from this coalfield to Eastern India and Northern India as well. Necessary infrastructures like rail and port facilities are being developed/ augmented in the region.

The proximity of Ib-valley coalfield to Hirakud reservoir has generated a lot of opportunities for setting-up super thermal power stations in the vicinity of the coalfield. To meet the increasing demand of power in the country, more and more super thermal power

stations are being planned in western, northern and eastern India, majority of which are coal based and may be linked from Ib-valley coalfield.

1.5 JUSTIFICATION FOR PREPARATION OF MINING PLAN

The consumers of MCL are linked to the company and not to any specific coalfield. The actual supply from any coalfield of MCL will depend upon the production and transport logistics. Under the above circumstances coalfield wise demand has been assessed based on the production share of these two coalfield which is as below :

Table 1.2

Projected coal demand on MCL from Ib-valley coalfield.

(Fig. in Mt)

Sl. No	Particulars	2021-22	2026-27
1	Total Demand on MCL	244.83	274.134
2	Projected coal demand on Ib-valley coalfield	97.93	120.56
3	Coal Availability	73.82	85.32
	Gap	**(-)24.11**	**(-)35.24**

As per the above estimate, there is gap between demand and availability of MCL by from Ib-valley coalfield alone. Further new coal linkages have been given to MCL for which MCL has already issued LOA. The proposed project will meet the coal demand from the coalfield, especially to the new consumers and reduce the gap between demand and availability.

The coal seams in both the blocks under consideration for the project (Siarmal & Siarmal Extn. and Banapatra) are thick and occur at shallow depth. The entire net geological coal reserves of 1866.83 Mt has high quarriable potentiality.

Considering the coal demand on MCL and quarriable potential of the blocks, formulation of the present opencast mine for rated capacity of 50.0 Mty is justified.

1.6 SALIENT FEATURES OF PRESENT MINING PLAN

PROJECT REPORT

Project Report (PR) was approved by MCL Board in March on 07.03.2014 and subsequently by CIL Board on 29.05.2014 to be implemented in outsourcing mode (as per enclosure-I).

The proposed opencast mine is having net mineable reserves of about 1547.82 million tonnes with stripping ratio of around 1.47 cum/t. It is possible to have a high capacity opencast mine due to occurrence of thick seams with flat gradient and favourable stripping ratio.

The normative and peak production of the project as per approved project report is 40.0 Mty and 50.0 Mty respectively. Following two variants for operating the mine were prepared in the approved PR as explained below:

Variant-I: Departmental Variant (all the activities are proposed to be done departmentally in this variant).

Variant-II: Outsourcing Variant (activities related to the Coal extraction (winning, loading and transportation from face to reclaim feeder), OBR (drilling, loading and transportation) and other related auxiliary works like haul road construction and maintenance, pumping etc. are proposed to be outsourced). Blasting is proposed to be done departmentally in this variant. However coal movement from pit bottom to washery by belt conveyor will be done through departmental basis. Blasting is proposed to be done departmentally.

However the report has been approved by CIL Board to be implemented in total outsourcing variant. MCL now desired to implement the project with a capacity upto 50 Mty and adviced to prepare this Mining Plan & Mine Closure Plan accordingly (as per Annexure-II).

1.7 DIFFICULTIES AND CONSTRAINTS IN MINING WITH ASSOCIATED RISK

Following constraints are envisaged and should be considered while implementation of the report:

a) Diversion of Sundergarh-Raigarh State Highway. This will involve diversion of about 16 km of road.
b) Construction of bridge over Basundhara river for transportation of coal to the proposed silo/ rapid loading system at Barpalli yard on Jharsuguda-Barpalli railway line.

c) Construction of bridge over Chhattajor Nalla for access to the mine and coal transportation in the initial period.

d) Embankment along the Basundhara river to be constructed during implementation of the project.

e) Non-availability of non coal bearing area for external dump.

f) Construction & addition of railway tracks from the proposed silo loading point to Jharsuguda on Howrah-Mumbai main line for transportation of coal.

g) Land acquisition and proper rehabilitation of the villagers

Chapter – 2

DETAILS OF EARLIER APPROVAL OF MINING PLAN

2.1 STATUS

This is the first mining plan prepared for the Siarmal OCP.

Chapter - 3

LOCATION, TOPOGRAPHY & COMMUNICATION

3.1 LOCATION

The proposed Siarmal OCP has been formulated within Siarmal & Siarmal Extension block and Banapatra (also known as Western Extension of Siarmal) block in the Gopalpur Sector of Ib-valley coalfield.

The Siarmal & Siarmal Extension and Banapatra blocks are located in north-western central part of Ib River coalfield of Odisha, known as Gopalpur sector. This coalfield is the southern middle part of lower Gondwana basin of Sone-Mahanadi Valley and occupies an area of about 1460 sq.km. with potential coal bearing area of around 1050 sq.km. The Ib River coalfield lies in between latitude 21°31' to 22°14' North and longitude 83°32'00" to 84°10'00" East and falls mainly in Sundergarh, Jharsuguda and Sambalpur districts of Orissa.

The Siarmal & Siarmal Extension and Banapatra, the two contiguous blocks, lie towards north western part of Ib River coalfield in Odisha state and together covers an area of 14.67 sq.km. The blocks are situated between the Latitude 22°01'19"-22°03'59.99"N and Longitude 83° 37'09" – 83°42'59.58" E in Survey of India topo-sheet no.-64N/12 on RF 1:50,000.

3.2 COMMUNICATION

District headquarter Sundergarh, on State Highway-10 (Sambalpur to Rourkela), is at a distance of about 46 km. from the blocks. The Sundergarh (Odisha) – Raigarh (Chattisgarh) all weather road passes through the blocks. The blocks are also connected by black top road with two important towns of Odisha namely Rourkela at 145 km and Jharsuguda at 75 km. The blocks come under Himgir Tahsil and Balinga police station in the district of Sundergarh, Odisha. The blocks are around 6 km. south west of Basundhara West Colliery and are connected by part metallic road. There are katcha roads passing through the blocks and connect various villages like Kurain, Tumuliya, Haldibahal, Kunal, Gopalpur, Chikindhipa, Naktijor, Banapatra, Ratnasera and Haldilbahal (part) etc.

The village Siarmal is considerably a small one, lying towards the mid eastern part of the block and is well connected with other nearby villages and MCL establishment in Ib River coalfield. Banarpali Thermal Power Station of OPGC is at a distance of 65 km. south east from the blocks and is connected through fair weather/all weather roads from Siarmal village. The blocks are connected by road to the state capital Bhubaneswar through State Highway-10 and National Highway-42, with a total distance of around 450 km. The blocks are well connected with MCL HQ at Sambalpur situated at a distance of about 100 km.

Nearest railhead is Himgir on Mumbai-Howrah Broad Gauge of South Eastern Railway at a distance of about 35 km from the blocks. Jharsuguda railway station on Jharsuguda-Sambalpur-Bhubaneswar rail line of East Coast Railway is at a distance of about 75 km. The nearest port at Bay of Bengal is Paradip and situated at a distance of about 600 km. from the block. The Jharsuguda Airport, is the nearest airport from the block.

3.3 TOPOGRAPHY & DRAINAGE

The block under reference is represented by paddy fields, small hillocks and forests. Major part of the block is however, covered by paddy fields.

Basundhara river flowing west to east in the northern boundary of the block separates the blocks from Chaturdhara/Basundhara blocks and Chattajor nala flowing south to north in the eastern boundary of the block separates the block from Kulda block. One of the tributaries Barjhor nala flows from south to north towards the middle of the block and many other small nala cris cross within the block. Besides these, there are some small ponds and dug wells available within the block and used for irrigation and drinking purposes.

The general topography of the block is undulating and is used for agricultural purpose and some patches of barren lands are also featuring in the block. The general altitude of the block is varying from 260 metres to 311 metres. The lowest elevation is about 260 metres near borehole CMHG-45 along the Basundhara river within Siarmal and Siarmal Extn. block and highest elevation is about 311 metre and is located near the south-western corner near boreholes CMBB-240, 233 & 060 on either side of Sundergarh-Raigarh state road within Banapatra block.

Refer plate no.G-2 for topographical plan.

3.4 CLIMATE & RAINFALL

The area experiences a sub-tropical warm temperature. The mean annual precipitation is 1514.5mm of which 85% occurs during rainy season.

The mean temperature varies from 9.3^{o}C to 44.1^{o}C.

The wind speed varies from 1.1kmph to 8.3kmph. The average relative humidity varies from 15% (in April) to 90% (in July).

Chapter – 4

EXPLORATION, GEOLOGY, SEAM SEQUENCE, COAL QUALITY AND RESERVE

4.1 INTRODUCTION

The proposed Siarmal OCP has been formulated within Siarmal & Siarmal Extension block and Banapatra block in the Gopalpur Sector of Ib-valley coalfield. The Siarmal & Siarmal Extension and Banapatra (also known as Western Extension of Siarmal) blocks are located in north-western central part of Ib River coalfield of Orissa, known as Gopalpur sector. In this chapter, Geology of the OCP has been described from the GRs of Siarmal & Siarmal Extn. and Banapatra (Western Extension of Siarmal block) blocks prepared by CMPDI, R.I-VII in March 2008 and November 2009 respectively.

4.1.1 BLOCK BOUNDARY

The details of the boundary of the Siarmal and Siarmal Extension block are given below:

North : Northern boundary of the block is marked by east west trending Basundhara river.

South: Southern boundary is marked with arbitrary boundary of Barren Measures formation.

East : Eastern boundary is limited by Kulda block along Basundhara river, then followed by Chattajor nala.

West : Western boundary of the block is limited by Eastern boundary of Western Extension of Siarmal (Banapatra) block.

The limits of Banapatra block are as given below:

East : Western boundary of Siarmal & Siarmal Extn. block.

West : Eastern boundary of Rampia and Dip side of Rampia block.

North: Southern boundary of Chaturdhara & Basundhara West blocks

South: Northern boundary of Prajapara block.

Refer plate no.GEN-III for Block and lease boundaries.

4.2 EXPLORATION STATUS

The blocks under consideration (Siarmal & Siarmal Extn. and Banapatra) have been explored in detail and geological reports are available for the blocks. Details of exploration carried out in the two blocks are described below :

4.2.1 SIARMAL AND SIARMAL EXTN

CMPDI has drilled 28 nos. of CMHG, 102 nos. of CIBS and 1 no. of CMBB series boreholes involving 27206.40 m during Sept.'85 to June'89 and July'92 to Jan.'98. A sum total 133 boreholes of HGR, CMHG, CIBS and CMBB series (including one no. non coring) involving 27795.10 m have been drilled in the block for which geological report is available.

The details of the boreholes and meterage drilled within the Siarmal and Siarmal Extension block is summarized below:

Table 4.1

DETAILS OF EXPLORATION CARRIED OUT IN SIARMAL & SIARMAL EXTENSION BLOCK, IB VALLEY COALFIELD

Sl. No.	Borehole Name	Drilled by	No.	Meterage
1	HGR	GSI	2	588.70
2	CMHG	CMPDI	27	4486.65
3	CMHG	CMPDI	01	Non coring/ meterage not available
4	CIBS	CMPDI	102	22558.75
5	CMBB	CMPDI	01	161.00
	Grand Total :		**133**	**27795.10**

BANAPATRA BLOCK

A total of 86,675.84 meter of drilling in 370 boreholes was carried out in the block and the agency-wise breakup is given in the following table :

Table 4.2
DETAILS OF EXPLORATION CARRIED OUT IN BANAPATRA (WESTERN EXTN. OF SIARMAL) BLOCK, IB VALLEY COALFIELD.

Agency	Period of Drilling	Nos. of borehole drilled (BH series)	Meterage drilled
GSI	-	02 (HGR)	641.64
DGO	-	05 (OHG)	105.25*
CMPDI	-	24 (CMHG)	3870.00+
	July '87 to Mar. '89	12 (CMHG)	2344.45
	July '92 to April '06	327 (CIBS&CMBB)	79,714.50
Grand Total		370	86,675.84$

* Meterage drilled is available for 1 BH only.
\+ Meterage drilled is available for 22 BHs.
$ The total meterage drilled (86,675.84) is available for 364 BHs against a total of 370 boreholes drilled in the block.

4.2.2 DENSITY OF BOREHOLES IN BLOCK AREA

In Siarmal & Siarmal Extn. block a total of 133 nos. of boreholes have been drilled covering an area of 6.35 sq. km. The borehole density of the block comes to 21 BH/sq. km. In Banapatra block a total of 370 boreholes have been drilled covering an area of 8.32 sq.km. The borehole density of Banapatra block comes to 44 BH/sq.km. So in Siarmal & Siarmal Extn. and Banapatra blocks combined, a total of 503 boreholes have been drilled covering an area of 14.67 sq.km with a borehole density of 34 BH/sq.km.

4.3 GEOLOGICAL STRUCTURE

Mostly soil, alluvium or weathered mantle cover the area under investigation. As such, the geological features of the block are interpreted mainly on sub-surface

data. Though Talchir and Karharbari Formations have been encountered in boreholes drilled in nearby blocks, but they do not incrop or outcrop within the block. However, Barakar Formation outcrops at places in nala tract/cutting.

Since these two blocks from the structural continuity along with the adjoining blocks, the correlation, seam nomenclature, structural trend etc., have been maintained from the adjacent blocks i.e. Basundhara, Garjanbahal, Kulda, Basundhara East and West blocks.

The faults extending from the above adjoining blocks have been considered while making structural interpretation of the blocks. The nomenclatures of some of the faults have been given afresh following certain pattern. The nomenclatures of these faults are based on either encountering boreholes or level difference in floor of the seams.

Refer plate no. G-1 for geological plan.

4.3.1 DIP AND STRIKE

The strike of the strata has shown northwest – southeast trend with minor variation towards northern part. The strata dips 3° – 4° towards southwest. The same has increased to about 10° in the northern part with dip direction remaining towards south to southwest.

4.3.2 FAULTS

In total 28 number of faults with throw varying from 0 to 120 m have been deciphered in Siarmal & Siarmal Extn. and Banapatra blocks combined. Out of seven faults interpreted in Siarmal & Siarmal Extn. block, six faults extends to Banapatra block and hence common in both the blocks.

In Siarmal and Siarmal Extn. block, seven numbers of faults viz. F1-F1 to F7-F7 with varying amounts of throw and direction have been interpreted in the area under consideration. Eighteen boreholes have directly intersected the faults. The fault F1-F1 is continuing from adjacent Basundhara block with a throw of about 20 m. Most of the faults trend east to west.

In Banapatra block, twenty seven no. of faults with throw varying from 0 to 120 m have been interpreted mostly in the northern part of the block based on either direct evidence in boreholes or through level difference of seam floors.

4.4 DESCRIPTION OF COAL SEAMS

4.4.1 GENERAL

In Siarmal & Siarmal Extension and Banapatra block total 16 nos. of corelatable coal horizons/seams have been identified. Coal seams have been correlated depending upon their thickness, stratigraphic position, quality, in seam dirt band, intervening parting, nature of roof and floor and their lateral extent over the area. The block contains regionally corelatable coal seams with numerous splits.

Barakar formation contains 13 nos. of coal seams from RAM-I to RAM-V and LAJ-I to LAJ-IV along with their splits. The Parkhani seam has also been encountered within Barakar Formation but has been rendered non-potential due to its deterioration in quality and its highly interbanded nature. Ib seam occurs within Karharbari Formation in three splits viz. Top, Middle & Bottom.

The coal and carbonaceous horizons have been differentiated from each other on the basis of moisture and ash contents as applicable in high moisture non-coking coal. Ash + moisture values considered for different categories of coal and other litho types are as follows :

Coal	-	Ash%+Moisture% upto 40%
Shaly coal	-	Ash%+Moisture% >40 upto 55%
Carbonaceous shale	-	Ash%+Moisture% >55 upto 75%
Greyshale, sandy shale and sandstone	-	Ash%+Moisture% exceeding 75%

Correlation of coal seams of the block has been attempted on the basis of their stratigraphic positions, thickness and nature of in-seam dirt bands, parting between coal seams and quality of coal along with their lateral extent over the area in adjoining blocks.

The coal seams, especially Rampur and Lajkura, are highly interbanded. Due to occurrence of dirt bands in large numbers, there was difficulty in assigning roof and floor and also the in-seam dirt bands of 1 metre and above in thickness. Few coal bands were left along with the dirt bands either on roof, floor or along with in-seam dirt band of 1 metre and above in thickness.

The coal seams of the block are either thin or thick with very irregular development of dirt bands leaving no scope for identification of corelatable sections within a seam. However, the approach of identifying each split as separate seam even with less than 1 metre localized parting at places has helped to some extent to obtain better coal quality. The possibility of identification of better section within coal seam of this block otherwise appears to be difficult due to inherent inferior coal quality. The de-shaling of ROM coal may be thought for improvement of quality to a certain extent.

The coal seams of Ib, Rampur and to certain extent Lajkura exhibits high unit carbon, appropriate VM, Moisture, CV etc. which encourages to go into detail for its possible identification as high ash semi coking coal. For this, requisite chemical and petrographic analysis are necessary. Such analysis may be C1, CT, SI, Reflectance, Reactive Index etc. The washability characteristics also needs to be ascertained.

4.4.2 **SEQUENCE OF COAL SEAMS**

The sequence of coal seams and its nomenclature is same in Siarmal & Siarmal Extension and Banapatra blocks. In the Karharbari Formation Ib seam occurs in three splits. Barakar Formation contains seams Rampur and Lajkura also in splits. Altogether, 13 nos. of seams / split seams are reported in Barakar Formation in this block. Among these, seam RAM-IV, LAJ-I, LAJ-II T and LAJ-IV are the most potential coal horizons in this block. (Refer plate no-G-14 for geological cross sections along D-D’ and E-E’). The sequence of coal seams within Siarmal & Siarmal Extn. and Banapatra block is given in Table below:

Table

SUCCESSION OF COAL SEAMS, SIARMAL & SIARMAL EXTENSION AND BANAPATRA BLOCKS COMBINED

Seams / Parting	ROOF DEPTH		FLOOR DEPTH		THICKNESS		RRL		FRL		No. of Bh's.
	MIN (M)	MAX (M)	MIN (M)	MAX (M)	MIN (M)	MAX (M)	MIN (M)	MAX (M)	MIN (M)	MAX (M)	
SOIL	0	0	0	15.00	0	15.00	259.91	301.1	254.38	296.96	126+362
	CIBS	CIBS	CIBS	CIBS-	CIBS	CIBS	CIBS	CIBS	CIBS	CIBS	
	-2	-76	-5	039	-74	-039	-137	-125	-67	-5	
WM	0	15.00	1.53	26.20	0.00	21.35	254.38	296.96	254.38	289.83	132+362
	CIBS	CIBS	CIBS	CMHG-	CIBS-	CMHG-	CIBS	CIBS	CIBS	CIBS	
	-5	-039	-38	056	096	056	67	5	67	31	
PART ABOVE LAJ-IV	3.50	26.20	14.70	155.05	2.60	144.05	264.48	289.83	159.04	265.75	86+269
	CIBS	CMHG-	CMHG	CMBB-	CIBS	CMBB-	CMHG	CIBS	CIBS	CMHG	
	64	056	175	290	78	290	183	31	30	175	
LAJ-IV	14.70	155.05	29.25	167.00	1.26	17.17	159.04	269.91	137.15	266.06	86+264
	CMHG	CMBB-	CMHG	CMBB-	CMHG-	CIBS-	CIBS	CIBS	CMBB-	CIBS	
	175	290	175	290	003	090	30	80	109	80	
PARTING	7.21	167.00	12.45	185.00	3.26	29.51	143.40	266.06	130.79	260.39	91+261
	CIBS	CMBB-	CIBS	CMBB-	CIBS	CMBB-	CIBS	CIBS	CIBS	CIBS	
	38	290	38	290	76	200	30	80	29	80	
LAJ-III	8.59	185.00	12.17	189.21	0.11	6.13	121.75	283.42	117.68	280.42	94+273
	CIBS	CMBB-	CIBS	CMBB-	CMHG-	CMBB-	CMBB-	CMBB-	CMBB-	CMBB-	
	110	290	110	290	058	126	107	230	107	230	
PARTING	6.49	189.21	7.79	194.14	0.16	6.32	126.72	266.80	126.56	264.02	97+265
	CMHG	CMBB-	CMHG	CMBB-	CIBS	CMBB-	CIBS	CMHG	CIBS	CMHG	
	218	290	218	290	29	271	29	46	29	46	
LAJ-IIT3	7.79	194.14	9.18	195.16	0.12	3.31	114.70	284.35	113.68	283.63	99+264
	CMHG	CMBB-	CMHG	CMBB-	CMBB-	CMBB-	CMBB-	CMBB-	CMBB-	CMBB-	
	218	290	218	290	271	016	290	229	290	229	
PARTING	5.07	185.70	6.29	188.18	0.10	6.86	125.36	264.6	123.54	263.7	99+138
	CIBS	CMBB-	CIBS	CMBB-	CMBB-	CIBS-	CIBS	CIBS	CIBS	CIBS	
	136	107	136	107	088	040	29	115	29	115	
LAJ-IIT2	6.29	188.18	6.94	188.55	0.05	2.40	123.54	275.77	122.12	275.19	99+135
	CIBS	CMBB-	CIBS	CMBB-	CMBB-	CIBS	CIBS	CMBB-	CIBS	CMBB-	
	136	107	136	107	051	124	29	220	29	220	
PARTING	5.21	188.55	6.63	189.56	0.34	12.73	122.12	264.11	121.48	262.69	101+276
	CIBS	CMBB-	CIBS	CMBB-	CIBS	CMBB-	CIBS	CIBS	CIBS	CIBS	
	36	107	36	107	94	232	29	36	29	36	

Seams / Parting	ROOF DEPTH		FLOOR DEPTH		THICKNESS		RRL		FRL		No. of Bh's.
	MIN (M)	MAX (M)	MIN (M)	MAX (M)	MIN (M)	MAX (M)	MIN (M)	MAX (M)	MIN (M)	MAX (M)	
LAJ-IIT1	6.63 CIBS 36	199.62 CMBB-290	25.28 CIBS 36	223.85 CMBB-290	16.94 CMBB-278	28.56 CMBB-158	109.22 CMBB-290	280.57 CMBB-229	84.99 CMBB-290	259.50 CMBB-229	100+265
PARTING	9.30 CIBS-103	223.85 CMBB-290	9.58 CIBS-103	224.85 CMBB-290	0.21 CIBS 134	9.91 CMBB-227	99.09 CIBS 29	258.17 CIBS 111	97.99 CIBS 29	254.12 CIBS 111	116+297
LAJ-IIB	9.58 CIBS-103	224.85 CMBB-290	17.15 CMHG-061	230.58 CMBB-290	1.47 CIBS 107	12.34 CMBB-192	83.92 CMBB-107	272.46 CMHG 061	78.26 CMBB-290	266.71 CMHG 061	120+295
PARTING	6.70 CMBB-163	230.58 CMBB-290	8.00 CMBB-163	233.19 CMBB-290	0.34 CMHG 213	33.09 CMHG-181	91.71 CIBS 29	264.62 CIBS 132	88.27 CIBS 29	260.73 CIBS 132	115+297
LAJ-I	8.00 CMBB-163	233.19 CMBB-290	16.07 CMBB-260	241.78 CMBB-107	1.20 CMBB-131	24.90 CMBB-093	75.65 CMBB-290	268.77 CMBB-260	57.65 CMBB-107	263.23 CMBB-260	114+295
PARTING	7.14 CMHG-081	286.41 CMBB-107	8.98 CMHG-079	303.04 CMBB-275	31.24 CIBS 111	95.60 CMBB-187	13.10 CMBB-107	273.36 CMBB-061	13.02 CMBB-107	272.95 CMBB-061	98+238
RAM-V	15.13 OHG-003	303.04 CMBB-275	15.44 OHG-003	308.69 CMBB-275	0.22 CMBB-231	7.90 CMBB-300	1.19 CMBB-275	246.69 OHG-003	-4.46 CMBB-275	246.38 OHG-003	115+263
PARTING	15.44 OHG-003	308.69 CMBB-275	18.54 OHG-003	309.98 CMBB-275	0.24 CMBB-272	10.65 CMBB-136					106+266
RAM-IV	18.54 OHG-003 003	309.98 CMBB-275	29.76 OHG-003	329.61 CMBB-275	0.89 CIBS 133	21.97 CMBB-048	-5.75 CMBB-275	243.28 OHG-003	-25.38 CMBB-275	232.06 OHG-003	109+255
PARTING	29.76 OHG-003	329.61 CMBB-275	31.20 OHG-003	330.52 CMBB-275	0.17 CMBB-191	9.50 CMBB-270					108+260
RAM-IVB	31.20 OHG-003	330.52 CMBB-275	32.00 OHG-003	332.89 CMBB-275	0.08 CMBB-104	4.54 CIBS 10	-26.29 CMBB-275	230.62 OHG-003	-28.66 CMBB-275	229.82 OHG-003	110+252
PARTING	32.00 OHG-	332.89 CMBB-	33.50 OHG-	335.75 CMBB-	0.30 CMBB-	7.10 CMBB-					110+258

Seams / Parting	ROOF DEPTH		FLOOR DEPTH		THICKNESS		RRL		FRL		No. of Bh's.
	MIN (M)	MAX (M)	MIN (M)	MAX (M)	MIN (M)	MAX (M)	MIN (M)	MAX (M)	MIN (M)	MAX (M)	
	003	275	003	275	191	125					
RAM-III	33.50 OHG-003	335.75 CMBB-275	46.38 OHG-003	343.40 CMBB-275	2.70 CMBB-138	12.88 OHG-003	-31.52 CMBB-275	228.32 OHG-003	-39.17 CMBB-275	215.44 OHG-003	108+262
PARTING	46.38 OHG-003	343.40 CMBB-275	47.74 OHG-003	344.10 CMBB-275	0.14 CIBS 62	6.93 CIBS 107					107+269
RAM-II	57.35 CIBS 43	344.10 CMBB-275	60.38 CIBS 43	349.51 CMBB-275	0.37 CIBS 37	11.56 CMBB-226	-40.21 CMBB-107	210.25 CMBB-121	-45.28 CMBB-275	207.84 CMBB-121	107+261
PARTING	60.38 CIBS 43	349.51 CMBB-275	65.18 CIBS 43	349.77 CMBB-275	0.09 CMBB-098	8.77 CMBB-261					104+263
RAM-I	65.18 CIBS 43	349.77 CMBB-275	67.74 CIBS 43	356.40 CMBB-275	0.50 CMBB-211	14.81 CMBB-048	-45.54 CMBB-275	207.15 CMBB-121	-52.17 CMBB-275	201.17 CMBB-121	111+261
PARTING	56.21 OHG-003	348.51 CMBB-107	64.04 OHG-003	352.11 CMBB-107	0.59 CIBS 62	20.12 CMBB-182					105+231
IB TOP	64.04 OHG-003	352.11 CMBB-107	65.19 OHG-003	354.11 CMBB-107	0.10 CIBS 43	6.75 CMHG 113	-52.68 CMBB-107	197.78 OHG-003	-54.68 CMBB-107	196.63 OHG-003	109+230
PARTING	70.27 CIBS 43	354.11 CMBB-	77.18 CIBS 43	355.07 CMBB-	0.11 CIBS 49	14.60 CIBS 132					94+181
IB MID	77.18 CIBS 43	355.07 CMBB-107	77.25 CIBS 43	361.69 CMBB-107	0.04 CIBS 67	9.14 CMBB-080	-55.64 CMBB-107	193.29 CMHG-079	-62.26 CMBB-107	193.15 CMHG-079	96+173
PARTING	77.25 CIBS 43	361.69 CMBB-107	78.01 CIBS 43	368.83 CMBB-107	0.09 CMBB-076	14.96 CIBS 111					75+109
IB BOT	75.79 OHG-003	368.83 CMBB-107	76.54 OHG-003	369.96 CMBB-107	0.04 CIBS- 090	5.65 CMBB-127	-69.40 CMBB-107	187.37 CIBS 43	-70.53 CMBB-107	187.24 CIBS 43	77+110

4.4.3 **DESCRIPTION OF INDIVIDUAL COAL SEAMS**

Characteristic features of the coal seams occurring in Siarmal & Siarmal Extension and Banapatra blocks are given below **:**

Characteristic features of Coal Seam LAJ-IV

Sl. No.	Particulars	Details	
1	No. of BH intersections	350	
2	Area of occurrence (in sq.km)	12.00	
3	Borehole Density (BHs/Sq.Km)	29	
4	Range of depth of occurrence (in metre)	14.70(CIBS-175)	155.05(CMBB-290)
5	Range of Floor reduced level (FRL) range	137.15(CMBB-109)	266.06 (CIBS-80)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	1.26 (CMHG-003)	17.17(CIBS-090)
7	Parting with the lower seam (in metre)	3.26 (CIBS-76)	29.51 (CMBB-200)
8	Floor of the seam	Shale and Carbonaceous Shale	
9	Roof of the seam	Sandstone, Carb shale & shale	
10	OB/ Parting above the seam (in metre)	6.00	155.05
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	 1 1.10	
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40^{o}C		
	i) Moisture (%)	3.7 (CMBB-250)	9.7 (CMHG-8)
	ii) Ash (%)	21.2 (CIBS-99)	47.8 (CMBB-096)
	iii) VM (%)	21.9 (CMBB-277)	30.3 (CIBS-99)
	iv) FC(%)	24.3 (CMBB-235)	41.0 (CIBS-99)
13	Useful heat value K.cal/kg (UHV)	1489 (CMBB-096)	4939 (CIBS-99)
14	Grade	G (CMBB-096)	D (CIBS-99)
15	Gross CV range K.cal/kg	3349(CMBB-277) G14	5469 (CIBS-99) G7
16	CVDF range K.cal/kg	7081 (CIBS-120)	8371 (CIBS-49)
17	Ash fusion temperature range in ^{o}C		
	i) IDT (Initial Deformation Temperature)	1090 (CMHG-8)	>1400 (CIBS-64)
	ii) Hemispherical temperature	1290 (CIBS-82)	>1400 (CIBS-66)
	iii) Flow temperature	>1400 (CIBS-21)	>1400 (CIBS-64)
18	HGI (Hard Grove Grindability Index)	54 (CIBS-49)	65 (CIBS-66)
19	Ultimate Analysis (on DMMF basis)		
	i) C %	77.82 (CIBS-16)	86.00 (CMBB-235)
	ii) H%	3.59 (CIBS-58)	5.70 (CIBS-64)
	iii) N%	1.30 (CIBS-109)	2.35 (CMBB-048)
	iv) S%	0.12 (CIBS-95)	2.31 (CMBB-236)
	v) O% (by diff.)	5.35 (CMBB-235)	16.67 (CMBB-006)
	vi) CO2% (as carbonate)	0.17 (CIBS-64)	1.14 (CIBS-73)
	vii) Phosphorus %	-	-
20	Range of UVM %	36.3 (CMHG-8)	50.0 (CIBS-95)
21	Long flame characteristic	Marginally falls in B_5 group of long flame coals	
22	Reserves in million tonnes	226.90	

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATIONS (LAJ – IV)

Seam LAJ-IV is the upper most seam within the block. It was encountered as full seam in 350 boreholes and as incrop in 13 boreholes in the entire Siarmal & Siarmal Extn and Banapatra blocks. The maximum full seam thickness of the seam LAJ-IV is 17.17 metres and its maximum depth of occurrence is 155.05 metres. The general thickness varies from 11.0 meters to 14.0 meters. Seam thickness is more towards southern part of the block. The seam is less interbanded and contains more than 1 metre inseam dirt bands in 9 boreholes only. The proximate analysis on 60% RH & 40^0 C of the full seam on I_{100} sample shows moisture %, ash% and volatile matter % as 3.7% to 9.7%, 21.2% to 47.8% and 21.9% to 36.3%. The UHV varies from 1489 K.Cal/kg to 4939 K.cal/kg. The grade varies from D to G, but the general grade is F. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. HGI value from 54 to 65 indicates that coal is not friable. The major oxides of coal ash content confirm normal pelletic nature.

Refer plate no.G-3 for folio of Lajkura IV seam.

Characteristic features of Coal Seam LAJ-III

Sl. No.	Particulars	Details		
1	No. of BH intersections	367		
2	Area of occurrence (in sq.km)	12.30		
3	Borehole Density (BHs/Sq.Km)	30		
4	Depth of occurrence (in metre)	8.59 (CIBS-110)		185.00(CMBB-290)
5	Floor reduced level (FRL) range	117.68(CMBB-107)		280.42(CMBB-230)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	0.11(CMHG-058)		6.13(CMBB-126)
7	Parting with lower seam (in metre)	0.16 (CIBS-29)		6.32 (CMBB-271)
8	Floor of the seam	Sandstone, shale and carbonaceous Shale		
9	Roof of the seam	Shale and carbonaceous shale		
10	Parting with upper seam (in metre)	3.26 (CIBS-76)		29.51 (CMBB-200)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	-		
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40^oC			
	i) Moisture (%)	2.9 (CMBB-258)		8.8 (CMBB-073)
	ii) Ash (%)	20.7 (CIBS-99)		49.4 (CMBB-141)
	iii) VM (%)	22.8 (CMBB-262)		29.9 (CIBS-99)
	iv) FC(%)	25.1 (CMBB-077)		42.1 (CIBS-99)
13	Useful heat value K.cal/kg (UHV)	1407 (CMBB-141)		5036 (CIBS-99)

14	Grade	G(CMBB-141)		C (CIBS-99)
15	Gross CV range K.cal/kg	3350(CMBB-077) G14		5545 (CIBS-99) G7
16	CVDF range K.cal/kg	7077 (CIBS-120)		8333 (CIBS-95)
17	Ash fusion temperature range in ^{o}C			
	i) IDT (Initial Deformation Temperature)	1130 (CMHG-8)		>1400 (CIBS-64)
	ii) Hemispherical temperature	1270 (CIBS-82)		>1400 (CIBS-95)
	iii) Flow temperature	>1400 (CIBS-12)		>1400 (CIBS-16)
18	HGI (Hard Grove Grindability Index)	51 (CIBS-49)		62 (CMBB-253)
19	Ultimate Analysis (on DMMF basis)			
	i) C %	75.62 (CMBB-006)		82.86(CMBB-098)
	ii) H%	4.12 (CMBB-256)		5.32 (CMBB-006)
	iii) N%	1.50 (CMBB-237)		2.60 (CIBS-69)
	iv) S%	0.55 (CIBS-95)		2.25 (CMBB-256)
	v) O% (by diff.)	9.64 (CMBB-098)		16.12 (CMBB-006)
	vi) CO2% (as carbonate)	0.05 (CMBB-275)		3.00 (CIBS-112)
	vii) Phosphorus %	-		-
20	Range of UVM %	36.2 (CMHG-008)		49.0 (CMBB-045)
21	Long flame characteristic	Marginally falls in B_5 group of long flame coals		
22	Reserves in million tonnes	73.62		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATIONS (LAJ – III)

Seam LAJ III was encountered as full seam in 367 boreholes and as incrop in 9 boreholes in the entire Siarmal & Siarmal Extn. and Banapatra block. The maximum full seam thickness of LAJ III is 6.13 metres and its maximum depth of occurrence is 185.00 metres. The general thickness of the seam varies from 3 to 5 meters. Seam thickness is more towards southern part of the block. The seam is less interbanded and contains less than 1 metre inseam dirt bands only. The proximate analysis on 60% RH and 40^{0}C of the full seam LAJ III on I_{100} sample shows moisture%, ash% and volatile matter% as 2.9% to 8.8%, 20.7% to 49.4% and 22.8% to 29.9%. The UHV varies from 1407 K.cal/kg to 5036 Kcal/kg. The grade varies from C to G, but the general grade is F. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. HGI value from 51 to 62 indicates that coal is not friable. The major oxides of coal ash content confirm normal pelletic nature.

Characteristic features of Coal Seam LAJ-IIT3

Sl. No.	Particulars	Details		
1	No. of BH intersections	363		
2	Area of occurrence (in sq.km)	13.12		
3	Borehole Density (BHs/Sq.Km)	28		
4	Depth of occurrence (in metre)	7.79 (CMHG-218)		194.14 (CMBB-290)
5	Floor reduced level (FRL) range	113.68(CMBB-290)		283.63 (CMBB-229)

6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	0.12 (CMBB-271)		3.31(CMBB-016)
7	Parting with lower seam (in metre)	0.10 (CMBB-088)		6.68 (CIBS-040)
8	Floor of the seam	Shale and carbonaceous Shale		
9	Roof of the seam	Sandstone, Shale and carbonaceous shale		
10	Parting with upper seam (in metre)	0.16 (CIBS-29)		6.32 (CMBB-271)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	NIL		
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40°C			
	i) Moisture (%)	4.6 (CMBB-067)		9.5 (CMBB-191)
	ii) Ash (%)	16.9 (CIBS-78)		50.3 (CMBB-125)
	iii) VM (%)	23.7 (CIBS-73)		34.5 (CMBB-191)
	iv) FC(%)	27.5 (CIBS-69)		38.9 (CIBS-99)
13	Useful heat value K.cal/kg (UHV)	1310 (CMBB-125)		5367 (CMHG-78)
14	Grade	G (CMBB-125)		C (CMHG-78)
15	Gross CV range K.cal/kg	3491(CMBB-66) G13		4805 (CMBB-034) G9
16	CVDF range K.cal/kg	7264 (CIBS-120)		8021 (CIBS-69)
17	Ash fusion temperature range in °C			
	i) IDT (Initial Deformation Temperature)	1100 (CMHG-46)		>1400 (CIBS-69)
	ii) Hemispherical temperature	1380 (CMHG-46)		>1400 (CIBS-66)
	iii) Flow temperature	>1400 (CIBS-64)		>1400 (CIBS-64)
18	HGI (Hard Grove Grindability Index)	55 (CIBS-69)		-
19	Ultimate Analysis (on DMMF basis)			
	i) C %	76.12 (CMBB-111)		83.80 (CIBS-73)
	ii) H%	4.26 (CMBB-171)		5.40 (CIBS-117)
	iii) N%	1.48 (CMBB-171)		2.90 (CIBS-69)
	iv) S%	0.50 (CIBS-66)		1.03 (CMBB-111)
	v) O% (by diff.)	8.70 (CIBS-73)		16.52 (CMBB-111)
	vi) CO2% (as carbonate)	0.16 (CIBS-64)		0.71 (CIBS-69)
	vii) Phosphorus %	-		-
20	Range of UVM %	38.9 (CIBS-73)		54.00 (CMBB-191)
21	Long flame characteristic	Marginally falls in B_5 group of long flame coals.		
22	Reserves in million tonnes	15.78		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATIONS (LAJ–IIT3)

Seam LAJ-II T 3 occurs below seam LAJ-III and overlies seam LAJ-IIT2. The maximum full seam thickness of seam LAJ-II T3 is 3.31 metres and its maximum depth of occurrence is 191.14 metres. The thickness is more towards south western part of the block. The general seam thickness varies from 1 to 2 meters. There is repetition of incrop of the coal seam due to strike faults throwing towards up dip/rise direction. The seam is less interbanded and contains less than 1 metre dirt bands only. The proximate analysis on 60% RH and 40^0C of the full seam LAJ-II T3 on I_{100} sample shows moisture%, ash% and volatile matter% as 4.6% to 9.5%, 16.9% to 50.3% and 23.7% to 34.5%. The UHV varies from 1310 Kcal/kg to 5367 Kcal/kg. The

grade varies from C to G, however the average grade is F. HGI value 55 indicates that coal is not friable. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. The major oxides of coal ash content confirm normal pelletic nature.

