सीएमपीडीआई

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A Mini Ratna Company

सख्त प्रतिबंधित
सिर्फ कम्पनी के प्रयोग के लिए
इस रिपोर्ट में दी गई जानकारी प्रत्यक्ष या अप्रत्यक्ष रूप से प्रेस या किसी ऐसे व्यक्ति, जो सीआईएल/भारत सरकार का अधिकारी नहीं है, को संबोधित नहीं किया जाय।

PROJECT REPORT

FOR

TILABONI UG MINE

(1.86 MTY)

Bankola Area
(Eastern Coalfields Limited)

March' 2018

सेन्ट्रल माइन प्लानिंग एण्ड डिजाइन इन्स्टीच्यूट लिमिटेड
कोल इण्डिया लिमिटेड की अनुषंगी कम्पनी / भारत सरकार का एक लोक उपक्रम)
क्षेत्रीय संस्थान-1, वेस्ट एंड, जी. टी. रोड, आसनसोल-713304
Central Mine Planning & Design Institute Limited
(A Subsidiary of Coal India Limited / Govt. of India Public Sector Undertaking)
Regional Institute-1, G. T. Road West, Asansol-713304
CORPORATE IDENTITY NO. U14292JH1975G01001223

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SUMMARISED DATA

Sl. No.	Particulars	Unit	Value
A.	**GENERAL**		
1	Name of Project		PR for Tilaboni UG Mine
2	Name of Area / Company		Bankola Area / ECL
3	Nearest Railway Station from project	Name	Ukhra at a distance of 3 km
4	Nearest National / State Highway / Approach road	Name km	NH-2 (14 km from the Project) Approach Road – metalled road connect to NH-2 by Andal-Madhaiganj Road
B.	**GEOLOGICAL**		
1	Name of geological blocks considered	Name	Tilaboni & Tilaboni Extension Block
2	Area of the geological block	sq. km	10.83 (Combined Block)
3	Borehole density within blocks	BHs/ sq.km	13.2
4	Project / Mining area within the geological block	sq. km	8.69
5	Borehole density within the Project / Mining area	BHs/ sq.km	10.01
6	**Description of all coal seams within the Project / Mining area**		

Seam	Thickness range (m)		Geological Reserves (Mt)	Remarks
	Min.	Max.		
R-X A	0.84	2.22	0.6325	Unworkable
Parting	26.76	32.95		
R-IX Top	0.98	2.73	3.0631	Unworkable
Parting	1.63	21.81		
R-IX Bot	0.36	2.23	4.6733	Unworkable
Parting with R-VIII T1	28.35	80.85		
Parting with R-VIII (Top)	99.63	100.59		
R-VIII Top	1.07	1.32		Unworkable
R-VIII T1	0.10	1.01	-	Unworkable
Parting	14.30	31.88		
R-VIII T2	**0.50**	**2.01**	**12.5810**	**Considered for mining**
Parting with R-VIII B1(Top)	6.00	27.73		
Parting with R-VIII B1(Comb)	23.76	27.50		
R-VIII B1 (Top)	0.30	1.47	7.5236	Unworkable
Parting	1.12	8.95		
R-VIII B1 (Bot)	**0.90**	**2.59**	**13.0029**	**Considered for mining**
R-VIII B1	**3.10**	**4.82**	**20.5636**	**Working in progress & Considered for mining**
Parting	8.20	21.77		

Seam	Thickness range (m)		Geological Reserves (Mt)	Remarks
	Min.	Min.		
R-VIII B2	0.30	1.45	4.8036	Unworkable
R-VIII Bot	1.65	1.84		Unworkable
Parting with R-VII (Top)	27.14	42.45		
Parting with R-VII (Comb)	26.84	53.35		
R-VII Top	0.70	2.26	3.7302	Unworkable
Parting	1.14	14.09		
R-VII Bot	**1.95**	**2.95**	**8.6470**	**Considered for mining**
R-VII	**1.95**	**6.18**	**41.9954**	**Dev. in progress & Considered for mining**
Parting with R-VII A	23.85	48.74		
Parting with R-VII A/B Comb	39.00	54.55		
R-VII A	**1.37**	**3.33**	**20.1713**	**Dev. in progress & Considered for mining**
Parting	3.85	27.20		
R-VII B	**0.21**	**3.40**	**21.0555**	**Considered for mining**
R-VII A/B (Comb)	**3.23**	**5.18**	**16.0614**	**Considered for mining**
Parting	12.96	27.50		
R-VII C	0.12	2.20	19.8299	Beyond the scope of this PR
Parting	18.13	51.08		
R-VI	1.98	6.58	63.8800	Beyond the scope of this PR
Parting	19.70	63.17		
R-V	1.20	6.30	61.9739	Beyond the scope of this PR
Parting	0.92	49.24	-	
R-IV	1.52	11.45	111.3215	Beyond the scope of this PR
Parting	24.12	35.34		
R-III	2.05	3.59	37.1007	Beyond the scope of this PR
Parting	9.42	45.52		
R-II	0.45	2.32	21.9464	Beyond the scope of this PR
Total			**494.5568**	

C.	**TECHNICAL**		
Sl. No.	**Particulars**	**Unit**	**Value**
1	Area of the proposed mine block (with break-up of different geological blocks)	sq. km	8.69 [Tilaboni & Tilaboni Extension blocks]
2	Borehole density within mine area	BHs/ sq. km	4.51 - 11.76 (Mine-1) 1.74 – 9.18 (Mine-2)
3	Mine parameters (seam-wise)		
	Mine-1		
	Extent along strike (min. – max.)	km	0.3 – 2.0
	Extent along dip (min.-max.)	km	1.3 – 2.1
	Mine-2		
	Extent along strike (min. – max.)	km	0.3 – 1.5
	Extent along dip (min.-max.)	km	0.5 – 3.1

4	**Description of coal seams proposed to be worked:**						
Name of seam	*Mining Area (sq.km)*	*Thickness range considered (m)*	*Av. Thickness (m)*	*Grade*	*Av. Gradient (1 in …)*	*Depth range (m)*	*Extractable Reserves (Mt)*
Mine-1							
R-VIII T2	*0.32*	*1.50 - 1.95*	*1.7*	*G8-G9*	*1 in 5 to 1 in 10*	*18-135*	*0.6924*
R-VIII B1	*2.38*	*2.73 - 4.72*	*4.0*	*G4*		*19-164*	*5.4843*
R-VIII B1 (Bot)	*0.50*	*1.70 - 2.59*	*2.3*	*G4*			
R-VII	*3.97*	*2.71 - 6.29*	*5.3*	*G4*		*76-212*	*8.8315*
R-VIIA & R-VIIA&B (Comb)	*3.94*	*1.50 - 3.27*	*2.5*	*G4*	*1 in 5 to 1 in 10*	*109-196*	*6.1263*
R-VIIB	*3.48*	*1.50 - 3.20*	*2.5*	*G5-G7*		*127-288*	*5.6015*
						Total	***26.7360***
Mine-2							
R-VIII T2	*0.39*	*1.50 - 2.92*	*1.7*	*G7-G9*	*1 in 5 to 1 in 10*	*55-223*	*0.5459*
R-VIII B1 (Bot)	*1.56*	*1.50 – 2.65*	*2.0*	*G4*		*88-237*	*4.3210*
R-VII	*1.35*	*3.74 – 5.82*	*4.5*	*G4*		*139-294*	*7.1463*
R-VII (Bot)	*1.95*	*1.95 – 3.03*	*2.5*	*G4*			
R-VIIA/ R-VIIA&B (Comb)	*3.27*	*1.50 – 2.65/ 3.23 – 4.78*	*2.0/ 4.4*	*G6-G10*		*184-336*	*8.2898*
						Total	***20.3030***
					Grand Total		***47.0390***

5	**Mine Entries**			
Entries Name / No.	***Size (length/Dia) (m /m)***	***Approach (from / to) (surface/seam to seam)***	***Gradient (1 in.. /vertical)***	***Purpose***
Mine-1				
Incline No. 1 & 2	5.5 m x 3.5 m (finished section)	Normal upto R-VI seam-1145m, (Upto R-VII B seam – 828m); Reverse (From R-VI to R-II seam- 520m) **Total – 1665m**	1 in 4.5	Coal (belt conveyor) (Inc. No. 1), man riding and material transport (haulage) (Inc. No. 2), intake
Pit no,2 (Tilaboni Unit)	Widening (4.2 m dia to 6.0 m dia)	Deepening upto R-VII B seam(94.7m to 155 m), 340 m (upto R-II seam)	Vertical	Air return
Mine-2				
Incline no.3 & 4	5.5 m x 3.5 m (finished section)	Normal upto R-VI seam-1180m (Upto R-VII A&B seam – 960m); Reverse (From R-VI to R-II seam- 725m) **Total – 1905m**	1 in 4.5	Coal (belt conveyor) (Inc. No. 3), man riding and material transport (haulage) (Inc. No. 4), intake
Air shaft	6.0 m	220 m (upto R-VII A&B seam) 415 m (upto R-II seam)	Vertical	Return

Sl. No.	Particulars	Unit	Value
6	**Method of Mining**		B&P mining with CM
7	**Panel Parameters:**		
	No. of headings in each panel	Nos.	7/5
	Size of galleries / roadways	m	6.0 x 4.6 (max.)
	Pillar sizes	m x m	21m x 21m to 45m x 45m
8	**Production Parameters**		
	No. of panels to be worked	Nos.	Four CM districts & one heightening district
	Production from each panel	TPD / Mty	Std. Height CM -1700/0.51 Low Height CM - 1200/0.36 Heightening district- 400/0.12
9	**Target Output**	Mt	1.86
	Normative prodn. capacity (at 100%)	TPD	6200
	Peak prodn. capacity (at 115%)	TPD	7130
	Production capacity (at 85%)	TPD	5270
10	**Year of achieving Target Production** (from zero date)	yr	7th
11	Production Phasing (from zero date upto target year)	Mt	

Mine	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7-17**	**Year 18**	**Year 19-25**
Mine-1	0.138	0.198	0.258	0.73	0.99	0.99	0.99	0.97	0.87
Mine-2	-	-	-	0.25	0.36	0.61	0.87	0.87	0.87
Total	**0.138**	**0.198**	**0.258**	**0.98**	**1.35**	**1.60**	**1.86**	**1.84**	**1.74**

12	Total Mine Life (at Nominal production capacity)	Years	More than 25 years
	Pre-construction period	Years	0
	Construction period	Years	3
	Production build-up period	Years	4
	Production period	Years	>25
13	Degree of Gassiness (I / II / III)		II
14	Major Equipment Deployed in panels CM Panel (4 no.)	Nos.	CM (2 sets Std. height & 2 sets Low height), Shuttle Car (8 no.), Roof Bolter (4 no.), Feeder Breaker (4 no.), Gate Belt Conveyor, Auxiliary Fan (12 nos.), Face Pump (8 nos.),
	Roof heightening Panel (1 no.)	Nos.	LHD (Remote controlled)(2 nos.), Roof bolter (1 no.), pony / gate belt conveyor) (5 nos.),