Characteristic features of Coal Seam LAJ-IIT2

Sl. No.	Particulars	Details		
1	No. of BH intersections	234		
2	Area of occurrence (in sq.km)	13.23		
3	Borehole Density (BHs/Sq.Km)	18		
4	Depth of occurrence (in metre)	6.29 (CIBS-136)		188.18 (CMBB-107)
5	Floor reduced level (FRL) range	110.88(CMBB-107)		275.19 (CMBB-220)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	0.05 (CMBB-051)		2.40 (CIBS-124)
7	Parting with lower seam (in metre)	0.34 (CIBS-94)		12.73(CMBB-232)
8	Floor of the seam	Shale and carbonaceous Shale		
9	Roof of the seam	Sandstone, Shale and carbonaceous shale		
10	Parting with upper seam (in metre)	0.10 (CMBB-088)		6.68 (CIBS-040)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	NIL		
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40°C			
	i) Moisture (%)	5.3 (CIBS-41)		10.0 (CMHG-46)
	ii) Ash (%)	13.8 (CIBS-97)		42.1 (CIBS-41)
	iii) VM (%)	24.3 (CIBS-112)		36.0 (CIBS-133)
	iv) FC(%)	27.6 (CIBS-133)		45.6 (CIBS-99)
13	Useful heat value K.cal/kg (UHV)	2276 (CIBS-112)		5836 (CIBS-97)
14	Grade	G (CIBS-112)		E (CIBS-99)
15	Gross CV range K.cal/kg	3505(CIBS-112) G13		6034 (CIBS-97) G5
16	CVDF range K.cal/kg	7129 (CIBS-120)		7938 (CIBS-136)
17	Ash fusion temperature range in °C			
	i) IDT (Initial Deformation Temperature)	1160 (CMHG-64)		>1400 (CIBS-112)
	ii) Hemispherical temperature	1340 (CMHG-64)		>1400 (CIBS-112)
	iii) Flow temperature	1360 (CIBS-64)		>1400 (CMHG-46)
18	HGI (Hard Grove Grindability Index)	57 (CIBS-112)		58 (CIBS-64)
19	Ultimate Analysis (on DMMF basis)			
	i) C %	76.20 (CIBS-64)		
	ii) H%	4.80 (CIBS-64)		
	iii) N%	1.80 (CIBS-64)		
	iv) S% (organic)	0.60 (CIBS-64)		
	v) O% (by diff.)	16.10 (CIBS-64)		
	vi) CO2% (as carbonate)	1.06 (CIBS-127)		4.32(CIBS-64)
	vii) Phosphorus %	-		-
20	Range of UVM %	40.1 (CIBS-99)		54.5 (CIBS-133)
21	Long flame characteristic	Marginally falls in B_5 group of long flame coals		
22	Reserves in million tonnes	11.52		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATIONS (LAJ–IIT2)

Seam LAJ- II T2 occurs below seam LAJ-IIT3 and overlies seam LAJ-IIT1. Seam LAJ-II T 2 was encountered as full seam in 234 boreholes and as incrop in 1 borehole in northern part of the block. The maximum full seam thickness of seam LAJ II T 2 is 2.40 metres and its maximum depth of occurrence is 188.18 metres. Incrop of the seam is limited in northern part along the strike length of the block. There is repetition of the incrop due to strike faults throwing towards up dip/rise direction. The seam is less interbanded and contains only less than 1 metre dirt bands. In the Banapatra block seam is mostly unworkable due to unfavourable thickness which is less than 1 meter. The proximate analysis on 60% RH and 40^0C of the full seam LAJ-II T2 on I_{100} sample shows moisture%, ash% and volatile matter% as 5.3% to 10.0%, 13.8% to 42.1% and 24.3% to 36.0%. The UHV varies from 2276 Kcal/kg to 5836 Kcal/kg. The grade varies from E to G. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. The major oxides of coal ash content confirm normal pelletic nature.

Characteristic features of Coal Seam LAJ-IIT1

Sl. No.	Particulars	Details		
1	No. of BH intersections	365		
2	Area of occurrence (in sq.km)	13.72		
3	Borehole Density (BHs/Sq.Km)	27		
4	Depth of occurrence (in metre)	6.63 (CIBS-36)		199.62 (CMBB-290)
5	Floor reduced level (FRL) range	84.99(CMBB-290)		259.50 (CMBB-229)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	16.94 (CMBB-278)		28.56 (CMBB-158)
7	Parting with lower seam (in metre)	0.21 (CIBS-134)		9.91 (CMBB-227)
8	Floor of the seam	Shale and carbonaceous Shale		
9	Roof of the seam	Sandstone, Shale and carbonaceous shale		
10	Parting with upper seam (in metre)	0.34 (CIBS-94)		12.73(CMBB-232)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	 0 – 2 6.86 (CMBB-271)		
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40^oC			
	i) Moisture (%)	3.4 (CIBS-110)		7.6 (CMHG-8)
	ii) Ash (%)	24.5 (CIBS-99)		46.9 (CMBB-011)
	iii) VM (%)	23.0 (CMBB-270)		29.7 (CIBS-99)
	iv) FC(%)	25.1 (CIBS-98)		39.3 (CIBS-99)
13	Useful heat value K.cal/kg (UHV)	1765 (CMBB-011)		4622 (CIBS-99)

14	Grade	G (CMBB-011)		D (CIBS-99)
15	Gross CV range K.cal/kg	3410 (CMBB-270) G13		5304 (CIBS-99) G7
16	CVDF range K.cal/kg	7090 (CIBS-110)		8084 (CIBS-76)
17	Ash fusion temperature range in ^{o}C			
	i) IDT (Initial Deformation Temperature)	1140 (CMHG-8)		>1400 (CIBS-112)
	ii) Hemispherical temperature	>1400 (CIBS-64)		>1400 (CIBS-110)
	iii) Flow temperature	>1400 (CIBS-64)		>1400 (CIBS-72)
18	HGI (Hard Grove Grindability Index)	54 (CMBB-238)		60 (CMBB-242)
19	Ultimate Analysis (on DMMF basis)			
	i) C %	78.17(CMBB-290)		81.91(CMBB-237)
	ii) H%	4.60(CMBB-275)		5.30 (CIBS-111)
	iii) N%	1.40(CMBB-096)		1.97(CMBB-239)
	iv) S%	0.54(CMBB-078)		2.29(CMBB-238)
	v) O% (by diff.)	9.73(CMBB-237)		14.12(CMBB-290)
	vi) CO2% (as carbonate)	0.23(CMBB-088)		2.19 (CMBB-255)
	vii) Phosphorus %	-		-
20	Range of UVM %	36.6 (CMHG-8)		44.7 (CIBS-98)
21	Long flame characteristic	Marginally falls in B_5 group of long flame coals		
22	Reserves in million tonnes	405.70		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATIONS (LAJ–IIT1)

Seam LAJ-II T1 occurs below seam LAJ-IIT2 and overlies seam LAJ-IIB. Incrop of the seam is limited in northern part along the strike length of the block. There is repetition of the incrop due to strike faults throwing towards up dip/rise direction. The maximum full seam thickness of seam LAJ II T1 is 28.56 metres and its maximum depth of occurrence is 199.62 metres. The seam thickness is more towards south central part of the block. The general thickness of the seam varies between 21 to 23 meters. The seam is interbanded and contains both less and more than 1 metre inseam dirt bands. The proximate analysis on 60% RH and 40^{0}C of the full seam LAJ II T1 on I_{100} sample shows moisture%, ash% and volatile matter% as 3.4% to 7.6%, 24.5% to 46.9% and 23.0% to 29.7%. The UHV varies from 1765 Kcal/kg to 4622 Kcal/kg. The grade varies from D to G and the general grade is F. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. The major oxides of coal ash content confirm normal pelletic nature. **Refer plate no.G-4 for folio of L2T1 seam.**

Characteristic features of Coal Seam LAJ-IIB

Sl. No.	Particulars	Details		
1	No. of BH intersections	415		
2	Area of occurrence (in sq.km)	13.89		
3	Borehole Density (BHs/Sq.Km)	30		
4	Depth of occurrence (in metre)	9.58 (CIBS-103)		224.85 (CMBB-290)
5	Floor reduced level (FRL) range	78.26 (CMBB-290)		266.71(CMHG-061)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	1.56 (CMBB-227)		12.34 (CMBB-192)
7	Parting with lower seam (in metre)			
8	Floor of the seam	Shale and carbonaceous Shale		
9	Roof of the seam	Sandstone, Shale and carbonaceous shale		
10	Parting with upper seam (in metre)	0.21 (CIBS-134)		9.91 (CMBB-227)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	 0 – 2 4.14 (CMBB-117)		
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40°C			
	i) Moisture (%)	2.2 (CMBB-258)		6.6 (CMHG-46)
	ii) Ash (%)	25.7 (CIBS-41)		57.3 (CMBB-038)
	iii) VM (%)	19.8 (CMBB-242)		26.1 (CIBS-82)
	iv) FC(%)	19.9 (CMBB-038)		32.7 (CMHG-46)
13	Useful heat value K.cal/kg (UHV)	634 (CMBB-038)		4456 (CIBS-41)
14	Grade	UNGR (CMBB-038)		D (CIBS-41)
15	Gross CV range K.cal/kg	2405 (CMBB-038) G17		5188 (CIBS-41) G8
16	CVDF range K.cal/kg	6997 (CMBB-038)		9584 (CMBB-063)
17	Ash fusion temperature range in °C			
	i) IDT (Initial Deformation Temperature)	1150 (CMHG-8)		>1400 (CIBS-64)
	ii) Hemispherical temperature	1340 (CIBS-82)		>1400 (CIBS-95)
	iii) Flow temperature	>1400 (CIBS-64)		>1400 (CIBS-95)
18	HGI (Hard Grove Grindability Index)	51 (CIBS-112)		68 (CIBS-49)
19	Ultimate Analysis (on DMMF basis)			
	i) C %	77.54 (CMBB-242)		84.31 (CMBB-258)
	ii) H%	3.20 (CMBB-111)		5.92 (CMBB-075)
	iii) N%	1.55 (CMBB-106)		2.28 (CMBB-048)
	iv) S%	0.27 (CIBS-95)		0.85 (CIBS-82)
	v) O% (by diff.)	9.10 (CIBS-73)		14.90 (CIBS-82)
	vi) CO2% (as carbonate)	0.26 (CIBS-64)		1.78 (CMBB-239)
	vii) Phosphorus %	-		-
20	Range of UVM %	39.1 (CMBB-253)		50.6 (CIBS-051)
21	Long flame characteristic	Marginally falls in B_5 group of long flame coals		
22	Reserves in million tonnes	116.88		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATIONS (LAJ–IIB)

Seam LAJ-II B occurs below seam LAJ-IIT1 and overlies seam LAJ-I. Seam LAJ-II B was encountered in 415 boreholes. The maximum full seam thickness of seam LAJ-II B is 12.34 metres and its maximum depth of occurrence is 224.85

metres. The general seam thickness varies between 5 meters to 7 meters. The thickness is more towards central part of the block. The incrop stretches all along the strike direction towards northern part of the block. There is repetition of incrop of the coal seam due to strike faults throwing towards up dip/ rise direction. The seam is interbanded and contains both less than and more than 1 metre inseam dirt bands. The proximate analysis on 60% RH and 40^0C of the full seam LAJ II B on I_{100} sample shows moisture%, ash% and volatile matter% as 2.2% to 6.6%, 25.7% to 57.3% and 19.8% to 26.1%. The UHV varies from 634 Kcal/kg to 4456 Kcal/kg. The grade varies from D to UNGR and the average grade is F. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. The major oxides of coal ash content confirm normal pelletic nature.

Characteristic features of Coal Seam LAJ-I

Sl. No.	Particulars	Details		
1	No. of BH intersections	409		
2	Area of occurrence (in sq.km)	14.08		
3	Borehole Density (BHs/Sq.Km)	29		
4	Depth of occurrence (in metre)	8.00 (CMBB-163)		233.19 (CMBB-290)
5	Floor reduced level (FRL) range	57.65 (CMBB-107)		263.23 (CMBB-260)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	1.20 (CMBB-131)		24.90 (CMBB-093)
7	Parting with lower seam (in metre)	31.24 (CIBS-111)		95.60 (CMBB-187)
8	Floor of the seam	Shale and carbonaceous Shale		
9	Roof of the seam	Sandstone, Shale and carbonaceous shale		
10	Parting with upper seam (in metre)	0.34 (CIBS-213)		33.09 (CMHG-181)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	 0 – 2 15.33 (CMBB-093)		
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40^oC			
	i) Moisture (%)	2.3 (CMBB-258)		7.8 (CMHG-46)
	ii) Ash (%)	31.5 (CMHG-009)		51.9 (CIBS-134)
	iii) VM (%)	21.3 (CMBB-110)		28.8 (CIBS-26)
	iv) FC(%)	23.1 (CIBS-26)		34.7 (CMHG-46)
13	Useful heat value K.cal/kg (UHV)	1351 (CMBB-047)		3739 (CMHG-009)
14	Grade	G (CMBB-047)		E (CMHG-009)
15	Gross CV range K.cal/kg	3130 (CMBB-110) G14		4594 (CMHG-120) G10
16	CVDF range K.cal/kg	7117 (CMBB-037)		8193 (CIBS-95)
17	Ash fusion temperature range in ^oC			
	i) IDT (Initial Deformation Temperature)	1210 (CMHG-46)		>1400 (CIBS-21)
	ii) Hemispherical temperature	1320 (CIBS-16)		>1400 (CIBS-21)
	iii) Flow temperature	>1400 (CIBS-16)		>1400 (CIBS-16)

18	HGI (Hard Grove Grindability Index)	58 (CIBS-49)		67 (CIBS-95)
19	Ultimate Analysis (on DMMF basis)			
	i) C %	76.09 (CMBB-258)		84.58 (CIBS-95)
	ii) H%	2.91 (CIBS-21)		5.30 (CIBS-75)
	iii) N%	1.60 (CIBS-108)		2.90 (CIBS-69)
	iv) S%	0.39 (CIBS-95)		1.64 (CMBB-239)
	v) O% (by diff.)	8.20 (CIBS-69)		16.66(CMBB-258)
	vi) CO2% (as carbonate)	0.24 (CIBS-64)		2.92 (CMBB-255)
	vii) Phosphorus %	-		-
20	Range of UVM %	22.0 (CIBS-134)		43.7(CMBB-034)
21	Long flame characteristic	Marginally falls in B_5 group of long flame coals		
22	Reserves in million tonnes	218.77		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATIONS (LAJ–I)

Seam LAJ-I occurs below LAJ-IIB and overlies seam RAM-V. The maximum full seam thickness of seam LAJ-I is 24.90 metres and its maximum depth of occurrence is 233.19 metres. The general seam thickness varies from 6 to 10 meters. Seam thickness is more towards south-western part of the block. The incrop has limited occurrence towards north eastern boundary and near north western boundary. There is repetition of incrop of the coal seam due to strike faults throwing towards updip/rise direction. The seam is interbanded and contains both less than and more than 1 metre inseam dirt bands. The proximate analysis on 60% RH and 40^0C of the full seam on I_{100} sample shows moisture%, ash% and volatile matter% as 2.3% to 7.8%, 31.5% to 51.9% and 21.3% to 28.8%. The UHV varies from 1351 Kcal/kg to 3739 Kcal/kg. The grade varies from E to G, however the general grade varies from F to G. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. The major oxides of coal ash content confirm normal pelletic nature. **Refer plate no.G-5 for folio of Laj- I seam.**

Characteristic features of Coal Seam RAM-V

Sl. No.	Particulars	Details		
1	No. of BH intersections	378		
2	Area of occurrence (in sq.km)	14.67		
3	Borehole Density (BHs/Sq.Km)	26		
4	Depth of occurrence (in metre)	15.13 (OHG-003)		303.04 (CMBB-275)
5	Floor reduced level (FRL) range	-4.46 (CMBB-275)		246.38 (OHG-003)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	0.22 (CMBB-231)		7.90 (CMBB-300)
7	Parting with lower seam (in metre)	0.24 (CMBB-272)		10.65 (CMBB-136)
8	Floor of the seam	Shale and carbonaceous Shale		
9	Roof of the seam	Shale and carbonaceous shale		

10	Parting with upper seam (in metre)	31.24 (CIBS-111)		95.60 (CMBB-187)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	 0 – 2 3.11 (CIBS-52)		
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40°C			
	i) Moisture (%)	2.1 (CMBB-258)		7.1 (CIBS-82)
	ii) Ash (%)	24.0 (CMHG-78)		58.9 (CMBB-043)
	iii) VM (%)	18.2 (CMBB-043)		33.0 (CIBS-72)
	iv) FC(%)	20.1 (CMBB-043)		37.1 (CIBS-82)
13	Useful heat value K.cal/kg (UHV)	385 (CMBB-043)		4829 (CMHG-78)
14	Grade	UNGR (CMBB-043)		D (CMHG-078)
15	Gross CV range K.cal/kg	2650 (CMBB-242) G17		5504 (CMHG-78) G6
16	CVDF range K.cal/kg	7231 (CMBB-242)		8431 (CIBS-95)
17	Ash fusion temperature range in °C			
	i) IDT (Initial Deformation Temperature)	1087 (CMBB-098)		>1400 (CIBS-95)
	ii) Hemispherical temperature	1098 (CMBB-098)		>1400 (CIBS-62)
	iii) Flow temperature	1141 (CMBB-098)		>1400 (CIBS-16)
18	HGI (Hard Grove Grindability Index)	55 (CIBS-82)		74 (CMBB-242)
19	Ultimate Analysis (on DMMF basis)			
	i) C %	78.57 (CIBS-82)		85.64 (CMBB-64)
	ii) H%	3.71 (CIBS-62)		5.32 (CMBB-078)
	iii) N%	1.44 (CMBB-098)		2.79 (CIBS-62)
	iv) S%	0.23 (CIBS-95)		1.16 (CIBS-16)
	v) O% (by diff.)	6.71 (CMBB-258)		14.02 (CIBS-82)
	vi) CO2% (as carbonate) /bcs	0.24 (CIBS-65)		4.62 (CMBB-260)
	vii) Phosphorus %	-		-
20	Range of UVM %	35.7 (CMBB-203)		48.3 (CIBS-72)
21	Long flame characteristic	Marginally fall in B_5 group of long flame coals		
22	Reserves in million tonnes	84.40		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATIONS (RAM-V)

Seam RAM-V occurs below seam LAJ-I and overlies seam RAM-IV. The maximum thickness of seam RAM-V is 7.90 metres and its maximum depth of occurrence is 303.04 metres. The general seam thickness varies between 4 to 6 meters. Seam thickness is more towards southern part of the block. The seam is interbanded and contains both less and more than 1 metre dirt bands. The proximate analysis on 60% RH and 40°C of the full seam RAM-V on I_{100} samples shows moisture%, ash% and volatile matter% as 2.1% to 7.1%, 24.0% to 58.9% and 18.2% to 33.0%. The UHV varies from 385 Kcal/kg to 4829 Kcal/kg. The grade varies from Ungraded to D, however the general grade of the seam is F to G. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. The major oxides of coal ash content confirm normal pelletic nature.

Characteristic features of Coal Seam RAM-IV

Sl. No.	Particulars	Details		
1	No. of BH intersections	364		
2	Area of occurrence (in sq.km)	14.67		
3	Borehole Density (BHs/Sq.Km)	25		
4	Depth of occurrence (in metre)	18.54 (OHG-003)		309.98 (CMBB-275)
5	Floor reduced level (FRL) range	-25.38 (CMBB-275)		232.06 (OHG-003)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	5.71 (CMBB-121)		21.97 (CMBB-048)
7	Parting with lower seam (in metre)	0.17 (CMBB-191)		9.50 (CMBB-270)
8	Floor of the seam	Shale and carbonaceous Shale		
9	Roof of the seam	Sandstone, Shale and carbonaceous shale		
10	Parting with upper seam (in metre)	0.24 (CMBB-272)		10.65 (CMBB-136)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	 0 – 5 11.10 (CMBB-191)		
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40°C			
	i) Moisture (%)	1.8 (CMBB-203)		6.6 (CIBS-82)
	ii) Ash (%)	33.7 (CMBB-259)		56.2 (CMBB-295)
	iii) VM (%)	19.3 (CMBB-161)		29.4 (CIBS-69)
	iv) FC(%)	21.1 (CIBS-69)		32.7 (CMBB-171)
13	Useful heat value K.cal/kg (UHV)	799 (CMBB-295)		3684 (CMBB-259)
14	Grade	UNGR (CMBB-295)		E (CMBB-259)
15	Gross CV range K.cal/kg	3074 (CIBS-83) G15		4710 (CMHG-114) G9
16	CVDF range K.cal/kg	7527 (CIBS-69)		8225 (CIBS-52)
17	Ash fusion temperature range in °C			
	i) IDT (Initial Deformation Temperature)	1240 (CIBS-82)		>1400 (CIBS-69)
	ii) Hemispherical temperature	1310 (CIBS-82)		>1400 (CIBS-72)
	iii) Flow temperature	>1400 (CIBS-82)		>1400 (CIBS-69)
18	HGI (Hard Grove Grindability Index)	55 (CIBS-82)		70 (CIBS-118)
19	Ultimate Analysis (on DMMF basis)			
	i) C %	78.45 (CIBS-82)		88.81 (CIBS-62)
	ii) H%	3.95 (CIBS-62)		5.29 (CMBB-004)
	iii) N%	1.36 (CMBB-253)		2.50 (CIBS-69)
	iv) S%	0.17 (CIBS-62)		0.83 (CIBS-82)
	v) O% (by diff.)	4.95 (CIBS-62)		14.14 (CIBS-82)
	vi) CO2% (as carbonate)	0.59 (CIBS-118)		1.60 (CIBS-72)
	vii) Phosphorus %	-		-
20	Range of UVM %	35.3 (CMBB-161)		54.0(CIBS-69)
21	Long flame characteristic	Marginally falls in B_5 group of long flame coals		
22	Reserves in million tonnes	249.92		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATION (RAM-IV)

Seam RAM-IV occurs below seam RAM-V and overlies seam RAM-IVB. The maximum full seam thickness of seam RAM-IV is 21.97 metres and its maximum depth of occurrence is 309.98 metres. The general seam thickness varies between

11 to 15 meters. Seam thickness is more towards south and south western part of the block. The seam is interbanded and contains both less and more than 1 metre dirt bands. The proximate analysis on 60% RH and 40°C of the full seam RAM IV on I_{100} samples shows moisture%, ash% and volatile matter% as 1.8% to 6.6%, 33.7% to 56.2% and 19.3% to 29.4%. The UHV varies from 799 Kcal/kg to 3559 Kcal/kg. The grade varies from E to Ungraded, however the general grade of the seam from F to G. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. The major oxides of coal ash content confirm normal pelletic nature. **Refer plate no.G-6 for folio of Rampur IV seam.**

Characteristic features of Coal Seam RAM-IVB

Sl. No.	Particulars	Details		
1	No. of BH intersections	362		
2	Area of occurrence (in sq.km)	14.67		
3	Borehole Density (BHs/Sq.Km)	25		
4	Depth of occurrence (in metre)	31.20 (OHG-003)		330.52 (CMBB-275)
5	Floor reduced level (FRL) range	-28.66 (CMBB-275)		229.82 (OHG-003)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	0.08 (CMBB-104)		4.54 (CIBS-10)
7	Parting with lower seam (in metre)	0.30 (CMBB-191)		7.10 (CMBB-125)
8	Floor of the seam	Shale and carbonaceous Shale		
9	Roof of the seam	Sandstone, Shale and carbonaceous shale		
10	Parting with upper seam (in metre)	0.17 (CMBB-191)		9.50 (CMBB-270)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	-		
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40°C			
	i) Moisture (%)	1.4 (CIBS-64)		6.1 (CMBB-016)
	ii) Ash (%)	29.2 (CIBS-97)		58.9 (CMBB-209)
	iii) VM (%)	19.5 (CMBB-170)		26.8 (CIBS-99)
	iv) FC(%)	21.9 (CIBS-136)		33.5 (CMBB-016)
13	Useful heat value K.cal/kg (UHV)	496 (CMBB-209)		4346 (CIBS-97)
14	Grade	UNGR (CMBB-209)		D (CIBS-97)
15	Gross CV range K.cal/kg	3076 (CIBS-136) G15		4510 (CMBB-016) G10
16	CVDF range K.cal/kg	7534 (CMBB-199)		8559 (CIBS-62)
17	Ash fusion temperature range in °C			
	i) IDT (Initial Deformation Temperature)	1150 (CMHG-46)		>1400 (CIBS-64)
	ii) Hemispherical temperature	>1400 (CMHG-46)		>1400 (CIBS-62)
	iii) Flow temperature	>1400 (CIBS-64)		>1400 (CIBS-62)
18	HGI (Hard Grove Grindability Index)	67 (CIBS-62)		
19	Ultimate Analysis (on DMMF basis)			
	i) C %	82.79 (CMBB-096)		90.81 (CIBS-62)
	ii) H%	3.06 (CIBS-62)		5.40 (CIBS-75)

	iii) N%	1.50 (CIBS-64)		2.50 (CIBS-69)
	iv) S%	0.16 (CIBS-62)		0.86 (CMBB-048)
	v) O% (by diff.)	3.70 (CIBS-62)		10.49 (CMBB-096)
	vi) CO2% (as carbonate)	0.40 (CIBS-64)		0.78 (CIBS-112)
	vii) Phosphorus %	-		-
20	Range of UVM %	33.2 (CMHG-46)		43.8 (CMBB-096)
21	Long flame characteristic	Marginally falls in B_5 group of long flame coals		
22	Reserves in million tonnes	30.03		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATION (RAM-IVB)

Seam RAM-IVB occurs below seam RAM-IV and overlies seam RAM-III. The maximum full seam thickness of seam RAM-IV B is 4.54 metres and its maximum depth of occurrence is 330.52 metres. The general thickness varies between 1 to 3 meters. Seam thickness is more towards northern central part of the block. The seam is interbanded and contains less than 1 metre dirt bands only. The proximate analysis on 60% RH and 40^{o}C of the seam RAM IV B on I_{100} samples shows moisture%, ash% and volatile matter% as 1.4% to 6.1%, 29.2% to 58.9% and 19.5% to 26.8%. The UHV varies from 496 Kcal/kg to 4346 Kcal/kg. The grade varies from Ungraded to D, predominant grade being G. These qualities of the seam RAM-IVB suggest that the seam may marginally fall in B_5 group of long flame coals. The HGI value is available for 1 borehole which is 67 and indicates that coal is not friable. The major oxides of coal ash content confirm normal pelletic nature.

Characteristic features of Coal Seam RAM-III

Sl. No.	Particulars	Details		
1	No. of BH intersections	370		
2	Area of occurrence (in sq.km)	14.67		
3	Borehole Density (BHs/Sq.Km)	25		
4	Depth of occurrence (in metre)	33.50 (OHG-003)		335.75 (CMBB-275)
5	Floor reduced level (FRL) range	-39.17 (CMBB-275)		215.44 (OHG-003)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	2.70 (CMBB-138)		12.88(OHG-003)
7	Parting with lower seam (in metre)			
8	Floor of the seam	Shale and carbonaceous Shale		
9	Roof of the seam	Sandstone, Shale and carbonaceous shale		
10	Parting with upper seam (in metre)	0.30 (CMBB-191)		7.10 (CMBB-125)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	 0-2 6.39 (CMBB-098)		
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40^{o}C			
	i) Moisture (%)	1.7 (CIBS-67)		7.0 (CIBS-12)
	ii) Ash (%)	24.3 (CIBS-99)		58.5 (CMBB-179)

	iii) VM (%)	21.1 (CMHG-46)		30.0 (CIBS-120)
	iv) FC(%)	27.0 (CIBS-36)		41.4 (CIBS-99)
13	Useful heat value K.cal/kg (UHV)	510(CMBB-179)		4953 (CIBS-93)
14	Grade	UNGR (CMBB-179)		C (CIBS-93)
15	Gross CV range K.cal/kg	3584 (CMHG-54) G13		5930 (CIBS-95) G5
16	CVDF range K.cal/kg	7235 (CIBS-12)		9782 (CIBS-95)
17	Ash fusion temperature range in ^{o}C			
	i) IDT (Initial Deformation Temperature)	1200 (CMHG-46)		>1400 (CIBS-21)
	ii) Hemispherical temperature	1340 (CMBB-106)		>1400 (CIBS-65)
	iii) Flow temperature	1360 (CMBB-106)		>1400 (CIBS-21)
18	HGI (Hard Grove Grindability Index)	51 (CIBS-95)		70 (CMBB-242)
19	Ultimate Analysis (on DMMF basis)			
	i) C %	78.49 (CIBS-82)		89.82 (CMBB-266)
	ii) H%	4.09 (CIBS-21)		5.40 (CIBS-74)
	iii) N%	1.23 (CIBS-95)		2.40 (CIBS-69)
	iv) S%	0.13 (CIBS-95)		0.87 (CIBS-12)
	v) O% (by diff.)	2.52 (CMBB-266)		14.14 (CIBS-82)
	vi) CO2% (as carbonate)	0.56 (CIBS-65)		1.52 (CIBS-75)
	vii) Phosphorus %	-		-
20	Range of UVM %	31.6 (CIBS-118)		45.7 (CIBS-120)
21	Long flame characteristic	Marginally falls in B5 group of long flame coals.		
22	Reserves in million tonnes	166.34		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATION (RAM-III)

Seam RAM-III occurs below seam RAM-IVB and overlies seam RAM-II. The maximum full seam thickness of seam RAM-III is 12.88 metres and its maximum depth of occurrence is 335.75 metres. The general seam thickness varies between 6 to 9 meters. Seam thickness is more towards southern part of the block. The seam is interbanded and contains both less and more than 1 metre dirt bands. The proximate analysis on 60% RH and 40^{o}C of the seam RAM-III on I_{100} samples shows moisture%, ash% and volatile matter% as 1.7% to 7.0%, 24.3% to 58.5% and 21.1% to 30.0%. The UHV varies from 510Kcal/kg to 4952 Kcal/kg. The grade varies from C to Ungraded, however the general grade is F. HGI value varies from 51 to 70 and it indicates that coal is not friable. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. The major oxides of coal ash content confirm normal pelletic nature.

Characteristic features of Coal Seam RAM-II

Sl. No.	Particulars	Details		
1	No. of BH intersections	368		
2	Area of occurrence (in sq.km)	14.67		
3	Borehole Density (BHs/Sq.Km)	25		
4	Depth of occurrence (in metre)	57.35 (CIBS-43)		344.10 (CMBB-275)
5	Floor reduced level (FRL) range	-45.28 (CMBB-275)		207.84(CMBB-121)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	1.01 (CMHG-183)		2.30 (CMHG -75)
7	Parting with lower seam (in metre)	0.09 (CMBB-098)		8.77 (CMBB-261)
8	Floor of the seam	Shale and carbonaceous Shale		
9	Roof of the seam	Sandstone, Shale and carbonaceous shale		
10	Parting with upper seam (in metre)	0.14 (CIBS-62)		6.93 (CIBS-107)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	 0 - 2 6.39 (CMBB-098)		
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40^{o}C			
	i) Moisture (%)	2.0 (CIBS-111)		5.5 (CMHG-75)
	ii) Ash (%)	15.0 (CMHG-75)		50.1 (CIBS-119)
	iii) VM (%)	21.2 (CIBS-119)		29.4 (CIBS-126)
	iv) FC(%)	26.2 (CIBS-99)		37.3 (CIBS-126)
13	Useful heat value K.cal/kg (UHV)	1614 (CIBS-37)		6071 (CMHG-75)
14	Grade	G (CIBS-37)		B (CMHG-75)
15	Gross CV range K.cal/kg	3435 (CIBS-119) G13		5739 (CMBB-088) G6
16	CVDF range K.cal/kg	7861 (CMBB-016)		8245 (CIBS-126)
17	Ash fusion temperature range in ^{o}C			
	i) IDT (Initial Deformation Temperature)	1340 (CIBS-67)		>1400 (CMBB-090)
	ii) Hemispherical temperature	>1400 (CIBS-111)		>1400 (CIBS-67)
	iii) Flow temperature	>1400 (CIBS-67)		>1400 (CIBS-111)
18	HGI (Hard Grove Grindability Index)	61 (CMBB-078)		68 (CIBS-67)
19	Ultimate Analysis (on DMMF basis)			
	i) C %	83.89(CMBB-078)		85.90 (CIBS-67)
	ii) H%	4.62(CMBB-090)		5.10 (CIBS-67)
	iii) N%	1.60 (CIBS-67)		1.85(CMBB-090)
	iv) S%	0.14 (CIBS-67)		0.58(CMBB-078)
	v) O% (by diff.)	7.10 (CIBS-67)		8.95(CMBB-078)
	vi) CO2% (as carbonate)	0.60 (CIBS-67)		1.72(CMBB-090)
	vii) Phosphorus %	-		
20	Range of UVM %	35.8 (CMBB-088)		42.3(CIBS-36)
21	Long flame characteristic	Marginally falls in B5 group of long flame coals.		
22	Reserves in million tonnes	57.50		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATION (RAM-II)

Seam RAM-II occurs below seam RAM-III and overlies RAM-I. The maximum full seam thickness of RAM-II is 11.56metres and its maximum depth of occurrence is

344.10 metres. The general seam thickness varies between 2 to 4 meters. Seam thickness is more towards south western part of the block. The seam is interbanded and contains both less and more than 1 metre in-seam dirt bands. The proximate analysis on 60% RH and 40°C of the full seam RAM II on I_{100} samples shows moisture%, ash% and volatile matter% as 2.0% to 5.5%, 15.0% to 50.1% and 21.2% to 29.4%. The UHV varies from 1614 Kcal/kg to 6071 Kcal/kg. The grade varies from B to G, the general grade varies between D to E. HGI values between 61 to 68 indicate that coal is not friable. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. The major oxides of coal ash content confirm normal pelletic nature.

Characteristic features of Coal Seam RAM-I

Sl. No.	Particulars	Details		
1	No. of BH intersections	372		
2	Area of occurrence (in sq.km)	14.67		
3	Borehole Density (BHs/Sq.Km)	25		
4	Depth of occurrence (in metre)	65.18 (CIBS-43)		349.77 (CMBB-275)
5	Floor reduced level (FRL) range	-52.17 (CMBB-275)		201.17(CMBB-121)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	0.50 (CMBB-211)		14.81 (CMBB-048)
7	Parting with lower seam (in metre)	0.59 (CIBS-62)		20.12 (CMBB-182)
8	Floor of the seam	Shale and carbonaceous Shale		
9	Roof of the seam	Sandstone, Shale and carbonaceous shale		
10	Parting with upper seam (in metre)	0.09 (CMBB-098)		8.77 (CMBB-261)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	 0 - 1 6.60 (CMBB-179)		
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40°C			
	i) Moisture (%)	2.2 (CMBB-090)		6.4 (CMBB-018)
	ii) Ash (%)	20.2(CMHG-006)		51.9 (CMBB-175)
	iii) VM (%)	22.8 (CIBS-127)		28.7 (CMBB-088)
	iv) FC(%)	30.2 (CIBS-120)		46.8 (CMBB-261)
13	Useful heat value K.cal/kg (UHV)	1310 (CIBS-14)		5312 (CMHG-006)
14	Grade	G (CIBS-14)		C (CMHG-006)
15	Gross CV range K.cal/kg	3220 (CIBS-14) G14		5624 (CMBB-088) G6
16	CVDF range K.cal/kg	6646 (CIBS-111)		8282 (CMBB-088)
17	Ash fusion temperature range in °C			
	i) IDT (Initial Deformation Temperature)	1340 (CIBS-67)		>1400 (CIBS-111)
	ii) Hemispherical temperature	>1400 (CIBS-67)		>1400 (CIBS-111
	iii) Flow temperature	>1400 (CIBS-67)		>1400 (CIBS-111)
18	HGI (Hard Grove Grindability Index)	65 (CIBS-67)		
19	Ultimate Analysis (on DMMF basis)			

	i) C %	84.01(CMBB-277)		84.40 (CIBS-67)
	ii) H%	5.04(CMBB-277)		5.20 (CIBS-67)
	iii) N%	1.40 (CIBS-67)		1.78(CMBB-277)
	iv) S%	0.44 (CMBB-088)		0.59(CMBB-277)
	v) O% (by diff.)	8.26 (CMBB-088)		8.58(CMBB-277)
	vi) CO2% (as carbonate)	0.24 (CIBS-67)		
	vii) Phosphorus %	-		
20	Range of UVM %	39.8 (CIBS-67)		
21	Long flame characteristic	Marginally falls in B5 group of long flame coals.		
22	Reserves in million tonnes	121.725		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATION (RAM-I)

Seam RAM-I occurs below seam RAM-II and overlies seam IB TOP. The maximum full seam thickness of seam RAM I is 14.81 metre and its maximum depth of occurrence is 349.77 metres. The general seam thickness varies between 5 to 7 meter. Seam thickness is more towards north and north western part of the block. The seam is interbanded and contains both less and more than 1 metre dirt bands. The proximate analysis on 60% RH and 40^{o}C of the full seam RAM I on I_{100} samples shows moisture%, ash% and volatile matter% as 2.2% to 6.4%, 20.2% to 51.9% and 22.8% to 28.7%. The UHV varies from 1310 Kcal/kg to 5312 Kcal/kg. The grade varies from C to G, the general grade being E. HGI value is 65 indicate that coal is not friable. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. The major oxides of coal ash content confirm normal pelletic nature.

Characteristic features of Coal Seam IB TOP

Sl. No.	Particulars	Details		
1	No. of BH intersections	339		
2	Area of occurrence (in sq.km)	14.67		
3	Borehole Density (BHs/Sq.Km)	23		
4	Depth of occurrence (in metre)	64.04 (OHG-003)		368.83 (CMBB-107)
5	Floor reduced level (FRL) range	-54.68 (CMBB-107)		196.63 (OHG-003)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	0.10 (CIBS-43)		6.75 (CIBS-113)
7	Parting with lower seam (in metre)	0.11 (CIBS-49)		14.60 (CIBS-132)
8	Floor of the seam	Sandstone ,Shale and carbonaceous Shale		
9	Roof of the seam	Sandstone, Shale and carbonaceous shale		
10	Parting with upper seam (in metre)	0.59 (CIBS-62)		20.12 (CMBB-182)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	– 1 1.55(CIBS-101)		

12	Quality Proximate analysis on I_{100} samples on 60% RH & 40°C			
	i) Moisture (%)	0.9 (CMHG-022)		5.8 (CIBS-12)
	ii) Ash (%)	16.9 (CIBS-108)		74.4 (CMHG-022)
	iii) VM (%)	18.1 (CIBS-131)		32.0 (CIBS-66)
	iv) FC(%)	24.4 (CIBS-131)		50.1 (CMBB-095)
13	Useful heat value K.cal/kg (UHV)	1 (CMBB-022)		6030 (CIBS-108)
14	Grade	UNGR (CMBB-022)		B (CIBS -108)
15	Gross CV range K.cal/kg	3057 (CIBS-131) G15		5905 (CIBS-95) G4
16	CVDF range K.cal/kg	7657 (CIBS-12)		9547 (CIBS-95)
17	Ash fusion temperature range in °C			
	i) IDT (Initial Deformation Temperature)	1200 (CIBS-67)		>1400 (CIBS-95)
	ii) Hemispherical temperature	>1400 (CIBS-82)		>1400 (CIBS-82)
	iii) Flow temperature	>1400 (CIBS-65)		>1400 (CIBS-95)
18	HGI (Hard Grove Grindability Index)	48 CMBB-171)		66 (CMBB-004)
19	Ultimate Analysis (on DMMF basis)			
	i) C %	81.45 (CMBB-171)		86.90 (CIBS-67)
	ii) H%	4.19 (CMBB-247)		5.40 (CIBS-66)
	iii) N%	1.40 (CIBS-66)		1.91 (CMBB-080)
	iv) S% (organic)	0.40 (CIBS-72)		0.78(CMBB-247)
	v) O% (by diff.)	5.90 (CIBS-67)		11.71 (CMBB-171)
	vi) CO2% (as carbonate)	0.52 (CIBS-67)		1.28 (CIBS-72)
	vii) Phosphorus %	-		
20	Range of UVM %	31.2 (CIBS-110)		44.4(CIBS-64)
21	Long flame characteristic	Marginally falls in B5 group of long flame coals.		
22	Reserves in million tonnes	22.26		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATION (IB TOP)

Seam IB TOP occurs below seam RAM-I and overlies seam IB MID. The maximum full seam thickness of seam IB TOP is 6.75 metres and its maximum depth of occurrence is 352.11 metres. The general thickness of the seam varies between 1 to 2 meters. Seam thickness is more towards south eastern part of the block. The seam is interbanded and contains both less than 1 metre and more than 1 meter dirt bands. The proximate analysis on 60% RH and 40°C of the IB TOP on I_{100} samples shows moisture%, ash% and volatile matter% as 0.9 to 5.8%, 16.9% to 74.4% and 18.1% to 32.6%. The UHV varies from 1 Kcal/kg to 6030 Kcal/kg. The grade varies from Ungraded to B, the general grade of the seam is E. HGI value from 48 to 66 indicates that the coal are not friable. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. The major oxides of coal ash content confirm, pelletic nature.