Sl. No.	Particulars	Unit	Value
15	Average Specific Energy Consumption of the target year for Mine-1	kWh/t	24.35
16	Average Specific Energy Consumption of the target year for Mine-2	kWh/t	20.06
17	Total actual requirement of Manpower	Nos.	Risk-Gain Sharing option : 1203 Equipment Hiring option : 799
18	Overall Output per manshift (OMS) of the target year	tonnes	Risk-Gain Sharing : 5.90 Equipment Hiring option : 8.88
19	Seam-wise average grade of coal (non-coking/coking)		G4 to G6 (non-coking)
20	Presence of Major Surface Constraints (forest, nallas, road, Power line, etc.)	(type)	Villages, HFL of nala, ponds, OHT line, DB/village roads, forest/plantation
21	Coal Transport i. Main Trunk Roadway ii. Panel		 Belt conveyor Belt conveyor
22	Men Transport	(type)	Mine-1: Incline No.2 Mine-2: Incline No.4 4 nos. Free Steered Vehicles (1 no. for each CM district)
23	Material Transport	(type)	Multi Utility vehicles - 4 nos.
24	Surface Coal Transport (From Pit-head to Siding)		By Belt conveyor from Mine-1 By Road from Mine-2
25	Name of any Specific Customer/Industry		Likely customers - Power, other industries
D.	**ENVIRONMENTAL & OTHERS**		
1	Civil Construction Residential houses	Nos.	 Risk-Gain Sharing option: 494 Equipment Hiring option: 333
2	Water Demand Colony Industrial	kl	 Risk-Gain Sharing option: 470 Equipment Hiring option: 318 1045
3	Total Land to be acquired	Ha	Risk-Gain Sharing option: 773.70 Equipment Hiring option: 771.70
4	Land to be acquired within minetake	Ha	869.00

Sl. No.	Particulars	Unit	Value
5	Net Present Value of Forest Land	₹ Lakh/Ha	11.17
	Total Area	Ha	38.44
	Total Value	₹ Crore	4.294
6	Habitation & Rehabilitation		
	No. of villages within mine boundary	Nos.	Four
	No. of land oustees		-
	No. of PAFs to be rehabilitated		58
7	Cost of land Total Cost	₹ Crore	Risk-Gain Sharing option: 347.15 Equipment Hiring option: 346.83
	R&R only	₹ Crore	8.98
8	Total EMP Capital	₹ Crore	2.08
9	Average annual rainfall	mm	1400
10	Make of Water	Cum/day	Mine 1: 19504.25 Mine 2: 16310.00
11	Total installed pumping capacity (through borehole or through incline/shaft)	Cum/hr	Mine 1:1192.16 Mine 2: 966.92
12	Drainage of the Area (Name of river/nalla)		Ajoy River/ Tumni nallah/ Kunur nalla
13	Any proposed diversion of nalla or power line		One seasonal nala, Ukhra-Laudoha DB Road

Sl. No.	Particular	Unit	Value	
E	**FINANCIAL**		**Risk-Gain Sharing**	**Equipment Hiring**
1	**Total Capital Investment**	₹ Cr	1416.25	941.853
	Existing		25.236	
	Additional		1391.01	916.61
2	Specific Investment	₹ / te	7614.24	5063.73
3	Total Capital Investment on P&M	₹ Cr	661.53	287.06
	Existing		11.98	
	Additional		649.55	275.08
4	Specific Investment on P&M	₹ / te	3556.62	1543.33
5	Capital requirement upto target year	₹ Cr	1314.43	840.03
6	Year of opening of Revenue account (from zero date)	Yr	1st	
7	Earnings per manshift (EMS)	₹	3149.50	3205.73
8	Output per manshift (OMS)	Te	5.90	8.88
9	**Estimated Cost of Production**			
	At 100% production level	₹ / te	2539.29	2328.87
	At 85% production level	₹ / te	2807.21	2519.93
10	**Average Selling Price**	**₹ / te**	2944.04	
11	**Estimated Profit**			
	At 100% production level	₹ / te	404.75	615.17
	At 85% production level	₹ / te	136.83	424.11
12	**Financial Internal rate of return (FIRR)**			
	At 100% production level	%	11.07%	19.88%
	At 85% production level	%	5.85%	14.03%
13	**Desired Ave. Selling Price to yield 12% FIRR**			
	at 100% Production Level	₹ / te	**2997.47**	
	at 85% Production Level	₹ / te	**3346.96**	
14	**Break-even point (Profit / Loss based)**			
	Production	Mty	1.47	1.19
	Production level	%	78.95%	63.77%
15	**Mine Closure Cost**			
	Total	₹ Cr	11.57	
	At 100% production level	₹ / te	2.97	
	At 85% production level	₹ / te	3.49	
16	Expected Completion Capital	₹ Cr	1600.66	1070.29
17	EMP Cost	₹ / te	6.00	
		₹ Cr	23.40	

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TEXT

Chapter-1

INTRODUCTION

1.1 Background of the Project Report

Tilaboni Colliery is located in the north eastern part of the Raniganj Coalfield and is about 30 km from Raniganj township. The colliery is under the administrative control of Bankola Area of ECL.

A Feasibility Report on Tilaboni Block was prepared in Sept.' 1985. The report was approved by ECL Board in Dec.'1985 for a targeted production of 1.65 Mt/Year and a capital investment of ₹ 13649.28 lakhs.

The report was discussed in the Empowered Committee of CIL wherein it was pointed out that a gestation period of 16 year was too long and contributed to a great extent to the adverse economics of the project.

Consequently the report was revised and the total gestation period of the project was reduced to 8 years. It projected a profit at 85% of the target production, but the total production was reduced to 1.17 Mt (The report was named as "FR for Reorganisation of Tilaboni colliery Phase-I", covering an area of 4.36 km^2 upto the north of Fault F_9-F_9.