Characteristic features of Coal Seam IB MID

Sl. No.	Particulars	Details		
1	No. of BH intersections	269		
2	Area of occurrence (in sq.km)	14.67		
3	Borehole Density (BHs/Sq.Km)	118		
4	Depth of occurrence (in metre)	77.18 (CIBS-43)		355.07 (CMBB-107)
5	Floor reduced level (FRL) range	-62.26 (CMBB-107)		193.15 (CMHG-079)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	0.04 (CIBS-67)		9.14 (CMBB-080)
7	Parting with lower seam (in metre)			
8	Floor of the seam	Sandstone and Shale		
9	Roof of the seam	Sandstone and shale		
10	Parting with upper seam (in metre)	0.11 (CIBS-49)		14.60 (CIBS-132)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	– 1 1.09		
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40°C			
	i) Moisture (%)	2.3 (CMBB-165)		5.0 (CIBS-12)
	ii) Ash (%)	14.8 (CMBB-081)		50.3 (CMBB-199)
	iii) VM (%)	17.8 (CMBB-165)		29.3(CMBB-162)
	iv) FC(%)	28.6 (CMBB-199)		51.7 (CIBS-69)
13	Useful heat value K.cal/kg (UHV)	1600 (CMBB-199)		6209 (CMBB-081)
14	Grade	G (CMBB-199)		A (CMBB-081)
15	Gross CV range K.cal/kg	3197 (CMBB-199) G14		6350(CIBS-069) G4
16	CVDF range K.cal/kg	7233 (CIBS-75)		8318 (CMBB-165)
17	Ash fusion temperature range in °C			
	i) IDT (Initial Deformation Temperature)	1290 (CIBS-12)		1360 (CIBS-95)
	ii) Hemispherical temperature	>1400 (CIBS-12)		>1400 (CIBS-95)
	iii) Flow temperature	>1400 (CIBS-65)		>1400 (CIBS-95)
18	HGI (Hard Grove Grindability Index)	48(CIBS-95)		72 (CIBS-65)
19	Ultimate Analysis (on DMMF basis)			
	i) C %	78.76 (CIBS-12)		86.07 (CIBS-21)
	ii) H%	3.36 (CIBS-21)		5.06 (CMBB-242)
	iii) N%	1.07 (CIBS-95)		1.96 (CIBS-21)
	iv) S%	0.21 (CIBS-95)		1.07 (CIBS-12)
	v) O% (by diff.)	6.87 (CMBB-004)		13.71 (CIBS-12)
	vi) CO2% (as carbonate)	0.60 (CIBS-66)		1.10 (CIBS-112)
	vii) Phosphorus %	-		
20	Range of UVM %	28.2 (CMBB-170)		40.4 (CIBS-12)
21	Long flame characteristic	Marginally falls in B_5 group of long flame coals.		
22	Reserves in million tonnes	52.09		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATION (IB MID)

Seam IB MID occurs below seam IB TOP and overlies seam IB BOT. The maximum full seam thickness of seam IB MID is 9.14 metres and its maximum depth of occurrence is 355.07 metres. The general thickness of the seam varies between 2

to 5 meters. Seam thickness is more towards south western part of the block. The seam is interbanded and contains both less than and more than 1 metre in-seam dirt bands. The proximate analysis on 60% RH and 40°C of the full seam IB MID on I_{100} samples shows moisture%, ash% and volatile matter% as 2.3 to 5.0%, 14.8% to 50.3% and 17.8% to 29.3%. The UHV varies from 1600 Kcal/kg to 6209 Kcal/kg. The grade varies from A to G, the general grade being C to D. The HGI value between 48 to 72 indicates that coal is not friable. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. The major oxides of coal ash content confirm normal pelletic nature.

Characteristic features of Coal Seam IB BOT

Sl. No.	Particulars	Details		
1	No. of BH intersections	187		
2	Area of occurrence (in sq.km)	14.67		
3	Borehole Density (BHs/Sq.Km)	13		
4	Depth of occurrence (in metre)	75.79 (OHG-003)		368.83(CMBB-107)
5	Floor reduced level (FRL) range	-70.53 (CMBB-107)		187.24 (CIBS-43)
6	Seam thickness range (excluding dirt band of >1m thick) (in metre)	0.04 (CIBS-090)		5.65 (CMBB-127)
7	Parting with lower seam (in metre)	-		-
8	Floor of the seam	Sandstone and Shale		
9	Roof of the seam	Sandstone and shale		
10	Parting with upper seam (in metre)	0.09 (CMBB-076)		14.96 (CIBS-111)
11	Dirt bands (>1m in thickness) Nos. Thickness (in metre)	 1-2 2.33(CMBB-127)		 -
12	Quality Proximate analysis on I_{100} samples on 60% RH & 40°C			
	i) Moisture (%)	2.2 (CIBS-64)		6.4 (CMBB-115)
	ii) Ash (%)	12.0 (CMBB-115)		58.0 (CMBB-030)
	iii) VM (%)	17.7 (CIBS-95)		31.0 (CMBB-110)
	iv) FC(%)	33.1 (CIBS-95)		51.6 (CMBB-107)
13	Useful heat value K.cal/kg (UHV)	523(CMBB-030)		6361 (CMBB-115)
14	Grade	UNGR(CMBB-030)		A (CMBB-115)
15	Gross CV range K.cal/kg	4225 (CIBS-95)/ G11		6225 (CMBB-044)/ G4
16	CVDF range K.cal/kg	7954 (CIBS-118)		9143 (CIBS-95)
17	Ash fusion temperature range in °C			
	i) IDT (Initial Deformation Temperature)	>1400 (CIBS-95)		
	ii) Hemispherical temperature	>1400 (CIBS-95)		
	iii) Flow temperature	>1400 (CIBS-95)		
18	HGI (Hard Grove Grindability Index)			
19	Ultimate Analysis (on DMMF basis)			
	i) C %	83.70 (CIBS-64)		87.71 (CIBS-95)
	ii) H%	4.25 (CMBB-171)		5.20 (CIBS-118)

	iii) N%	1.54 (CIBS-95)		1.70 (CIBS-118)
	iv) S%	0.28 (CIBS-95)		0.50 (CIBS-118)
	v) O% (by diff.)	5.75 (CIBS-95)		9.40 (CIBS-64)
	vi) CO2% (as carbonate)	0.10 (CIBS-64)		0.68 (CIBS-118)
	vii) Phosphorus %			
20	Range of UVM %	28.4 (CIBS-95)		40.5 (CMBB-110)
21	Long flame characteristic	Marginally falls in B_5 group of long flame coals.		
22	Reserves in million tonnes	13.38		

SUMMARY OF SEAM PARAMETERS AND SPECIAL OBSERVATION (IB BOT)

Seam IB BOT occurs below IB MID and is the lowermost seam of the block. The maximum full seam thickness of seam IB BOT is 5.65 metres and its maximum depth of occurrence is 368.83 metres. The general seam thickness varies between 1 to 2 meters. Seam thickness is more towards south eastern part of the block. The seam is practically free from dirt bands. The proximate analysis on 60% RH and 40^{o}C of the full seam IB BOT on I_{100} samples shows moisture%, ash% and volatile matter% as 2.2 to 6.4%, 12.0% to 58.0% and 17.7% to 31.0%. The UHV varies from 523 Kcal/kg to 6361 Kcal/kg. The grade varies from UNGR to A, general grade being E. The available M_{100}, unit volatile matter and unit calorific value indicate that the seam may marginally fall in B_5 group of long flame coals, subject to confirmation by generating more data. The major oxides of coal ash content confirm normal pelletic nature.

4.5 COAL RESERVES

Reserves have been estimated for all sixteen coal seams/splits viz. IB BOT, IB MID, IB TOP occurring within Karharbari Formation and RAM-I, RAM-II, RAM-III, RAM-IVB, RAM-IV, RAM-V,LAJ-I, LAJ-IIB, LAJ-IIT1, LAJ-IIT2, LAJ-IIT3, LAJ-III & LAJ-IV occurring within Barakar Formation separately in Siarmal & Siarmal Extension and Banapatra blocks.

4.5.1 BASIC ASSUMPTIONS & NORMS FOLLOWED

1. In seam dirt bands of 1m and above thickness have been excluded from the thickness of the coal seams and considered as Intra-seam burden for which separate Iso-dirt bands have been drawn in

respective seam Folio plans for estimating volume of in seam overburden.

2. Coal seam having minimum 1m thickness & consistent development has been considered for reserves estimation.
3. Seams/sections having less than 1m thickness have been accounted for OB above the corresponding seam.
4. Normally, two coal seams or splits are considered separate if the intervening parting is 1m and more. However, depending upon regional continuity of the intervening parting the splits having even less than 1m. parting (at places) has also been considered as separate seams.
5. Reserves have been estimated for full thickness as well as for incrop zones separately.
6. All the reserves of coal seams from IB BOT to LAJ-IV (in ascending order) have been placed under 'proved category'.
7. Specific gravity for each grade has been calculated by using the following formula.

   Sp. Gr. = 1.29 + 0.01 x Ash
8. Useful heat value (UHV) has been calculated by the following formula.

   UHV = 8900 – 138 (Ash+Moisture)
9. Coal seam with UHV 1300 K.Cal./Kg or less has been placed under upgraded category.
10. 10% deduction has been made towards unforeseen geological reasons from the gross geological reserves to obtain net geological reserves.

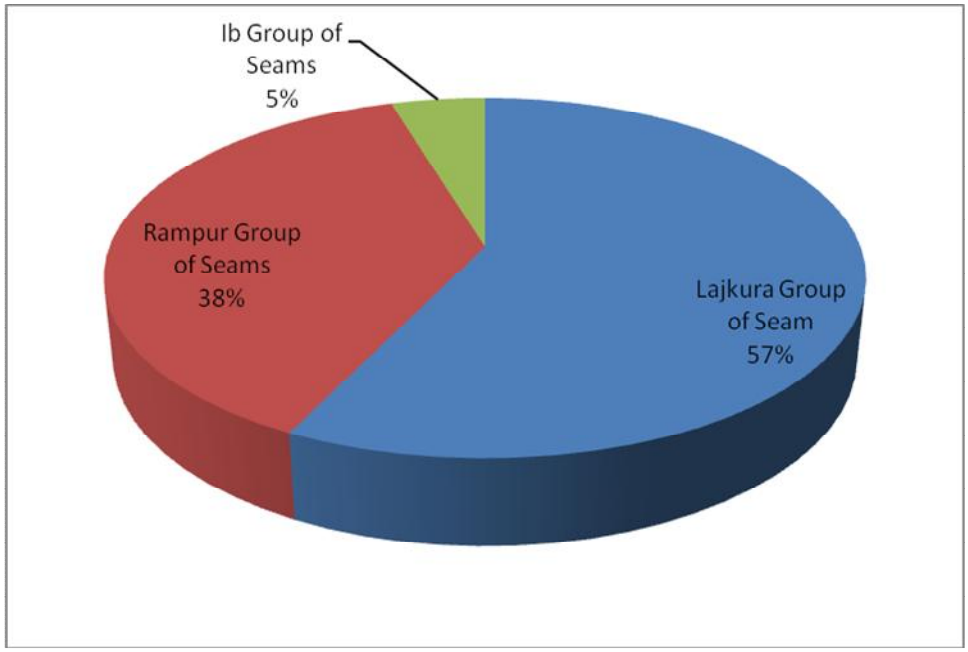
4.5.2 NET PROVED GEOLOGICAL RESERVE

Based on the above assumptions, major seam wise, grade wise, net proved coal reserves within Siarmal & Siarmal Extn. and Banapatra blocks are given below in Table & Fig.

Major seam wise grade wise net proved coal reserves within Siarmal & Siarmal Extn. and Banapatra block combined

Major Seam with its splits	Grade-wise Net Proved Reserves in million tonnes							Net Proved Reserves (Mt.)	**SEAM-WISE PERCENTAGE**
	A	B	C	D	E	F	G		
Lajkura group of seams	0	0.178	5.55	6.88	197.08	632.62	226.85	1069.17	57.27
Rampur group of seams	0	0.078	3.77	28.96	182.79	212.33	282.00	709.92	38.03
Ib group of seams	0.02	5.920	34.14	24.21	14.48	6.59	2.37	87.73	4.70
Total	**0.02**	**6.176**	**43.46**	**60.05**	**394.36**	**851.54**	**511.22**	**1866.83**	**100.00**

Fig. : Major seam wise net proved coal reserve within Siarmal & Siarmal Extn. and Banapatra block combined.



Seam wise, grade wise, net proved geological reserves for Siarmal & Siarmal Extension are given below:

Seam wise, Grade wise Net Proved Geological Reserves Of Siarmal and Siarmal Extension block, Ib River coalfield

Seam	Grade-wise Net Proved Reserves in million tonnes							Net Proved Reserves (Mt.)	SEAM-WISE PERCENTAGE
	A	B	C	D	E	F	G		
LAJ-IV				0.55	17.22	86.27	0.19	104.23	**12.32%**
LAJ-III			0.015	0.29	11.69	21.96		33.96	**4.01%**
LAJ-IIT3			0.052	0.23	6.58	4.61	0.08	11.55	**1.36%**
LAJ-IIT2		0.18	5.425	4.39	1.41	0.05	0.00	11.45	**1.35%**
LAJ-IIT1			0.062	0.93	107.17	62.19	0.38	170.73	**20.17%**
LAJ-IIB				0.05	0.32	10.88	39.59	50.84	**6.01%**
LAJ-I					0.37	48.24	61.79	110.41	**13.05%**
RAM-V			0.049	0.26	1.94	16.90	22.70	41.85	**4.94%**
RAM-IV					0.21	34.37	59.06	93.64	**11.06%**
RAM-IVB				0.01	0.27	4.91	9.36	14.55	**1.72%**
RAM-III				2.15	42.00	36.51	1.86	82.52	**9.75%**
RAM-II		0.03	0.16	2.89	6.42	7.96	1.19	18.65	**2.20%**
RAM-I			0.04	0.17	22.10	25.11	1.51	48.93	**5.78%**
IBTOP		0.06	3.00	5.59	3.47	0.85	0.36	13.33	**1.58%**
IBMID		2.39	22.34	8.42	0.63	0.00		33.78	**3.99%**
IBBOT		0.26	1.03	2.52	1.41	0.37	0.31	5.90	**0.70%**
TOTAL		2.92	32.18	28.43	223.23	361.17	198.39	846.32	**100.00%**
GRADE-WISE PERCENTAGE		**0.34%**	**3.80%**	**3.36%**	**26.38%**	**42.67%**	**23.44%**	**100.00%**	

Seam wise, grade wise, net proved geological reserves for Banapatra block are given below:

Seam wise, Grade wise Net Proved Geological Reserves of Banapatra block, Ib River coalfield

Seam	Grade-wise Net Proved Reserves in million tonnes							Total Net Proved Reserves (Mt.)	SEAM-WISE PERCENTAGE
	A	B	C	D	E	F	G		
LAJ-IV					2.13	114.35	6.19	122.67	12.02
LAJ-III				0.08	2.842	36.124	0.618	39.664	3.89
LAJ-IIT3				0.16	2.86	1.07	0.14	4.23	0.41
LAJ-IIT2				0.03	0.04			0.07	0.01
LAJ-IIT1				0.18	43.49	188.51	2.79	234.97	23.02
LAJ-IIB					0.25	1.51	64.28	66.04	6.47
LAJ-I					0.7	56.87	50.79	108.36	10.62
RAM-V				0.08	4.23	16.41	21.83	42.55	4.17
RAM-IV					0.06	8.37	147.85	156.28	15.31
RAM-IVB					0.04	0.92	14.52	15.48	1.52
RAM-III			0.02	2.86	37.97	41.72	1.25	83.82	8.21
RAM-II		0.05	3.43	17.88	14.61	2.66	0.22	38.85	3.81
RAM-I			0.07	2.66	52.93	16.49	0.65	72.8	7.13
IBTOP		0.05	0.35	2.47	3.91	1.75	0.4	8.93	0.88
IBMID	0.01	2.76	6.63	3.39	2.61	2.11	0.8	18.31	1.79
IBBOT	0.01	0.4	0.78	1.83	2.45	1.51	0.5	7.48	0.73
TOTAL	**0.02**	**3.26**	**11.28**	**31.62**	**171.12**	**490.37**	**312.83**	**1020.50**	**100**
GRADEWISE PERCENTAGE	**0.001**	**0.32**	**1.11**	**3.1**	**16.77**	**48.05**	**30.65**	**100**	

Seam wise, grade wise, net proved geological reserves for Siarmal & Siarmal Extn. and Banapatra Blocks together are given below in Table and Figures.

Seam wise, Grade wise Net Proved Geological Reserves of Siarmal & Siarmal Extn. and Banapatra block

Seam	Grade-wise Net Proved Reserves in million tonnes							Net Proved Reserves (Mt.)	SEAM-WISE PERCENTAGE
	A	B	C	D	E	F	G		
LAJ-IV	0	0	0	0.55	19.35	200.62	6.38	226.90	12.15
LAJ-III	0	0	0.01	0.37	14.54	58.08	0.62	73.62	3.94
LAJ-IIT3	0	0	0.05	0.39	9.44	5.68	0.22	15.78	0.85
LAJ-IIT2	0	0.18	5.43	4.42	1.45	0.05	0.00	11.52	0.62
LAJ-IIT1	0	0	0.06	1.11	150.66	250.70	3.17	405.70	21.73
LAJ-IIB	0	0	0	0.05	0.57	12.39	103.87	116.88	6.26
LAJ-I	0	0	0	0.00	1.07	105.11	112.58	218.77	11.72
RAM-V	0	0	0.0487	0.34	6.17	33.31	44.53	84.40	4.52
RAM-IV	0	0	0	0.00	0.27	42.74	206.91	249.92	13.39
RAM-IVB	0	0	0	0.01	0.31	5.83	23.88	30.03	1.61
RAM-III	0	0	0.02	5.01	79.97	78.23	3.11	166.34	8.91
RAM-II	0	0.08	3.59	20.77	21.03	10.62	1.41	57.50	3.08
RAM-I	0	0	0.11	2.83	75.03	41.60	2.16	121.73	6.52
IBTOP	0	0.11	3.35	8.06	7.38	2.60	0.76	22.26	1.19
IBMID	0.01	5.15	28.97	11.81	3.24	2.11	0.80	52.09	2.79
IBBOT	0.01	0.66	1.81	4.35	3.86	1.88	0.81	13.38	0.72
TOTAL	0.02	6.18	43.46	60.05	394.36	851.54	511.22	1866.83	100.00
GRADE-WISE PERCENTAGE	0.00	0.33	2.33	3.22	21.12	45.61	27.38	100.00	

Fig:

Major seam wise coal reserves, Siarmal & Siarmal Extn. and Banapatra blocks

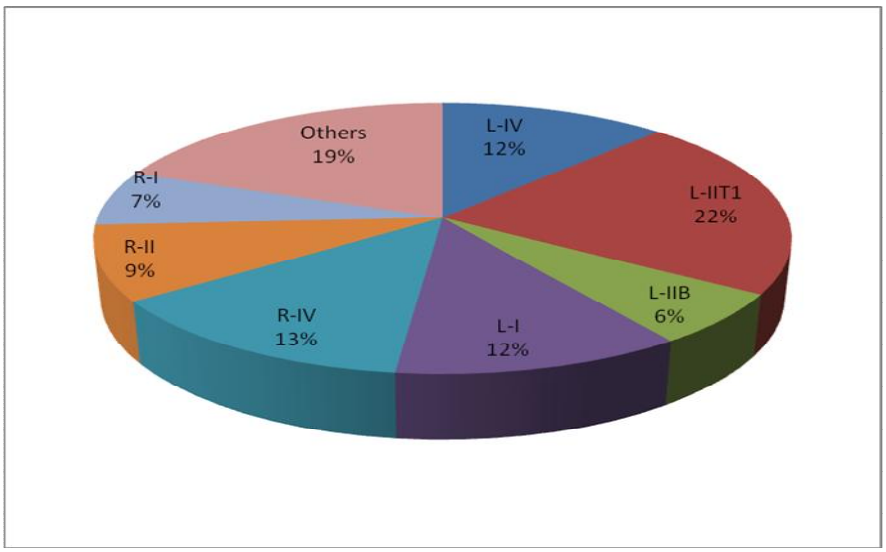
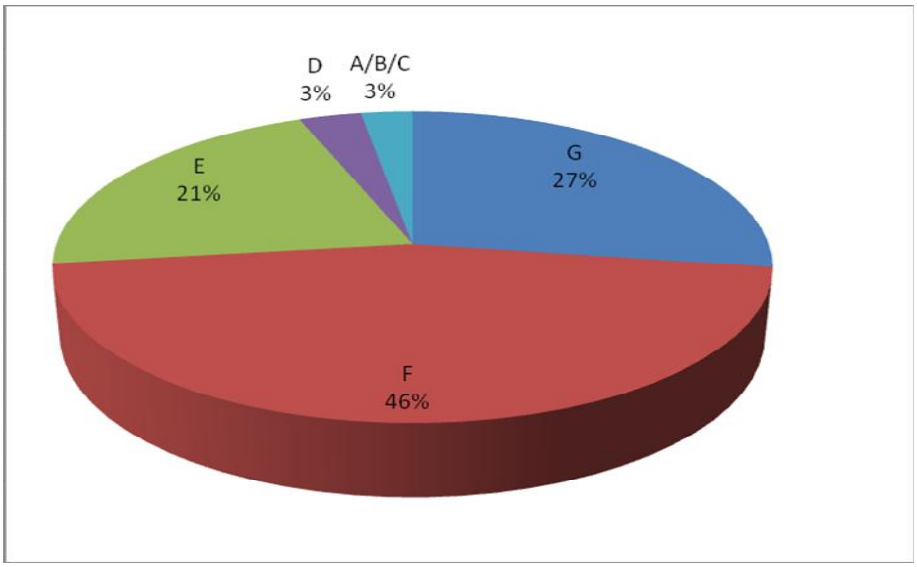


Fig- Grade wise Net Proved Geological Reserves of Siarmal & Siarmal Extn. and Banapatra block, Ib River coalfield



Thus, a sum total of 1866.83 million tonnes net proved geological reserves for the coal seams viz. IB BOT to LAJ-IV have been estimated over an area of 14.67 sq.km in Siarmal & Siarmal Extension and Banapatra blocks combined.

Chapter - 5

MINING TECHNOLOGY

5.1 INTRODUCTION

This report has been prepared for mining the total area available under two coal blocks named “Siarmal & Siarmal Extension block” and “Banapatra (also known as Western Extension of Siarmal) block” in the Gopalpur Sector of Ib-valley coalfield. All drawings, estimates and calculations are based on final Geological reports for Siarmal & Siarmal Extension block and geological report on Banapatra block. Coal deposit details, coal characteristics and estimates of coal and overburden quantities have been given in Chapter-4 of this report.

5.2 PIT FORMULATION STRATEGY

The strike length of combined geological clock is around 6.5 km at its centre and the same will be reduced towards north, combined block area is around 14.67 sq.km. Thick seams occur at shallow depth in wide area towards north-eastern part of the combined block having huge power grade coal reserve. It can be best extracted by opencast mining method deploying mechanical shovels of high capacity and dumpers of matching sizes.

Sequence of coal seams with all splits, maximum and minimum thicknesses and levels of roof and floor are given in Chapter-4 of this report. Three major seams in this block are Ib seam, Rampur seam and Lajkura seam. There are seventeen identified coal sections in this combined block. Incrop of upper sections of Lajkura seam occurs towards north and north-eastern part of both the blocks. Rampur seam roof occurs after a parting of 45-50m below lowest section of Lajkura seam. Ib seam sections are mostly thin and occurs below Rampur seam at a higher depth.

The proposed pit considers most of the area of the combined block, barriers will be left towards north and east due to presence of Basundhara river and Chhatajhor nala respectively.

In view of conservation of coal, mine floor considered is the floor of any of the three sections of Ib seam which is found to be the lowermost workable seam having thickness of more than 1m within the block. In the area where all the sections of ib seams area less than 1m quarry floor will be limited to the bottommost section of Rampur seam.

Following are the critical factors regarding pit formulation strategy:

- Presence of Basundhara river towards north and Chhatajhor nala towards east and its confluence point with the river towards north eastern corner of the coal block. Quarry needs to be opened from this north east corner as the seams occur at shallowest point in this area. So adequate measures are necessary to prevent inundation.
- Total block area is coal bearing so location of infrastructure and overburden dump will block certain quantity of coal during initial years. Later these infrastructures may be relocated in the backfilled area.
- Although upper seams occur at a shallow depth but lower seams occur at a higher depth during initial mining operations. So development of pit necessitates considerable time and external dumping requirement will be high.
- Total northern part of the combined block is geologically disturbed, it requires detailed planning scheme for working this area.
- Due to presence of water body towards north and east hydrogeological study should be done with much care, impact on groundwater due to high quarry depth should be properly assessed.

5.3 MINE BOUNDARIES

All the geological sectors are proposed to be mined in proposed quarry.

With due considerations to all surface constraints and geological dispositions within the block, quarry boundaries have been derived as below:

SURFACE BOUNDARIES

North : After leaving a sufficient surface barrier from the Basundhara river. This surface barrier will accommodate embankment against the river after considering HFL of that area, a transport road and conveyor passage. Embankment width will vary as per surface elevation in that area.

West : 15 m from common block boundary between Banapatra and Rampia block. This space is required for drain, one road and fencing. Towards northwest corner 60m barrier is kept for nala diversion along the common boundary.

South : Floor of Lajkura-I seam is limited upto southern geological block boundary, the surface boundary has been arrived further south with a quarry slope angle of around 37^0 with horizontal towards south.

East : Around 60-80 m from Chattajor nala and straightening the nala course. Barrier width depends on the embankment width.

FLOOR BOUNDARIES

Based on surface boundaries on north, east and west and south, floor boundaries have been arrived after provisioning of sufficient number of flank roads with safety berms. Average slope on all sides is about 35^0-40^0 with horizontal.

In view of high depth of the quarry, slope stability studies are recommended to be carried out all along the final slope, particularly for areas along the main access trench which needs to be stable for a long period. Mine floor and surface boundary, access trench and main haul road and other flank roads are shown in Final stage Excavation plan (**Plate no. MIN-I**), slope stability monitors should be used in running mines to avoid any danger due to slope failure and to monitor the running pit slope.

5.4 MINEABLE RESERVE

Within the mine boundaries detailed above, extractable coal quantity is estimated as 1547.82 Mt with corresponding overburden of 2269.69 Mcum. Extractable coal quantity is arrived after provisioning for “mining loss” over Net Geological Reserves.

Following procedure is adopted for assessing mineable coal, overburden and partings:

i) Extent of each coal seam and intervening partings are projected on quarry slope. Grade wise areas between two successive iso-chores/ iso-parting lines are measured within this extent and multiplied by average of two consecutive thickness values to arrive at volume. Coal volume is multiplied by grade wise specific gravity to arrive at Gross Geological Reserve. Areas of coal seams having thickness less than 1 m and grade below G are also separately calculated and added to overburden volume. Band volumes for seams IX, VI/VII/VIII, sections of seam-III, ID have been added to overburden. Grade wise specific gravity considered is shown in following table 5.01.

Table - 5.01
Gradewise Specific Gravity of Coal

Grade of coal	Specific Gravity
Grade-B	1.45
Grade-C	1.50
Grade-D	1.55
Grade-E	1.61
Grade-F	1.68
Grade-G	1.75

ii) Net Geological Reserve as given in Chapter-4 has been arrived after providing 10 % loss on Gross Reserve to account for geological uncertainties.

iii) Due to multiple seams of different thicknesses and in-seam bands of more than 1 m thickness, ***Mining Loss*** has been estimated for each seam separately to arrive at **Mineable Coal Reserve.** Mining loss depends on:

a) Loss of coal in roof and floor of seam
b) Loss of seam while cleaning roof of bench
c) Loss of coal during selective mining for >1m bands
d) Loss of coal during transportation

Seam wise mining losses are given in table 5.02 below:

Table - 5.02
Seam-wise Mining Loss

Seam name	Mining loss
Lajkura IV	2.23%
Lajkura III	7.00%
Lajkura IIT3	19.87%
Lajkura IIT2	18.44%
Lajkura IIT1	1.5%
Lajkura IIB	6.0%
Lajkura I	3.0%
Rampur V	7.25%
Rampur IV	2.25%
Rampur IVB	17.38%
Rampur III	7.25%
Rampur II	8.0%
Rampur I	5.32%
Ib top	18.34%
Ib middle	6.18%
Ib bottom	20.00%

Table - 5.03
Seamwise details of Mineable reserves.

	AREA CONSIDERED (Ha)	**THICKNESS RANGE** (m)	**NET GEOLOGICAL RESERVE** (Mt)	**MINEABLE RESERVE** (Mt)	**EXTRACTABLE RESERVE** (Mt)
LAJKURA IV		10-17	226.9	218.93	214.05
LAJKURA III		1-6	73.62	69.57	64.7
LAJKURA IIT3		1-3	15.78	14.63	11.72
LAJKURA IIT2		1-3	11.53	9.82	8.01
LAJKURA IIT1		14-27	405.7	374.35	368.73
LAJKURA IIB		2-12	116.88	106.91	100.5
LAJKURA I		1-18	218.77	198.66	192.7
RAMPUR V		1-8	84.4	67.91	62.99
RAMPUR IV		2-15	249.92	193.76	189.4
RAMPUR IVB		4-19	30.03	22.55	18.63
RAMPUR III		4-12	166.34	128.31	119.01
RAMPUR II		1-12	57.5	39.79	36.61
RAMPUR I		1-15	121.73	90.77	85.94
IB TOP		2-20	22.26	9.1	7.43
IB MIDDLE		2-21	52.09	37.18	34.88
IB BOTTOM		2-22	13.38	6.21	4.97
TOTAL	**1467**		**1866.83**	**1588.45**	**1520.27**

	AREA CONSIDERED In slope (Ha)	THICKNESS RANGE (m)	NET GEOLOGICAL RESERVE (Mt)	**MINEABLE RESERVE** (Mt)	**EXTRACTABLE** RESERVE (Mt)
LAJKURA IV		12-15	14.38	14.71	14.05
LAJKURA III		3-5	3.34	3.59	3.11
LAJKURA IIT3		1-2	1.16	1.45	0.93
LAJKURA IIT2		1-2	0.65	0.8	0.53
LAJKURA IIT1		21-23	9.07	9.21	8.93
TOTAL	**182**		**28.6**	**29.76**	**27.55**

	NET GEOLOGICAL RESERVE (Mt)	**MINEABLE RESERVE** (Mt)	**EXTRACTABLE** RESERVE (Mt)
GRAND TOTAL	**1895.43**	**1618.21**	**1547.82**

It may be mentioned here that mineable reserve is arrived at after 10% deduction from the Gross Geological reserves (to arrive at the Net Geological reserve) and after

considering suitable deduction for mining losses. So, actual reserve realization during mining may vary compared to the estimated mineable reserves due to geological uncertainty and mining method. Losses due to mining and geological uncertainty may be reviewed during actual mining operations if the mine is operated through outsourcing means.

5.5 SECTOR & SECTION WISE MINEABLE RESERVES

The total mining block has been proposed to be worked into two quarry sections. Quarry-1 (eastern quarry) has been divided into eight sectors and Quarry-2 (western quarry) has been divided into five sectors.

Table - 5.04

SECTORWISE NET MINEABLE RESERVE (QUARRY-1)

		GRADE							Coal in Mt
		A	B	C	D	E	F	G	TOTAL
LAJKURA IV	sec1S					0.08	1.05		**1.13**
	sec2S								
	sec3S						2.53		**2.53**
	sec4S				0.07	2.00	7.34		**9.41**
	sec5S				0.47	8.62	44.18	0.1	**53.37**
	sec6S					3.39	25.01		**28.4**
	sec7S					1.38	24.67	0.19	**26.24**
	sec8S						14.99		**14.99**
	TOTAL				**0.54**	**15.47**	**119.77**	**0.29**	**136.07**
LAJKURA III	sec1S					0.45	0.38		**0.83**
	sec2S								
	sec3S					0.31	0.46		**0.77**
	sec4S					1.55	1.29		**2.84**
	sec5S				0.26	4.3	9.1		**13.66**
	sec6S					2.9	5.89		**8.79**
	sec7S				0.01	0.9	6.76		**7.67**
	sec8S					0.17	4.44		**4.61**
	TOTAL				**0.27**	**10.58**	**28.32**		**39.17**
LAJKURA IIT3	sec1S								
	sec2S					0.16	0.11		**0.27**
	sec3S					0.07	0.14		**0.21**
	sec4S					0.43	0.46		**0.89**
	sec5S			0.04	0.12	1.97	1.12	0.08	**3.33**
	sec6S				0.03	1.74	0.76		**2.53**
	sec7S				0.13	1.2	1.22		**2.55**
	sec8S					0.44	1.05	0.06	**1.55**
	TOTAL			**0.04**	**0.28**	**6.01**	**4.86**	**0.14**	**11.33**
LAJKURA IIT2	sec1S								
	sec2S		0.02	0.16	0.07	0.03			**0.28**
	sec3S			0.11	0.05	0.06			**0.22**
	sec4S			0.22	0.41	0.16			**0.79**
	sec5S		0.05	0.84	0.57	0.33	0.04		**1.83**
	sec6S		0.03	1.85	0.56	0.1			**2.54**
	sec7S		0.02	0.45	1.24	0.08			**1.79**
	sec8S			0.03	0.79	0.27			**1.09**
	TOTAL		**0.12**	**3.66**	**3.69**	**1.03**	**0.04**		**8.54**
LAJKURA IIT1	sec1S								
	sec2S			0.06	0.32	2.86	0.63		**3.87**
	sec3S					2.11	0.57		**2.68**
	sec4S				0.02	9.94	2.21	0.02	**12.19**
	sec5S				0.58	43.2	28.81	0.04	**72.63**

SECTORWISE NET MINEABLE RESERVE (QUARRY-1)

		GRADE							Coal in Mt
		A	B	C	D	E	F	G	TOTAL
	sec6S				0.13	33.5	11.26	0.32	**45.21**
	sec7S				0.05	16.95	21.65		**38.65**
	sec8S					12.56	15.2		**27.76**
	TOTAL			**0.06**	**1.1**	**121.12**	**80.33**	**0.38**	**202.99**
LAJKURA IIB	sec1S								
	sec2S						0.98	1.08	**2.06**
	sec3S						0.07	0.3	**0.37**
	sec4S				0.05	0.2	2.35	2.17	**4.77**
	sec5S					0.02	3.92	15	**18.94**
	sec6S						1.48	11.55	**13.03**
	sec7S					0.29	1.57	8.56	**10.42**
	sec8S					0.02	0.03	6.6	**6.65**
	TOTAL				**0.05**	**0.53**	**10.4**	**45.26**	**56.24**
LAJKURA I	sec1S								
	sec2S								
	sec3S						1.77	2.24	**4.01**
	sec4S						4.84	2.13	**6.97**
	sec5S					0.44	16.98	21.45	**38.87**
	sec6S					0.13	13.47	16.43	**30.03**
	sec7S					0.02	8.66	15.64	**24.32**
	sec8S						1.12	16.55	**17.67**
	TOTAL					**0.59**	**46.84**	**74.44**	**121.87**
RAMPUR V	sec1S								
	sec2S								
	sec3S								
	sec4S			0.04	0.07	0.23	2	0.02	**2.36**
	sec5S				0.14	1.31	3.41	1.23	**6.09**
	sec6S					0.08	3.4	4.53	**8.01**
	sec7S					0.18	3.05	7.56	**10.79**
	sec8S					0.19	1.95	8.09	**10.23**
	TOTAL			**0.04**	**0.21**	**1.99**	**13.81**	**21.43**	**37.48**
RAMPUR IV	sec1S								
	sec2S								
	sec3S								
	sec4S					0.13	3.11	2.03	**5.27**
	sec5S						5.28	27.69	**32.97**
	sec6S					0.06	7.87	13.17	**21.1**
	sec7S					0.03	4.55	12.82	**17.4**
	sec8S						6.94	11.02	**17.96**
	TOTAL					**0.22**	**27.75**	**66.73**	**94.7**
RAMPUR IVB	sec1S								
	sec2S								
	sec3S								
	sec4S						0.28	0.14	**0.42**
	sec5S					0.01	1	2.38	**3.39**
	sec6S					0.03	0.98	1.25	**2.26**
	sec7S					0.03	0.7	1.53	**2.26**
	sec8S				0.01	0.16	0.5	1.56	**2.23**
	TOTAL				**0.01**	**0.23**	**3.46**	**6.86**	**10.56**
RAMPUR III	sec1S								
	sec2S								
	sec3S								
	sec4S				0.07	1.44	0.74	0.08	**2.33**
	sec5S				0.95	13.21	3.6	0.11	**17.87**
	sec6S				0.73	8.64	4.02	0.01	**13.4**
	sec7S				0.2	6.87	10.86	0.08	**18.01**
	sec8S			0.02	1.69	9.73	8.31	0.17	**19.92**
	TOTAL			**0.02**	**3.64**	**39.89**	**27.53**	**0.45**	**71.53**
RAMPUR II	sec1S								
	sec2S								

SECTORWISE NET MINEABLE RESERVE (QUARRY-1)

		GRADE							Coal in Mt
		A	B	C	D	E	F	G	TOTAL
	sec3S								
	sec4S				0.04	0.22	0.15		**0.41**
	sec5S		0.03		1.52	2.33	1.3	0.41	**5.59**
	sec6S				0.73	1.33	0.63	0.08	**2.77**
	sec7S				0.86	0.91	0.9	0.18	**2.85**
	sec8S			0.32	0.85	1.81	0.55	0.12	**3.65**
	TOTAL		**0.03**	**0.32**	**4**	**6.6**	**3.53**	**0.79**	**15.27**
RAMPUR I	sec1S								
	sec2S								
	sec3S								
	sec4S				0.02	0.14	0.8		**0.96**
	sec5S				0.16	5.29	7.07	0.4	**12.92**
	sec6S					6.82	3.18	0.06	**10.06**
	sec7S					6.65	2.94	0.04	**9.63**
	sec8S				0.22	7.32	3.72	0.21	**11.47**
	TOTAL				**0.4**	**26.22**	**17.71**	**0.71**	**45.04**
IB TOP	sec1S								
	sec2S								
	sec3S								
	sec4S								
	sec5S								
	sec6S		0.03	0.1	0.21	0.21	0.11	0.05	**0.71**
	sec7S		0.09	0.21	0.43	0.12	0.01		**0.86**
	sec8S			0.2	0.72	0.48			**1.4**
	TOTAL		**0.12**	**0.51**	**1.36**	**0.81**	**0.12**	**0.05**	**2.97**
IB MIDDLE	sec1S								
	sec2S								
	sec3S								
	sec4S								
	sec5S	0.05	0.22	0.19	0.56	0.07			**1.09**
	sec6S	0.08	1.16	2.41	1.49				**5.14**
	sec7S		1.41	6.03	0.23	0.01			**7.68**
	sec8S		1.34	10.01	2.42	0.35			**14.12**
	TOTAL	**0.13**	**4.13**	**18.64**	**4.7**	**0.43**			**28.03**
IB BOTTOM	sec1S								
	sec2S								
	sec3S								
	sec4S								
	sec5S								
	sec6S		0.03	0.1	0.21	0.21	0.11	0.05	**0.71**
	sec7S		0.09	0.21	0.43	0.12	0.01		**0.86**
	sec8S			0.2	0.72	0.48			**1.4**
	TOTAL		**0.12**	**0.51**	**1.36**	**0.81**	**0.12**	**0.05**	**2.97**
TOTAL	sec1S					0.53	1.43		**1.96**
	sec2S		0.02	0.22	0.39	3.05	1.72	1.08	**6.48**
	sec3S			0.11	0.05	2.55	5.54	2.54	**10.79**
	sec4S			0.26	0.75	16.44	25.57	6.59	**49.61**
	sec5S	0.05	0.3	1.07	5.33	81.1	125.81	68.89	**282.55**
	sec6S	0.08	1.25	4.46	4.09	59.14	78.17	47.5	**194.69**
	sec7S		1.61	6.9	3.58	35.74	87.55	46.6	**181.98**
	sec8S		1.34	10.78	7.42	33.98	58.8	44.38	**156.7**
	TOTAL	**0.13**	**4.52**	**23.8**	**21.61**	**232.53**	**384.59**	**217.58**	**884.76**

Table - 5.05

SECTORWISE NET MINEABLE RESERVE (QUARRY-2)