1.1.1 Salient features of the Feasibility Report, 1986:

Entries

Existing pits of the colliery was proposed to be utilized for man & material winding and ventilation. The no. 2 pit of S. S. P. unit and No.2 pit of Tilaboni unit were proposed to be deepened upto R-VII A seam for transportation of coal from different seams. One new incline (972 m length & 4.5 m x 2.4 m finished section) was proposed upto R-VII A seam. A new shaft was proposed upto R-VII A seam (208 m depth, 8 m dia.) for air return of all the seams and man and material winding for different seams.

Method of Mining

R-VIII B1, R-VII and R-VIIA seams were proposed to be exploited by mechanized bord & pillar method with LHD, whereas R-VIII T2 seam was proposed to be exploited by Room & Pillar method with shoveling onto chain conveyors. Area below surface features in R-VII and R-VIIA seams were to be extracted by Bord & Pillar stowing method. At shallow depth, splitting of pillar as final operation and stowing was proposed. Only one bord & pillar stowing panel was proposed at a time.

Details of the production parameters at the target production of 1.17 MTY was as follows:

Seam	Method of work	No. of panels	Prodn. Per panel (TPD)	Total prodn. (TPD)
R-VIIIT2	Heading development for bord & pillar	1	100	100
	Bord & pillar extraction with caving	1	300	300
R-VIII B1	Mechanised B&P with LHD-Development/depillaring (caving)	4	400	1600
R-VII	Mechanised B&P with LHD-Development/depillaring (caving)	4	400	1600
	Mechanised B&P depillaring (stowing) with LHD	1	300	300
	Total	**11**		**3900 (1.17 MTY)**

Underground Transport

In all seams (except R-VIII T2 seam) coal at face was to be loaded by LHDs and discharge onto chain conveyor. In R-VIII T2 seam, coal was to be shovelled onto chain conveyors. The coal in turn was to be discharged onto gate belt conveyor and then onto trunk belt conveyor and then into strata bunkers. Main belt conveyor in the incline was to receive coal from the strata bunker and discharge coal into 1100 t capacity ROM surge bunker at the surface.

Surface Transport

The coal from the surge bunker was to be fed to a pair of vibrating screens for segregating to (-) 50 mm slack coal and (+) 50 mm steam coal and transporting the same into 3500 t slack ground bunker and into 4500 t steam ground bunker.

Railway Siding

For centralized coal dispatch from the project, a new railway siding was proposed. Take off point was proposed from the proposed Jhanjra Siding. A CHP of 1.17 MTY capacity was also proposed near the siding.

Reserves, grade & life

Total net and mineable reserves upto R-VIIA seam was about 62.10 Mt & 26.18 Mt respectively and the weighted average UHV grade of coal being C. At the rate of 1.17 MTY, the life of the mine was envisaged to be more than 25 years.

1.1.2 Recent studies

Tilaboni UG mine including Tilaboni Extension Block was identified as one of the seven high capacities underground mine for Global Tender for Development, Construction and Operation on Turnkey Basis. On the basis of EOI notification issued by CIL, nine parties were short listed by CMPDI, HQ, and was approved by CIL.

The Global Bid document prepared by CMPDI, HQ for seven UG mines, after incorporating the views of CMDs, as suggested during 27th meeting of CMDs held on 12.01.09 was placed before CMDs. After discussion at length, CMDs opined that respective subsidiary companies may take tendering action with regard to individual mines under their jurisdiction and the entire process from approval of NIT, floating of tender, processing/concluding of tender should be under the control of concerned subsidiary with approval of respective Boards.

The Global Tender was floated by ECL on 06.08.2009. Copy of the tender document was sent to short listed parties but no party submitted their bid within stipulated time i.e. 02/03/12.09.

As per the request of one of the short listed parties, the last date of bid submission was extension by 2 months i.e. up to 02/03/02.10 but even then no party responded. Further the date of bid submission was extended to 03/04.06.10 and still no party submitted their offer.

In the 236th ECL Board Meeting held on 1.7.2010, the Board approved delinking Tilaboni & Tilaboni Extn. Blocks from Turnkey model proposed by CIL and advised that immediate action should be taken for preparation of Project Report to work on 'risk/gain sharing' basis. The preparation of project report has accordingly been taken up as per letter No.Ref.No.ECL:PLG:352 dt. 26.7.10 of CGM (P&P), ECL.

The PR was discussed at CMPDI (HQ), Ranchi on 27.01.2011. It was desired that the PR should include another option, i.e. to work the block by opencast method.

Accordingly the possibility of opencast mining in this block was examined and was placed before the 243rd Meeting of ECL Board. "Draft Minutes of the 243rd ECL Board meeting held on 03.03.1011" is enclosed as Annexure-I. The observations of Board were as below:

- "Due to presence of surface structures and shortage of space for OB dump, the extraction of upper seams by opencast method would not be feasible."
- "Financial evaluation of the project report has been done on the basis of geological grade and as such due to revision in the notified price, the IRR of the project will be below the desired level of 12%."
- "Board advised to revise the report on the basis of declared grade and place in the next Board considering only underground option."

The report was revised in March 2011, considering the observations of the 243rd ECL Board meeting and was placed before 244th meeting of ECL Board. ECL Board in its 244th meeting held on 28.03.2011 approved the stage-1 for Tilaboni UG mine (1.86 Mtpa) with capital investment of ₹ 716.69 Crores. ECL Board in this meeting also decided to work out the financial viability of the project at declared grade price of Grade 'B'. Accordingly report was revised and updated in October' 2011. The updated report was sent to M/s Deloitte Touche Tohmatsu India Private Limited (DTTIPL) for financial appraisal. The revised report was discussed in the 3rd Sub-Committee of ECL Board for Financial, Appraisal and Approval of Project held on 24th July, 2012. The Sub-Committee after detailed deliberations advised to update the information based on GCV based pricing mechanism and considering the NCWA-IX wages impact. The project report was further updated upto July 2012 considering the advices of the Sub-Committee.

In the 257th ECL Board Meeting held on 5.11.2012, the Board approved the Project Report on 'risk/gain sharing' basis with a capital investment of ₹788.53 crores. Subsequently ECL advised to prepare the Updated Cost Estimate of the Project Report considering the Equipment hiring basis also (Annexure-II).

Incorporating the suggestions of ECL, the Project Report was again revised and updated upto November 2014 and was placed before 276th meeting of ECL Board**.** ECL Board in its 276th meeting held on 27.01.2015 approved the P. R. for Tilaboni UG mine (Hiring option) with a capital investment of ₹727.40 crores.

The report was placed before the 85th Empowered Sub-Committee meeting of CIL Board for Appraisal, Evaluation & Approval of projects held on 08.05.2015. Empowered Sub Committee of CIL Board advised CMPDIL to examine the proposal in totality. After detailed deliberations, the committee directed ECL to-

a) re-examine the model to be worked based on the ground conditions,
b) assess the implication of grade slippage, and
c) calculate fresh economics and place the proposal to CIL ESC meeting through ECL Board for its consideration.

Considering the observations of 85th Empowered Sub-Committee of CIL Board, this report has been revised and updated upto August' 2015. The report of August' 2015 was prepared on Risk-Gain Sharing option as well as on Equipment Hiring option.

Revised report was again placed before 24th meeting of the Sub-committee of ECL board for "Evaluation. Appraisal and Approval of Projects" held on 29.12.2015. The Sub-Committee directed that the Service Tax should not be included in the cost as it is allowed as set off. The Sub-Committee after detailed deliberations recommended, the Project Report of Tilaboni UG mine under Risk-Gain sharing option, to the ECL Board for accord of approval. ECL Board in its 284th meeting held on 29.12.2015 accorded approval for the Project Report of Tilaboni UG mine with a capital investment of ₹1178.56 crores under Risk-Gain sharing option and advised to send it to CIL Board through Empowered Sub-committee (ESC) of CIL Board for final approval.

Accordingly, the PR was prepared in January 2016 under Risk-Gain sharing option after excluding Service Tax. Sub-committee of ECL board for "Evaluation, Appraisal and Approval of Projects" in its 26th meeting held on 22.02.2016 recommended the revised report to ECL Board for approval. ECL Board in its 286th meeting held on 23.02.2016 accorded approval for the Project Report of Tilaboni UG mine, January 2015, with a capital investment of ₹1177.44 crores under Risk-Gain sharing option and for sending it to the Empowered Sub-committee of CIL Board for final approval of CIL Board.

The report was sent to CIL for placing before the Empowered Sub-Committee of CIL Board for Appraisal, Evaluation & Approval of projects. With effect from 30.5.2016, selling price of coal got revised and the CIL advised to recalculate the economics with the new sale price. As the IRR at 85% capacity utilization with the new sale price in Risk-Gain Sharing Option was less than 12%, CIL advised to prepare the updated cost estimate and place before ECL Board. ECL further advised to revise the report again on both the options i.e. Risk-Gain sharing option and Equipment Hiring Option as the project was not yielding desired IRR under Risk-Gain Sharing Option. Accordingly this report has been prepared.

1.2 Exploration Status

The proposed project area lies in the Tilaboni Combined block as shown in Figure-1.1. Tilaboni Combined block comprises of Tilaboni and Tilaboni Extension Geological Blocks. Geological Report for Tilaboni Block was prepared in July'1984 considering the data of 38 boreholes falling within the Tilaboni Block as well as data of 15 peripheral boreholes. Geological Report of Tilaboni Extension Block was prepared in May' 91 involving the 81 boreholes drilled by various agencies In addition to this, data of peripheral boreholes have also taken cognizance of during the course of geological documentation of Tilaboni Extension Block.

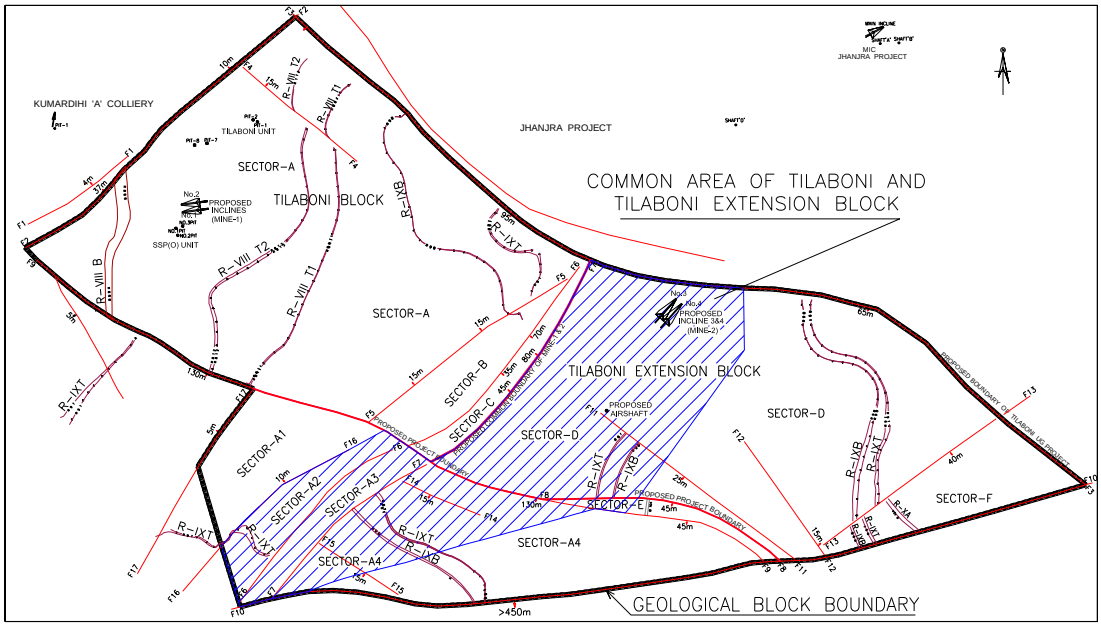

Figure-1.1

Total area of Tilaboni Combined block is about 10.83 sq.km Total number of boreholes falling in the combined area of Tilaboni and Tilaboni Extension blocks is 104. Out of these 104 BHs, 16 boreholes with a total meterage of 4576.39 m are common in both the Tilaboni block and Tilaboni Extension block. The borehole density of the lower seams in the block is low. Capital provision has been kept in this report for additional drilling upto R-II seam.