		GRADE							Coal in Mt
		A	B	C	D	E	F	G	TOTAL
LAJKURA IV	sec1B					0.06	3.1	0.16	**3.32**
	sec2B						6.23	0.02	**6.25**
	sec3B					0.35	33.34	3.1	**36.79**
	sec4B					0.28	27.83	1.46	**29.57**
	sec5B						16.08	0.02	**16.1**
	TOTAL					**0.69**	**86.58**	**4.76**	**92.03**
LAJKURA III	sec1B				0.07	0.2	0.47		**0.74**
	sec2B					0.08	1.66		**1.74**
	sec3B					0.3	9.35	0.42	**10.07**
	sec4B					0.59	10.3	0.16	**11.05**
	sec5B					0.21	4.83		**5.04**
	TOTAL				**0.07**	**1.38**	**26.61**	**0.58**	**28.64**
LAJKURA IIT3	sec1B								
	sec2B				0.01	0.08			**0.09**
	sec3B					0.09	0.06		**0.15**
	sec4B				0.02	0.48	0.23	0.03	**0.76**
	sec5B					0.24	0.08		**0.32**
	TOTAL				**0.03**	**0.89**	**0.37**	**0.03**	**1.32**
LAJKURA IIT1	sec1B					0.53	7.31		**7.84**
	sec2B					1.44	5.35		**6.79**
	sec3B					9.39	48.42	1.49	**59.3**
	sec4B					7.22	54.88		**62.1**
	sec5B					3.91	34.73		**38.64**
	TOTAL					**22.49**	**150.69**	**1.49**	**174.67**
LAJKURA IIB	sec1B						0.06	1.7	**1.76**
	sec2B							2.74	**2.74**
	sec3B						0.23	14.29	**14.52**
	sec4B							16.4	**16.4**
	sec5B							8.84	**8.84**
	TOTAL						**0.29**	**43.97**	**44.26**
LAJKURA I	sec1B					0.06	2.24	0.42	**2.72**
	sec2B						1.22	1.48	**2.7**
	sec3B					0.09	11.91	11.16	**23.16**
	sec4B					0.21	15.99	9.64	**25.84**
	sec5B					0.02	11.8	4.59	**16.41**
	TOTAL					**0.38**	**43.16**	**27.29**	**70.83**
RAMPUR V	sec1B					0.23	0.34	0.4	**0.97**
	sec2B					0.02	0.1	0.12	**0.24**
	sec3B					0.01	1.88	2.44	**4.33**
	sec4B				0.03	0.79	4.51	5.03	**10.36**
	sec5B					1.34	2.88	5.39	**9.61**
	TOTAL				**0.03**	**2.39**	**9.71**	**13.38**	**25.51**
RAMPUR IV	sec1B						0.37	4.42	**4.79**
	sec2B						0.3	1.37	**1.67**
	sec3B						0.74	16.96	**17.7**
	sec4B					0.05	0.63	30.8	**31.48**
	sec5B						1.07	37.99	**39.06**
	TOTAL					**0.05**	**3.11**	**91.54**	**94.7**
RAMPUR IVB	sec1B						0.01	0.45	**0.46**
	sec2B						0.01	0.11	**0.12**

SECTORWISE NET MINEABLE RESERVE (QUARRY-2)

		GRADE							Coal in Mt
		A	B	C	D	E	F	G	TOTAL
	sec3B						0.01	1.21	**1.22**
	sec4B						0.05	2.79	**2.84**
	sec5B					0.01	0.09	3.33	**3.43**
	TOTAL					**0.01**	**0.17**	**7.89**	**8.07**
RAMPUR III	sec1B					1.29	0.51		**1.8**
	sec2B				0.01	1.17	0.68	0.01	**1.87**
	sec3B					1.45	3.17	0.28	**4.9**
	sec4B				0.31	5.95	11.27	0.61	**18.14**
	sec5B				0.22	10.66	9.89		**20.77**
	TOTAL				**0.54**	**20.52**	**25.52**	**0.9**	**47.48**
RAMPUR II	sec1B				0.32	0.5	0.13		**0.95**
	sec2B				0.15	0.26	0.06		**0.47**
	sec3B			0.1	1.25	1.17	0.33	0.09	**2.94**
	sec4B			0.51	4.51	1.37	0.27	0.03	**6.69**
	sec5B		0.03	1.72	5.89	2.56	0.09		**10.29**
	TOTAL		**0.03**	**2.33**	**12.12**	**5.86**	**0.88**	**0.12**	**21.34**
RAMPUR I	sec1B				0.04	1.14	0.6		**1.78**
	sec2B					0.51	0.29		**0.8**
	sec3B			0.04	0.52	4.43	1.47	0.12	**6.58**
	sec4B				0.21	9.91	2		**12.12**
	sec5B				0.02	16.12	3.44	0.04	**19.62**
	TOTAL			**0.04**	**0.79**	**32.11**	**7.8**	**0.16**	**40.9**
IB TOP	sec1B								
	sec2B								
	sec3B					0.3	0.29		**0.59**
	sec4B				0.21	0.57	0.25	0.04	**1.07**
	sec5B		0.03	0.19	0.8	1.38	0.4		**2.8**
	TOTAL		**0.03**	**0.19**	**1.01**	**2.25**	**0.94**	**0.04**	**4.46**
IB MIDDLE	sec1B								
	sec2B								
	sec3B								
	sec4B			0.04	0.32	0.36	0.07		**0.79**
	sec5B	0.01	0.3	3.41	1.65	0.53	0.14	0.02	**6.06**
	TOTAL	**0.01**	**0.3**	**3.45**	**1.97**	**0.89**	**0.21**	**0.02**	**6.85**
IB BOTTOM	sec1B								
	sec2B								
	sec3B				0.01	0.05	0.01		**0.07**
	sec4B	0.01	0.04	0.12	0.27	0.23	0.1		**0.77**
	sec5B		0.16	0.2	0.41	0.26	0.12	0.01	**1.16**
	TOTAL	**0.01**	**0.2**	**0.32**	**0.69**	**0.54**	**0.23**	**0.01**	**2**
TOTAL	sec1B				0.43	4.01	15.14	7.55	**27.13**
	sec2B				0.17	3.56	15.9	5.85	**25.48**
	sec3B			0.14	1.78	17.63	111.21	51.56	**182.32**
	sec4B	0.01	0.04	0.67	5.88	28.01	128.38	66.99	**229.98**
	sec5B	0.01	0.52	5.52	8.99	37.24	85.64	60.23	**198.15**
	TOTAL	**0.02**	**0.56**	**6.33**	**17.25**	**90.45**	**356.27**	**192.18**	**663.06**

Table - 5.06
MINEABLE RESERVE FOR COMBINED BLOCK

Coal in Mt

		A	B	C	D	E	F	G	TOTAL
LAJKURA IV	Q1	0	0	0	0.54	15.47	119.77	0.29	**136.07**
	Q2	0	0	0	0	0.69	86.58	4.76	**92.03**
	TOTAL	**0**	**0**	**0**	**0.54**	**16.16**	**206.35**	**5.05**	**228.1**
LAJKURA III	Q1	0	0	0	0.27	10.58	28.32	0	**39.17**
	Q2	0	0	0	0.07	1.38	26.61	0.58	**28.64**
	TOTAL	**0**	**0**	**0**	**0.34**	**11.96**	**54.93**	**0.58**	**67.81**
LAJKURA IIT3	Q1	0	0	0.04	0.28	6.01	4.86	0.14	**11.33**
	Q2	0	0	0	0.03	0.89	0.37	0.03	**1.32**
	TOTAL	**0**	**0**	**0.04**	**0.31**	**6.9**	**5.23**	**0.17**	**12.65**
LAJKURA IIT2	Q1	0	0.12	3.66	3.69	1.03	0.04	0	**8.54**
	Q2	0	0	0	0	0	0	0	**0**
	TOTAL	**0**	**0.12**	**3.66**	**3.69**	**1.03**	**0.04**	**0**	**8.54**
LAJKURA IIT1	Q1	0	0	0.06	1.1	121.12	80.33	0.38	**202.99**
	Q2	0	0	0	0	22.49	150.69	1.49	**174.67**
	TOTAL	**0**	**0**	**0.06**	**1.1**	**143.61**	**231.02**	**1.87**	**377.66**
LAJKURA IIB	Q1	0	0	0	0.05	0.53	10.4	45.26	**56.24**
	Q2	0	0	0	0	0	0.29	43.97	**44.26**
	TOTAL	**0**	**0**	**0**	**0.05**	**0.53**	**10.69**	**89.23**	**100.5**
LAJKURA I	Q1	0	0	0	0	0.59	46.84	74.44	**121.87**
	Q2	0	0	0	0	0.38	43.16	27.29	**70.83**
	TOTAL	**0**	**0**	**0**	**0**	**0.97**	**90**	**101.73**	**192.7**
RAMPUR V	Q1	0	0	0.04	0.21	1.99	13.81	21.43	**37.48**
	Q2	0	0	0	0.03	2.39	9.71	13.38	**25.51**
	TOTAL	**0**	**0**	**0.04**	**0.24**	**4.38**	**23.52**	**34.81**	**62.99**
RAMPUR IV	Q1	0	0	0	0	0.22	27.75	66.73	**94.7**
	Q2	0	0	0	0	0.05	3.11	91.54	**94.7**
	TOTAL	**0**	**0**	**0**	**0**	**0.27**	**30.86**	**158.27**	**189.4**
RAMPUR IVB	Q1	0	0	0	0.01	0.23	3.46	6.86	**10.56**
	Q2	0	0	0	0	0.01	0.17	7.89	**8.07**
	TOTAL	**0**	**0**	**0**	**0.01**	**0.24**	**3.63**	**14.75**	**18.63**
RAMPUR III	Q1	0	0	0.02	3.64	39.89	27.53	0.45	**71.53**
	Q2	0	0	0	0.54	20.52	25.52	0.9	**47.48**
	TOTAL	**0**	**0**	**0.02**	**4.18**	**60.41**	**53.05**	**1.35**	**119.01**
RAMPUR II	Q1	0	0.03	0.32	4	6.6	3.53	0.79	**15.27**
	Q2	0	0.03	2.33	12.12	5.86	0.88	0.12	**21.34**
	TOTAL	**0**	**0.06**	**2.65**	**16.12**	**12.46**	**4.41**	**0.91**	**36.61**
RAMPUR I	Q1	0	0	0	0.4	26.22	17.71	0.71	**45.04**
	Q2	0	0	0.04	0.79	32.11	7.8	0.16	**40.9**
	TOTAL	**0**	**0**	**0.04**	**1.19**	**58.33**	**25.51**	**0.87**	**85.94**
IB TOP	Q1	0	0.12	0.51	1.36	0.81	0.12	0.05	**2.97**
	Q2	0	0.03	0.19	1.01	2.25	0.94	0.04	**4.46**
	TOTAL	**0**	**0.15**	**0.7**	**2.37**	**3.06**	**1.06**	**0.09**	**7.43**
IB MIDDLE	Q1	0.13	4.13	18.64	4.7	0.43	0	0	**28.03**
	Q2	0.01	0.3	3.45	1.97	0.89	0.21	0.02	**6.85**
	TOTAL	**0.14**	**4.43**	**22.09**	**6.67**	**1.32**	**0.21**	**0.02**	**34.88**
IB BOTTOM	Q1	0	0.12	0.51	1.36	0.81	0.12	0.05	**2.97**
	Q2	0.01	0.2	0.32	0.69	0.54	0.23	0.01	**2**
	TOTAL	**0.01**	**0.32**	**0.83**	**2.05**	**1.35**	**0.35**	**0.06**	**4.97**
TOTAL	Q1	**0.13**	**4.52**	**23.8**	**21.61**	**232.53**	**384.59**	**217.58**	**884.76**
	Q2	**0.02**	**0.56**	**6.33**	**17.25**	**90.45**	**356.27**	**192.18**	**663.06**
	TOTAL	**0.15**	**5.08**	**30.13**	**38.86**	**322.98**	**740.86**	**409.76**	**1547.82**

Table - 5.07
QUARRYWISE OVERBURDEN & PARTING

	QUARRY-1	QUARRY-2	TOTAL
TOTAL TOP OB	**609.35**	**569.94**	**1179.1**
PART bet LAJ IV/ LAJ III	56.22	79.2	135.42
PART bet LAJ III/ LAJ IIT3	11.06	13.41	24.47
PART bet LAJ IIT3/ LAJ IIT2	10.43	11.5	21.93
PART bet LAJ IIT2/ LAJ IIT1	4.39	8.27	12.66
PART bet LAJ IIT1/ LAJ IIB	15.27	7.25	22.52
PART bet LAJ IIB/ LAJ I	19.04	17.19	36.23
PART bet LAJ I/ RAM V	301.4	308.99	610.39
PART bet RAM V/ RAM IV	12.71	9.05	21.76
PART bet RAM IV/ RAM IVB	8.06	10.26	18.32
PART bet RAM IVB/ RAM III	14.08	15.23	29.31
PART bet RAM III/ RAM II	14.72	5.44	20.16
PART bet RAM II/ RAM I	4.97	0.38	5.35
PART bet RAM I/ IB Top	15.69	15.15	30.84
PART bet IB Top/ IB Mid	14.65	8.24	22.89
PART bet IB Mid/ IB Bot	2.55	3.19	5.95
TOTAL PARTING	**505.24**	**512.75**	**1018.2**
Inseam Band LAJ IV	0.05	0.39	0.44
Inseam Band LAJ IIT1	0.76	1.76	2.52
Inseam Band LAJ IIB	0.79	0.52	1.31
Inseam Band LAJ I	10.2	13.52	23.73
Inseam Band RAM V	0.71	2.27	2.98
Inseam Band RAM IV	16.91	10.7	27.61
Inseam Band RAM III	0.51	0.27	0.78
Inseam Band RAM II	0.01		0.01
Inseam Band RAM I	0.13	0.12	0.25
Inseam Band IB BOT		0.08	0.08
TOTAL INSEAM BAND	**30.07**	**29.63**	**59.71**
UG/<1m LAJ III	0.02		0.03
UG/<1m LAJ IIT3	0.32	2.13	2.45
UG/<1m LAJ IIT2	1.37	1.38	2.75
UG/<1m LAJ IIB	0.25	0.55	0.8
UG/<1m RAM V	0.22	1.62	1.84
UG/<1m RAM IV	0.08	3.33	3.41
UG/<1m RAM IVB	0.49	0.74	1.23
UG/<1m RAM III		0.06	0.06
UG/<1m RAM II	0.15		0.15
TOTAL UG/<1m	**2.9**	**9.81**	**12.72**
TOTAL OVERBURDEN	**1147.56**	**1122.13**	**2269.69**
TOTAL COAL	**884.76**	**663.06**	**1547.82**
TOTAL SR	**1.3**	**1.69**	**1.47**

5.6 TARGET OUTPUT & MINE LIFE

The mine has been approved by CIL Board for normative production capacity of 40 Mty & peak capacity of 50 Mty. However now MCL desires to keep the production capacity at 50 Mty for all the years considering increased demand and favourable geo-mining conditions in the block.

ZERO DATE

The zero date may be defined as the date of approval of PR by CIL Board. Project report was approved on 29.05.2014. As per sanctioned project report and it's approval, mine should start production from 2019-20 considering 4 years for getting statutory approvals and process of initial land acquisition and R&R activities.

MINE LIFE

The mine life for is 38 years for the mine capacity of 50 Mty. The break-up is as under:

- Production build-up period of 8 years.
- Production period of 27 years.
- Tapering period of 3 years.
- Total period of 38 years.

5.7 FUTURE EXPANSION POTENTIAL

Prajapara coal block is located beyond southern block boundary of Siarmal and Banapatra block. In future this mine can be extended in the Prajapara area after the block is fully explored. Economic viability of extending the mine towards dipside block may be studied in detail in future due to occurrence of the coal seams at higher depth. Occurrence of hillock in this area may also be considered during expansion proposal.

5.8 No further boreholes are required at this stage in this block as the borehole density is adequate.

5.9 DETAILS OF SEQUENCE OF COAL SEAMS AND PARTING

In Siarmal & Siarmal Extension and Banapatra block total 16 nos. of corelatable coal horizons/seams have been identified. In the Karharbari Formation Ib seam occurs in three splits. Barakar Formation contains seams Rampur and Lajkura in number of splits.

Altogether, 13 nos. of seams / split seams are reported in Barakar Formation in this block. Among these, seam Rampur-I, II, III, IV, Lajkura-I, IIB, IIT1 and Lajkura-IV are the most potential thick coal horizons in this block. The sequence of coal seams within proposed mining area is given in Table 5.08 below:

Table 5.08(a)
Average effective thickness of seams

Seam	Thickness (in m.)	
	average	range
SEAM-LAJKURA-IV	12.92	1-17
PARTING	12.14	3-30
SEAM-LAJKURA-III	4.08	1-6
PARTING	2.19	1-7
SEAM-LAJKURA-II T3	1.51	1-3
PARTING	2.29	1-7
SEAM-LAJKURA-II T2	1.63	1-3
PARTING	2.04	1-8
SEAM-LAJKURA-II T1	21.04	14-27
PARTING	1.97	1-7
SEAM-LAJKURA-II B	5.75	2-12
PARTING	3.03	1-34
SEAM-LAJKURA-I	10.75	1-18
PARTING	52.79	31-95
SEAM-RAMPUR-V	4.53	1-8
PARTING	2.20	1-11
SEAM-RAMPUR-IV	13.27	4-18
PARTING	1.92	1-10
SEAM-RAMPUR-IVB	1.68	1-4
PARTING	2.72	1-8
SEAM-RAMPUR-III	8.02	2-12
PARTING	2.27	1-7
SEAM-RAMPUR-II	2.74	1-9
PARTING	2.71	1-9
SEAM-RAMPUR-I	5.99	1-15
PARTING	4.17	1-19
SEAM-IB TOP	1.68	1-7
PARTING	4.69	1-15
SEAM-IB MIDDLE	4.85	1-10
PARTING	2.87	1-15
SEAM-IB BOTTOM	1.69	1-4

5.10 DETAILS OF INSEAM BANDS

The coal seams, especially Rampur and Lajkura, are highly interbanded. Due to occurrence of dirt bands in large numbers, there was difficulty in assigning roof and floor and also the in-seam dirt bands of 1 metre and above in thickness.

Table 5.08(b)

Seam	Inseam band Thickness (in m.)	
	average	range
SEAM-LAJKURA-IV	1.93	1-4
SEAM-LAJKURA-II T1	1.69	1-7
SEAM-LAJKURA-IIB	1.72	1-4
SEAM-LAJKURA-I	2.53	1-15
SEAM-RAMPUR-V	1.29	1-3
SEAM-RAMPUR-IV	3.20	1-10
SEAM-RAMPUR-III	1.69	1-7
SEAM-RAMPUR-I	1.54	1-7

5.11 BASIC MINE PARAMETERS

Following table shows broad mining parameters of the proposed mine:

Table 5.09
Mining Parameters

Sl.	Particulars	Unit	Q-1	Q-2	Total
1	Quarry floor area	ha	559.00	489.40	1048.40
2	Quarry surface area	ha	877.77	668.55	1546.32
3	Mineable reserve	Mt	884.76	663.06	1547.82
4	Overburden	Mcum	1147.56	1122.13	2269.69
5	Stripping ratio*	cum/t	1.30	1.69	1.47
6	No. of workable seams/ sections	No.	16	16	16
7	Annual capacity	Mt			50
8	Life (including 2 years of construction period)	Years	24	18	38
9	Average seam gradient	Degrees	3.7	4.4	
10	Strike length(along floor)				
	Maximum	m	2750	3200	5950
	Minimum	m	2200	1400	3600
11	Strike length(along surface)				
	Maximum	m	3500	3500	7000
	Minimum	m	2600	1600	4200
12	Quarry depth				
	Maximum	m	335	360	
	Minimum	m	115	90	
13	Quarry perimeter	m			18385
14	Dip-rise length				
	Along floor	m	2300	2200	
	Along surface	m	2900	2800	

*** working stripping ratio will be around 1.63 cum/t considering 246.04 Mcum OB rehandling of temporary external dumping in quarry-2 area.**

5.12 MINING METHOD

The proposed mining block represents presence of moderately flat multiple coal seams with intermediate varying parting. Thick seams occur at shallow depth in wide area having power grade coal reserve. So this will make the project most viable by adopting opencast mining method.

5.13 CHOICE OF TECHNOLOGY

Different technologies like shovel-dumper mining, dragline mining, bucket wheel excavator mining and surface miner-payloader-truck mining are available for opencast mining. Sometimes combination of several methods of mining are adopted to suit particular type of mining situations.

For coal deposit in block under consideration, bucket wheel excavator mining is inapplicable due to multi-seam deposit, abrasive sandstone and hard carb-shale strata and many faults with varying throw and directions. The dragline system of mining has not been proposed as it makes the whole system very rigid in quantities and layout. Also, this is not applicable in multi-seam condition with varying seam and parting thickness and in presence of number of faults.

Shovel-dumper system is very flexible and also offers convenient mining operations to deal with sudden occurrences of unworkable or poor quality patches and change of floor position due to repeated faulting and varying seam gradient and thickness. It also offers flexibility for easy transition to any other technology or equipment configuration. The technology is well known and advantageous to get skilled manpower. So shovel-dumper mining method is adopted for overburden removal and partial coal extraction.

Surface-miner excavation is still limited to winning coal only. This method of mining by deploying outsourcing agencies has become very popular in Talcher & Ib valley coalfield. There are many advantages in this technology, of avoiding drilling, blasting, crushing of coal and related environmental hazards, improvement in grade of ROM coal by removing thin bands, clean surface for transport etc. Ideally, surface miners require working space of about 400 m length and about 50 m width for its optimum use. The high-wall angle required is comparatively flatter to shovel-dumper system. This bench geometry makes overall working angle flatter which will generate more overburden compared to shovel-dumper system if the seams are thin with thick intermediate parting. But as seams Lajkura-IV, IIT1, IIB, I and Rampur-IV, III, I are thick seams with number of bands, surface miner will be introduced in

these seams. Other thin seams and lower seams with thick intermediate partings will be worked by either surface miner or shovel-dumper system depending on geological and geotechnical conditions.

As the seam gradient is relatively flat (around 3^0 to 4^0), coal and the parting will be worked by parallel slicing method (working along seam floor) whereas top overburden and thick parting between Rampur and Lajkura seam will be removed by level slicing method.

5.14 EQUIPMENT SELECTION

Two variants have been prepared for working the proposed mine.

- **MINING OF OVERBURDEN AND COAL AND ALL OTHER ASSOCIATED ACTIVITIES BY DEPARTMENTAL MEANS.**
- **MINING OF OVERBURDEN AND COAL (DRILLING, EXTRACTION, LOADING AND TRANSPORTATION) AND MOST OTHER SUPPORTING ACTIVITIES (HAUL ROAD MAINTENANCE, PUMPING, LIGHTING etc.) WILL BE DONE BY OUTSOURCING MEANS.**

However the project report has been approved in outsourcing variant by CIL Board.

5.14.1 MINING OF OVERBURDEN AND COAL BY DEPARTMENTAL MEANS

In this variant it is assumed that all mining operations will be done by departmental equipments.

For better management and higher capacity utilization, large size excavators have been proposed. The compressive strength of overburden lies generally within 250-350 kg/cm^2 which can be easily drilled and blasted. Hydraulic shovels of high capacities are available from various manufacturers. When compared with rope shovels, they are better in maneuverability and have lesser cycle time. Their modular design enables achieving higher availability. They are also more useful for selective mining of bands and for wide variations in strata thicknesses.

Thin horizons of both coal and partings are proposed to be ripped, dozed and loaded by Front-End-Loaders on to tipping trucks provided in common category of equipment. Moderately thick horizons of overburden like 2m-10m are proposed to be excavated by 10-12 cum hydraulic shovels in combination with 100 T dumpers after proper drilling and blasting in overburden. These parting strata mostly occur between different coal

horizons within Rampur and Lajkura seam with varying thickness. Parting between Lajkura and Rampur seam is thick and consistent (31m-95m), this parting and thick top overburden will be removed by high capacity 20-23 hydraulic shovel with 190-200t rear dumper. The proposed sizes and combination will reduce congestion for such high capacity mining activity and increase the overall working angle which in turn maximizes the internal dump capacity. Electric rope shovels of similar size can also be deployed in this thick parting or top overburden and can be decided later.

It is observed that coal seam thickness varies from workable limit of 1 m to 27 m. surface miners along with higher size front end loader and 100t dumper will be introduced for extraction of coal from major seams. Surface miners of 3800mm drum dia are proposed to work in windrowing method as per present practice in Talcher & Ib valley coalfield, In windrowing mode the cut material is directly discharged behind the machine without using a conveyor. Therefore the cutting operation is independent from the truck loading operation. But the coal has to be loaded by the front end loader into the dump truck. For many reasons, the higher productivity in windrowing method compensates the rehandling cost. In addition, no belt wear and operating cost for conveyor will arise when working with windrowing mode of operation. Presently 3800 mm drum dia surface miner is only practiced in Indian coal mines and price and details of higher capacity 4200 mm drum dia machine is not available. At the time of procurement & starting of mine the surface miner size may be reviewed and it may be upgraded to 4200 mm drum dia with much higher productivity. If desired this system may be reviewed by surface miner-conveyor method directly loading onto dumper in future.

Grade and reserve has been assessed on I100 basis as per present practice, where bands of 1m or more are excluded from coal seam and bands less than 1m are included in the seam. But surface miner can selectively mine the bands which are less than 1m, so improvement in grade of coal is possible, coal quality, quantity and overburden volume as calculated for this block may also change with application of surface miner. Applicability of surface miner in intermediate coal band may be reviewed at a later date.

Coal production from thin seams can mostly be done by surface miner-loader-dumper system. Extraction by surface miner system or shovel-dumper system may vary as per geological conditions and technical problems by machines in different working conditions. More number of surface miner may be procured for extraction of coal seams instead of hydraulic shovel/backhoe provided depending on actual working conditions in the mine. 100 T dumpers working in coal will be fitted with higher body plates to utilize the dumper’s payload capacity.

Two types of drills have been proposed. 250 mm drills will be deployed for benches in thicker parting and top overburden, 160 mm drills will be deployed for thinner parting horizons.

Dozers of 850-870 HP and 410 HP have been proposed with ripper attachments. At places ripping-dozing and loading by front-end-loaders have to done be for thin seams/partings. Other supporting equipments like graders, cranes, tire-handler etc, of appropriate sizes have been provided.

Introduction of any new technology at a future date may be studied at that time for improved performance, productivity and safety in the mine.

5.14.2 MINING OF OVERBURDEN AND COAL BY OUTSOURCING AGENCIES

In this variant all the major activities involved in mining operations (DRILLING, EXTRACTION, LOADING AND TRANSPORTATION OF COAL AND OVERBURDEN) AND MOST OTHER SUPPORTING ACTIVITIES (HAUL ROAD MAINTENANCE, PUMPING, LAND RECLAMATION, WATER SPRINKLING, LIGHTING etc.) will be done by selected outsourcing agency/agencies. In this variant HEMM deployed by outsourcing for mining of coal and overburden should be similar to departmental option for operational efficiency and to avoid traffic congestion and environmental pollution. No major departmental HEMM has been provided in this variant. **This outsourcing variant has been sanctioned by CIL Board.**

5.15 MINING SYSTEM & SYSTEM PARAMETERS

Benches will be aligned along general strike. Bench floor should follow own seam floor/roof or that of adjacent seam. Main bench parameters for above mentioned equipments are:

Maximum bench height	:	10-12 m for 9-11/ 20-22 cum hydraulic face shovel and backhoe
Bench width	:	24-36 m for overburden/coal benches with 9-11 cum hydraulic shovels/backhoes.
	:	26-44m for overburden benches with 20-22cum hydraulic shovels.

Coal bench width will be kept at a minimum width of 50m for surface miner operations.

Working angle : 70^0 with horizontal for individual working bench

Again, bench dimensions may vary with different equipments deployed.

5.16 MINING STRATEGY

5.16.1 CONSTRAINTS ON MINE DEVELOPMENT

The proposed mining block is surrounded by Basundhara river and Chaturdhara nala towards its northern periphery and Chattajhor nala towards east. Strata is also dipping from north and north east towards south, so mining has to be started from area adjacent to the water body towards north-east corner of the block. Coal evacuation system and infrastructure have to be located near this area. **So major precautions are necessary to prevent inundation from initial stage of quarry operations.** Embankments all along Basundhara river/Chaturdhara nala towards north and Chattajhor nala towards east should be constructed during mining operation. Embankments should be constructed considering high flood level of the area. **(Ref plate no-MIN-II for plan showing mine position during production year-1)**

This geological block is basically dipside extension of Basundhara West mine towards north of this block separated by Basundhara river. So lot of coal will be blocked under embankment, slope and surface barrier towards north due to presence of river.

As the lower seams occur at a comparatively higher depth towards north of the block it requires a long access trench to reach mine floor for both the quarries, this necessitates delay in void generation in the mine and increases requirement of external dumping.

Coal deposit is likely to continue towards dipside beyond southern block boundary so the quarry and its dipside slope cannot be backfilled totally after completion of its operation, it results in unused void in dipside of quarry-1 and shortage in internal dumping capacity even in the later stage of mining.

5.16.2 SEQUENCE OF MINING

Total available area within quarry limits as described in earlier section will be mined. The total strike of the block is around 6.5-7km, so the mine is proposed to be worked in two quarry sections to improve operational efficiency, to reduce working lead and equipment population.

Quarry-1 or the eastern quarry will be started initially and total coal production will come from this quarry upto year20, from year21 coal production will start from Quarry-2 or the western quarry. Two quarries will be operated simultaneously from year21 to year24, quarry-1 will be exhausted in year24 and afterwards the total coal production will come from Quarry-2.

Opening of the deposit has been suggested from north eastern side of the block due to following reasons:

- Depth of lowermost seam is the minimum near north-east part of the combined block, length of access trench and time for mine development is comparatively less in this area.
- Occurrence of thick incrop of upper seams with shallow cover, initial stripping ratio will be minimum in this area.
- North eastern part of the block is relatively free from fault, the remaining northern periphery of the block is traversed by number of faults and is represented by a complicated structure. Strike between each of these faults is small and variation in dip, strike and gradient is observed. So initial access trench in this area makes it difficult to maintain such a high production.
- In the western and north western part coal is deep seated due to repeated faulting.
- Coal evacuation arrangement as per masterplan is towards north east part of the block on the northern side of Basundhara river, so it is preferred to open the mine from north east side of the block.

(Refer plate no- MIN-II,MIN-III,MIN-IV,MIN-V,MIN-VI,MIN-VII for plans showing mine positions during production year-1, year-3, year-5, year-10, year-18 and year-25 respectively)

ACCESS TRENCH

Initial mine opening will be near the incrop of Lajkura-III & IV seam. So an access trench will be started towards north of CMHG-179 and this will be driven towards south to touch the floor of the above mentioned seams, mine strike will initially be limited upto a width of 900-1000m towards west. Later this access trench will be turned towards north to touch the floor of lower seams, the mining operations will then be done towards up dip direction towards north. As the access trench is deepened towards north, the mine will also be deepened keeping the same working width. Initially as the mining operation is advanced towards north more and more lower seams will be exposed and excavated.

MINE DEVELOPMENT

In production year 3-4 the access trench will reach the floor of Lajkura-I seam and mining operation will be limited upto incrop of this seam in north eastern corner of the block, working width is kept within 1000m until the mine reaches floor of lower most workable seam in this area.

In production year 5 and year 6 mine will be extended towards west to increase its strike length and access trench will be further deepened. In year5 the access trench will reach the floor of Rampur-I seam which is the lowest workable seam in this area.

In production year9 mine will reach its target production of 50 Mty, after reaching northern most boundary, mine will now be extended towards both west and south. Full strike length of quarry-I will be exposed now and mine will be advanced towards dip direction. Coal receiving hoppers and sizers will be located on both surface at north-east corner of the block and intermediate bench. Coal will be transported from inpit coal receiving hoppers via belt conveyor to the surface.

When quarry-I is advanced towards north west it will encounter highly disturbed zone, floor of the seams are repeatedly faulted with much variation in strike due to uneven swing, in this area horizontal slicing method of mining may be adopted, backhoes and dozers will be used to excavate coals in the lower horizon where seam gradient is steep and working patch is narrower. From production year9 to year13 quarry-I will be worked in both western and southern area to maintain the level of production, main haul road will be laid on the floor of quarry and will be connected to the main access trench along eastern slope of the proposed mine adjoining Chattajhor nala.

In production year-20 another access trench will be started near CMBB-121 to open quarry-2, this is located just south of confluence point of Basundhara river and Chaturdhara nala. This access trench will touch the floor of Rampur-I seam, depth of floor of the seam at the bottom of the access trench is around 100m, length of access trench will be around 1.6 km. as the quarry is advanced towards south it will encounter thick incrop of Lajkura seam. From 21st year onwards coal will be produced from this quarry, initial build up from this quarry is kept less as mining has to be continued in the area where the seams are downthrown due to repeated faulting and due to low void generation.

From production year13 to year24, quarry-1 will be advanced towards further dipside in the south. During production year14-15 main access trench in this quarry will be realigned along eastern boundary, initially the access trench is driven towards south upto a level of 220m and then it will be realigned towards north to touch the seam floor in extreme north –east corner of the block, later when the mining will be advanced sufficiently towards south in production year14, access trench will be aligned directly towards south from level 220m to 150m in eastern batter itself and then it will be turned towards north upto quarry floor level of 60m . main haul road on the floor of the quarry will be connected to this access trench, portion of haul road on quarry floor beyond 60m level towards will be backfilled. Before doing this the coal blocked in Rampur seam in north-eastern corner where coal receiving hoppers are located should be decoaled. Coal receiving arrangement from this area will be relocated to the backfilled area of quarry-1 towards further west. While advancing quarry-2 towards dipside there will be some rehandling in common batter between quarry-1 & 2.

Quarry-I will be exhausted in year-24 and then onwards total coal production will be done from quarry-2. Access trench and haul road in quarry-2 will be maintained in the north-western batter of this quarry. The main haul road will touch the quarry floor at a level of 40m of Rampur-I seam (around 250 m depth), length of this haul road and access trench in the quarry batter will be around 4.75km. Afterwards this haul road will be aligned along quarry floor. Major part of coal will be transported from inpit coal receiving hopper via belt conveyor to the surface.

5.17 DUMPING STRATEGY

Minimum depth of the lowest quarriable seam in north-east corner of the quarry-1 is around 115m, so a long access trench is necessary to reach the quarry floor. It has been designed to develop the quarry initially with extraction of upper seams and simultaneously

deepening the quarry in the lower seams to maintain high rate of production, in this process access trench of the quarry will be developed to touch the bottommost quarry floor, so there will be no internal dumping during this period upto year9. After year9 as the mining in quarry-1 is extended towards both west and south some quantity of backfilling can be started, but the volume of void generation in the quarry will be much less compared to the volume of overburden generated due to following reasons.

- Presence of multiple faults and narrow working width between different faults in northern part/ rise side of the quarry requires sufficient advance in overburden benches.
- Much void space will be lost with increase in depth due to creation of different dump tiers to maintain overall dump slope of 260.
- Western slope cannot be filled upto surface to avoid high quantity of rehandling.
- Long access trench/haul road on eastern quarry batter has to be maintained during quarry operation, so this side of the quarry cannot be filled up upto end of mining operation in quarry-1. All these factors will lead to a situation of creation of low void generation.

Dip side of quarry-1 cannot be filled upto surface after completion of its operation due to continuation of coal seam in the dip side block. So lot of void at a high depth towards dipside will be unused, all these factors necessitate requirement of huge external dumping.

There is no non coal bearing area in the block or towards south in dipside, the block is surrounded by Basundhara river and Chatta jhor nala towards north and east respectively, so there is no favourable area for external dumping in close proximity. Only non coal bearing area is available towards north of existing Basundhara west OCP, this area has been already selected for power plant to be set up by Mahanadi Basin Power Corpoartion Ltd which is a subsidiary of MCL. So only the void in Basundhara West OCP can be filled up by some quantity of overburden from Siarmal OCP. But construction of a bridge over Basundhara river is necessary to transport overburden, this bridge should be capable of withstanding load of heavy duty 190t rear dumpers suggested for overburden transport. Construction of this bridge may take long time, considering this fact it is proposed to dump initial overburden towards dipside of quarry-2 towards south-western side. From year7 to year10 some dumping will also be done into the voids of Basundhara west OCP.

External Dump towards dipside of quarry-2 will accommodate 89.25 Mcum of overburden and external dumping in this area will continue upto 8th year. This dump will have to be rehandled while extending the mine operation towards dipside of the block after 38 years. Exploration in this dipside block should be completed before starting of external dumping. Economic viability of mining operations in the dipside block can be studied only after detailed exploration. From 7th year this same external dump will be extended towards north in the future quarry area of quarry-2 by overburden from quarry-1, around 193.85 Mcum of overburden of quarry -1 from year-7 to year14 will be dumped in mining area of quarry-2, this huge volume of overburden has to be rehandled while working quarry-2 in year29 to year38.

Backfilling in the quarry-1 will be started from year-10, simultaneous backfilling and external dumping will be done upto year18, from year19 there will be no external dumping and total overburden can be backfilled. From year12 to year18 external overburden will be located beyond southern boundary of quarry-1. This dump will have to be rehandled while extending the mine operation towards dipside of the block. Exploration in this dipside block should be completed before starting of external dumping. Economic viability of mining operations in the dipside block can be studied only after detailed exploration. Average height of all the external dumps will be around 82-85 m. care has been taken to accommodate external dump in the notified boundary of MCL.

It is proposed to complete the construction of heavy duty bridge over Basundhara river within year6 so that overburden from the mine can be transported beyond Basundhara river, the available void in Basundhara West OCP can be filled up by the overburden from Siarmal OCP in year7 to year10. Around 77.18 Mcum of overburden can be accommodated in exhausted Basundhara west OCP, some void towards dipside of this mine will not be filled for maintaining water reservoir considering scarcity of water in this area.

Refer plate no.MIN-VIII for final stage dump plan.

Average height of the external dump will be around 82-85 m. Details of external dumping and yearwise dumping schedule and are shown in following tables respectively.

Table 5.10

DETAILS OF DUMPING

Particulars	Quantity (in Mcum)	Top reduced level (in m)
BACKFILLING IN OWN QUARRY	2007.79	350
BACKFILLING IN BASUNDHARA WEST OCP	77.18	310
EXTERNAL DUMP	184.72	
EXTERNAL DUMP 1	89.25	390
EXTERNAL DUMP 2	93.96	380
EMBANKMENT	1.51	

Table 5.11
DUMPING SCHEDULE

	OB	INTERNAL	BACKFILLING IN	EXT DUMP	EXT DUMP1	EXT DUMP2	EMBANK-	TEMP. EXT	REHANDLING
YEAR	REMOVAL	DUMP	BASUNDHARA	(to be rehandled	(to be rehandled	(to be rehandled	-MENT	DUMP IN	OF EXT DUMP
				during expansion)	during expansion)	during expansion)		QUARRY-2	IN QUARRY-2
	(in Mcum)	(in Mcum)	(in Mcum)	(in Mcum)	(in Mcum)	(in Mcum)	(in Mcum)	(in Mcum)	(in Mcum)
1	3.73			3.73	3.38		0.35		
2	4.78			4.78	4.43		0.35		
3	4.78			4.78	4.38		0.40		
4	12.03			12.03	11.62		0.41		
5	23.87			23.87	23.87				
6	26.92			26.92	26.92				
7	37.22		17.22	20.00	10.00			10.00	
8	49.67		25.00	24.67	4.65			20.02	
9	60.00		25.00	35.00				35.00	
10	66.56	17.00	9.96	39.60				39.60	
11	66.56	25.00		41.56				41.56	
12	66.56	35.00		31.56		10.00		21.56	
13	65.59	40.00		25.59		10.00		15.59	
14	65.59	45.00		20.59		10.07		10.52	
15	66.56	50.00		16.56		16.56			
16	72.03	55.00		17.03		17.03			
17	77.50	60.00		17.50		17.50			
18	77.74	64.94		12.80		12.80			
19	77.74	77.74							
20	79.35	79.35							
21	51.76	51.76							
22	51.76	51.76							
23	58.56	58.56							
24	56.74	56.74							
25	89.60	89.60							
26	89.16	89.16							
27	94.62	94.62							
28	94.94	94.94							
29	89.45	112.86		-23.41					23.41
30	93.31	112.87		-19.56					19.56
31	93.29	112.86		-19.57					19.57
32	93.30	112.87		-19.57					19.57
33	87.08	110.60		-23.52					23.52
34	70.15	96.36		-26.21					26.21
35	67.95	94.15		-26.20					26.2
36	43.15	58.88		-15.73					15.73
37	35.26	45.74		-10.48					10.48
38	4.83	14.43		-9.60					9.6
TOTAL	**2269.69**	**2007.79**	**77.18**	**184.72**	**89.25**	**93.96**	**1.51**	**193.85**	**193.85**

External dump-1 & 2 (183.21 Mcum) are also temporary and will be rehandled back into quarry while extending the mine into dipside area.

5.18 DESIGN CRITERIA (VARIANT-I: DEPARTMENTAL VARIANT)

The following design criteria has been adopted for mining operations as per prevalent norms of mine design considered in CIL mine.

- No of annual working days : 330 days
- No of daily shifts : 3
- Duration of shift hours : 8

Excavation category:

- COAL : cat-III
- OVERBURDEN : 50% cat-III+50% cat-IV

Insitu volume weight:

- For coal : 1.68 t/cum
- For overburden : 2.4 t/cum

5.19 EQUIPMENT PRODUCTIVITY

Design parameters are same as approved standards of CMPDI. The annual productivities considered for excavators and dumpers for departmental variant are given below :

Table 5.12

EXCAVATOR PRODUCTIVITY

Equipment Configuration	Annual Productivity
In Overburden	
Hydraulic **Shovel(20-22 cum),** 22 cum bucket with 190 T Rear Dumper	5.47 Mcum
Hydraulic **Shovel(9-11 cum),** 9.5 cum bucket with 100 T Rear Dumper	2.45 Mcum
Hydraulic **Backhoe(8-11 cum),** 8.5 cum bucket with 100 T Rear Dumper	2.10 Mcum
In Coal	
Hydraulic **Shovel(9-11 cum),** 9.5 cum bucket with 100 T Rear Dumper	2.73 Mcum
Surface Miner 3000-3800mm drum dia*	2.08 Mcum

- Capacity of surface miner may vary according to drum diameter and method of working, productivity is assumed as per present practice of 900 ton per hour in windrowing mode as there is no existing CMPDI norm on productivity for surface miners. Capacity of surface miner may vary depending on working condition.