The agency wise nos. of borehole drilled and meterage as per the Geological Reports is as follows:

Block	Agency	No. of BHs.	Drilled meterage (m)
Tilaboni Comb. Block Area- 10.83 sq.km.	MECL (TLB & TLB-II series)	90	22990.30
	MECL (SS, JNR, JNP series)	04	1263.30
	GSI	03	1940.05
	NCDC	07	2676.60
	Total	***104***	***28870.25***
Boreholes outside the Block	MECL	10	2969.90
	NCDC	05	1697.51
	Total	***15***	***4667.41***
Grand Total		**118**	**33374.16**

In addition to 104 nos. of boreholes, 39 nos. of new boreholes were drilled within the Tilaboni Combined block. Considering this, overall borehole density in the combined block workout to be 13.2 boreholes per sq.km and for the bottom most R-II seam is about 3.3 boreholes/sq. km.

Coal Seams

In Tilaboni Block, 8 seams (R-II at the bottom to R-IX at the top) out of the 10 index coal seams of Raniganj Coalfield have been developed. In addition to the index seams, there are three persistent seams (R-VIIA, R-VII B & R-VII C) which occur between R-VII and R-VI and R-XA seam above seam R-IX. The seams R-VIII B1, R-VIIA, R-VIIB, R-V and R-IV have splitting and merging character. R-VIII splits onto as many as five sections. There are in all 18 seams/sections in Tilaboni block, out of which 13 Seams/sections viz. R-VIII T2, R-VIIIB1, R-VIIIB1(Bot), R-VII, R-VIIA, R-VIIB, R-VIIA/B (Comb), R-VIIC, R-VI, R-V, R-IV, R-III and R-II are mineable. Other seams/sections viz. R-IX Top, R-IX Bot, R-VIIIT1, R-VIIIB1(Top) and R-VIIIB2 being thin or occurring in a limited area have not been considered for mining.

In Tilaboni Extension Block, nine (R-II to R-X) out of the ten standard coal horizons occur. Here also R-VIIA, R-VIIB and R-VIIC seams occur between R-VII and R-VI seams and R-XA between R-X & R-IX seams. Seams R-IX, R-VIII and R-VII are split into two or more splits making it a total of 21 seams / sections. Out of the 22 seams/sections, 12 seams/sections viz. R-VIIIT2, R-VIIIB1(Bot), R-VII, R-VII(Bot), R-VIIA, R-VIIA/B(Comb), R-VIIC, R-VI, R-V, R-IV, R-III and R-II are mineable. Other seams/sections viz. R-X, R-XA, R-IXTop, R-IXB, R-VIII(Top), R-VIIIT1, R-VIIIB1(Top), R-VIIIB2, R-VIII(Bot) and R-VII(Top) being thin or occurring in a limited area have not been considered for mining.

1.3 Present Mining activity

Presently mining operation are in progress in Sector-A of Tilaboni Block. There is no mining activity in other sectors. Tilaboni Extension Block is totally virgin.

The status of mining in Tilaboni colliery is as follows:

Seam	Present Status	Machine deployed	Prodn. (16-17) (Mt)	M/C Productivity (16-17) (TPD)
R-VIIIT2	Virgin	-	-	-
R-VIIIB1	Extensively developed through Tilaboni and SSP (O) units upto F1-F1 (throw 65) & F9-F9 (throw 15-30m) and standing on pillars. Development has been done by B&P method by haulage & SDL combination. On south-west side six panels have been depillared with caving and on western part there is a patch of old abandoned workings through 7 & 8 Pits. The seam is partly virgin to the south of fault F5-F5 (throw 0-15 m).	SDL-5 nos.	0.1377	80
R-VII	Almost entire property has been developed upto F1-F1 (throw 65) & F9-F9 (throw 15-30m) except in the eastern portion of the existing leasehold. Development of this portion is being done by B&P method.			
R-VIIA	This seam is under development by B&P method.			

Mine entries

Unit	Mine Entry	Landing at	Depth of pit (m)	Dia. of Pit (m)	Specification of winder/Fan	Purpose
Tilaboni Unit	No. 1 pit	R-VIII B1 (Jambad)	46.56	4.2	Steam winder 30 cm x 60 m, Single tub cage, Fan: PV-200, 130 HP	Man & Material winding, Up cast
	No. 2 pit	R-VII (Bonbahal)	94.71	4.2	-do-	Man & Material winding, Down cast
S.S.P. (Old) Unit	No.1 pit	R-VIII B1 (Jambad)	24.00	4.2	40 HP electric Double drum winder, Single tub cage	Man & Material winding, Down cast
	No. 2 pit	R-VIII B1 (Jambad)	28.00	4.2	No winding installation, Fan: PV-200, 130 HP	Fan drift, Up cast
	No. 3 pit	R-VII A (Kenda)	120.00	4.2	75 KW electric winder, Single tub cage	Man & Material winding

Past production Performance:

The production and profitability of the mine for the last 5 years is as follows:

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17
Production (Lte)	1.30	1.32	1.29	1.30	1.377
OMS (te)	0.53	0.54	0.53	0.53	0.55
Cost of production (₹/te)	6473.99	6366.79	7839.09	7823.96	8688.60
Selling price (₹/te)	4597.19	3947.17	4872.31	4312.43	3271.39
Profit / loss (₹/te)	(-)1876.80	(-)2419.62	(-)2966.79	(-)3511.53	(-)5417.21
Profit / loss (₹ Lakh)	(-)2307.00	(-)3025.00	(-)3654.19	(-)4342.53	(-)7130.94

Coal evacuation & despatch:

Coal transport from face to pit bottom in underground is by a series of haulages. The production from the mine is being raised through pits. There is a surface bunker of 40 t capacity in each of the units. The maximum capacity of existing Tilaboni colliery is about 520 TPD (0.159 MTY). Coal is despatched by trucks to Bankola Railway siding No.1 at a distance of about 5 km.