Capacity of hydraulic shovel may change depending on actual bucket capacity of the selected machine.

Table5.13

DUMPER PRODUCTIVITY

Figures in Mcum

Equipment Configuration /Lead(km)---→	3.00	3.25	3.50	3.75	4.00	4.50 km
In Overburden						
190 T with 22 cum Hydraulic Shovel	0.5803	0.5562	0.5348	0.5160	0.4990	0.4699
100 T with 9.5 cum Hydraulic Shovel	0.2982	0.2861	0.2753	0.2656	0.2571	0.2423
100 T with 8.5 cum Hydraulic backhoe	0.2906	0.2790	0.2687	0.2596	0.2514	0.2372
In Coal						
Lead(km)	**2.50**	**3.00**	**3.25**	**3.50**	**3.75**	**4.00**
100 T Coal Body with 9.5 cum Hydraulic Shovel	0.4004	0.3647	0.3502	0.3372	0.3257	0.3154
100 T Coal Body with 10 cum Front end loader	0.3613	0.3293	0.3162	0.3045	0.2942	0.2849

5.20 DRILLING AND BLASTING

Some part of coal (except the portion which will be extracted through surface miner) and overburden require drilling and blasting before excavation. It is proposed to deploy 250mm dia elect. RBH drills in top overburden. The partings between various seams are generally thin and the partings which are less than 2m thick may be ripped & dozed other partings may be drilled by using 160mm drills. In coal, 160mm dia elect. RBH drills are envisaged.

Total requirement of drills is assessed on 2 shift operation, physical deployment and productivity of drills. The annual productivity of drills adopted is given below:

250mm drills - 31,000m

160mm drills - 35,000m

The tentative blasting pattern in coal and overburden is given below in table.

Table 5.14

Description	Unit	Overburden		Coal
Bench height	m	15		10
Blasthole dia	mm	250	160	160
Spacing & burden	m	9 x 7.5	6 x 5	7 x 6

5.21 CALENDER PROGRAMME OF EXCAVTION

Detailed bench plans have been drawn for initial few years of mining operation, Total quarry area is divided into number of mining sectors showing bench positions of each coal seam and parting. All seams are calculated grade wise separately for each year/sector

using standard iso-chore-area method. Coal volumes for “ungraded”, “in-seam band” and “less-than-1m” criteria were added to respective overlying partings. Volumes of “Top overburden” and “Partings” were also calculated using same method. Standard factor for “geological loss” and “mining losses” as mentioned earlier were applied. Quantities of seamwise coal and stratawise overburden for different sectors are compiled in detail and are described in chapter5. Yearly production programme has been formulated based on these sectorwise quantities and sequence of operation. These detailed seamwise and stratawise production programme for quarry-1& quarry-2 are described in below Tables. Combined seam wise & stratawise programme is shown in Tables. Following is the summary of quarrywise total coal and overburden schedule:

Table5.15

PRODUCTION PROGRAMME (BOTH VARIANT)

	COAL(in Mt)			OB(in Mcum)			Stripping ratio
	Q1	Q2	TOTAL	Q1	Q2	TOTAL	(in cum/t)
1	1.50		**1.50**	3.73		**3.73**	***2.49***
2	4.00		**4.00**	4.78		**4.78**	***1.20***
3	7.00		**7.00**	4.78		**4.78**	***0.68***
4	10.00		**10.00**	12.03		**12.03**	***1.20***
5	15.00		**15.00**	23.87		**23.87**	***1.59***
6	22.00		**22.00**	26.92		**26.92**	***1.22***
7	30.00		**30.00**	37.22		**37.22**	***1.24***
8	40.00		**40.00**	49.67		**49.67**	***1.24***
9	50.00		**50.00**	60.00		**60.00**	***1.20***
10	50.00		**50.00**	66.56		**66.56**	***1.33***
11	50.00		**50.00**	66.56		**66.56**	***1.33***
12	50.00		**50.00**	66.56		**66.56**	***1.33***
13	50.00		**50.00**	65.59		**65.59**	***1.31***
14	50.00		**50.00**	65.59		**65.59**	***1.31***
15	50.00		**50.00**	66.56		**66.56**	***1.33***
16	50.00		**50.00**	72.03		**72.03**	***1.44***
17	50.00		**50.00**	77.50		**77.50**	***1.55***
18	50.00		**50.00**	77.74		**77.74**	***1.55***
19	50.00		**50.00**	77.74		**77.74**	***1.55***
20	50.00		**50.00**	76.90	2.45	**79.35**	***1.59***
21	49.00	1.00	**50.00**	49.55	2.21	**51.76**	***1.04***
22	46.00	4.00	**50.00**	44.08	7.68	**51.76**	***1.04***
23	42.00	8.00	**50.00**	40.51	18.05	**58.56**	***1.17***
24	18.26	31.74	**50.00**	11.09	45.65	**56.74**	***1.13***
25		50.00	**50.00**	0.00	89.60	**89.60**	***1.79***
26		50.00	**50.00**	0.00	89.16	**89.16**	***1.78***
27		50.00	**50.00**	0.00	94.62	**94.62**	***1.89***
28		50.00	**50.00**	0.00	94.94	**94.94**	***1.90***
29		50.00	**50.00**	0.00	89.45	**89.45**	***1.79***
30		50.00	**50.00**		93.31	**93.31**	***1.87***
31		50.00	**50.00**		93.29	**93.29**	***1.87***
32		50.00	**50.00**		93.30	**93.30**	***1.87***
33		50.00	**50.00**		87.08	**87.08**	***1.74***
34		50.00	**50.00**		70.15	**70.15**	***1.40***

35		50.00	**50.00**		67.95	**67.95**	***1.36***
36		30.00	**30.00**		43.15	**43.15**	***1.44***
37		20.00	**20.00**		35.26	**35.26**	***1.76***
38		18.32	**18.32**		4.83	**4.83**	***0.26***
TOTAL	**884.76**	**663.06**	**1547.82**	**1147.56**	**1122.13**	**2269.69**	***1.47***

* working stripping ratio will be around 1.63 cum/t considering 246.04 Mcum OB rehandling of temporary external dumping in quarry-2 area(details given table 5.19 & 5.21)

Major part of coal will be extracted by blast free method using surface miner, pay loader and truck depending on geological conditions.

PRODUCTION PROGRAMME (QUARRY-1)

Coal in Mt

TABLE 5.16

YEAR	TOTAL	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM
	COAL	**LAJ IV**	**LAJ III**	**LAJ IIT3**	**LAJ IIT2**	**LAJ IIT1**	LAJ IIB	LAJ I	RAM V	RAM IV	RAM IVB	RAM III	RAM II	RAM I	IBT	IBM	IBB
1	**1.50**	0.86	0.64														
2	**4.00**	0.27	0.19	0.15	0.15	2.11	1.13										
3	**7.00**	0.95	0.29	0.20	0.21	2.77	1.07	1.51									
4	**10.00**	2.20	0.67	0.19	0.19	2.47	0.54	2.96	0.16	0.35	0.03	0.15	0.03	0.06			
5	**15.00**	2.85	0.86	0.27	0.24	3.68	1.45	2.11	0.71	1.59	0.12	0.71	0.12	0.29			
6	**22.00**	4.17	1.26	0.39	0.35	5.41	2.11	3.09	1.05	2.34	0.19	1.03	0.18	0.43			
7	**30.00**	5.67	1.53	0.41	0.28	7.62	2.28	4.15	0.89	3.40	0.33	1.75	0.49	1.12		0.08	
8	**40.00**	7.56	1.93	0.47	0.26	10.28	2.69	5.50	0.86	4.67	0.48	2.53	0.79	1.83		0.15	
9	**50.00**	9.44	2.42	0.59	0.33	12.84	3.35	6.88	1.08	5.83	0.60	3.16	0.99	2.29		0.20	
10	**50.00**	9.45	2.42	0.59	0.32	12.85	3.35	6.88	1.07	5.84	0.60	3.16	0.99	2.29		0.19	
11	**50.00**	9.44	2.41	0.59	0.32	12.88	3.35	6.88	1.08	5.83	0.60	3.16	0.99	2.28		0.19	
12	**50.00**	9.45	2.42	0.59	0.33	12.81	3.35	6.88	1.08	5.84	0.60	3.17	0.99	2.29		0.20	
13	**50.00**	8.23	2.33	0.63	0.51	12.17	3.35	7.35	1.63	5.60	0.59	3.31	0.83	2.45	0.10	0.82	0.10
14	**50.00**	7.29	2.26	0.65	0.65	11.61	3.35	7.71	2.05	5.42	0.58	3.45	0.71	2.59	0.18	1.32	0.18
15	**50.00**	7.30	2.25	0.64	0.65	11.63	3.34	7.71	2.06	5.41	0.58	3.44	0.71	2.58	0.19	1.32	0.19
16	**50.00**	7.29	2.26	0.65	0.65	11.62	3.35	7.71	2.06	5.42	0.58	3.44	0.71	2.58	0.18	1.32	0.18
17	**50.00**	7.24	2.16	0.69	0.55	10.91	3.02	7.03	2.66	5.00	0.61	4.45	0.76	2.63	0.22	1.85	0.22
18	**50.00**	7.21	2.11	0.70	0.49	10.62	2.87	6.68	2.97	4.78	0.62	4.95	0.79	2.64	0.23	2.11	0.23
19	**50.00**	7.21	2.10	0.70	0.49	10.64	2.86	6.68	2.96	4.78	0.62	4.94	0.78	2.65	0.24	2.11	0.24
20	**50.00**	7.14	2.09	0.69	0.49	10.58	2.84	6.65	2.97	4.81	0.62	4.99	0.79	2.68	0.24	2.18	0.24
21	**49.00**	5.29	1.62	0.55	0.34	7.83	2.08	5.53	3.20	5.61	0.70	6.23	1.14	3.58	0.44	4.42	0.44
22	**46.00**	5.00	1.54	0.51	0.32	7.31	1.95	5.18	3.01	5.27	0.65	5.85	1.08	3.37	0.41	4.14	0.41
23	**42.00**	4.56	1.41	0.48	0.29	6.65	1.79	4.74	2.74	4.82	0.60	5.34	0.97	3.07	0.38	3.78	0.38
24	**18.26**				0.13	5.70	0.77	2.06	1.19	2.09	0.26	2.32	0.43	1.34	0.16	1.65	0.16
TOTAL	**884.76**	**136.07**	**39.17**	**11.33**	**8.54**	**202.99**	**56.24**	**121.87**	**37.48**	**94.70**	**10.56**	**71.53**	**15.27**	**45.04**	**2.97**	**28.03**	**2.97**

PRODUCTION PROGRAMME (QUARRY-1)

OB in Mcum

Table 5.17

YEAR	TOTAL	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	TOTAL	BAND	TOP	TOTAL	STRIPPING
	COAL	LIV/III	LIII/IIT3	LIIT3/IIT2	LIIT2/IIT1	LIIT1/IIB	LIIB/I	L1/RAM V	RAM V/IV	RAM IV/IVB	RAM IVB/III	RAM III/II	RAM II/I	RAM I/IBT	IBT/IBM	IBM/IBB	PARTING		OB	OB	RATIO(cum/t)
1	**1.50**	0.36															0.36		3.37	**3.73**	**2.49**
2	**4.00**	0.11	0.10	0.09	0.03	0.24											0.57	0.11	4.10	**4.78**	**1.20**
3	**7.00**	0.23	0.17	0.13	0.06	0.22	0.39										1.20	0.36	3.22	**4.78**	**0.68**
4	**10.00**	0.52	0.19	0.12	0.08	0.12	0.47	2.08	0.09	0.03	0.04	0.04	0.04				3.82	0.62	7.59	**12.03**	**1.20**
5	**15.00**	0.68	0.23	0.15	0.20	0.32	0.37	9.21	0.41	0.14	0.21	0.15	0.22				12.29	0.73	10.85	**23.87**	**1.59**
6	**22.00**	0.99	0.33	0.21	0.28	0.46	0.53	13.63	0.60	0.21	0.29	0.23	0.32				18.08	1.09	7.75	**26.92**	**1.22**
7	**30.00**	1.85	0.44	0.46	0.29	0.56	0.75	12.43	0.68	0.31	0.45	0.36	0.20		0.10		18.88	1.29	17.05	**37.22**	**1.24**
8	**40.00**	2.77	0.60	0.73	0.32	0.71	1.01	12.84	0.83	0.41	0.62	0.50	0.14		0.19		21.67	1.59	26.41	**49.67**	**1.24**
9	**50.00**	3.48	0.74	0.94	0.41	0.88	1.25	16.12	1.03	0.52	0.77	0.62	0.18		0.26		27.20	2.00	30.80	**60.00**	**1.20**
10	**50.00**	3.47	0.74	0.90	0.40	0.89	1.26	15.98	1.04	0.52	0.77	0.63	0.17		0.24		27.01	1.98	37.57	**66.56**	**1.33**
11	**50.00**	3.46	0.75	0.91	0.41	0.88	1.26	16.12	1.03	0.52	0.78	0.62	0.18		0.24		27.16	2.29	37.11	**66.56**	**1.33**
12	**50.00**	3.47	0.74	0.93	0.40	0.88	1.26	16.12	1.04	0.52	0.77	0.63	0.17		0.26		27.19	2.05	37.32	**66.56**	**1.33**
13	**50.00**	3.58	0.71	0.67	0.29	0.90	1.13	17.17	0.85	0.49	0.78	0.79	0.18	2.99	1.08	0.13	31.74	1.91	31.94	**65.59**	**1.31**
14	**50.00**	3.63	0.68	0.47	0.18	0.89	1.02	18.04	0.71	0.47	0.79	0.92	0.19	1.08	1.74	0.22	31.03	1.79	32.77	**65.59**	**1.31**
15	**50.00**	3.57	0.68	0.47	0.19	0.90	1.03	18.00	0.70	0.47	0.78	0.92	0.18	1.12	1.77	0.24	31.02	1.83	33.71	**66.56**	**1.33**
16	**50.00**	3.63	0.67	0.47	0.19	0.90	1.03	18.04	0.71	0.47	0.78	0.92	0.18	1.10	1.73	0.22	31.04	1.80	39.19	**72.03**	**1.44**
17	**50.00**	3.71	0.62	0.46	0.08	0.86	0.89	17.92	0.54	0.46	0.82	0.83	0.34	1.00	1.29	0.10	29.92	1.65	45.93	**77.50**	**1.55**
18	**50.00**	3.70	0.59	0.44	0.02	0.84	0.82	17.81	0.46	0.47	0.84	0.79	0.40	0.96	1.04	0.20	29.38	1.58	46.78	**77.74**	**1.55**
19	**50.00**	3.71	0.59	0.45	0.03	0.84	0.81	17.82	0.46	0.47	0.83	0.78	0.43	0.95	1.08	0.21	29.46	1.57	46.71	**77.74**	**1.55**
20	**50.00**	3.63	0.58	0.44	0.02	0.84	0.83	17.71	0.45	0.46	0.83	0.80	0.41	0.98	1.06	0.21	29.25	1.59	46.06	**76.90**	**1.54**
21	**49.00**	2.02	0.29	0.31	0.16	0.68	0.92	13.99	0.34	0.35	0.93	1.32	0.33	1.74	0.81	0.38	24.57	1.62	23.36	**49.55**	**1.01**
22	**46.00**	1.88	0.27	0.30	0.15	0.63	0.87	13.14	0.32	0.34	0.87	1.24	0.31	1.63	0.76	0.36	23.07	1.54	19.47	**44.08**	**0.96**
23	**42.00**	1.77	0.24	0.26	0.14	0.58	0.80	12.02	0.29	0.30	0.78	1.14	0.28	1.49	0.70	0.33	21.12	1.38	18.01	**40.51**	**0.96**
24	**18.26**		0.11	0.12	0.06	0.25	0.34	5.21	0.13	0.13	0.35	0.49	0.12	0.65	0.30	0.14	8.40	0.60	2.09	**11.09**	**0.61**
TOTAL	**884.76**	**56.22**	**11.06**	**10.43**	**4.39**	**15.27**	**19.04**	**301.40**	**12.71**	**8.06**	**14.08**	**14.72**	**4.97**	**15.69**	**14.65**	**2.74**	**505.43**	**32.97**	**609.16**	**1147.56**	**1.30**

PRODUCTION PROGRAMME (QUARRY-2)

Coal in Mt

TABLE 5.18

YEAR	TOTAL	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM
	COAL	**LAJ IV**	**LAJ III**	**LAJ IIT3**	**LAJ IIT1**	LAJ IIB	LAJ I	RAM V	RAM IV	RAM IVB	RAM III	RAM II	RAM I	IBT	IBM	IBB
20																
21	**1.00**	0.12	0.03		0.27	0.06	0.10	0.04	0.18	0.02	0.07	0.04	0.07			
22	**4.00**	0.49	0.11		1.18	0.26	0.40	0.14	0.70	0.06	0.26	0.14	0.26			
23	**8.00**	0.98	0.21		2.32	0.52	0.80	0.28	1.42	0.14	0.53	0.28	0.52			
24	**31.74**	6.05	1.59	0.06	8.78	2.81	3.29	0.68	3.64	0.32	2.23	0.81	1.48			
25	**50.00**	10.43	2.87	0.06	15.78	4.21	6.18	1.07	4.61	0.32	1.71	0.83	1.77	0.14		0.02
26	**50.00**	10.09	2.76	0.05	16.24	3.98	6.35	1.19	4.85	0.34	1.35	0.81	1.81	0.16		0.02
27	**50.00**	10.09	2.76	0.04	16.29	3.98	6.35	1.19	4.86	0.33	1.34	0.80	1.80	0.16		0.01
28	**50.00**	9.37	2.69	0.06	15.73	3.90	6.21	1.39	5.24	0.39	1.85	0.94	1.97	0.18	0.03	0.05
29	**50.00**	6.43	2.40	0.17	13.48	3.57	5.62	2.25	6.85	0.62	3.95	1.45	2.63	0.23	0.18	0.17
30	**50.00**	6.43	2.41	0.16	13.50	3.56	5.62	2.26	6.84	0.62	3.94	1.45	2.64	0.23	0.17	0.17
31	**50.00**	6.43	2.40	0.17	13.49	3.57	5.62	2.25	6.85	0.61	3.95	1.46	2.63	0.23	0.17	0.17
32	**50.00**	6.43	2.40	0.16	13.53	3.56	5.61	2.25	6.84	0.62	3.94	1.45	2.64	0.24	0.17	0.16
33	**50.00**	5.01	1.73	0.12	11.26	2.77	4.74	2.36	8.64	0.77	4.72	2.14	4.01	0.51	0.98	0.24
34	**50.00**	4.07	1.27	0.08	9.74	2.23	4.14	2.42	9.86	0.86	5.24	2.60	4.95	0.71	1.53	0.30
35	**50.00**	4.06	1.27	0.08	9.76	2.23	4.14	2.43	9.85	0.87	5.24	2.59	4.96	0.70	1.53	0.29
36	**30.00**	3.23	1.04	0.07	4.74	1.34	2.49	1.45	5.92	0.52	3.14	1.56	2.97	0.43	0.92	0.18
37	**20.00**	2.32	0.70	0.04	3.03	0.89	1.65	0.97	3.94	0.34	2.10	1.04	1.98	0.28	0.61	0.11
38	**18.32**				5.55	0.82	1.52	0.89	3.61	0.32	1.92	0.95	1.81	0.26	0.56	0.11
TOTAL	**663.06**	**92.03**	**28.64**	**1.32**	**174.67**	**44.26**	**70.83**	**25.51**	**94.70**	**8.07**	**47.48**	**21.34**	**40.90**	**4.46**	**6.85**	**2.00**

PRODUCTION PROGRAMME (QUARRY-2)

OB in Mcum

Table 5.19

YEAR	TOTAL	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	TOTAL	BAND	TOP	TOTAL	STRIPPING	REHANDLING
	COAL	LIV/III	LIII/IIT3	LIIT3/IIT2	LIIT2/IIT1	LIIT1/IIB	LIIB/I	L1/RAM V	RAM V/IV	RAM IV/IVB	RAM IVB/II	RAM III/II	RAM II/I	RAM I/IBT	IBT/IBM	IBM/IBB	PARTING		OB	OB	RATIO	
20																			**2.45**	**2.45**		
21	**1.00**	0.05			0.01	0.01	0.03	0.34	0.03	0.04	0.03	0.01					0.55	0.05	**1.61**	**2.21**	**2.21**	
22	**4.00**	0.19			0.04	0.02	0.11	1.18	0.09	0.11	0.11	0.03					1.88	0.18	**5.62**	**7.68**	**1.92**	
23	**8.00**	0.36			0.09	0.06	0.23	2.36	0.20	0.26	0.23	0.07					3.86	0.38	**13.81**	**18.05**	**2.26**	
24	**31.74**	2.50	0.66	0.79	0.49	0.31	1.32	9.46	0.44	0.55	0.54	0.19					17.25	1.39	**27.01**	**45.65**	**1.44**	1.46
25	**50.00**	7.90	1.14	0.74	0.98	0.68	1.66	16.78	0.51	0.40	0.61	0.22	0.02	0.28		0.11	32.03	2.24	**55.33**	**89.60**	**1.79**	6.51
26	**50.00**	8.39	1.56	0.83	0.99	0.70	1.48	17.45	0.57	0.42	0.63	0.22	0.02	0.31		0.12	33.69	2.42	**53.05**	**89.16**	**1.78**	6.95
27	**50.00**	8.38	1.24	0.67	0.99	0.71	1.49	17.45	0.56	0.41	0.64	0.22	0.01	0.32		0.06	33.15	2.33	**59.14**	**94.62**	**1.89**	6.96
28	**50.00**	8.13	1.13	0.69	0.91	0.67	1.46	19.65	0.62	0.52	0.74	0.25	0.03	0.44	0.04	0.16	35.44	2.52	**56.98**	**94.94**	**1.90**	6.64
29	**50.00**	7.04	1.15	1.10	0.63	0.57	1.39	29.27	0.87	0.93	1.15	0.41	0.07	0.84	0.23	0.25	45.90	3.42	**40.13**	**89.45**	**1.79**	28.79
30	**50.00**	7.07	1.08	1.04	0.63	0.56	1.39	29.40	0.87	0.93	1.15	0.41	0.07	0.83	0.22	0.26	45.91	3.38	**44.02**	**93.31**	**1.87**	24.93
31	**50.00**	7.04	1.15	1.10	0.63	0.57	1.38	29.27	0.88	0.92	1.16	0.41	0.07	0.84	0.21	0.26	45.89	3.42	**43.98**	**93.29**	**1.87**	24.95
32	**50.00**	7.03	1.09	1.04	0.63	0.56	1.39	29.26	0.87	0.93	1.15	0.40	0.06	0.87	0.22	0.24	45.74	3.38	**44.18**	**93.30**	**1.87**	24.94
33	**50.00**	4.70	0.90	0.93	0.40	0.47	1.06	26.22	0.68	0.90	1.47	0.54	0.03	1.84	1.18	0.35	41.67	3.34	**42.07**	**87.08**	**1.74**	25.69
34	**50.00**	3.09	0.68	0.76	0.25	0.40	0.83	23.99	0.55	0.87	1.67	0.61		2.56	1.82	0.42	38.50	3.27	**28.38**	**70.15**	**1.40**	26.21
35	**50.00**	3.09	0.69	0.76	0.26	0.41	0.83	24.09	0.55	0.88	1.67	0.61		2.52	1.83	0.40	38.59	3.27	**26.09**	**67.95**	**1.36**	26.20
36	**30.00**	2.54	0.60	0.67	0.15	0.24	0.50	14.38	0.34	0.52	1.00	0.37		1.55	1.09	0.25	24.20	2.03	**11.92**	**38.15**	**1.27**	20.73
37	**20.00**	1.70	0.34	0.38	0.10	0.16	0.33	9.62	0.22	0.35	0.67	0.25		1.01	0.73	0.16	16.02	1.32	**13.32**	**30.66**	**1.53**	15.08
38	**18.32**				0.09	0.15	0.31	8.82	0.20	0.32	0.61	0.22		0.94	0.67	0.15	12.48	1.10	**0.85**	**14.43**	**0.79**	
TOTAL	**663.06**	**79.20**	**13.41**	**11.50**	**8.27**	**7.25**	**17.19**	**308.99**	**9.05**	**10.26**	**15.23**	**5.44**	**0.38**	**15.15**	**8.24**	**3.19**	**512.75**	**39.44**	**569.94**	**1122.13**	**1.69**	**246.04**

PRODUCTION PROGRAMME (TOTAL QUARRY)

Coal in Mt

TABLE 5.20

YEAR	TOTAL	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM	SEAM
	COAL	**LAJ IV**	**LAJ III**	**LAJ IIT3**	**LAJ IIT2**	**LAJ IIT1**	LAJ IIB	LAJ I	RAM V	RAM IV	RAM IVB	RAM III	RAM II	RAM I	IBT	IBM	IBB
1	**1.50**	0.86	0.64														
2	**4.00**	0.27	0.19	0.15	0.15	2.11	1.13										
3	**7.00**	0.95	0.29	0.20	0.21	2.77	1.07	1.51									
4	**10.00**	2.20	0.67	0.19	0.19	2.47	0.54	2.96	0.16	0.35	0.03	0.15	0.03	0.06			
5	**15.00**	2.85	0.86	0.27	0.24	3.68	1.45	2.11	0.71	1.59	0.12	0.71	0.12	0.29			
6	**22.00**	4.17	1.26	0.39	0.35	5.41	2.11	3.09	1.05	2.34	0.19	1.03	0.18	0.43			
7	**30.00**	5.67	1.53	0.41	0.28	7.62	2.28	4.15	0.89	3.40	0.33	1.75	0.49	1.12		0.08	
8	**40.00**	7.56	1.93	0.47	0.26	10.28	2.69	5.50	0.86	4.67	0.48	2.53	0.79	1.83		0.15	
9	**50.00**	9.44	2.42	0.59	0.33	12.84	3.35	6.88	1.08	5.83	0.60	3.16	0.99	2.29		0.20	
10	**50.00**	9.45	2.42	0.59	0.32	12.85	3.35	6.88	1.07	5.84	0.60	3.16	0.99	2.29		0.19	
11	**50.00**	9.44	2.41	0.59	0.32	12.88	3.35	6.88	1.08	5.83	0.60	3.16	0.99	2.28		0.19	
12	**50.00**	9.45	2.42	0.59	0.33	12.81	3.35	6.88	1.08	5.84	0.60	3.17	0.99	2.29		0.20	
13	**50.00**	8.23	2.33	0.63	0.51	12.17	3.35	7.35	1.63	5.60	0.59	3.31	0.83	2.45	0.10	0.82	0.10
14	**50.00**	7.29	2.26	0.65	0.65	11.61	3.35	7.71	2.05	5.42	0.58	3.45	0.71	2.59	0.18	1.32	0.18
15	**50.00**	7.30	2.25	0.64	0.65	11.63	3.34	7.71	2.06	5.41	0.58	3.44	0.71	2.58	0.19	1.32	0.19
16	**50.00**	7.29	2.26	0.65	0.65	11.62	3.35	7.71	2.06	5.42	0.58	3.44	0.71	2.58	0.18	1.32	0.18
17	**50.00**	7.24	2.16	0.69	0.55	10.91	3.02	7.03	2.66	5.00	0.61	4.45	0.76	2.63	0.22	1.85	0.22
18	**50.00**	7.21	2.11	0.70	0.49	10.62	2.87	6.68	2.97	4.78	0.62	4.95	0.79	2.64	0.23	2.11	0.23
19	**50.00**	7.21	2.10	0.70	0.49	10.64	2.86	6.68	2.96	4.78	0.62	4.94	0.78	2.65	0.24	2.11	0.24
20	**50.00**	7.14	2.09	0.69	0.49	10.58	2.84	6.65	2.97	4.81	0.62	4.99	0.79	2.68	0.24	2.18	0.24
21	**50.00**	5.41	1.65	0.55	0.34	8.10	2.14	5.63	3.24	5.79	0.72	6.30	1.18	3.65	0.44	4.42	0.44
22	**50.00**	5.49	1.65	0.51	0.32	8.49	2.21	5.58	3.15	5.97	0.71	6.11	1.22	3.63	0.41	4.14	0.41
23	**50.00**	5.54	1.62	0.48	0.29	8.97	2.31	5.54	3.02	6.24	0.74	5.87	1.25	3.59	0.38	3.78	0.38
24	**50.00**	6.05	1.59	0.06	0.13	14.48	3.58	5.35	1.87	5.73	0.58	4.55	1.24	2.82	0.16	1.65	0.16
25	**50.00**	10.43	2.87	0.06		15.78	4.21	6.18	1.07	4.61	0.32	1.71	0.83	1.77	0.14		0.02
26	**50.00**	10.09	2.76	0.05		16.24	3.98	6.35	1.19	4.85	0.34	1.35	0.81	1.81	0.16		0.02
27	**50.00**	10.09	2.76	0.04		16.29	3.98	6.35	1.19	4.86	0.33	1.34	0.80	1.80	0.16		0.01
28	**50.00**	9.37	2.69	0.06		15.73	3.90	6.21	1.39	5.24	0.39	1.85	0.94	1.97	0.18	0.03	0.05
29	**50.00**	6.43	2.40	0.17		13.48	3.57	5.62	2.25	6.85	0.62	3.95	1.45	2.63	0.23	0.18	0.17
30	**50.00**	6.43	2.41	0.16		13.50	3.56	5.62	2.26	6.84	0.62	3.94	1.45	2.64	0.23	0.17	0.17
31	**50.00**	6.43	2.40	0.17		13.49	3.57	5.62	2.25	6.85	0.61	3.95	1.46	2.63	0.23	0.17	0.17
32	**50.00**	6.43	2.40	0.16		13.53	3.56	5.61	2.25	6.84	0.62	3.94	1.45	2.64	0.24	0.17	0.16
33	**50.00**	5.01	1.73	0.12		11.26	2.77	4.74	2.36	8.64	0.77	4.72	2.14	4.01	0.51	0.98	0.24
34	**50.00**	4.07	1.27	0.08		9.74	2.23	4.14	2.42	9.86	0.86	5.24	2.60	4.95	0.71	1.53	0.30
35	**50.00**	4.06	1.27	0.08		9.76	2.23	4.14	2.43	9.85	0.87	5.24	2.59	4.96	0.70	1.53	0.29
36	**30.00**	3.23	1.04	0.07		4.74	1.34	2.49	1.45	5.92	0.52	3.14	1.56	2.97	0.43	0.92	0.18
37	**20.00**	2.32	0.70	0.04		3.03	0.89	1.65	0.97	3.94	0.34	2.10	1.04	1.98	0.28	0.61	0.11
38	**18.32**					5.55	0.82	1.52	0.89	3.61	0.32	1.92	0.95	1.81	0.26	0.56	0.11
TOTAL	**1547.82**	**228.10**	**67.81**	**12.65**	**8.54**	**377.66**	**100.50**	**192.70**	**62.99**	**189.40**	**18.63**	**119.01**	**36.61**	**85.94**	**7.43**	**34.88**	**4.97**

PRODUCTION PROGRAMME (TOTAL QUARRY)

OB in Mcum

Table 5.21

YEAR	TOTAL	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	PART	TOTAL	BAND	TOP	TOTAL	STRIPPING	REHANDLE
	COAL	LIV/III	LIII/IIT3	LIIT3/IIT2	LIIT2/IIT1	LIIT1/IIB	LIIB/I	L1/RAM V	RAM V/IV	RAM IV/IVB	RAM IVB/III	RAM III/II	RAM II/I	RAM I/IBT	IBT/IBM	IBM/IBB	PARTING		OB	OB	RATIO	
1	**1.50**	0.36															0.36		**3.37**	**3.73**	**2.49**	
2	**4.00**	0.11	0.10	0.09	0.03	0.24											0.57	0.11	**4.10**	**4.78**	**1.20**	
3	**7.00**	0.23	0.17	0.13	0.06	0.22	0.39										1.20	0.36	**3.22**	**4.78**	**0.68**	
4	**10.00**	0.52	0.19	0.12	0.08	0.12	0.47	2.08	0.09	0.03	0.04	0.04	0.04				3.82	0.62	**7.59**	**12.03**	**1.20**	
5	**15.00**	0.68	0.23	0.15	0.20	0.32	0.37	9.21	0.41	0.14	0.21	0.15	0.22				12.29	0.73	**10.85**	**23.87**	**1.59**	
6	**22.00**	0.99	0.33	0.21	0.28	0.46	0.53	13.63	0.60	0.21	0.29	0.23	0.32				18.08	1.09	**7.75**	**26.92**	**1.22**	
7	**30.00**	1.85	0.44	0.46	0.29	0.56	0.75	12.43	0.68	0.31	0.45	0.36	0.20		0.10		18.88	1.29	**17.05**	**37.22**	**1.24**	
8	**40.00**	2.77	0.60	0.73	0.32	0.71	1.01	12.84	0.83	0.41	0.62	0.50	0.14		0.19		21.67	1.59	**26.41**	**49.67**	**1.24**	
9	**50.00**	3.48	0.74	0.94	0.41	0.88	1.25	16.12	1.03	0.52	0.77	0.62	0.18		0.26		27.20	2.00	**30.80**	**60.00**	**1.20**	
10	**50.00**	3.47	0.74	0.90	0.40	0.89	1.26	15.98	1.04	0.52	0.77	0.63	0.17		0.24		27.01	1.98	**37.57**	**66.56**	**1.33**	
11	**50.00**	3.46	0.75	0.91	0.41	0.88	1.26	16.12	1.03	0.52	0.78	0.62	0.18		0.24		27.16	2.29	**37.11**	**66.56**	**1.33**	
12	**50.00**	3.47	0.74	0.93	0.40	0.88	1.26	16.12	1.04	0.52	0.77	0.63	0.17		0.26		27.19	2.05	**37.32**	**66.56**	**1.33**	
13	**50.00**	3.58	0.71	0.67	0.29	0.90	1.13	17.17	0.85	0.49	0.78	0.79	0.18	2.99	1.08	0.13	31.74	1.91	**31.94**	**65.59**	**1.31**	
14	**50.00**	3.63	0.68	0.47	0.18	0.89	1.02	18.04	0.71	0.47	0.79	0.92	0.19	1.08	1.74	0.22	31.03	1.79	**32.77**	**65.59**	**1.31**	
15	**50.00**	3.57	0.68	0.47	0.19	0.90	1.03	18.00	0.70	0.47	0.78	0.92	0.18	1.12	1.77	0.24	31.02	1.83	**33.71**	**66.56**	**1.33**	
16	**50.00**	3.63	0.67	0.47	0.19	0.90	1.03	18.04	0.71	0.47	0.78	0.92	0.18	1.10	1.73	0.22	31.04	1.80	**39.19**	**72.03**	**1.44**	
17	**50.00**	3.71	0.62	0.46	0.08	0.86	0.89	17.92	0.54	0.46	0.82	0.83	0.34	1.00	1.29	0.10	29.92	1.65	**45.93**	**77.50**	**1.55**	
18	**50.00**	3.70	0.59	0.44	0.02	0.84	0.82	17.81	0.46	0.47	0.84	0.79	0.40	0.96	1.04	0.20	29.38	1.58	**46.78**	**77.74**	**1.55**	
19	**50.00**	3.71	0.59	0.45	0.03	0.84	0.81	17.82	0.46	0.47	0.83	0.78	0.43	0.95	1.08	0.21	29.46	1.57	**46.71**	**77.74**	**1.55**	
20	**50.00**	3.63	0.58	0.44	0.02	0.84	0.83	17.71	0.45	0.46	0.83	0.80	0.41	0.98	1.06	0.21	29.25	1.59	**48.51**	**79.35**	**1.59**	
21	**50.00**	2.07	0.29	0.31	0.17	0.69	0.95	14.33	0.37	0.39	0.96	1.33	0.33	1.74	0.81	0.38	25.12	1.67	**24.97**	**51.76**	**1.04**	1.46
22	**50.00**	2.07	0.27	0.30	0.19	0.65	0.98	14.32	0.41	0.45	0.98	1.27	0.31	1.63	0.76	0.36	24.95	1.72	**25.09**	**51.76**	**1.04**	6.51
23	**50.00**	2.13	0.24	0.26	0.23	0.64	1.03	14.38	0.49	0.56	1.01	1.21	0.28	1.49	0.70	0.33	24.98	1.76	**31.82**	**58.56**	**1.17**	6.95
24	**50.00**	2.50	0.77	0.91	0.55	0.56	1.66	14.67	0.57	0.68	0.89	0.68	0.12	0.65	0.30	0.14	25.65	1.99	**29.10**	**56.74**	**1.13**	6.96
25	**50.00**	7.90	1.14	0.74	0.98	0.68	1.66	16.78	0.51	0.40	0.61	0.22	0.02	0.28		0.11	32.03	2.24	**55.33**	**89.60**	**1.79**	6.64
26	**50.00**	8.39	1.56	0.83	0.99	0.70	1.48	17.45	0.57	0.42	0.63	0.22	0.02	0.31		0.12	33.69	2.42	**53.05**	**89.16**	**1.78**	28.79
27	**50.00**	8.38	1.24	0.67	0.99	0.71	1.49	17.45	0.56	0.41	0.64	0.22	0.01	0.32		0.06	33.15	2.33	**59.14**	**94.62**	**1.89**	24.93
28	**50.00**	8.13	1.13	0.69	0.91	0.67	1.46	19.65	0.62	0.52	0.74	0.25	0.03	0.44	0.04	0.16	35.44	2.52	**56.98**	**94.94**	**1.90**	24.95
29	**50.00**	7.04	1.15	1.10	0.63	0.57	1.39	29.27	0.87	0.93	1.15	0.41	0.07	0.84	0.23	0.25	45.90	3.42	**40.13**	**89.45**	**1.79**	24.94
30	**50.00**	7.07	1.08	1.04	0.63	0.56	1.39	29.40	0.87	0.93	1.15	0.41	0.07	0.83	0.22	0.26	45.91	3.38	**44.02**	**93.31**	**1.87**	25.69
31	**50.00**	7.04	1.15	1.10	0.63	0.57	1.38	29.27	0.88	0.92	1.16	0.41	0.07	0.84	0.21	0.26	45.89	3.42	**43.98**	**93.29**	**1.87**	26.21
32	**50.00**	7.03	1.09	1.04	0.63	0.56	1.39	29.26	0.87	0.93	1.15	0.40	0.06	0.87	0.22	0.24	45.74	3.38	**44.18**	**93.30**	**1.87**	26.20
33	**50.00**	4.70	0.90	0.93	0.40	0.47	1.06	26.22	0.68	0.90	1.47	0.54	0.03	1.84	1.18	0.35	41.67	3.34	**42.07**	**87.08**	**1.74**	20.73
34	**50.00**	3.09	0.68	0.76	0.25	0.40	0.83	23.99	0.55	0.87	1.67	0.61		2.56	1.82	0.42	38.50	3.27	**28.38**	**70.15**	**1.40**	15.08
35	**50.00**	3.09	0.69	0.76	0.26	0.41	0.83	24.09	0.55	0.88	1.67	0.61		2.52	1.83	0.40	38.59	3.27	**26.09**	**67.95**	**1.36**	
36	**30.00**	2.54	0.60	0.67	0.15	0.24	0.50	14.38	0.34	0.52	1.00	0.37		1.55	1.09	0.25	24.20	2.03	**11.92**	**38.15**	**1.27**	
37	**20.00**	1.70	0.34	0.38	0.10	0.16	0.33	9.62	0.22	0.35	0.67	0.25		1.01	0.73	0.16	16.02	1.32	**13.32**	**30.66**	**1.53**	
38	**18.32**				0.09	0.15	0.31	8.82	0.20	0.32	0.61	0.22		0.94	0.67	0.15	12.48	1.10	**0.85**	**14.43**	**0.79**	
TOTAL	**1547.82**	**135.42**	**24.47**	**21.93**	**12.66**	**22.52**	**36.23**	**610.39**	**21.76**	**18.32**	**29.31**	**20.16**	**5.35**	**30.84**	**22.89**	**5.93**	**1018.18**	**72.41**	**1179.10**	**2269.69**	**1.47**	**246.04**

5.22 EQUIPMENT SCHEDULE (VARIANT I)

Overburden removal : by departmental drilling-blasting and shovel - dumper working.

Coal extraction : by departmental machine

Mostly Lajkura-IV, IIT1, IIB & I, Rampur-IV,III are thick and highly interbanded. Major coal production from these thick sections will be extracted by surface miner, front end loader and dumper, there will not be any drilling blasting and crushing for this quantity of coal. Departmental coal extraction has been considered by windrowing method as practiced by MCL, involving addl. cost for front end loader, this system may be reviewed by higher size surface miner(4200 mm drum dia) -conveyor method directly loading onto dumper by appropriate authority at the time of starting the mine.

All other activities of mine development and auxiliary activities are proposed to be done by departmental machines and manpower.

Based on yearly work load, excavator requirement has been assessed. Dumpers have been calculated as per year wise average lead separately for coal, partings and top overburden. Following table shows year-wise average lead distances for coal and overburden.

Table 5.22
Average Lead Distances (km)

Particulars	Yr.1-2	Yr.3-4	Yr.5-6	Yr.7-8	Yr.11	Yr.16	Yr21
Overburden	5.0	5.25	5.25	5.0	4.25	4.0	3.25
Coal	1.75	1.75	1.75	2.00	2.25	2.25	2. 50

Year wise population of shovels, dumpers and drills have been estimated based on yearwise quantities from different strata as shown in the production programme. Following table 5.23 shows requirement of HEMM throughout mine life if the mine is operated departmentally. Similar type of HEMM should also be deployed by outsourcing agency.

Table 5.23

SL.	EQUIPMENT NAME	SIZE	**TOTAL NO**
A.	***OVERBURDEN***		
1.	ELEC. HYDRAULIC SHOVEL	20-23 cum	**18**
2.	HYDRAULIC SHOVEL/ BACKHOE	10-12 cum	**8**
4.	REAR DUMPER	190-205 T	**146**
5.	REAR DUMPER	100 T	**101**
6.	ELC. R.B.H. DRILL	Dia 250 mm	**26**
7.	ELC. R.B.H. DRILL	150-170 mm	**8**
8.	RIPPER DOZER	850-870 H.P.	**12**
9.	DOZER/ RIPPER DOZER	410 H.P.	**18**
B.	***COAL***		
1.	SURFACE MINER, 800-1000HP	3800mm drum	**16**
2.	HYDRAULIC SHOVEL/ BACKHOE	10-12 cum	**1**
3.	FRONT END LOADER	10-12 cum	**16**
4.	DUMP TRUCK/TIPPER	100 T	**77**
5.	ELC. R.B.H. DRILL	150-170 mm	**1**
6.	DOZER	410 H.P.	**8**
7.	WHEEL DOZER	460 H.P.	**8**
C.	***COMMON***		
1.	TELESCOPIC HYD. CRANE	75 T	**1**
2.	TELESCOPIC HYD. CRANE	50-55 T	**1**
3.	TELESCOPIC HYD. CRANE	20 T	**2**
4.	SERVICE CRANE	8 T	**5**
5.	DIESEL HYD. BACKHOE	1.5-1.7 cum.	**4**
6.	FRONT END LOADER	2-2.5 cum	**4**
7.	GRADER	280 H.P.	**4**
8.	WATER SPRINKLER	70 KL	**3**
9.	WATER SPRINKLER	28 KL	**6**
10.	FUEL BOWSER	9 KL	**3**
11.	FIRE TENDER		**2**
12.	MAINTENANCE VAN		**5**
13.	VIBRATORY COMPACTOR		**2**
14.	TYRE HANDLER		**3**
15.	TIPPING TRUCK	8 T	**10**
16.	ROAD SWEEPER		**2**
D.	***LAND RECLAMATION***		
1.	DOZER WITH WIDE ANGLE BLADE	410 HP	**5**
2.	DOZER	410 HP	**2**
3.	FRONT END LOADER	2-2.5 cum.	**3**
4.	TIPPING TRUCK	8T	**10**
5.	TRACTOR WITH TWO TRAILORS		**3**

VARIANT-II (OUTSORCING)

In this variant major activities involved in mining operations will be done by selected outsourcing agencies. Production programme in this variant will remain same as that of departmental variant. However coal movement from pit bottom to railway loading arrangement/ washery by belt conveyor will be done through departmental basis. Blasting is proposed to be done departmentally. HEMM deployed by outsourcing agencies for mining of coal and overburden should be similar to departmental option for operational efficiency and to avoid traffic congestion and to reduce environmental pollution. A small fleet of departmental HEMM has been provided in this variant to do some auxiliary emergency operations.

Table 5.24

SL. NO.	EQUIPMENT NAME	SIZE	**TOTAL NO**	**NO UPTO YEAR 8**	**NO AFTER YEAR 8**	YEAR 1	YEAR 2	YEAR 3
	COAL PRODUCTION (in Mt)					**1.50**	**4.00**	**7.00**
	OVERBURDEN REMOVAL (in M cum)					**3.73**	**4.78**	**4.78**
	COMMON							
1.	SERVICE CRANE	8 T	**1**	**1**		1		
2.	DIESEL HYD. BACKHOE	1.5-1.7 cum.	**1**	**1**		1		
3.	FRONT END LOADER	2-2.5 cum	**1**	**1**				1
4.	FIRE TENDER		**1**	**1**		1		
5.	TIPPING TRUCK	8 T	**4**	**4**		4		

Chapter - 6

MANPOWER, SAFETY AND SUPERVISION

6.1 MANPOWER ASSESSMENT, PHASING, PRODUCTIVITY FOR DEPARTMENTAL VARIANT

Manpower for OB removal, coal extraction together with common services and land reclamation considering 330 working days and 16.5% absenteeism in a year has been estimated for all the variants. Office and allied functions shall be computerised. Security, canteen and some other services are proposed to be hired, as decided by MCL. Modern communication facilities shall be adopted. Essential numbers of vehicles has been provided and the required numbers of drivers has been provided for the same in Variant-II. Other vehicles which will be required is proposed to be provided on hire basis. Manpower assessment for departmental variant is given below in table-6.1.

6.1.1 REQUIREMENT ON VARIOUS WORKING HEADS

Table 6.1

Manpower requirement (Departmental Variant)

Sl. No.	Particulars	No. of persons (upto target year i.e Yr-12)	No. of persons (beyond target year)
1	OB	854	400
2	Coal	484	21
3	Common	1609	357
4	Land reclamation	48	
	Total	2995	778

Office and allied functions shall be computerised. Security, canteen and some other services are proposed to be hired, as decided by MCL. Modern communication facilities shall be adopted. Essential numbers of vehicles has been provided and the required numbers of drivers has been provided for the same.

6.1.2 GROUPWISE MANPOWER

Break-up of total manpower in various groups is given in table 6.2.

Table 6.2
Groupwise manpower requirement

Sl. No.	Particulars	No. of persons (upto target year)	No. of persons (beyond target year)
1	Executive	94	
2	Monthly rated	351	102
3	Daily rated	2550	676
	Total	**2995**	**778**

6.2 MANPOWER ASSESSMENT, PHASING, PRODUCTIVITY FOR COAL AND OB BOTH OUTSOURCING VARIANT.

6.2.1 REQUIREMENT ON VARIOUS WORKING HEADS

Table 6.3
Manpower requirement

Sl. No.	Particulars	No. of persons (upto target year i.e. Yr-10)	No. of persons (beyond target year)
1	OB	51	54
2	Coal	157	
3	Common	325	3
4	Land reclamation		
	Total	533	57

6.2.2 GROUPWISE MANPOWER

Table 6.4
Groupwise manpower

Sl. No.	Particulars	No. of persons (upto target year)	No. of persons (beyond target year)
1	Executives	51	
2	Monthly rated	190	57
3	Daily rated	292	
	Total	**533**	**57**

6.3 SAFETY AND SUPERVISION

6.3.1 PREAMBLE

Opencast mining operation in general is associated with a number of hazards/risks.

Some of the various anticipated sources of danger are enumerated as under:

- Slope failure.
- Dangers due to handling and use of explosives and accidents due to fly-rocks following a faulty heavy blast.
- Hazards associated with use of electricity
- Accidents due to unruly operation of HEMM
- Dust hazards
- Fire hazards due to spontaneous heating of coal in stockpiles and exposed benches.
- Fire hazards in stores & workshops where inflammable & highly inflammable materials are stored or used.
- Danger of inundation from surface and/or ground water

Adequate provisions have been made for safe working of the mine in form of design of operational systems, provision of safety measures for safe use of explosives, electricity and HEMM etc.. Sufficient financial provisions have been made under different heads for procurement of necessary safety equipment.

Adequate skilled & trained manpower has also been provided for compliance of safety provisions. Regular training/refresher courses, "on job" training shall be conducted & mock rehearsals shall be made to make the manpower conversant with various rules, regulations, methods of prevention & combat with hazards.

6.3.2 INUNDATION

Due care should be taken during mining to prevent water ingress operations from the higher ground local rivers/reservoir. Provisions of coal Mine Regulations shall be followed. There are three sources of water in the mine:

i) Surface run off from the surrounding area and nalla flowing over the property:

Major threat of Inundation is from Basundhara river/nala & Chaturdhara nala, which flows along the northern boundary of the block and Chattajhor nala towards eastern boundary of the block. Embankment with a height of three meter above the HFL has been proposed against Basundhara river. The HFL should again be ascertained & precautions taken before taking up the mining activities. Detailed design of the embankment should be done by experienced agency and the same should be constructed during initial years.

ii) Direct Precipitation:

Rain Water

a) Garland drains along the periphery of excavated area of the mine shall be provided to stop rainwater from surface entering into the mine. Garland drains shall be kept clean without any obstruction and shall be inspected regularly during the monsoon.

b) All Rainwater in the catchment area of the opencast mine shall be channelized to gravitate into the main sump constructed in the dip most part of the mine. Adequate pumping arrangement shall be kept to pump out water from the sump to the surface.

iii) Seepage from Strata: There is no danger of inundation due to make of water in the mine while mining coal. The water will gravitate into the sump and will be pumped out.

6.3.3 FIRE AND SPONTANEOUS HEATING

FIRE DUE TO SPONTANEOUS HEATING IN COAL BENCHES & GROUND STOCKS

The following measures will be taken to avoid spontaneous heating:

a) Coal bench slopes and seam outcrops will be overlain with an impervious layer of soil/clay.

b) Treatment of exposed coal seams & outdoor coal stocks with anti-pyrogenic substances.

c) Exposure of coal benches for long time shall be avoided.

FIRE IN PROJECT STORES & WORKSHOPS

Sufficient provision has been made in the PR for the prevention & control of fire in the project store, both E&M & HEMM workshops & sub-stations by way of installing fire extinguishers of right type & size. Timely inspection & refilling of fire extinguishers will be done.

Systematic layout of both stores & workshops has been made so that inflammable & highly inflammable materials do not come in contact with any spark or flame. Adequate number of cautions in the form of hoardings will be displayed near such places.

6.3.4 SLOPE STABILITY

COAL/OB BENCHES

The exposed ends of the coal seams and OB shall be left with a safe slope to avoid slope failure and collapse of benches. Similarly, at the end of mining operation, safe terminal pit slope is provided to avoid pit failure. At design stage, a safe angle of not steeper than 40 degrees overall has been proposed as quarry slope. Detailed site specific tests for slope stability shall be carried out and site specific parameters determined. Present provision is a broad guideline.

Following parameters have been adopted in the PR:

Maximum bench height	:	10-12m for shovel depending on excavator size
Bench width	:	24-36 m for overburden/coal benches with 10-12 cum hydraulic shovels/backhoes.
	:	26-44m for overburden benches with 20-22cum hydraulic shovels.

Coal bench width will be kept at a minimum width of 50m for surface miner operations.

Working angle	:	70^0 for individual working bench

Again, bench dimensions may vary with different equipments deployed. Bench height and angle should as per guidelines from statutory authority & will vary with equipment size.

OB DUMP

Dumps will be formed in 30m tiers with an overall slope of about 26°, angle of individual dump will be around 37^0 depending on angle of repose of material and there should be horizontal berm of width 30m in between the individual 30 m dump tiers. Height of each dump may even kept at a lesser height where the dump is near any road or locality. Each berm between dump tiers should be properly graded and drains should be provided at toe with sufficient gradient. Fencing may be done near bottommost tier to stop unauthorized entry near the dump, adequate safety distance on surface from dump toe should be maintained to avoid any accident due to slope failure.

For better stability of internal dumps it is suggested to rip the mine floor in strips before backfilling. It is suggested to level the dumps and grade them outward properly to obviate water accumulation and will be followed by garland drains all along the periphery of the dump.

HAZARD AND RISK ASSESSMENT OF OB DUMPS

Hazard of OB dump failure is mainly governed by following factors :

1. Height of benches.
2. Slope of benches.
3. Nature of material.
4. Slope of foundation rock.
5. Nature of foundation rock.
6. Drainage of foundation.
7. Depth of ground water table.

The following precautions will be taken to reduce the risk of dump failure.

1. OB dump tiers will be made of <30m ht in each tier.
2. The angle of repose for each dump tier will be around 37°. Overall dump slope should not be higher than 26^0
3. Soil should be scraped separately, so that it is not mixed in OB rock.
4. The slope of ground is kept mild so that it will not have any adverse effect.
5. The soil from the foundation ground should be scrapped before starting of OB dumping.

6. Garland drain to be made around OB dump area to avoid water flow during monsoon below the OB dump.
7. Ground water table is generally 3-5m below ground level hence may have no adverse impact.
8. Leveling, grading and drainage arrangement for top of OB dumps will be done.
9. Technical & Biological reclamation will be done.
10. Sufficient clearance as per DGMS regulations or any other statutory law should be maintained between toe of the dump and nearby road/village/infrastructure to avoid any accident or slope failure.

6.4 HAUL ROAD MAINTENANCE

For proper haul road maintenance, following aspects have to be considered and implemented:

i) Proper design and maintenance of the haul roads

ii) Formulation, approval and enforcement of traffic rules regarding :
   a) Speed limit
   b) Parking and standing
   c) Overtaking

iii) One way traffic, otherwise width should not be less than 3 times the width of the largest vehicle.

iv) Gradient should not be greater than 1 in 16.

v) Berm should not less than 1 m in width.

vi) Separate machines and personnel for maintenance of haul road.

During rainy season soil erosion will take place and it will deteriorate the haul road corridor and therefore.

i) Proper drainage arrangement shall be made along the haul road.
ii) Cross slopes (1 in 50 to 1 in 25) shall be provided on the haul road so that water flows into the drain.
iii) Water barrier, cross drains, relief drains etc. should be constructed and maintained properly.
iv) Culverts shall be designed, installed and maintained to withstand the vertical soil pressure, weight of the vehicles plying over the road etc.

6.5 BLASTING

SAFE USE OF EXPLOSIVES

Site Mixed Slurry (SMS) has been proposed to be used for good fragmentation and to obviate storage of bulk quantum of explosives. However, for storage of explosives meant for priming, detonating fuse and detonators, two explosive magazines have been provided in this report.

For transportation of explosives, explosive van of approved type is also envisaged.

For proper blasting and minimizing the adverse side effects due to blasting viz. noise, ground vibration, back-breaks, air blast and fly rocks etc., the optimal blast design parameters will be suggested during the mine operation after conducting a study for determining the blasting parameters.

Provision has been made in the PR for qualified blasting-in-charge with requisite number of assistants. Adherence to relevant statutory safety provisions as stipulated by DGMS, Chief Controller of Explosives and others shall be made.

Blasting danger zone of 300m for blasting has been taken in non-forest area. In forest area this demarcation will be done on the ground as only 7.5m has been considered as safety zone for permissive possession in case of forest area. Accordingly, land beyond the quarry limit is envisaged to be acquired for the project from safety considerations. It is suggested to resort to controlled blasting near built-up areas and surface features, if any, within the safety zone.

6.6 SAFETY MANAGEMENT

Special precaution should be taken while deploying workers in the mine. Before employing any labour in the mine proper vocational training should be imparted and recommendations of the latest Safety Conference should be strictly followed. Management for deployment of labours by outside agency shall fix terms and conditions. Some of the major aspects are as follows:

A) FOR PERSONS

i) No persons shall be deployed unless he is trained at VTC

ii) Records in Form-B, Form-D shall be maintained.

iii) Records of Vocational training Certificate and driving license of operators shall be kept by HEMM outsourcing agency and shall be made readily available for inspection by management.

iv) No person shall be employed unless person holds VTC certificate and Management is informed. A record of it shall be maintained.

v) Qualified competent persons shall maintain adequate supervision.

vi) Outside agency shall follow safety guidelines and safety instruction from Project Authorities.

B) FOR MACHINERIES AS RECOMMENDED BY DGMS CIR. (TECH.) 1 OF 1999.

i) All the machineries to be deployed in mines should be checked before deployment by competent authority.

ii) Regular checking of m/c deployed by outside agency shall be done. No unfit machine shall be deployed before the defect is rectified.

iii) A proper record of repair and maintenance along with inspection done by management and defect pointed out shall be maintained and signed by authorized person.

iv) The trucks deployed outside agency shall be provided with Audio visual alarms, proper light for use at night and period when natural light is not sufficient. Also audio-visual alarms for reversing on trucks shall be provided.

OTHER PRECAUTIONS FOR MACHINE

i) RTO certificate photo copies of all vehicles shall be submitted to management

ii) Daily welding, monitoring, inspection shall be done by the agency's mechanic as directed by management.

iii) Machine manufacturers should be asked to give risk analysis details in respect machines deployed by outside agencies.

iv) Suitable type of the fire extinguishers shall be provided in every machine.

v) General:

vi) No person/vehicle shall be deployed at any place other than authorised place.

vii) All worker should obey lawful instruction of mine management.

viii) Risk management Plan shall be made and implemented.

ix) All driver shall obey systematic traffics rules prepared by management

x) Before deploying workers they must be trained and briefed about safety aspects in opencast mine. However, during course of execution of the work, if any accident occurs whether major or minor, the matter shall have to be immediately informed to mine management i.e. Colliery Manager/Agent/GM of the area so that Notices of accidents in a accordance of (Reg.9 of CMR 1957) and Section 23 of Mines Act 1952 may be given and other necessary steps may be taken in accordance with the Mines Act 1952.

xi) Outside agency shall operate transport system in such a way so as to minimize pollution in the mine.

STABILITY OF BENCHES, QUARRY HIGHWALLS AND SPOIL DUMPS:

During quarry operations, it is necessary to adopt required mining parameters for the stability of benches, high walls and spoil dumps. It is also mandatory to examine systematically the fencing of mine workings, landslides and cracks between benches. It is required to maintain well-graded and wide roads on benches keeping the width of working areas sufficient for spreading of blasted rock and movement of the mining and transport equipment. During actual mining operation, systematic observations of the conditions of benches high wall slopes and spoil dumps should be carried out and the dimensions be modified if necessary to suit the local conditions.

PRECAUTIONS AGAINST DANGER OF INUNDATION FROM SURFACE WATER

1) A careful assessment is to be made against the danger from surface water before on the onset of rainy seasons. The necessary precautions should be clearly laid down and implemented. A garland drain needs to be provided to drain away the surface rainwater from coming into the mine.
2) Inspections for any accumulation of rainwater, obstruction in normal drainage and weakening in embankment.
3) Standing order; for withdrawal of working persons in case of apprehended danger.
4) During heavy rain inspection of vulnerable points is essential. In case of any danger persons are to be withdrawn to safer places.

5) Nallah or water inlets may be diverted or isolated by embankments/if so required.

PREVENTIONS OF FLOODING OF EQUIPMENT DEPLOYED AT BOTTOM HORIZONS

During the heavy monsoon period, the mining operation in the lower-most bench may have to be stopped. Therefore, it is proposed to drawn the lowest bench, which would work as a sump. The water will be pumped out and discharged into the drain through settling tank. For ensuring safety of the equipment while working out horizons with no access to surface profile, the following measures should be taken:

1) Drivage of initial trenches and coal cutting benches should be done during the dry period of the year.
2) Ramps should be made for quick shifting of equipment from bottom horizons, liable to be flooded during monsoon period, to the top horizons.

PREVENTION OF ELECTRIC SHOCKS

During mining operations, all the statutory provisions of the Indian Electricity Rules 1956, and the Indian Standards for installation and maintenance of electrical equipment etc. should be observed.

1) For protection from electric shocks to persons, from electrical equipment with high voltage, Earth Leakage Relay should be provided which will automatically disconnect electrical circuits.
2) Closed mobile substations and switchgears should be mechanically interlocked which exclude the possibility of opening the door when oil switch and air circuit breaks are in operation.
3) All metal parts of electrical equipment should be properly earthed to avoid failure of insulation.
4) All H.T. lines and cables located within the blasting zones should be disconnected during blasting operations.

DUST SUPPRESSION & DILUTION OF EXHAUST FUMES

The following measures should be adopted for dust suppression at all quarry working places, dumps, haul roads, CHP and near auxiliary mining operations:

1) Spraying with water on all working faces & haul roads, by special spraying machines or water-sprinkler.
2) While drilling holes, it is necessary to use dust extraction devices.
3) Installation of local dust suppression and air conditioning devices in cabins of excavators and drilling rigs may be considered.
4) Levelling of spoil dump surface.
5) Separate dust suppression arrangement should be provided for CHP.

To prevent collection of harmful mixture in the atmosphere, from the different sections of quarry working, it is recommended:-

1) To spread out the sources of dust formation and omission of harmful gases throughout the working area of the quarry.
2) Drilling & blasting operations should be timed for periods of maximum wind activity during the day.
3) Dumpers may be provided with purifiers for exhaust gases.

MEASURES TO BE TAKEN FOR FIRE FIGHTING AND FIRE PREVENTION

In addition to statutory provisions, the measures for firefighting and prevention of fires are as follows:

1) Organization of special cell for systematic observations to examine and prevent fire.
2) Removal of spillage of coal on benches and cleaning of coal horizons to prevent cases of coal heating.
3) Storage of lubricants and cotton waste in enclosed fireproof containers in working places.
4) Provisions of fire extinguishers

MEASURES TO BE TAKEN WHILE DRILLING BLASTING

Following measures should be taken while drilling and blasting operations in the quarry:

1) Drilling and Blasting in quarry should be done in accordance with the provisions of Mines Safety Act, rules and regulations.
2) Adequate safety measures have to be taken during blasting operation in the quarry so that men/machine are not affected.

6.7 CONSERVATION

Suitable measures should be taken to minimize coal loss during mining operations. Selective mining of in-seam dirt bands has been proposed. It is proposed to rehandle any spoil material dumped over coal bearing area, amenable for opencast mining, at present or even at a future date.

6.8 SCIENTIFIC STUDIES

It is proposed that scientific studies in respect of effects of vibration and flying fragments on surface buildings/ structures due to blasting is carried out. Studies regarding slope stability should also be carried out.

6.9 ADDITIONAL PERMISSION/RELAXATIONS REQUIRED FROM DGMS

For the purpose of usage of bulk explosive, following permission from the competent authority will be required :

i) Permission for will be required for under CMR 161 clause (1) and CMR 168(5) for usage of explosive in other than cartridge form and other type of explosive.
ii) Permission for sleeping of holes shall be obtained.

6.10 **USE OF HEMM**

Based on the excavation requirement of the mine and envisaged calendar programme, adequate number of HEMM has been envisaged.

A well equipped workshop is suggested in the PR to cater to the maintenance needs of HEMM and other equipments besides provision of necessary maintenance crew. A project store is provided for storage of slow and fast- moving spares and other necessary spares of vital importance.

Adequate number of trained/skilled operators and maintenance crew are provided in the PR with due consideration of leave/sick provisions.

Properly designed haul roads are envisaged in the PR, away from the general and traffic congestion. The traffic rules as enforced by the DGMS shall be strictly followed by the operators of mobile equipments like rear dumpers, water sprinklers, tippers and other light motor vehicles. All mobile equipments shall be provided with audio-visual alarms.

Safety devices like fire alarm and control, operated by sensors should be inbuilt in the equipment/HEMM. Flashers should be fitted in relevant HEMM. The haul roads should be sufficiently wide to prevent accidents.

Inter-locking of starting with normal positioning of dumper body should be provided, so that dumper cannot be started when the body is in lifted position beyond a certain limit.

Chapter - 7

COAL HANDLING, WASHING & MODE OF DISPATCH

7.1 INTRODUCTION

The CHP for Siarmal OCP will have to be constructed to handle the total production of around 50 Mty from the mine. This mine has been planned to meet the demand of the future thermal power stations and dispatched through basket linkage.

7.2 COAL HANDLING ARRANGEMENTS

As per approved project report coal handling plant has been designed for capacity of 40 Mty. Now the system will have to be updated to handle 50 Mty of raw coal. The permanent coal handling arrangement shall have the following provisions:

- Initially, two numbers of two stage Twin shaft sizer to crush from (-)1200 mm to (-)100 mm will be provided near the first access trench to handle any coal produced from the conventional system.
- Initially, three numbers of Reclaim feeders will be provided near the first access trench to handle (-) 100mm size blast free coal.
- Belt conveyors system in three parallel series from the access trench up to the proposed washery.
- From the washery the washed coal will be transported to the number of Rapid Load out system with pre-weigh loading arrangement @5500(av) tph through no of silo/ central dispatch system and dispatch through the rail.
- The loading of the coal to RLS from washery will be the scope under washery.
- Based on the advancement of mine, in the intermediate stage about 60m below twin shaft sizer/ Reclaim feeder will be installed to handled the inpit coal and dispatch to the main stream on surface by the series of belt conveyors.
- In floor inpit, sets of reclaim feeder with Sizers will also be provided as the mine reached to the floor.
- Based on the production enhancement and the advancement of the mine the Sizers and Reclaim feeder will be shifted to Intermediate and Inpit floor.

The system layout plan showing mine entries, sizing and handling complexes, Belt conveyors, washery location, CDS siding with loading points etc. are given in Plate GEN-V. The coal flow diagram is given in Plate Engg.-I. As per the production programme, the CHP will start functioning from 5th year.

7.3 BASIC PARAMETERS

The basic parameters considered for the planning of the coal handling plant will be as under:

No. of working days	-	330
No. of shifts/day	-	3
No. of hours/shift	-	8
No. of effective hours of work of CHP/shift	-	5

7.4 PERMANENT COAL DESPATCH ARRANGEMENT

a) **RECEIVING PITS & SIZING COMPLEXES**

The brief details of the sizing complexes are given below:

i) **TWO STAGE SIZING UNIT**

Nos.	-	4
Location	-	2 Nos to be installed on surface near first access trench and working upto 8th year & one no will be shifted thereafter at intermediate floor inpit point.

Additional two nos sizers to be installed in the Inpit floor from 12th year towards the southern side.

Capacity	-	1000 tph
Max feed size	-	(-) 1200 mm
Final output size	-	(-) 100 mm

ii) RECLAIM FEEDER

Nos.	-	9
Location	-	3 Nos to be installed on surface to handled the blast free coal and one will be shifted to Intermediate floor after 8th year along with three additional deployment. Additional 3 nos. will be installed at Floor Inpit based on the quarry advancement.
Capacity	-	1500 tph (Peak)
Handled size	-	(-) 100mm

b) **DESCRIPTION OF COAL FLOW (REF. DWG. NO. PLATE NO. ENGG.-IIB)**

i) **ON SURFACE NEAR FIRST ACCESS TRENCH**

Initially, the blast free coal from the quarry will be transported by dumpers and loaded onto the Reclaim feeder installed on surface. Some dozers/Pay loaders have been provided to dozing the coal and fed onto the reclaim feeders.

For conventional ROM coal of (-) 1200 mm brought by dumpers from the quarry shall be unloaded into the Twin shaft sizers. The coal fed to hoppers of the Primary sizing unit for the output size (-) 250mm. To get (-) 100mm size of coal, the coal have to be fed into the Secondary sizing units.

The sized and blast free coal will be collected by a 2000mm wide belt conveyor C1,C2 & C3(Main stream) from the sizers as well as from the reclaim feeders via two conveyors (S1&S2) and transported through a system of belt conveyors C4,C5,C6,C7,C8,C9,C10,C11 & C12 upto the proposed washery. From the washery, the washed coal will be transported through the 4 nos Rapid Load out system located at a central dispatch system. All the conveyors are 1800mm wide except S1&S2 which are 1600mm wide. Loading upto the top of the proposed RLS will be under the scope of washery.

ii) **INTERMEDIATE INPIT SYSTEM**

ROM coal as well as blast free coal brought by dumpers from the quarry shall be unloaded into the coal receipt hopper of the Primary sizing unit and over to the reclaim feeders respectively. From intermediate Inpit the coal will be transported to the surface by a set of belt conveyors like P1, P2, P3, P4, P5, P7 &P8 installed inside the quarry benches and loaded to the main stream on surface. All the conveyors are 1600mm wide except P7&P8 which are 1800mm wide.

iii) **FLOOR INPIT SYSTEM**

ROM coal as well as blast free coal brought by dumpers from the quarry shall also be unloaded into the coal receipt hopper of the Primary sizing unit and over to the reclaim feeders respectively. From the floor Inpit the coal will be transported to the surface by a set

of belt conveyors like P9, P10, P11 & P12 installed inside the quarry benches and loaded to the main stream on surface. All the conveyors are 1800mm wide.

Based on the production schedule and the advancement of the mine the sizing units and reclaim feeder units will be shifted inside the quarry.

To handled the coal from the western side of the quarry (Banapatra block), the surface as well as Inpit system will be shifted towards the western. At later stage the major production will be from the Banapatra side and the present Inpit conveyors will be utilized gainfully.

c) BUNKERAGE AND RECLAMATION OF COAL

No bunkerage has been provided in this system. The raw coal bunker as well as the washed coal bunkers will be provided in the proposed washery premises.

d) RAPID LOAD OUT SYSTEM FROM CDS

The reclaim conveyors from the washery will discharge coal onto the hopper of the RLS system. There will be 4 nos of RLS system consisting with an approx. 500te surge bin over the pre-weigh hoppers. The bridge conveyors for loading other two nos 2nd RLS hoppers will be under the scope of washery also. Each system shall have pre-weighment facility with the help of pre-weigh hopper. The pre-weigh hopper shall have one opening provided with swing/telescopic chute and gate. The whole loading operation will be automatic. The load out system will be complete with hydraulic power pack, logic circuits etc. Facilities like passenger lift, electric hoist, chain-pulley blocks, pressurisation system for MCC rooms etc shall also be provided.

7.5 WASHERY

Siarmal OC Project has been planned for extraction of available non-coking coal reserves of three major seams (viz. Ib, Rampur & Lajkura) occurring within the project area by opencast method. During later years a two-product (viz. washed coal & rejects) non-coking coal washery for coal produced from this OCP may be conceptualized. Washed coal of about 34% ash for thermal power plants and rejects for power generation through FBC technology will have to be considered.

The ash% of washed coal for thermal use has been considered as 34%. keeping in view the MOEF Gazette Notification according to which thermal power plants located beyond 1000 Kms. from the pit head and those located in urban areas or sensitive areas or critically polluted areas irrespective of their distance from the pithead (except any pit head power plant using FBC) shall use coal of ash content not exceeding 34% on annual average basis.

Chapter - 8

INFRASTRUCTURE FACILITIES PROPOSAL AND THEIR LOCATION

8.1 GENERAL

Two-tier system of maintenance is envisaged for the plant and machinery of the project, one at the unit level in the workshop located at the quarry top to cater to the needs of day-to-day work and the other at Central Workshop for major overhauls and capital repairs.

The workshops for both HEMM and E&M and stores are proposed to be located at the same place with separate boundaries. The project stores shall be an integral part of this complex.

Scope of work, provision of facilities, capabilities of workshop, requirement of equipment etc. have been given in subsequent paragraphs hereunder:

8.2 SCOPE OF WORK

The scope of work will be as follows:

a) HEMM section

- Preventive maintenance.
- Daily maintenance, routine lubrication including washing of equipment.
- Technical inspection and running repair of transport equipment and checking of tyres.
- Scheduled technical maintenance including lubrication and inspection.
- Day-to-day minor repairs/replacement of components and sub-assemblies.
- Daily and fast filling of diesel at fuel delivery station for transport equipment and at site for field equipment.
- Dismantling, opening and refitting of tyres.
- Routine inspection and scheduling for attending to major repairs and
- Overhauls of central workshop/outside agencies.
- Scheduling of machines for repairs at central workshop.

E&M SECTION

- Lubrication, inspection and minor repairs of the E&M equipment as required.
- Routine/scheduled maintenance of all E&M equipment (lubrication and minor adjustments and filling of POL etc.).
- Incidental minor repair/replacement of sub-assemblies and components of CHP equipment and accessories, water pumps and pumping installations and other E&M equipment.
- Periodical lubrication.
- Bi-weekly washing of LMVs and washing of equipment assemblies and sub-assemblies as and when required.
- Repair of small electrical motors, switch gears and instruments etc. except rewinding jobs.
- Battery charging facilities and re-conditioning of batteries.
- Inspection and scheduling for attending to Regional/Central Workshop.
- The LMV shed has not been provided since a very minor vehicle has been provided in the PR

8.3 SHOP FACILITIES

The following facilities have been provided:

a) **HEMM section**

- Mechanised washing of dozers and dumpers.
- Daily maintenance shop for dumpers.
- Scheduled inspection, lubrication and maintenance shops for dumpers.
- Maintenance and minor repair shop for dozers.
- Dumper repair shop.
- Heavy repair shop for repairs and overhauling of assemblies of shovels, drills, cranes and other auxiliary equipment.
- Engineering shops like machine shop, welding and structural shop etc.
- Open/concrete pavements for parking of dumpers.
- Pavement near office.
- Supporting facilities like switch room, office, canteen, cycle stand, security and time office system etc.
- Heavy material handling equipment.
- In addition to the above a tyre handler and fuel bowser have been provided

b) E&M section

- Mechanical repair shop for routine maintenance and minor repair of water pumps, CHP equipment and other allied E&M equipment etc.
- Machine shop & electrical repair shop, for reconditioning of spares and minor repairs of small motors and testing of electrical installations.
- Supporting facilities like small material stores, cycle shed, toilet, security and time office, engineer and foreman offices, pump room, canteen and firefighting facilities.
- Pavement/roads.

8.4 SHOP LAYOUT

The layout takes into account the sequence of various operations/activities, men and material movement etc. The shops are mostly self sufficient. In addition to the above facilities like washing station for dumpers/dozers, fuelling station, parking areas for dumpers, pavement within the HEMM section have also been envisaged.

Also, provision for open parking area for sick equipment, pavement/roads, security and time office, cycle stand, switch room has also been made in E&M section.

8.5 POWER SUPPLY AND ILLUMINATION

Provision for power supply and illumination within the workshop and open area has been made.

8.6 PROJECT STORES

The Feasibility study has envisaged a project store for reception, storage and issue of all kinds of materials, equipment and consumables required for mine operation and maintenance of mining, mechanical and electrical equipment. The storage capacity is planned for 30 to 45 days consumption of materials. Due consideration has also been given for proper working environment, cleanness and safety measures. Proper equipment and material handling facilities have also been provided. Provision for a closed sheds are made for the project stores. Separate provision for a store yard is also made for loading/unloading, truck movement etc.

Store racking system and fork lift truck have also been provided in the project stores which shall be located adjacent to the workshop complex for quick issuing of materials to the workshops.

Chapter - 9

LAND REQUIREMENT

9.1 GENERAL

Implementation of proposed Siarmal Opencast project (50 Mty) will require about 2290.45 ha of land for its operation. This includes the area required for actual excavation, safety zone, blasting danger zone, other infrastructural facilities, etc. and excludes area for colony & Rehabilitation. Requirement of forest land will be around 349.709 Ha. Lease boundary has been considered upto common block boundary with Basundhara West, Kulda and Rampia blocks towards north, east and west respectively, towards south lease area has been considered upto notified village boundary which includes blasting danger zone , overburden dump and future expansion area of present mining block.

Infrastructural facilities like workshops, stores etc. have been proposed either in block area itself and some dispatch system will be accommodated within lease area of kulda OCP.

Provision of land in the eastern side has been estimated upto block boundary of Kulda block. However actual financial provision of land may be done after considering the approved land provision of sanctioned of Kulda OCP. Provision of land in the west has been made upto the boundary of Rampia dip side block. In the north, provision of land upto Basundhara river has been considered.

9.2 LAND REQUIREMENT

Total land requirement under different heads is indicated in following table 9.1:

Table-9.1
Landuse pattern of mine lease area

Sl. No.	Particulars	Total Area in ha		
		Forest	Non-forest	Total
1	Mining & pit top infrastructure	260.769	1328.373	1589.142
2	Safety zone	3.930	14.662	18.592
3	External OB Dump, embankment, other infra & Blasting danger zone icl future exp. area	85.01	597.71	682.72
A.	**Total mining lease area**	**349.709**	**1940.745**	**2290.45**

Note: 1. **the above land schedule is based on the actual village/plotwise data and**

landuse plan as per authenticated land schedule provided by the concerned area of MCL while preparing mining plan and may change after actual ground survey. However there may be minor mismatch between measured lease boundary area with area obtained from plotwise data from revenue plan (as per land records).

2. Around 290 Ha of additional land will be required for colony, rehabilitation & resettlement site, highway diversion and railway link.

Table-9.2
villagewise land requirement

Sl. No.	Village name	Forest (in Ha)	Non forest (in Ha)	Area (in Ha)
1	Siarmal	79.999	126.661	206.66
2	Gopalpur	94.18	499.36	593.54
3	Ratansara	48.47	196.72	245.19
4	Kulda	9.16	17.93	27.09
5	Jhupurunga	53.81	693.97	747.78
6	Tumulia	64.09	406.10	470.19
	TOTAL	349.709	1940.745	2290.45

Data as per authenticated land schedule submitted by project authority.

9.3 VILLAGES AFFECTED

The core zone of the project comprising of excavation zone, infrastructure area, OB dump sites, safety zone for blasting, etc., covers partly and/or fully the land from five (5) villages namely, Siarmal, Jhupuranga, Tumulia, Ratansara, Gopalpur. About 2645 families will be displaced due to mining and other associated activities of this project. R&R benefit of Kulda village has been already incorporated in Kulda OCP.

These families will be resettled and rehabilitated socially, culturally and economically along with other displaced such as major married sons, unmarried daughters of 30 years of age, etc., as per latest Norms of Govt. of Odisha, May,2006. Details of project affected families and project affected persons are given below :

Table-9.3

Name of village	Project affected families	Project affected persons
Siarmal	189	943
Jhupuranga	529	1895
Tumulia	625	2974
Ratansara	238	943
Gopalpur	1064	3522
Total	**2645**	**10277**

However, the exact number of project affected families will be known after due enumeration by the Project Authority.

9.4 EMBANKMENT AGAINST WATER BODIES

It is proposed to construct an embankment with a height of 5m above HFL against Basundhara river, Chaturdhara Nalla and Chhattajor nalla. The length of the proposed embankment will be about 8 km. Diversion of Sundargarh to Raigarh road may temporarily constructed on top of embankment, detailed design of the embankment should be done by expert agency.

9.5 PROPOSED SURFACE REORGANISATION

a) Infrastructural facilities and dumps have been located as far as possible to avoid forest land. Surface master plan is given in **Plate No. GEN-V**.

b) A proper resettlement and rehabilitation (R&R) plan is to be drawn up in consultation with the state govt. and project affected persons (PAPs) taking into consideration the existing norms of Government of Orissa.

c) Suitable provision for compensatory afforestation, arboriculture and technical reclamation have been made as per latest guidelines of EAC. Government land shall be chosen for compensatory afforestation and resettlement of PAPs. These shall be finalised during implementation.

d) In rainy season, water from the proposed mining area flows down to Chhatta jore and Basundhara river mainly. Mining operation will disrupt the existing drainage system. Garland drains around the periphery have therefore, been provided.

e) The existing State Highway from Sundargarh to Raigarh is proposed to be diverted since it passes across the Kulda and Siarmal OCP. The alignment of the proposed diversion will be initially along embankment of Basundhara river temporarily and later it will be to the south of the proposed Siarmal OCP as decided by the project authority.

f) Area indicated in table 9.1 is required for mining Siarmal block. But area of 290 Ha may additionally be required for colony, rehabilitation and resettlement, railway siding if the same cannot be accommodated in existing facility of MCL in Basundhara-Garjanbahal area.

Chapter - 10

ENVIRONMENTAL MANAGEMENT

10.1 GENERAL

Siarmal OCP is located in north-western part of Ib-valley coalfield in the district of Sundergarh, Odisha. The project comes under administrative control of MCL, Sambalpur. The blocks are situated between the Latitude 22º01'19"-22º03'59.99"N and Longitude 83º 37'09" – 83º42'59.58" E in Survey of India topo-sheet no.-64N/12 on RF 1:50,000.

10.2 PROJECT PROFILE

The mineable reserve for is 1547.82 Mt. The production capacity is proposed to be 50.0 Mty. Mine life at this target works out to be 38 years.

10.3 CLIMATE

The area experience a sub-tropical warm temperature. Mean annual precipitation is 1514.5 mm of which 85% occurs during rainy seasons. Mean temperature varies from 6º to 49º.