Ventilation:

A PV-200 fan has been installed in pit no.1 of Tilaboni unit and pit no. 2 of SSP (Old) unit, the pits acting as upcast shaft. Pit no. 2 in Tilaboni unit and Pit no. 1 in SSP (Old) unit act as downcast shafts.

Existing Manpower:

The existing manpower of the mine is 904 as on 1.3.2018.

Approach road:

The mine is approached by a metalled road.

Service & Residential Building:

There are 730 nos. of residential building of different types at the mine. All necessary service buildings viz. pit office, store, magazine (3600 kg capacity) etc. exist at the mine.

Land acquisition status:

The present leasehold area of Tilaboni UG mine is 4.36 sq.km (436 ha) upto fault F9-F9 (i.e. Sector-A of Tilaboni Geological Block). Out of the above leasehold area only 72.60 ha land is under the possession of ECL.

Existing capital and financial performance:

The existing capital of Tilaboni colliery is ₹ 25.2361 crores (Gross Block) as on 31.3.2017.

1.4 Justification of preparation of PR

The Tilaboni UG mine is concurrently incurring losses. As the Tilaboni combined block is having multiple seams with the total geological reserves of 494.56 Mt in the project area, it is proposed to augment the production from the mine by introduction of mass production technology so as to improve the mine economics.

Tilaboni Extension Block has also been included in this PR, as the block is totally virgin and occur on the down dip side of the Tilaboni Block. Tilaboni

Extension Block occurs outside the ECL leasehold area, hence mining lease for the block has to be acquired before mining operation.

Accordingly, this PR has been prepared for introduction of Continuous Miner Technology (4 sets – 2 sets standard height and 2 sets low height) with a production capacity of 1.86 MTY. This report has been prepared with two options i.e. on Risk-Gain Sharing basis (Option-I) and on Equipment Hiring basis (Option-II).

As advised in the Planning Committee Meeting of ECL held on 17.10.2017 (Annexure-III), following variants have been considered in this report:

a. Economics of the entire project considering with and without belt conveyor for surface transport.
b. Economics of the project considering the mine-1 area only.

This report was again discussed at CMPDI (HQ), Ranchi on 16.12.2017, "Record Note of Discussion" annexed in this report (Annexure-IV). Considering the various suggestion of CMPDI and ECL this Project Report has been finalised.

1.5 Salient features of present PR

1.5.1 It is proposed to mine all the workable seams in the blocks from R-VIII T2 to R-II in succession. Mining projections, equipment and capital has however been provided upto 25 years only for working upto R-VIIB seam.

1.5.2 Two set of entries have been proposed, separately in Tilaboni and Tilaboni Extension blocks designated as Mine No. 1 and Mine No. 2 respectively. The detail of the proposed entries is as shown below:

Sl. No.	Mine entry (incline / Shaft)	X-section (W x H/ dia.) (m2/ m.)	Length / Depth (m)	Gradiant	Purpose & mode of transport / ventilation
	Mine No. 1				
1	Incline No. 1 & 2	5.5 m x 3.5 m (finished section)	Normal upto R-VI seam- 1145m, (Upto R-VII B seam – 828m); Reverse (From R-VI to R-II seam- 520m) **Total – 1665m**	1 in 4.5	Coal (belt conveyor) (Inc. No. 1), man riding and material transport (haulage) (Inc. No. 2), intake
2	Pit no,2 (Tilaboni Unit)	Widening (4.2 m dia to 6.0 m dia)	Deepening upto R-VII B seam (94.7m to 155 m), 340 m (upto R-II seam)	Vertical	Air return
	Mine No. 2				
1	Incline no.3 & 4	5.5 m x 3.5 m (finished section)	Normal upto R-VI seam- 1180m (Upto R-VII A&B seam – 960m); Reverse (From R-VI to R-II seam- 725m) **Total – 1905m**	1 in 4.5	Coal (belt conveyor) (Inc. No. 3), man riding and material transport (haulage) (Inc. No. 4), intake
2	Air shaft	6.0 m	220 m (upto R-VII A&B seam) 415 m (upto R-II seam)	Vertical	Return

Though the shafts would be sunk upto the lower most R-II seam, capital provision for sinking upto R-VIIB seam in Mine no.1 and upto R-VII A&B seam

in Mine no.2 has been proposed, that is the seams upto which mining has been proposed upto 25 years in this PR. Likewise the proposed inclines would also be driven upto R-II seam, but capital provision for drivage upto R-VII B seam in Mine no.1 and upto R-VII A&B seam in Mine no.2 has been proposed.

1.5.3 It is proposed to introduce 2 standard height Continuous Miner package and 2 low height Continuous Miner package to achieve a target production of 1.86 MTY. Additionally remote controlled LHDs (2 nos.) and roof bolter has been proposed for heightening of developed galleries in R-VIIIB1 and R-VII seam.