10.4 EXISTING ENVIRONMENTAL QUALITY

10.4.1 AIR QUALITY

Routine monitoring of Kulda OCP and Basundhara (W) OCP is carried out which are nearer to Siarmal OCP. The following stations are monitored and average values of SPM, RPM, SO_2 and NO_X recorded from pre monsoon season i.e. (March'17 to May'17) are given below:

	Name of the Air Station	(Values in µg/m^3)				
		PM 2.5	**PM10**	**SO_2**	**NO_X**	**SPM**
1	A3-West of Working Face	43.50	205.80	2.54	<6	417.5
2	Khamarpara	83.55	185.73	4.59	14.71	387
	Permissible Limit	**60***	**300**	**120**	**120**	**600**

* As per National Ambient Air Quality Standards (NAAQS), 2009

10.4.2 WATER QUALITY

DRINKING WATER QUALITY

The drinking water quality of of Kulda OCP and Basundhara OCP for the stations at filter plant and Basundhra colony tap water for March-May 2017 is given in following table:

Project / OCP	Kulda OCP	Kulda OCP	Kulda OCP		
Monitoring Station	**Filter plant**	**Filter plant**	**Filter plant**	**Indian Drinking Standards (IS-10500):2012**	
Dt. of sampling	**07-03-2017**	**15.04.17**	**11-05-2017**	**Acceptable**	**Permissible**
Colour(Hazen)	2	4	2	**5**	**15**
Odour	Agreeable	Agreeable	Agreeable	**Agreeable**	**Agreeable**
Taste	Agreeable	Agreeable	Agreeable	**Agreeable**	**Agreeable**
Turbidity(NTU)	1	1	1	**1**	**5**
pH	6.88	7.64	7.18	**6.5-8.5**	**No relaxation**
Total Alkalinity(mg/L)	20	48	24	**200**	**600**
Total Hardness(mg/L)	228	224	220	**200**	**600**
Iron(mg/L)	<0.06	<0.06	<0.06	**0.3**	**No relaxation**
Chloride(mg/L)	30	28	30	**250**	**1000**
Residual Free chlorine(mg/L)	<1.0	<1.0	<1.0	**0.2**	**1**
Total Dissolve Solid(mg/L)	338	362	314	**500**	**2000**
Calcium(mg/L)	46.4	46.4	48.0	**75**	**200**
Copper(mg/L)	<0.03	0.1	0.06	**0.05**	**1.5**
Manganese(mg/L)	0.04	0.06	<0.02	**0.1**	**0.3**
Sulphate(mg/L)	40	29	26	**200**	**400**
Nitrate(mg/L)	4.43	6.76	4.78	**45**	**No relaxation**
Fluoride(mg/L)	0.41	0.44	0.56	**1**	**1.5**
Selenium(mg/L)	<0.002	<0.002	<0.002	**0.01**	**No relaxation**
Arsenic(mg/L)	<0.002	<0.002	<0.002	**0.01**	**0.05**
Lead(mg/L)	<0.005	<0.005	<0.005	**0.01**	**No relaxation**
Zinc(mg/L)	0.07	<0.02	0.04	**5**	**15**
Boron(mg/L)	<0.2	<0.2	<0.2	**0.5**	**1.0**
Cadmium(mg/L)	<0.0005	<0.0005	<0.0005	**0.003**	**No relaxation**

Project / OCP	Basundhara OCP	Basundhara OCP	Basundhara OCP		
Monitoring Station	Basundhra colony tap water	Basundhra colony tap water	Basundhra colony tap water	Indian Drinking Standards (IS-10500):2012	
Dt. of sampling	07-03-2017	15.04.17	11-05-2017	Acceptable	Permissible
Colour (Hazen)	2	2	2	5	15
Odour	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
Turbidity(NTU)	1	1	1	1	5
pH	7.01	7.47	7.33	6.5-8.5	No relaxation
Total Alkalinity(mg/L)	20	20	12	200	600
Total Hardness(mg/L)	140	148	140	200	600
Iron(mg/L)	<0.06	<0.06	<0.06	0.3	No relaxation
Chloride(mg/L)	12	2	14	250	1000
Residual Free chlorine(mg/L)	<1.0	<1.0	<1.0	0.2	1
Total Dissolve Solid(mg/L)	292	336	274	500	2000
Calcium(mg/L)	28.8	30.4	30.4	75	200
Copper(mg/L)	<0.03	0.1	0.04	0.05	1.5
Manganese(mg/L)	0.03	0.06	<0.02	0.1	0.3
Sulphate(mg/L)	94	102	88	200	400
Nitrate(mg/L)	5.76	5.47	4.43	45	No relaxation
Fluoride(mg/L)	0.36	0.38	0.48	1	1.5
Selenium(mg/L)	<0.002	<0.002	<0.002	0.01	No relaxation
Arsenic(mg/L)	<0.002	<0.002	<0.002	0.01	0.05
Lead(mg/L)	<0.005	<0.005	<0.005	0.01	No relaxation
Zinc(mg/L)	0.09	0.1	0.07	5	15
Boron(mg/L)	<0.2	<0.2	<0.2	0.5	1.0
Cadmium(mg/L)	<0.0005	<0.0005	<0.0005	0.003	No relaxation

All the parameters are well within permissible limit.

MINE EFFLUENT DATA

Mine effluent data of Final Discharge point of mine & Outlet of settling pond of Kulda OCP for the period March-May, 2017 is given in following table:

Table: Effluent Quality Data
Project: Kulda OCP

Date of Sampling	Sampling Station	pH	Oil & Grease (mg/l)	TSS (mg/l)	COD (mg/l)
07-Mar-17	Final Discharge point of mine	7.17	<4.0	56	44
23-Mar-17	Final Discharge point of mine	7.42	<4.0	56	44
15-Apr-17	Final discharge point of mine	7.88	<4.0	14	8
26-Apr-17	Final discharge point of mine	7.03	<4.0	16	8
11-May-17	Final discharge point of mine	7.01	<4.0	26	16
26-May-17	Final discharge point of mine	7.99	<4.0	52	32
07-Mar-17	Outlet of settling pond	7.39	<4.0	48	32
15-Apr-17	Outlet to settling pond	7.37	<4.0	36	20
11-May-17	Outlet to Settling Pond	6.72	<4.0	58	44
Standards		**5.5 to 9.0**	**10**	**100**	**250**

All the parameters are well within permissible limit.

10.4.3 NOISE QUALITY

Noise is considered as a source for annoyance and health hazard. The high noise level disturbs the ambient environmental quality. The noise level has been monitored during day time (6:00 AM to 10:00 PM) and night time (10:00 PM to 6:00 AM) on fortnightly basis.

Table: Noise Level Data
Project: Basundhara OCP
Monitoring Station: Khamarpara

Date of Sampling	(Values in dB(A))	
	Day	Day
04-Mar-17	59.6	70.6
23-Mar-17	67.4	63.2
17-Apr-17	68.4	69.9
02-May-17	70.1	67.4
16-May-17	72.4	64.9
Standards	**75.0**	**70.0**

Table: Noise Level Data
Project: Basundhara OCP
Monitoring Station: Near CHP

Date of Sampling	(Values in dB(A))	
	Day	Day
04-Mar-17	66.6	73.3
23-Mar-17	70.2	64.9
17-Apr-17	63.8	72.6
02-May-17	69.4	67.2
16-May-17	68.7	67.5
Standards	**75.0**	**70.0**

Table: Noise Level Data
Project: Basundhara OCP
Monitoring Station: Near Embankment

Date of Sampling	(Values in dB(A))	
	Day	Day
04-Mar-17	63.9	69.8
23-Mar-17	67.8	66.1
17-Apr-17	58.0	72.4
02-May-17	68.8	67.2
16-May-17	75.3	72.4
Standards	**75.0**	**70.0**

Table: Noise Level Data
Project: Basundhara OCP
Monitoring Station: Tikilipara

Date of Sampling	(Values in dB(A))	
	Day	Day
04-Mar-17	64.6	69.4
23-Mar-17	65.0	60.6
17-Apr-17	67.7	67.1
02-May-17	68.8	65.6
16-May-17	66.6	67.5
Standards	**75.0**	**70.0**

The noise quality data are within the permissible limits of the Standards prescribed by the CPCB.

10.4.4 FLORA & FAUNA

A detailed study and its impact on flora & fauna will be done at the time of preparation of EIA/EMP.

10.4.5 SOCIO-ECONOMIC PROFILE

A detailed study and its impact on Socio Economic profile will be done at the time of preparation of EIA/EMP.

10.5 ENVIRONMENTAL IMPACT & MANAGEMENT

10.5.1 IMPACT ON AIR QUALITY AND ITS MANAGEMENT

The mining and its related activities will cause ambient air pollution. The ambient air will be polluted due to presence of RPM, SPM, SO2 & NOx which will be generated due to various activities related to the project. The concentration of pollutants will vary depending upon micro-meteorological parameters of area.

Appropriate air pollution control measures have been taken so that the ambient air quality is maintained within stipulated standards. Both preventive and suppressive measures which have been taken are elaborated below:

10.5.2 IMPACT ON WATER QUALITY AND ITS MANAGEMENT

The likely sources of water pollution from this project will be as follows:

* Sanitary (Domestic) wastewater.
* Industrial wastewater from workshop.
* Mine discharge water.
* Surface run-off passing through coal stockpiles and OB dump.
* Storm water from leasehold and built-up areas.

The impact of mining at this project on both surface water source and ground water resource has been assessed as follows:

- **SURFACE WATER SOURCES**

* Disruption of natural drainage pattern in the core zone.

* Deterioration of water quality & pollution of water bodies.
* Siltation and choking of water courses causing scarcity of surface water and flooding problem in the area

10.5.3 GROUND WATER RESOURCES

Due to excavation, ground water aquifers are disrupted.

* Due to pumping of mine water, the water table of the region may get lowered.

10.5.4 NOISE IMPACT

The adverse effect of high noise level like health effect (both auditory and non-auditory), masking effect, sleep interference, change in personal behavior.

10.5.5 FLORA AND FAUNA

A detailed study and its impact on flora & fauna will be done at the time of preparation of EIA/EMP.

10.5.6 IMPACT ON LAND USE

The major direct impacts on existing land use during the pre-mining phase area the removal of vegetation and resettlement of displaced population. There may also be land use changes with respect to agriculture, fisheries, recreation sites, housing, forestry areas, etc. Land reclamation / restoration of mined out lands may give rise to enhanced beneficial land use.

There exists major environment impacts due to landscape disruption particularly visuals (unsightly huge dumps, voids, mine structures, subsidence, mine fires, etc.). During mining and post-mining phases drastic changes in landscape with landforms take place. The major associated impacts are soil-erosion, loss of topsoil, change in complete geology, creation of huge dumps & voids, disposal of wastes, deforestation, etc.

Irrespective of the type of mining used for extracting coal, mining invariably results in enormous land disturbance – e.g. large scale excavation, removal of top soil, dumping of solid wastes, cutting of roads, creation of derelict land, etc. Opencast mining has more potential impact on land than underground mining. With improved technology, opencast coal

mining is being used extensively because of its cost effectiveness and productivity; though it results in large-scale land disturbance. The alteration in land use pattern due to infrastructure is not to be considered as true change as these facilities can be utilized for some other purposes after the mining operation is over. The alteration in land use pattern due to activities of quarrying and external dumping of OB materials may be considered as true change in land use pattern.

10.5.7 IMPACT ON SOCIO-ECONOMIC

The major adverse impact will be displacement and rehabilitation / resettlement of affected people including change in culture, heritage & related features. The crime and illicit activities also prop-up due to sudden economic development of the area.

SOCIAL IMPACT

- **POPULATION GROWTH**

Skilled manpower required for the project may not be available in the area. Only semi-skilled and unskilled workers will be available from the local population. So people will migrate to this segment both from within and outside the district as well as the state due to creation of new employment opportunities.

- **EDUCATIONAL FACILITIES**

A number of educational institutes are already there in the buffer zone and its neighbourhood. The facilities already provided in the neighbouring projects will cater to the need of this project. So migration of population will not strain the local educational facilities already available. Further, the educational institutes owned by MCL are also accessible to local population.

- **HEALTHCARE FACILITIES**

The coal company has a number of healthcare centres including a well equipped Regional Hospital and a specialised **"referral"** hospital in the coalfield area. Provision of healthcare facilities have been provided in the project report. Healthcare facilities have been provided in the neighbouring projects. The above facilities will cater to the need of employees of this project. The local people can also avail these healthcare facilities.

- **ECONOMIC IMPACT**
  - Loss of agricultural land
  - General improvement of economy of the area
  - Increase in revenue of the state exchequer

- **IMPACT ON VILLAGE HABITATION**

The Rehabilitation and resettlement in the six villages namely Siarmal, Jhupurunga, Tumulia, Ratansara, Gopalpur and Tikilipara falling in the project area is being carried out under the direction of "Claims Commission" set up by Hon'ble Supreme Court for the purpose. Details of rehabilitation & resettlement are given below:

Sl.	Name of the Village	Resettlement (opted for Plot/cash compensation in lieu of plot)			Rehabilitation site
		Total eligible PAF for resettlement (survey report)	Provided (Plot/cash in lieu)	Balance (Plot/cash in lieu)	
1	**Siarmal**	189	Nil	189	Chhatanpali
2	**Jhupuranga**	529	Nil	529	Not finalised by claims commission
3	**Tumulia**	625	Nil	625	Not finalised by claims commission
4	**Ratansara**	238	Nil	238	Not finalised by claims commission
5	**Gopalpur**	1064	Nil	1064	Sarangijharia+Chatanpali (120 plots)
6	**Tiklipara#**	-	-	-	-
	Total	**2645**		**2645**	

Already resettled and rehabilated under Basundhara (W) OCP

10.6 ENVIRONMENT MANAGEMENT

10.6.1 AIR QUALITY MANAGEMENT

Appropriate air control measures will be adopted to maintain the ambient air quality within the stipulated standard. The control measures will be adopted for various operations like drilling operation, blasting operation, loading and transport, coal handling plant, fires at coalfaces and coal stock yard, OB dump(s) and workshop and stores, etc.

- **DRILLING OPERATION**

  All drills will be equipped with dust extraction.

- **BLASTING OPERATION**

  The operation shall be conformity to the extent laws with more closure control of blasting parameters.

- **LOADING & TRANSPORTING**
  - Surfacing all service roads by asphalt.
  - Unmettaled roads shall be kept free of ruts.
  - Provision has been made for instant shower system.
  - Development of greenbelt.
  - Provision of silo system.

- **COAL HANDLING PLANT & TRANSPORTATION SYSTEM**
  - All coal will be produced through eco-friendly Surface Miners.
  - Suppression of dust by fixed sprinklers in all critical points.
  - Covered conveyor belts.
  - Provision for Silo loading has been proposed.
  - Total coal will be transported to silo from the CHP directly by covered conveyor belts.

- **FIRES AT COALFACES, COAL STOCK YARD**
  - Provision of adequate fire fighting.
  - Storage of water at all critical points.
  - Regular supervision.

- **OB DUMPS**
  - Blanketing with OB materials to put off the oxygen supply

- **WORKSHOP & STORE**
  - Proper ventilation system.

10.6.2 WATER QUALITY

* Sedimentation ponds/tanks to treat mine discharge water for suspended solids.

* Oil and grease traps and sedimentation tanks for industrial wastewater.

* The domestic wastewater will be treated for Bio-chemical Oxygen Demand (BOD) and Total Suspended Solids (TSS).

* Garland drains with settling tanks for surface run-off.

10.6.3 NOISE MANAGEMENT

* Proper designing of plant & machinery by providing inbuilt mechanism like silencers, mufflers and enclosures for noise generating parts and shock absorbing pads at the foundation of vibrating equipment.
* Greenbelts around infrastructure site, service building area and township.
* Adoption of personal protective devices like earplugs, etc.

10.6.4 FLORA AND FAUNA MANAGEMENT

- The enhancement of forest area occurs due to measures like biological reclamation of backfilled area, arboriculture / afforestation, compensatory afforestation creation of greenbelt and avenue plantation.
- Water body created by the final voids will be beneficial to flora as the area is prone to water scarcity.
- This project will have no detrimental impact on diversity of floral species within terrestrial and aquatic habitats.

CONTROL MEASURES TO REDUCE IMPACT ON FAUNA

- The balance in the regional population will be maintained in natural course, owing to existing undisturbed forest areas in the vicinity of the project. The increase in green cover due to implementation of various measures like biological reclamation of backfilled area, arboriculture / afforestation adopted by the mine establishment will be an added bonus, though expected in distant future.
- The mine will be a "**zero-discharge**" one. If required, water will be discharged only after suitable treatment. No adverse impact on downstream aquatic life of surface water courses will be expected.
- The project will not likely to have impact on the faunal species diversity within the terrestrial and aquatic habitats.

10.6.5 LAND RESOURCE MANAGEMENT

- Solid waste generated due to coal extraction will be dumped externally and internally. The external dump and internal dump should be reclaimed biologically and technically.

- During the process, the geometrical shape of the dumps will be altered to make it amenable to effective biological reclamation and also to provide safety and stability.
- The face slopes of the dump will be maintained at the natural angle of repose of the material and at overall slope angle of 28^{o}.
- Suitable drainage arrangement for smooth disposal of storm water.
- Appropriate garland drain will be provided to collect run-off.
- Backfilled area will be reclaimed bio-logically and technically.
- Topsoil shall be progressively and concurrently utilized during physical/ technical reclamation of external OB dumps and backfilled area, thus obviating the necessity of storage of topsoil separately.
- Arboriculture will be carried out in the vacant areas.
- Proper afforestation/plantation will be carried out for greenbelt development.

10.7 ENVIRONEMTNAL MANAGEMENT SYSTEM

Environmental management system is a system for maintaining and reviewing the sustainable development in the environment. It is the part of the overall management system which includes on organization structure, planning activities responsibilities, practices, procedures process and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy.

AIMS OF ENVIRONMENTAL MANAGEMENT SYSTEM

- Identification and control of aspects, impacts and risks.
- Establishing an environmental policy, objectives and targets including compliance with legislation.
- Identifying environmental opportunities.
- Monitoring and continual improvement of environmental performance.

PROCEDURES FOR IMPLEMENTATION

- For the implementation of the Environmental Management System within an organization, the first step is to define the environmental policy.
- The top management of the organization should define and document its environmental policy.

- The second step is to conduct an initial environmental reviews like legislative and regulatory requirement, an identification of significant environmental aspects, an examination of all existing environmental management practices and procedures and an evaluation of feedback from the investigation of the previous incidents to assess the company's environmental conditions.

ESTIMATED COST FOR SOCIAL RESPONSIBILITY

For MCL fund for the CSR should be allocated based on 2% of the average net profit of the Company for the three immediate preceding financial years or Rs. 2.0 per tonne of coal production of previous year which ever is higher. Different peripheral development and community development works will be taken.

-- Nature of Peripheral Development and Community Development Works

(A) DRINKING WATER SUPPLY

(i) Renovation / installation of handpump
(ii) Renovation / construction of well
(iii) Renovation / digging of ponds
(iv) Water supply through pipe line in some villages around the mining area.

(B) EDUCATION

(i) Construction / repair of educational building.
(ii) Providing additional facilities, furniture, lab instruments, etc.

(C) RURAL HEALTH CARE

(i) Organizing camps for eye operations / post operation care / welfare camps.
(ii) Providing medical instruments to the village hospitals
(iii) Providing medical facilities to the rural population through mobile medical van.

(D) ROADS

(i) Construction and repair of rural roads.
(ii) Construction and repair of roads connecting mining area
(iii) Construction and repair of culverts
(iv) Construction and repair of bridges

(E) RECREATION CENTRES

(i) Construction of community centers
(ii) Providing financial aid to the various social institutions
(iii) Preparation of play grounds & organising sports.

(F) ENVIRONMENT

(i) Plantation of various species in the nearby villages of mining area
(ii) Distribution of saplings – fruit bearing plants, medical plants & avenue plants

(G) OTHER MISCELLANEOUS HEADS

(i) Street lighting
(ii) Providing facilities to various institutions
(iii) Providing facilities to district administration offices

Chapter – 11

MINE CLOSURE PLANNING

11.1 INTRODUCTION

The Mine Closure Plan in this report is prepared in consonance with the latest guidelines of Ministry of Coal, Govt. of India notified vide letter no.55011-01-2009-CPAM, dated 27th August, 2009 and as per subsequent latest updation dated 07.01.2013. This plan provides an indication of the cost and guideline to the process that will be used to close the Mine.

11.2 NAME OF MINE OWNER/COMPANY

Mahanadi Coalfields Limited (a subsidiary of Coal India Limited; Govt of India Undrtaking)

11.3 ADDRESS

Mahanadi Coalfields Limited
Jagruti vihar, Burla
Dist: Sambalpur (Odisha) - 768020

11.4 ABOUT MCL

MAHANADI COALFIELDS LIMITED is a subsidiary of COAL INDIA LIMITED formed in 03.04.1992. It is the one of the largest coal producing company in Coal India Limited which has been already awarded Mini Ratna, Cat-I status. It has eleven areas in two coalfields of Odisha with 6 underground and 16 opencast mines. Total coal production of the company is 139.21 Mt in 2016-17 which was 23.14 Mt in 1992-93.

11.5 AREA AND LOCATION

The Siarmal & Siarmal Extension and Banapatra, the two contiguous blocks, lie towards north western part of Ib River coalfield in Orissa state and together covers an area of 14.67 sq.km. The blocks are situated between the Latitude 22°01’19”-22°03’59.99”N and Longitude 83° 37’09” – 83°42’59.58” E in Survey of India topo-sheet no.-64N/12 on RF 1:50,000.

11.6 REASONS FOR MINE CLOSURE

1. Siarmal OCP will be closed after exhaustion of coal reserve.
2. Economic viability of coal. The mining operation may become unviable due to high stripping ratio, increasing cost of fuel, electricity and wages.
3. Prohibitory order imposed by Directorate General of Mine Safety or any other Statutory/ Legal authority.
4. An act of God such as flooding of mine and other natural calamity.
5. Any Lock-out or Lay-off.

11.7 OBJECTIVES OF MINE CLOSURE PLANNING

- To allow a productive and sustainable after-use of the site which is acceptable to the mine owner and the regulatory authority;
- To protect public health and safety;
- To alleviate or eliminate environmental damage and thereby encourage environmental sustainability;
- To minimize adverse socio-economic impacts.
- To protect the flora and fauna of the are

11.8 VARIOUS ASPECTS OF MINE CLOSURE PLANNING

The mine closure planning broadly involves the following aspects:

(a) Technical aspects;
(b) Environmental aspects;
(c) Social aspects;
(d) Safety aspects;
(e) Financial aspects.

11.9 MINE CLOSURE OBLIGATION

Environmental clearance of development projects including mining is done by government with the following objective:

“Optimal utilization of finite natural resources through use of better technology & management package and increasing suitable remedial measures”.

There is a need to define the liabilities, responsibilities and authorities of the mine management, other regulatory bodies, Central and State Governments after mine closure. Some obligations relating to the mine management are as follows:

(a) **Health & Safety**: Regulation Nos. 6, 61, 106, 112 of Coal Mines Regulations, 1957 and its related DGMS Circulars;

(b) **Environment**

(i) Water (Prevention & Control of Pollution) Act, 1974;
(ii) Air (Prevention & Control of Pollution) Act, 1981;
(iii) Environmental (Protection) Act, 1986 and Environmental Protection (Amendment) Rule, 2000;
(iv) DGMS Directives on Noise & Ground Vibration;

(c) **Forest**

Forest (Conservation) Act, 1980.

(d) **Rehabilitation**

CIL's Policy and Odisha State Govt. Policy. Latest Policy / Norms of Govt. of Odisha is followed for this project.

(e) **Decommissioning/asset disposal, etc.**

Decommissioning of infrastructure is done, the land occupied by the infrastructure will be restored to some useful purpose. The salvaging and shifting operation of mining machinery and other equipment will be done considering the ground realities existing during the period 1 year advance of final closure of the mine.

11.10 STATUTORY OBLIGATIONS

	Subject	Status
1.	TOR	Recommemdation of TOR by vide letter no J-11015/230/2014-IA.II(M) dated 20.02.2015

11.11 CLOSURE PLAN PREPARATION

'Mine Closure Plan' is a whole-of-life exercise that begins at the start of a mine life and continues through to post-closure. Even though most of the physical activity occurs at

the end of the mine life, it must be planned and considered throughout the life of the mine and not deferred until it is too late to plan properly to prepare for closure. The dynamic nature of closure planning requires regular and critical review to reflect changing circumstances as a result of any operational change, new regulation, new technology and remain flexible enough to cope with unexpected events.

There are two types of **'Mine Closure Plan'** as given below:

- Progressive mine closure plan
- Final mine closure plan

A **'Progressive Mine Closure Plan'** means a progressive plan, for the purpose of providing protective reclamation and rehabilitation measures in a mine or part thereof. Progressive Mine Closure Plan would include various land use activities to be done continuously and sequentially during the entire period of the mining operations. A **'Final Mine Closure Plan'** means a plan for the purpose of decommissioning, reclamation and rehabilitation in the mine or part thereof after cessation of mining and related activities that has been prepared in the manner to address all environmental aspects taking into consideration. Final Mine Closure activities would start towards the end of the mine life, and may continue even after the reserves are exhausted and/or mining is discontinued till the mining area is restored to an acceptable level to create a self sustained eco system.

The final mine closure plan shall be formulated at least five years before the intended final closure of the mine. The final mine closure plan will be submitted to Ministry of Coal for approval. The final mine closure plan consists of cost estimates and time bound schedules for various mine closure activities and details of the escrow account.

However proposed mine in Siarmal block may not be closed and mining operation may be continued upto dipside block. Therefore if mining is continued indipside decisions regarding final closure will be prepared along with mining plan & mine closure plan of dipside block.

11.12 MINE DESCRIPTION

11.12.1 PHYSIOGRAPHY & DRAINAGE OF THE AREA

Details are furnished in Chapter-3

11.12.2 GEIOLOGY

The geological details of the block are based on 503 borehoes covering an area of 14.67 sq.km with a borehole density of 34 BH/sq.km.. Out of 503 boreholes, 494 boreholes were drilled by CMPDI, 5 boreholes were drilled by DGO and 4 boreholes were drilled by GSI.

Details are furnished in Chapter-4.

11.12.3 MINING

Details are furnished in chapter-5

11.12.4 COAL HANDLING & DESPATCH

Details are furnished in chapter-7

11.13 PROGRESSIVE MINE CLOSURE

Mine closure operation is a continuous series of activities starting from day one of the initiation of mining project. Therefore, progressive mine closure plan will be a continuous process throughout the life of mine which will be reviewed periodically. This includes various land reclamation activities to be done continuously and sequentially during the entire life of the mine. This is a life time of mine process which starts from of commencement of mining operations and leads to the final closure of the mine.

Statements showing the land uses for the project are given in following table.

Table-11.1

Sl. No.	Particulars	Total Area in ha		
		Forest	Non-forest	Total
1	Mining & pit top infrastructure	260.769	1328.373	1589.142
2	Safety zone	3.930	14.662	18.592
3	External OB Dump, embankment, other infra & Blasting danger zone icl future exp.area	85.01	597.71	682.72
A.	**Total mining lease area**	**349.709**	**1940.745**	**2290.45**

11.13.1 ACTIVITIES OF PROGRESSIVE MINE CLOSURE PLAN

- **OB DUMP RECLAMATION**
  - **Handling & dozing of OB dumps & backfilling**
  - **Technical and Bio-reclamation including plantation**
- **Landscaping of the open space in leasehold area for improving its esthetics an eco value**

- **Grass carpeting/ Plantation around the quarry area and in safety zone**
- **Grass carpeting/ Plantation over the external OB Dump**
- **Entrepreneurship Development (Vocational/skill development training for sustainable income of affected people**
- **Miscellaneous and other mitigative measures**

Progressively mine will be advanced with increase in depth and excavation area. Mine stage plans are included in this report showing status of excavation and backfilling. Part of this excavation area will be backfilled and grass carpeted. Similarly all the activities associated with this backfilling like levelling, compaction, spreading of top soil and grass carpeting and maintaining the same throughout the mine life should be properly monitored. A suitable action plan and activity implementation schedule should be formed by company to implement and monitor the same. Provision of fund can be utilized from mine closure fund which will be returned to company from time to time. Rehabilitation of displaced manpower, training for them who are eligible for employment should also be carried out as per schedule.

11.13.2 MANAGEMENT OF WASTES

a) External OB dump & internal backfilling details prior to closure of mine or during progressive mine closure.

EXTERNAL OB DUMPS

The face of slope of external dump will be maintained at the natural angle of repose and at overall slope angle of 26^{o}. Once the external dump will reach its predetermined level, top surface shall be leveled and graded. Gradiant of surface shall be maintained less than 2% i.e. very gently slopping to prevent standage of water. Drainage arrangement will be provided for smooth disposal of storm water to avoid gully formation. Garland drains shall be provided around the external dump to collect run off sedimentation ponds one to be provided in order to avoid silt.

INTERNAL DUMP

Major part of the quarry will be backfilled with overburden. The backfilling will be carried out in a phased manner. Once the backfilling has reached a certain predetermined reduced level, the plots will be levelled, graded and cleared of large stone pieces lying on the surface. The slope of the ground will be made very gentle as far as possible (preferably less

than 2%). The graded and levelled area will be divided into small sectors and small check bunds will be constructed to retain moisture and humus in the soil. The outer slope of each bench will be kept at the natural angle of repose of the spoil material and at overall slope angle of 26^{O} considering all benches.

Details of area excavated/ disturbed & area reclaimed for plantation

Table11.2

	AREA USED (in Ha)						PLANTATION AREA (in Ha)				
Year/Stage	Excavation area for OC	Backfilling	Void	Extn Dump	Others	Total	Backfill	Dump	Green Area	Infrastructure/ Barren	Total
Yr-1	**29.93**		**29.93**	**25**	**21**	**75.93**					
Yr-3	**68.98**		**68.98**	**60**	**44**	**172.98**			**10.0**		**10.0**
Yr-5	**96.38**		**96.38**	**113.5**	**50**	**259.88**			**10.0**	**12.0**	**22.0**
Yr-10	**351.52**	**58.83**	**292.69**	**325.36**	**185**	**861.88**		**192.0**	**10.0**	**70.0**	**272.0**
Yr-18	869.68	428.64	**441.04**	663.96	258.05	1791.69	173.0	250.0	19.0	80.0	**522.0**
Yr-25	**979.04**	**568.16**	**410.88**	**663.96**	**358.05**	**2001.05**	**254.0**	**250.0**	**19.0**	**80.0**	**603.0**
Yr-38 (final)	**1546.32**	**1231.73**	**314.59**	**386.08**	**358.05**	**2290.45**	**966.0**	**386.08**	**19.0**	**100.0**	**1471.08**

DRAINAGE ARRANGEMENT FOR EXTERNAL OB DUMP & FOR INTERNAL DUMP

◈ DRAINAGE ARRANGEMENT FOR OB DUMPS

- **CATCH DRAIN**

  An open drain of appropriate size will be provided on all terraces at the foot of next bench to receive the storm water from upper benches. This will be discharged to the lower benches through masonry chute, thus minimizing gully formation in the slope of external dump.

- **FOOT DRAIN**

  A foot drain of proper size will be provided around the OB dump. This drain collects run-off from dump and direct it to settling tank/sedimentation pond before discharge to nearby natural water courses.

DRAINAGE ARRANGEMENT FOR INTERNAL OB DUMP

The drainage arrangements for precipitation run-off are as follows :

- During working stage, the run-off will be collected from internal dump by foot drain for diverting to mine sump for pumping.
- In the post-mining period, the drainage pattern of the reclaimed area will be such that the run-off will be diverted to final void of the quarry which will be developed as a water reservoir for **water harvesting** and also recharging the aquifer in the surrounding area.

There is an intricate relationship between surface water and ground water. In the monsoon period, till the aquifer attains its original ground water level, surface water bodies like stream, ponds & lakes recharge the aquifer. As soon as ground water recoups and attains its level, it contributes again to surface water bodies. After post-monsoon period, this process is reversed again as ground water level gets lowered from the original level.

The mine dewatering brings down ground water level in the immediate vicinity of the mine. Maximum effort will be made to recycle or reuse the treated mine discharge water totally to the extent possible by keeping the make up water in different sumps or low lying areas of the project. In unusual situations during monsoon, mine discharge water will be allowed to go as recharge/run-off in the same basin of the area.

As such, this area is having an average annual rainfall of 1270mm. This rainfall replenishes the annual ground water draft every year. This will enhance the recharge of the aquifer in the area for mitigating the lowering of ground water level in the area surrounding the mine.

- During working stage, the run-off is collected from internal dump by foot drain for diverting to mine sump for pumping.
- In the post-mining period, the drainage pattern of the reclaimed area will be such that the run-off will be diverted to final void of the quarry as a measure for water harvesting.

b) Top soil/soil amendment application

This is an opencast mine. Top soil from broken-up area has been reclaimed in the external backfilled area. Top soil from unbroken area is scraped for progressive and concurrent utilization during technical reclamation of backfilled area, thus obviating the necessity of storage of top soil separately.

c) Plantation on external & backfilled area, avenue and block plantation with type of plantation i.e. local/native species. Name the local species for plantation.

For successful biological reclamation of the reclaimed area, preference is given to endemic species and mixed culture. The species are selected carefully from the following groups for quick reclamation :

- Nitrogen fixing tree species for fuel wood, timber and fodder
- Fruit bearing tree species
- Tree species with dense foliage for shade
- Flowering and ornamental tree species.

d) Plantation on external & backfilled area, avenue and block plantation with type of plantation i.e. local/native species. Name the local species for plantation.

For successful biological reclamation of the reclaimed area, preference is given to endemic species and mixed culture. The species are selected carefully from the following groups for quick reclamation :

- Nitrogen fixing tree species for fuel wood, timber and fodder
- Fruit bearing tree species
- Tree species with dense foliage for shade
- Flowering and ornamental tree species.

Top soil removal

Table11.3

Year	Top soil removal
Year-1	**0.09**
Year-3	**0.21**
Year-5	**0.29**
Year-10	**1.05**
Year-18	**2.61**
Year-25	**2.94**
Year-38(final)	**4.64**

11.13.3 MANAGEMENT OF AIR QUALITY

The average values of Routine Environmental Monitoring data of the existing Siarmal OCP project for SPM, RPM, SO2, NOX and PM2.5 during the period March-May 2017 are given in Chapter-10.

Details of existing air quality controls measures are described in chapter-10 which are summarized below:

DETAILS OF CONTROL MEASURES

- Dust extraction in drill machines
- Fixed water sprinklers at CHP, haul road
- Mist spraying in feeder breakers at CHP.
- Mobile water sprinkler for haul roads, transportation roads
- Black topping roads, colony roads, approach road to service buildings and to projects
- Greenbelt cover development

11.13.4 WATER QUALITY MANAGEMENT

Detailed water quality data & it's management are described in chapter-10.

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

The details of water pollution control measures are described in chapter-10.

MANAGEMENT OF HYDROLOGY AND HYDRO-GEOLOGY

- Assessment of hydrology and hydro-geology of the area

  Investigations have been carried out in and around the area comprising of core and buffer zones of this project. The matter has been dealt.

- Estimation of ground water availability of the area

  Ground water availability of the area comprising of core and buffer zones of this project has been assessed.

- Water demand, dewatering of the mine and waste water management

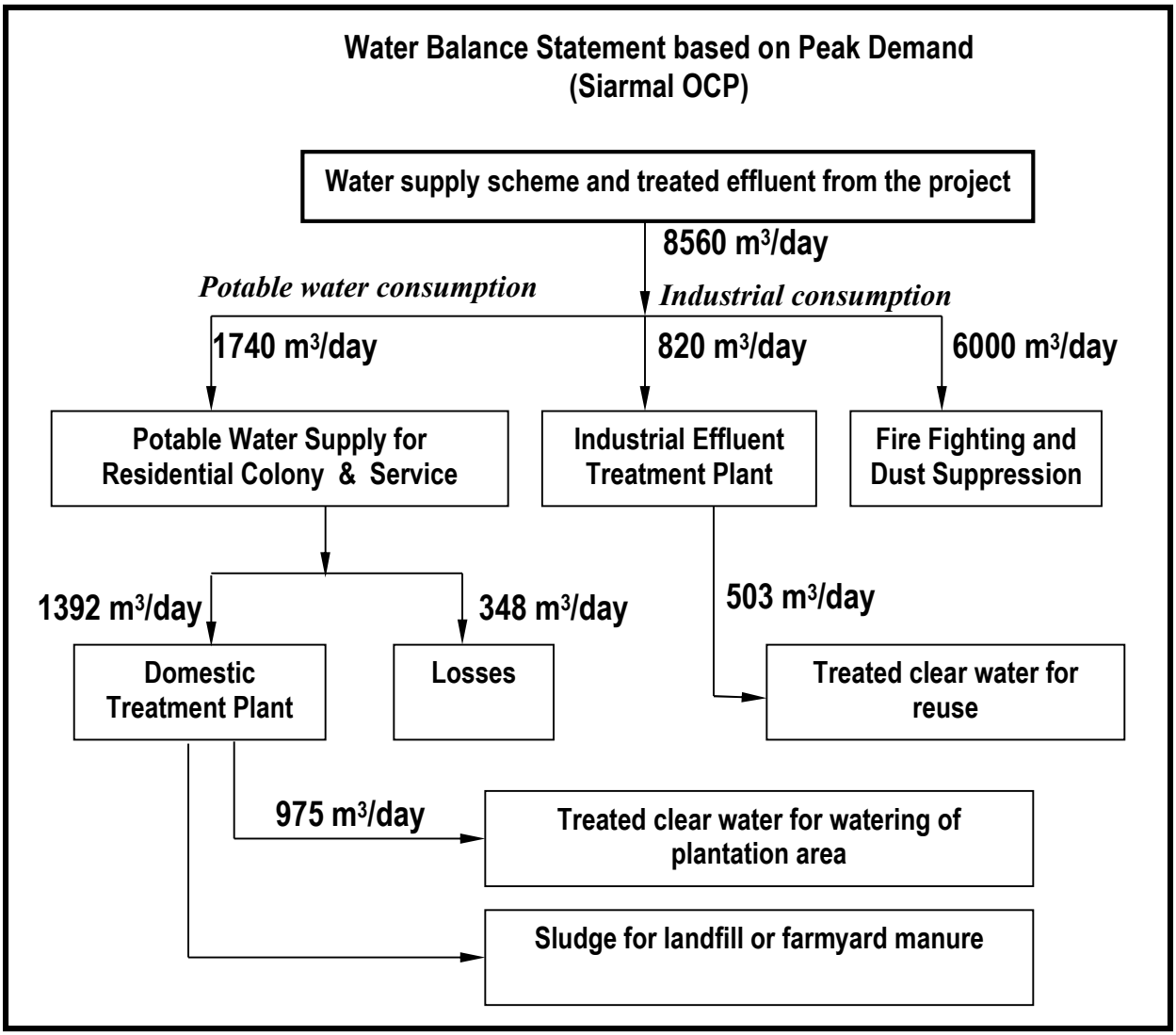
  The above details have been given in this report.

- Impact of the mine on ground water and surface water

MANAGEMENT OF RECHARGE AREAS

Mining operation of this project will create voids or depressions, which will induce / accelerate rainfall recharge and decrease run-off in the mining area. Maximum effort will be made to recycle or reuse the treated mine discharge water totally to the extent possible by keeping the make of water in different sumps or low lying areas of the mine. The remaining water will be discharged to the natural drainage for ground water recharge in the same basin. The final voids of the quarry will be left as a water reservoir for water harvesting and also recharging the aquifer in the surrounding area.

WATER BALANCE DIAGRAM



11.13.5 DIFFERENT ACTIVITIES TO BE MONITORED DURING PROGRESSIVE MINE CLOSURE

Major activities for the project during mine closure should be decided in detail by project auyhority, some of these activities are described below:

- Backfilling
- Levelling
- Land scaping
- Spreading of top soil
- Biological reclamation
- Grass carpeting/ tree plantation (if the dumps are rehandled during mine closure the same should be grass carpetted instead of bigger size tree plantation)
- Fencing, supervision of the reclaimed area
- Rehabilitation of displaced families, skill development programme for elligible persons.

Progressive reclamation and plantation should be monitored by project authority alongwith cost 5 yearly or yearly as desired by company. Following are the details of mine closure activities ;

Table 11.4

Closure activities	quantity	cost	Year 1-5	Year 6-10	Year 11-15
Technical reclamation	Ac/Ha				
Biologiacl reclamation	Ac/Ha				
Landscaping	Ac/Ha				
Tree plantation	Ac/Ha				
Entrepreneurship development					
Miscellaneous activities (fencing, supervision,vehicle,security)					

These closure activities are tentative, many other activities may be listed by project authority during implementation. Cost incurred for these activities should be recorded by them for future refund of mine closure deposit from escrow account.

EMANCIPATION FROM PAPs

- The resettlement site shall be named suitably.
- If any place of worship like temple, church, etc. are acquired, the same shall be provided on the replacement basis.
- A community of a particular caste, creed and religion shall be allowed to resettle in a particular area in the resettlement colony to foster the communal harmony.
- Training facilities shall be extended to the woman folk to give aequate access to income generating opportunities for raising their social status.

11.14 FINAL MINE CLOSURE PLAN

As per present schedule final mine closure operation will be taken up after exhaustion of coal reserve in Siarmal OCP.

Scenario 1: However if dipside block is proposed to be annexed in present property then mine closure activities will be taken up only after working of dipside area, backfilling and other elements of progressive mine closure will be continued while mining in dipside block. Final mine closure activities will only be taken up after exhaustion of coal reserve in it's dipside block.

Following is the the land status just after completion of mining activity in the present mining block.

Table 11.5

Post-mining land use (at the end of mining activity)							
Sl. No.	Category	Land use (in ha)					
		Plantation	Water body	Dip side slope, Active dump & haul road	Undis-turbed	Built-up area	Total
1	Quarry excavation	966.0	67.0	513.32	--	--	1546.32
2	Safety zone	18.59	--	--	--	--	18.59
3	OB dumps (external)	386.08	--	--	--	--	386.08
4	embankment	18.0	--	--	--	10.3	28.3
5	infrastructure	8.00	--	--	--	34.82	42.82
6	Blasting danger zone & other future exp area	74.41	--	--	193.93	--	268.34
A	**MINE LEASE AREA**	**1471.08**	**67.0**	**513.32**	**193.93**	**45.12**	**2290.45**
7	Residential colony	14.00	--	--	--	56.00	70.00
8	Resettlement site	28.00	--	--	--	112.0	140.00
9	Diversion of road & railway link	10.0				70.0	80.00
B	**Total PROJECT AREA**	**1523.08**	**67.0**	**513.32**	**193,93**	**283.12**	**2580.45**

11.14.1 ALTERNATIVE USE OF LAND

There are several options available for land use pattern of the reclaimed land. The following factors have been considered for selection of appropriate land use pattern:

- Pre-mining land use pattern
- Topsoil/sub-soil quality
- Socio-economic parameters of the area
- Availability of technology for land reclamation
- Climatic conditions of the area
- Local flora.

The alternatives available for utilising the reclaimed land are :

- ❖ Agricultural use
- ❖ Afforestation

The option for using the reclaimed backfilled area for agricultural purpose immediately is ruled out due to the following reasons :

- The reclaimed land is very different from its pre-mining conditions. It cannot sustain crops as the soil has poor fertility status. So the agriculture may prove uneconomic venture compared to afforestation.
- The development of soil regime for agriculture will take a considerable time.
- Reclamation is proposed to be done progressively and concurrently with mining operation. Carrying out agriculture within mining activity area by releasing reclaimed area in a phase-wise manner, may not be advisable from safety point of view.

In view of the above, it is suggested to utilise the reclaimed land for afforestation or grass carpeting purpose which will help improve the soil status i.e texture and nutrient levels, etc.

Scernario 2: In case it is decided not to work Dip Side block for any reason then mine will have to be closed after working of siarmal OCP.

Option-1: in this case mine will be closed after exhaustion of coal reserve in present mining block. All the dumping & final quarry slope will be grass carpeted or covered with plantation. Final mine void in quarry-2 will be around 360 m which will be kept as waterbody.

Table 11.6

Table : Post-closure land use

Sl. No.	Land Use Category	Land use in ha.				
		Left out unfilled void/ water body (depth 0-360m)	Afforested /grass carpetting	Land to be converted for agriculture (conceptual)	Undisturbed Built up area	Total
1.	Quarry excavation area	190.80	1355.52	--	--	1546.32
2.	Safety zone	--	18.59	--	--	18.59
3.	OB dump (external)	--	386.08	--	--	386.08
4.	embankment	-	18.0	--	10.3	28.3
5.	infrastructure	--	8.00	--	34.82	42.82
6.	Blasting danger zone & other future exp area	--	74.41	--	193.93	268.34
	Total :	**190.80**	**1860.60**	--	**239.05**	**2290.45**

Option-2: in this case mine will be closed after exhaustion of coal reserve in present mining block. All the external dumps will be rehandled back to ultimates voids of the prposed mine, similarly all the internal dumps which are above ground level also will be brought back into voids of the final pit and internal dumps will be reshaped to the surrounding ground level. Final mine void will be around m which will be kept as waterbody.

Table 11.7

Table : Post-closure land use						
Sl. No.	Land Use Category	Land use in ha.				
		Partially filled Left out void/ water body (av depth:155m)	Afforested /grass carpetting	Land to be converted for agriculture (conceptual)	Undisturbed Built up area	Total
1.	Quarry excavation area	549.69	409.99	586.64	--	1546.32
2.	Safety zone	--	18.59	--	--	18.59
3.	OB dump (external)	--	386.08	--	--	386.08
4.	embankment	-	18.0	--	10.3	28.3
5.	infrastructure	--	8.00	--	34.82	42.82
6.	Blasting danger zone & other future exp area	--	74.41	--	193.93	268.34
	Total :	**549.69**	**915.07**	**586.64**	**239.05**	**2290.45**

11.14.2 UNDERGROUND WATER/QUARRY WATER MANAGEMENT AFTER CLOSURE (SPECIFY ITS USAGE LIKE DOMESTIC WATER SUPPLY, IRRIGATION, PISCICULTURE OR STABILIZING THE GROUND WATER REGIME)

Maximum effort are being made and will be made to recycle or reuse the treated effluents totally to the extent possible by keeping the make of water in different sumps or low lying areas of the mine. The final voids of the quarries will be left as a water reservoir for **water harvesting** and also recharging the aquifer in the surrounding area which will serve following purposes :

- Source of supply of water for industrial and fire fighting purposes of near by mines.
- Source of supply of potable water after necessary treatment.
- Pisciculture.
- For recharging the aquifer in the area.

In the post-mining period, the drainage pattern of the reclaimed area will be such that the run-off will be diverted to final void of the quarry which will be developed as a water reservoir for **water harvesting** and also recharging the aquifer in the surrounding area.

All these activities will have to be continued till the area will be mined again for extraction of lower seams.

11.14.3 WATER QUALITY MONITORING FOR THREE YEARS AFTER CLOSURE THE SAMPLING STATIONS SHALL BE ONE NO. MINE WATER WITH FORTNIGHTLY FREQUENCY AND TWO NUMBERS GROUND WATER SAMPLES IN CORE AND BUFFER ZONE WITH MONTHLY FREQUENCY

At present water samples covering surface water, ground water and effluent are being analysed in the core and buffer zones of the project. Out of the above, three sample points will be utilized for Water quality monitoring for three years after closure of the mine.

11.14.4 DETAILS OF SURFACE STRUCTURES PROPOSED FOR DISMANTLING

All equipment and buildings erected on site for the mining operation should be dismantled and removed as part of the reclamation process, unless they form part of the future land use infrastructure. All these activities will not be taken up after phase-I as remaining portion will be taken up for mining as phase-II.

BUILDINGS/ ADMINISTRATION OFFICES

Buildings shall be constructed to last depending on the anticipated life of the mine operation. Buildings for short term use should preferably be prefabricated structures that can be easily dismantled at the time of closure and reclamation. Such structures should be totally removed from the site and may be disposed of at an approved facility or reused elsewhere. Foundations comprised of concrete should be broken up, buried or removed in accordance with applicable waste management regulations.

WEIGHBRIDGE

Fixed equipment and structures such as weigh scales may also have concrete pads or footings and these should be broken up, buried on site or removed in accordance with applicable waste management regulations.

SUB STATIONS/POWER LINES

All power lines, cables, towers and guy wires should be removed as well as any concrete footings or slabs where appropriate. If access roads were necessary for construction or decommissioning of power lines, they should be ripped and revegetated.

ROADS

Access and on-site roads should be properly designed and constructed as part of the initial operating plan to minimize adverse environmental effects and facilitate reclamation. In the operating plan, roads should fit the topography to minimize unnecessary earth moving for road cuttings and embankments. All culverts and drains should be removed and original drainage restored as much as possible in accordance with future land use planning.

11.14.5 DISPOSAL OF PLANTS & MACHINERIES

All the P&M will be reused in dipside mine or other projects of the company after the mine closure , in case not useful for company then Possibility shall be explored for handing over to state Govt. (including residential & non-residential buildings) for the benefit of local villagers and strengthening the area infrastructures. The end use of these facilities shall be decided by State Govt. with the help of local Govt. and village Panchayat.

a) DISPOSAL OR REUSE OF EXISTING HEMM, CHP AND WORKSHOP

HEMMs which will have balance life may be deployed in dipside mine or some other project of the company if possible, or otherwise will be disposed off. CHP, workshop at the end of mine life will be dismantled and disposed off. Every effort will be made to restore the area to economic utilisation value as per the mine closure plan.

b) DISPOSAL OR REUSE OF TRANSMISSION AND SUBSTATION

The transmission line and substation will be used by neighbouring mines or local community. The transmission line and transformers will be dismantled and removed from the site if not required for purposeful use by the local community or nearby mines.

11.14.6 CONTROL MEASURES TO RESTORE LAND USE & LANDSCAPE

- The face slopes of the dump will be maintained at the natural angle of repose of the material and at overall slope angle of 26^{o}.
- The newly backfilled area may be covered with suitable grass plants, plantation for bigger trees should be avoided as all these dumps will be rehandled while extraction of lower seams.
- Suitable drainage arrangement for smooth disposal of storm water.
- Appropriate garland drain is to be provided to collect run-off.
- Topsoil shall be progressively and concurrently utilized during physical/ technical reclamation of external OB dumps and backfilled area, thus obviating the necessity of storage of topsoil separately.

- Arboriculture carried out in the vacant areas which will not be mined in future.
- Proper grass carpeting/afforestation/plantation is carried out for greenbelt development.

11.14.7 SAFETY AND SECURITY ARRANGEMENT

a) DETAILS OF FENCING AROUND ABANDONED QUARRY INDICATING THE LENGTH OF THE FENCING

Fencing around abandoned quarry will be done as per details given in D.G.M.S Circulars.

b) MINE ENTRY SEALING ARRANGEMENTS AND SUBSIDENCE MANAGEMENT FOR UG MINES

Not Applicable.

c) PROVIDING ONE TIME LIGHTING ARRANGEMENT

Sufficient lighting as per standard will be provided at all the required places, i.e. working faces, OB dump area, haul road, coal transfer points, loading points, CHP, workshop, etc., to avoid accidents and to create efficient working conditions.

After closure of the mine, the lighting arrangements will be kept maintained at all locations which are not required to be demolished or dismantled like sub-stations, transformers, community services, pump-houses, water-treatment/ filtration plants, waterlines, power lines, roads etc. to be utilized for the neighbouring projects and at critical places for safety point of view.

The guidelines/instructions from DGMS will be followed in case of discontinuance of mine operation, if any.

d) SLOPE STABILITY ARRANGEMENT FOR HIGH WALL AND BACKFILLED DUMPS

During the process, the geometrical shape of the dumps is altered to make it amenable to effective biological reclamation and also to provide safety and stability & high wall will be maintained and stabilized as per norms.

The details of the final Mine Closure plan alongwith the details of the updated cost estimates for various mine closure activities and the Escrow account already set up shall be submitted to the Ministry of Coal for final approval at least five years before the intended final closure of the mine.

11.15 ECONOMIC REPERCUSSIONS OF CLOSURE OF MINE

Many infrastructures like roads, power line etc have been developed and the local people have gained out of it. Educational institutes owned by MCL are accessible to local population. Healthcare facilities (dispensaries/hospitals) have been provided in this project. The coal company has a number of healthcare centres including a specialised **"referral"** hospital in the coalfield area at Brajrajnagar. The local people can also avail these healthcare facilities. As part of peripheral development, MCL has widened and strenghened the existing roads with better connectivity with district HQ (Sundargarh) and Brajrajnagar and Jharsuguda.

Overall there has been positive impact in socio-economic area due to increased economic activities, creation of new employment opportunities, infrastructural development and better educational and healthcare facilties. Even after closure of the mine , these facilities will continue.

There has been creation of direct and indirect employment opportunities due to working of this mine. After closure, these people will be engaged in upcoming any oyher mines of MCL.

11.16 DETAILS OF MINE CLOSURE ACTIVITIES WITH TIME SCHEDULE

The peak workforce required for mine operations is in the first few years of the mine when construction activities as well as operational activities achieve their peak. This workforce slowly goes down with completion of development and when only the operational work remains. Again, near the end of mine life say, 5 years advance of closure, the activity of the mine starts getting reduced and therefore, management will get opportunity to taper the operational manpower. After closure, skeleton service people will be left for continuing the actual closer operations.

(i) ORGANISATION FOR EXECUTING THE CLOSURE ACTIVITIES AND POST-PROJECT MONITORING

An organization with necessary manpower and vehicle support will be needed. The manpower required for the closure activities and the then post-project monitoring are given below:

Table 11.8
Manpower for closer activities and post-project monitoring

Sl.No.	Designation	No.
1.	Asst.Colliery Manager	1
2.	Overman	1
3.	Mining Sirdar	1
4.	Watchman	2
	Total :	5

TIME SCHEDULE FOR DIFFERENT ACTIVITIES FOR MINE CLOSURE

The closure of mines evolves environmental, technical, social aspect and financial assurance for implementing activities will run for three years. The following activities will be implemented as per bar chart. The details of time schedule for all closure operation which are applicable for both Progressive and Final Mine Closure Plan has been described with bar chart.

IMPLEMENTATION SCHEDULE FOR MINE CLOSURE IN SIARMAL OCP

(LIFE OF THE MINE: 38YEARS)

	Activity	Time frame	Yr-1 to yr-5	Yr-6 to yr-10	Yr-11 to yr-15	Yr-16 to yr-20	Yr-21 to yr-25	Yr-26 to yr-30	Yr-31 to yr-35	Yr-36 to yr-38	Post Closure Phase		
											PC1	PC2	PC3
A	**Dismantling of Structures**												
	Service Buildings & Other Buildings	2 years											
	Industrial structures like CHP, Workshop, field sub-station, etc.	2 & ½ years											
B	**Permanent Fencing of mine void and other dangerous area**												
	Random rubble masonry of height 1.2 metre including leveling up in cement concrete 1:6:12 in mud mortar	2 years											
C	**Grading of highwall slopes**												
	Levelling and grading of highwall slopes	2 years											
D	**OB Dump Reclamation**												
	Handling/Dozing of OB Dump and backfilling	Throughout the life of the mine including 3 years after cessation of mining operation											
	Technical and Bio-reclamation including plantation and post care	Throughout the life of the mine including 3 years after cessation of mining operation											
E	Landscaping												

	Activity	Time frame	Yr-1 to yr-5	Yr-6 to yr-10	Yr-11 to yr-15	Yr-16 to yr-20	Yr-21 to yr-25	Yr-26 to yr-30	Yr-31 to yr-35	Yr-36 to yr-38	Post Closure Phase		
											PC1	PC2	PC3
	Landscaping of the open space in the leasehold area for improving its esthetics and eco value	Throughout the life of the mine including 3 years after cessation of mining operation											
F	**Plantation**												
	Plantation over cleared area obtained after dismantling	2 years											
	Plantation around the quarry area and in safety zone	Throughout the life of the mine including 3 years after cessation of mining operation											
	Plantation over the external OB Dump	Throughout the life of the mine											
G	**Post Closure Env Monitoring / testing of parameters for three years**												
	Air Quality	3 years											
	Water Quality	3 years											
H	**Entrepreneurship Development (Vocational/skill development training for sustainable income of affected people**	Throughout the life of the mine											
I	**Miscellaneous and other mitigative measures**	Throughout the life of the mine including 3 years after cessation of mining operation											
J	**Post Closure Manpower cost for supervision**	3 years											

PC1 : Post Closure Year 1 PC2 : Post Closure Year 2 PC3 : Post Closure Year 3

Activity wise Progressive & Final Mine Closure cost distribution is given in table below:

Table 11.9

S.No	ACTIVITY	Mine Closure Cost (percentage weightage)	Remarks
A	**Dismantling of Structures**		To be included in final mine closure plan
	Service Buildings	0.2	
	Residential Buildings	2.67	
	Industrial structures like CHP, Workshop, field sub-station, etc.	0.3	
B	**Permanent Fencing of mine void and other dangerous area**		To be included in final mine closure plan
	Random rubble masonry of height 1.2 metre including leveling up in cement concrete 1:6:12 in mud mortar	1.5	
C	**Grading of highwall slopes**		To be included in final mine closure plan
	Levelling and grading of highwall slopes	1.77	
D	**OB Dump Reclamation**		
	Handling/Dozing of OB Dump and backfilling	88.66	71% for progressive and 17.66% for final mine closure.
	Technical and Bio-reclamation including plantation and post care.	0.4	Equal weightage throughout the life of the mine.
E	**Landscaping**		
	Landscaping of the open space in leasehold area for improving its esthetics an eco value	0.3	Equal weightage throughout the life of the mine.
F	**Plantation**		
	Plantation over cleared area obtained after dismantling	0.5	To be included in final mine closure plan
	Plantation around the quarry area and in safety zone	0.2	Equal weightage throughout the life of the mine.
	Plantation over the external OB Dump	0.02	Equal weightage throughout the life of the mine.
G	**Post Closure Env. Monitoring / testing of parameters for three years**		For three years after mine closure
	Air Quality	0.22	
	Water Quality	0.2	
H	**Entrepreneurship Development (Vocational/skill development training for sustainable income of affected people**	0.26	Equal weightage throughout the life of the mine.
I	**Miscellaneous and other mitigative measures**	2.0	Equal weightage throughout the life of the mine.
J	**Post Closure Manpower cost for supervision**	0.8	To be included in final mine closure plan
	TOTAL	**100.00**	

Manpower requirement depends up on the method and machinery engaged for progressive and final closure activities.

11.17 ABANDONMENT/ CLOSURE COST

As per estimate and guidelines of Ministry of Coal the closure cost of open cast Mine has been calculated at Rs.6 Lakhs per hectare at the declared price level (August 2009) for the whole project area (which includes Mining Lease area, area covered by external overburden dumps, Pit head Mine Infrastructures). The August 2009 wholesale price index for all commodities was 129.6 based on base year of 2004-05. However recently base year has been revised to 2011-12 as per press release of Office of economic advisor, Ministry of Commerce & Industry Govt. of India dated 12 May 2017. As per this circular the linking factor to be adopted for conversion of base year from 2004-05 to 2011-12 is 1.561 for all commodities. Present provisional WPI for month of Nov 2017 is 116.3 with base year 2011-12. Same has been linked to base year 2004-05 as per linking factor and guidelines provided in above circular.

Updated cost of mine closure on Nov 2017 cost base (WPI: 116.3) is estimated to be Rs. 8.4048287 lakh/Ha.

Total Project area involved	: 2580.45 Ha
Mine closure cost/Ha	: Rs. 8.4048287 lakhs
Total Mine closure cost	: Rs. 21688.2402 lakhs

PHASING OF MINE CLOSURE COST

The annual closure cost is to be computed considering the total project area and dividing the same by the life of the mine. An amount equal to the annual cost is to be deposited each year throughout the mine life compounded @ 5% annually.

Total mine closure cost estimated	**:**	**Rs.21688.2402 lakhs**
Total mine life	:	38 years

Out of the total 38 years last 5 years are for final implementation of final mine closure activities, for annual cost calculations 38 years period has been considered:

Annual mine closure amount to be deposited with Coal Controller:

Rs. 21688.2402 lakhs/38 years = Rs.570.7432 lakhs per year.

Yearly phasing of mine closure cost is as below:

Table 11.10
(Yr-1 is considered as 2019-20)

Year	Mine closure cost (Rs. in lakh)
Yr-1	570.7432
Yr-2	599.2803
Yr-3	629.2443
Yr-4	660.7066
Yr-5	693.7419
Yr-6	728.4290
Yr-7	764.8504
Yr-8	803.0929
Yr-9	843.2476
Yr-10	885.4100
Yr-11	929.6805
Yr-12	976.1645
Yr-13	1024.9727
Yr-14	1076.2214
Yr-15	1130.0324
Yr-16	1186.5340
Yr-17	1245.8607
Yr-18	1308.1538
Yr-19	1373.5615
Yr-20	1442.2395
Yr-21	1514.3515
Yr-22	1590.0691
Yr-23	1669.5726
Yr-24	1753.0512
Yr-25	1840.7037
Yr-26	1932.7389
Yr-27	2029.3759
Yr-28	2130.8447
Yr-29	2237.3869
Yr-30	2349.2563
Yr-31	2466.7191
Yr-32	2590.0550
Yr-33	2719.5578
Yr-34	2855.5357
Yr-35	2998.3124
Yr-36	3148.2281
Yr-37	3305.6395
Yr-38	3470.9214
TOTAL	**61474.4870**

Total estimated mine closure cost compounded @5% annually for 38 years is : Rs. 61474.4870 lakhs.

The mine closure cost will be deposited as per guidelines issued by Ministry of Coal vide letter No. 55011-01-2009-CPAM, Dt.7/1/2013.

11.18 FINANCIAL ASSURANCE

1. MCL will open an Escrow Account with the Coal Controller Organization (on behalf of the Central Government) as exclusive beneficiary.
2. MCL shall cause payments to be deposited in the Escrow Account per year as per the table-11.11. The amount being deposited will be reviewed with such periodicity as deemed fit by the Coal Controller. A copy Board Resolution against the approval of Mine Closure cost is attached as **Annexure-.**
3. Mining will be carried out in a phased manner initiating afforestation/reclamation work in the mined out area of the first phase while commencing the mining in the second phase i.e. continuation of mining activities from one phase to other indicating the sequence of operations depending on the geo-mining conditions of the mine. Up to 80% of the total deposited amount including interest accrued in the ESCROW account may be released after every five years in line with the periodic examination of the Closure Plan as per Clause 3.1 of the Annexure of the Guidelines. The amount released may be equal to expenditure incurred on the progressive mine closure in past five years or 80% whichever is less. The balance amount at the end of the final Mine Closure may be released to MCL on compliance of all provisions of Closure Plan duly signed by MCL to the effect that said closure of mine compiled all statutory rules, regulations, orders made by the Central or State Government, statutory organizations, court etc. and duly certified by the Coal Controller.
4. An Agreement outlining detailed terms and conditions of operating the Escrow Account shall be executed amongst MCL, Coal Controller and the concerned bank in order to give effect to this.

11.19 RESPONSIBILITIES OF THE MINE OWNERS

1. It is the responsibility of MCL to ensure that the protective measures contained in the mine closure plan including reclamation and rehabilitation works have been carried out in accordance with the approved mine closure plan and final mine closure plan.

2. MCL shall submit to the Coal Controller a yearly report before 1st July of every year setting forth the extent of protective and rehabilitative works carried out as envisaged in the mine closure plans.

3. The details of the final Mine Closure plan along with the details of the updated cost estimates for various mine closure activities and the Escrow account already set up shall be submitted to the Ministry of Coal for final approval at least five years before the intended final closure of the mine.

11.20 PROVISIONS OF MINE CLOSURE

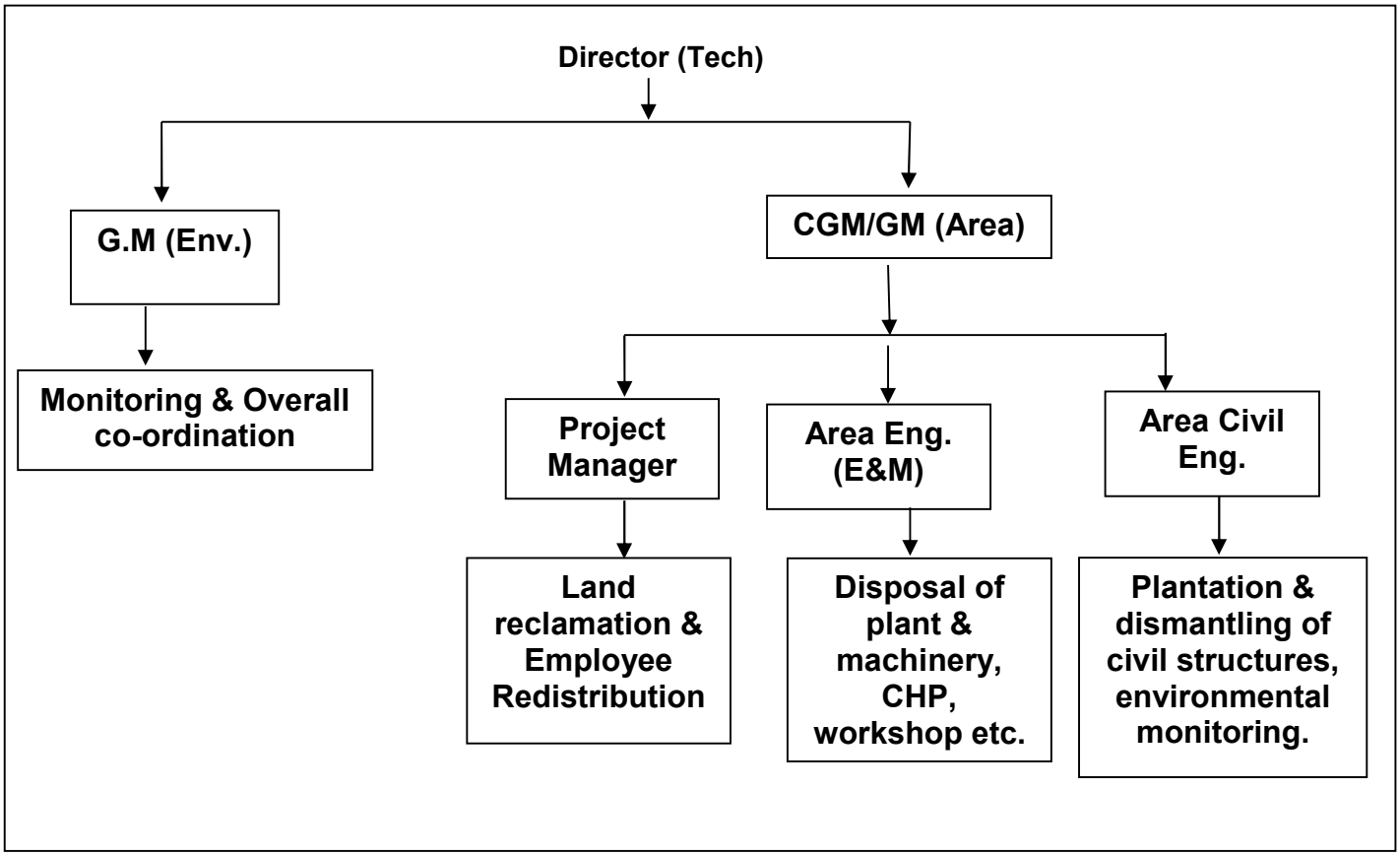
1. MCL shall be required to obtain a mine closure certificate from Coal Controller to the effect that the protective, reclamation and rehabilitation works in accordance with the approved mine closure plan/final mine closure plan have been carried out by the mine owner for surrendering the reclaimed land to the State Government concerned.

2. The balance amount at the end of the final Mine Closure may be released to MCL on compliance of all provisions of Closure Plan duly signed by MCL to the effect that said closure of mine complied with all statutory rules, regulations, orders made by the Central or State Government, statutory organizations, court etc. and duly certified by the Coal Controller. This will also indicate the estimated extractable coal reserves and coal actually mined out.

3. If the Coal Controller has reasonable grounds for believing that the protective, reclamation and rehabilitation measures as envisaged in the approved mine closure plan in respect of which financial assurance was given has not been or will not be carried out in accordance with mine closure plan, either fully or partially, the Coal Controller shall give MCL a written notice of his intention to issue the orders for forfeiting the sum assured at least thirty days prior to the date of the order to be issued after giving an opportunity to be heard.

11.21 **IMPLEMENTATION PROTOCOL**

For implementing the mine closure activities, the following organizational structure has been proposed:



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

DOCUMENTS ENCLOSED

Sl No	Description	Page
A.	Copy of the Allotment Order	The proposed Siarmal OCP lies in the Siarmal & it's extension, Banapatra geological block which belongs to MCL and where opencast mine is being operated. Sanction letter of Project report enclosed in Annexure-I
B	**LIST OF ANNEXURE**	
1	Copy of Approval letter of Original Project report (Annexure-I)	AN., page 1-2
2	Letter from MCL to CMPDI for preparation of Mining Plan (Annexure-II)	AN., page 3
3	Approval of the Mining plan & Mine closure cost by MCL Board (Annexure-III)	AN., page 4
4	Copy of grant of recognition to executives of CMPDI as competent to prepare mining plan of coal/ lignite blocks (Annexure-IV)	AN., page 5
5	Certificate from Technically qualified person from CMPDI (Annexure-V)	AN., page 6
C	INDEX of chapters contained in MP&MCP	Enclosed in contents
D	List of plates contained in MP&MCP	Enclosed in contents
E	TEXT & PLATES	Page as mentioned in contents
F	Confirmation from RQP that he has verified the Block area with the relevant plans supplied by CMPDI/SCCL/NLC and area covered by the Mining Plan does not encroach on any other Coal/Lignite Block.	This is to confirm that the proposed area has been verified with the relevant plans available in CMPDI and the area under consideration is under jurisdiction of MCL.
G	Copy of the document to establish that the Geological Report has been duly purchased from CMPDI, GSI/MECL as the case may be.	The Geological Report was prepared by CMPDI.

H. **List of Abbreviations used:**

- MoC : Ministry of Coal
- MoEF : Ministry of Environment and Forest
- EC : Environmental Clearance
- FC: Forestry Clearance
- CMPDIL : Central Mine Planning and Design Institute Limited.
- MCL : Mahanadi Coalfields Limited.
- NCDC: National Coal Development Corporation.
- OC : Opencast
- IBM : Indian Bureau of Mines
- MECL: Mineral development Corporation Limited
- RH- Relative Humidity
- UHV- Useful Heat Value
- PR : Project Report
- CBA (A&D) Act- Coal Bearing Areas (Acquisition & Development) Act.
- Yr 1,2,- Production year 1,2
- Mt- Million tonnes
- Mty- Million tonnes per year
- OB- Overburden
- TPD- Tonnes per day
- kW- kilo watt
- kV-kilo volt
- FLP- Flame Proof
- lps-liters per second
- CO- Carbon Monoxide
- CH_{4-} Methane
- CHP- Coal Handling Plant
- MTK room- Mine Time Keeper Room
- RPM- Rounds per Minute
- SPM- Suspeded Particulate Matter
- NO_{X-} Nitrogen Oxide/s
- EMP- Environmental Management Plan

ANNEXURE-I

Mahanadi Coalfields Limited
(A Subsidiary of Coal India Limited)
A Mini Ratna Company

ମହାନଦୀ କୋଲଫିଲ୍ଡସ୍ ଲିମିଟେଡ
महानदी कोलफील्ड्स लिमिटेड
Mahanadi Coalfields Limited
(A Subsidiary of Coal India Limited)
P. O.- Jagruti Vihar, Burla,
Dist. Sambalpur- 768020 (Odisha)
Tele Fax : 0663-2542977

Ref. No. MCL/SBP/CS/Bd-156/Exct/2014/7798 Date: 10.03.2014

गोपनीय/CONFIDENTIAL

सेवा में,
GM(CP&P)
महानदी कोलफील्ड्स लिमिटेड, सम्बलपुर

Sub: Extract from the minutes of 156th meeting of the Board of Directors of MCL held at 02.30 PM on 07.03.2014 at MCL Office, Bhubaneswar.

प्रिय महोदय,

आप के सूचनार्थ एवं उचित कार्यवाही हेतु एम. सी. एल. की निदेशक मण्डल की 156 वीं बैठक का Extract of Minutes दिये जा रहे हैं:

156.C/11 Approval of Project Report for Siarmal OCP (Normative Capacity 40.00 Mty) (Peak Capacity 50.00 Mty).

11.1 The Board deliberated on the subject in detail and in consideration of the facts highlighted in the agenda, approved the Project Report of Siarmal OCP (Normative Capacity 40.00 Mty) (Peak capacity 50.00 Mty) for both the variants as per the details brought out in the agenda note.

11.2 Further, the Board, also approved the proposal for getting EMP clearance for peak coal production level of 50.00 Mty.

भवदीय,
कंपनी सचिव

ANNEXURE-I (contd..)

महानदी कोलफील्डस् लिमिटेड
महानदी कोलफील्डस लिमिटेड
Mahanadi Coalfields Limited
(A subsidiary of Coal India Limited)

Office of the General Manager (CP & P)
P.O : Jagruti Vihar, Burla
Dist: Sambalpur, Odisha-768020
Ph: +91 (663) 254 2808
Fax: +91 (663) 254 2767,
e-mail: bn_shukla008@yahoo.co.in

No : MCL/HQ/Sambalpur/GM(CP&P)/14/ 389 Date: 20.06.2014

SANCTION ORDER

Subject: **Approval of Project Report for Siarmal Opencast Project (Normative Capacity-40.00Mty) (Peak Capacity-50.00Mty)**

The Project Report for Siarmal Opencast Project (Normative capacity 40.00Mty) (Peak Capacity 50.00 Mty) of Basundhara-Garjanbahal Area has been approved by CIL Board in its 307th meeting held on 29.05.2014 to be implemented in outsourcing variant with a capital investment of ₹ 3756.36 crore with IRR of 23.53% at 85% capacity.

Further, Board also approved 5% of capital expenditure of departmental operations to procure ancillary equipment for support functions.

The zero date of monitoring of the project will be from the date of issue of this letter. The monthly monitoring report should be sent to this office by 10th of every month for onward transmission to CIL/Ministry. This is for kind information and necessary action.

20/6/14

(**B. N. Shukla**)
General Manager (CP&P)

HOD (PSD) 9/7

Distribution:
1. CMD, MCL
2. Advisor (Projects), GoI, MoC, New Delhi-with a copy of CIL Board Resolution.

Cont..p/2

ANNEXURE-II

ମହାନଦୀ କୋଲ୍ ଫିଲ୍ଡସ୍ ଲିମିଟେଡ୍
महानदी कोलफील्डस लिमिटेड
Mahanadi Coalfields Limited
(A subsidiary of Coal India Limited)

महाप्रबंधक (परियोजना एवं योजना) का कार्यालय
Office of the General Manager (P&P)
At/Po : Jagruti Vihar, Burla, MCL
Dist: Sambalpur – 768 020 (Odisha)
CIN: U10102OR1992GOI003038
Ph: +91 (663) 254 2808 / Fax: +91 (663) 254 2767,
e-mail: ogm-cpnp.mcl@coalindia.in
Website : www.mcl.gov.in

क्रमांक : एम.सी.एल / मुख्यालय /सम्बलपुर/ महाप्रबंधक (परियोजना एवं योजना) /17/ 888 दिनांक: 17 .10.2017

सेवा मे,

क्षेत्रीय निदेशक,

क्षेत्रीय संस्थान- 7,

सेंट्रल माईन प्लानिंग एंड डिजाइन इंस्टिट्यूट लिमिटेड (सी.एम.पी.डी.आई.एल),

सामंतपुरी (गान्धी पार्क के नजदिक), आर. आर. एल,

भुवनेश्वर - 751 013 (ओडिशा)

Sub: Mining Plan and Mine Closure Plan for Siarmal OCP
Ref: CMPDI/RI-7/P&D/1283 dated 18.08.2017

महोदय,

In reference to above letter on the cited subject, it is to convey the decision of MCL as below:

1. Both Siarmal Washery and Garjanbahal Washery will not be included in the Mining Plan and Mine Closure Plan of Siarmal OCP.
2. Mining Plan and Mine Closure Plan for Siarmal OCP to be prepared for peak capacity of 50Mty and calendar programme & life of the project should be detailed accordingly.

This is for your kind information and needful action.

भवदीय,

17/x/2017

(अनवर हुसैन)

महाप्रबंधक(परियोजना एवं योजना)

सूचनार्थ : निदेशक(तकनीकी/ परियोजना एवं योजना); एम .सी.एल.

प्रतिलिपि:

1. GM(Envt & Forest), MCL HQ
2. GM(Washery), MCL HQ
3. GM, Basundhara-Garjanbahal Area
4. Office Copy

ANNEXURE-III

ମହାନଦୀ କୋଲ୍ ଫିଲ୍ଡସ୍ ଲିମିଟେଡ୍
महानदी कोलफील्डस लिमिटेड
Mahanadi Coalfields Limited
(A subsidiary of Coal India Limited)

Office of the Company Secretary
At/Po. Jagruti Vihar, Burla, MCL
Dist. Sambalpur – 768020 (Odisha)
CIN: U10102OR1992GOI003038
TeleFax No. 06632542977
Email id: cosecymcl@gmail.com
Website: www.mahanadicoal.in

Ref. No. MCL/SBP/CS/BD-198/Exct/2018/ 198 Date: 05.02.2018

गोपनीय/**CONFIDENTIAL**

सेवा में,
महाप्रबंधक (P&P)
महानदी कोलफील्ड्स लिमिटेड

Sub: Extract from the Minutes of the 198th Board meeting of MCL held at 10.30 AM on 31st January, 2018 at Registered Office of the Company, Jagruti Vihar, Burla, Sambalpur, Odisha-768020.

प्रिय महोदय,

आप के सूचनार्थ एवं उचित कार्यवाही हेतु एम.सी.एल. निदेशक मण्डल की 198 वी बैठक का उदधृत दिया जा रहा हैं। इसी के साथ आप को यह भी अनुरोध किया जा रहा है के इसका **ATR** यह कार्यालय मे यथासिघ्र भेज दें। The minutes is issued against your urgency note and is subject to confirmation of minutes in the next Board meeting as per the prevailing norms.

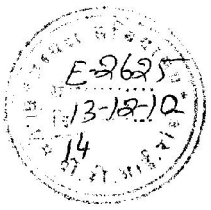
198.C/10 Approval of Mining Plan and Mine Closure Plan for Siarmal OCP (50 Mty) with total mine closure cost of Rs.61474.4870 lakh compounded @ 5% annually for 38 years.

10.1 The Board deliberated on the subject in detail and based on the facts brought out in the agenda note and clarification offered by GM (P&P), approved the Mining Plan and Mine Closure Plan for Siarmal OCP (Rated Capacity 50.0Mty) with total mine closure cost of Rs.61474.4870 lakh compounded @ 5% annually for 38 years as per the details brought out in the agenda note.

भवदीय,
कंपनी सचिव

ANNEXURE-IV

BY REGISTERED POST.



No. 34011/(22)/2005-CPAM
Government of India
Ministry of Coal
<><><>

Shastri Bhavan
New Delhi, 2nd December, 2010

To Chairman-cum-Managing Director,
Central Mine Planning & Design Institute,
Gondwana Place, Kanke Road,
Ranchi-834012 (Jharkhand).

Subject Grant of recognition to technically qualified executives of CMPDI as competent person to prepare Mining Plan for Coal/Lignite block(s).

Sir,

I am directed to refer to CMPDIL's letter No.CMPDI/TS/2010/41.01/1699 dated 4th/8th November, 2010 on the above mentioned subject and to convey approval of the Central Government to the grant of recognition in favour of Shri Sanjay Kumar Bhar, technically qualified executive of CMPDI as competent person to prepare Mining Plan for the assignment/jobs undertaken by CMPDI for 'OC mines' under Rule 22 (c) of Mineral Concession Rule, 1960 from the date of issue of this letter.

2. Your attention is also invited towards the decision of the Standing Committee that "***additional area beyond the block boundary may be considered in a mining plan subject to the condition that proper justification is given in the mining plan, and that annexed area is non-coal bearing and does not infringe upon any already allotted or identified coal/lignite blocks***".

Yours faithfully,

(L.S. Janoti)
Section Officer

ANNEXURE-V

CERTIFICATE

1. *Certified that M/s Mahanadi Coalfields Limited (MCL) have requested M/s Central Mine planning and Design Institute Limited to prepare the Mining plan & Mine Closure plan of SIARMAL OCP (50 MTY). It is also certified that the undersigned on behalf of CMPDI has a valid recognition from Ministry of Coal under MCR,1960 to prepare the mining plan.*

2. *Certified that the provisions of Mineral Conservation and Development Rules, 1988 and MCR, 1960 have been observed in the preparation of "**Mining Plan & Mine Closure plan for SIARMAL OCP (50 MTY) of MCL**" (A SUBSIDIARY OF COAL INDIA LIMITED) and wherever specific permissions are required, the applicant will approach the concerned authorities.*

3. *Certified that provisions of Mines Act, 1952 and of the Rules and Regulations made there under have been observed in the preparation of this Mining Plan & Mine Closure plan and that wherever specific permission is required the applicant will approach Director General of Mines Safety in the matter.*

4. *Certified further that the information furnished in this Mining Plan & Mine Closure plan is true and correct to the best of my knowledge.*

SANJAY KUMAR BHAR

RQP NO. 34011/(22)/2005-CPAM DTD. 02.12.2010.

Place : Bhubaneswar

Date :