1.5.4 Initially one set of standard height Continuous Miner would be introduced each in seam R-VIII B1 and seam R-VII in Mine no.1 and Mine no.2 respectively. Likewise one set of low height Continuous Miner would be introduced each in seam R-VIII T2 and R-VIII B1(Bottom) in Mine no.1 and Mine no.2 respectively.

1.5.5 The manpower requirement in Risk-Gain sharing option would be 1207 for the operation of underground workings, whereas the total existing manpower of Tilaboni colliery is 904. The additional manpower i.e. 303 (1207-904) nos. would be met from the neighboring mines of the area or from land oustees, after providing necessary training.

1.5.6 The manpower requirement in Equipment Hiring option would be 814 for the operation of underground workings, whereas the total existing manpower of Tilaboni colliery is 904. The surplus manpower i.e. 90 (904-814) nos. would be shifted to the neighboring mines of the area.

1.5.5 Presently coal evacuated from Tilaboni colliery is being transported to the Bankola No.1 railway siding by contractual trucks, which is at a distance of about 5 km from the mine. For coal transport a new railway siding has been proposed which would take off from the Andal Sainthia railway line. Distance of the siding will be about 1.5 km from the proposed incline of Mine No. 1 and about 4.5 km from Mine No. 2.

1.5.7 The grade of seams R-VIII B1/R-VIII B1 (Bot), R-VII/R-VII Bot and R-VIIA presently being worked at the mine is G-4 as informed by General Manager (Project) vide letter no. ECL/PM/492 dated 30/07/2014 and as per the Final Energy Level GCV (Grade) Notifications (Annexure-V). Grade of other virgin seams i.e. seams R-VIII T2, R-VII B and R-VII A&B Combined considered in this report varies from G4 to G11. Year wise overall GCV grade of coal seams considered in this report during the first 25 years of the project life varies from G-4 to G-6, as shown in Chapter-9, Page-3.

1.5.8 In the Risk-Gain Sharing model, the Continuous Miner package(s) would be procured by ECL and operated & maintained by the supplier with an annual production guarantee. The entire capital and operating cost of 2nd Continuous Miner Package as per the M/s Bucyrus (caterpillar) contract dated 14.06.12 of Jhanjra UG mine has been adopted after updating the figures as per the Standard Pricelist of Mining Equipment published by CMPDI HQ in June 2015. ECL will pay to the Continuous Miner package supplier or his sub-

assignee an Operation & Maintenance cost on per tonne basis which includes the maintenance spares. In addition to the maintenance spares the expenditure on revenue items such as roof bolt assembly, drill rods, drill bits, consumables and lubricants required for the operation of Continuous Miner district have also been proposed to be added in the Risk-Gain Sharing model under this report.

1.5.9 In the Equipment Hiring basis, the Continuous Miner package(s) and the Equipment for gallery Heightening would be procured by the Contractor. In this option, ECL will pay to the contractor a single outsourcing cost on per tonne basis. The cost will include the expenditure on revenue items such as roof bolt assembly, drill rods & drill bits, power cost, consumables and lubricants required for the Continuous Miner package.

1.5.10 Financial Evaluation has been carried out on the modalities of Risk-Gain Sharing Basis (option-I) for initial five years (assuming a contract period of 5 years) of the Project. After that project would be run on Departmental Basis with a provision of Annual Maintenance contract of Continuous Miner package with the supplier. Financial Evaluation has also been carried out on the modalities of Equipment Hiring basis (option-II).

1.5.11 The total capital requirement is estimated as ₹ 1416.249 crores and ₹ 941.85 crores in the Risk-Gain and Equipment Hiring respectively. The total capital requirement, CPT, SPT, Profit / Loss and IRR at 100% and 85% rated production levels for the two options is tabulated below:

Financial Indices	**Unit**	**Risk-Gain**		**Equipment Hiring**	
Rated production levels	%	100%	85%	100%	85%
Total capital requirement	₹ crores	1416.249		941.853	
Cost of Production	₹/te	2539.29	2807.21	2328.87	2519.93
Selling Price	₹/te	2944.04			
Profit / Loss	₹/te	404.75	136.83	615.17	424.11
IRR	%	11.07%	5.85%	19.88%	14.03%

1.5.12 Economics of the project considering the Mine-1 Area has also been worked out and has been shown in Annexure-VIII.

1.5.13 There was an approved EMP of Oct.'92 for a production level of 1.17 Mt. A new EMP for proposed Tilaboni UG Project having a capacity 1.86 MTY (Normative) and 2.14 MTY (Peak) with expansion in leasehold area from 436 ha to 869 ha has been prepared. This is one of the mines within the Cluster No. 12 Group of mines for which Environmental Clearance has been granted by MoEF vide letter no. J-11015-76/2011-IA-II.(M) dated 09.2.2015. Again cluster no. – 12 was amended in view of 1 BT production target of CIL by 2019-20. The amended EC was obtained on vide even letter no. dated 03.03.2016.

1.6 Difficulties and constraints in mining and associated risk

The constraints in mining Tilaboni & Tilaboni Extension Blocks are as follows:

Surface constraints:

i. Numbers of residential quarters of ECL lie near the rise side of the property in Tilaboni block.

ii. Ukhra Loudoha DB road passes through the middle of Tilaboni block. Additionally there are a number of other village roads.

iii. Majhi Basti, Shyamsundarpur village (part) lies over Tilaboni block and Tilaboni village (part) and Jhanjra village lies over Tilaboni Extension block.

iv. There are a number of seasonal nallas and ponds.

v. High Tension lines (11 kV) passes along the strike length of the block.

vi. Reserve forest and forest office over Tilaboni block.

Underground constraints:

i. Top most seam (R-VIII T2) is virgin, which has to be liquidated before commencement of depillaring operation in the lower seams.

ii. The next three seams viz. R-VIII B1, R-VII and R-VIIA, have been partly or fully developed. R-VIII B1, R-VII seams have been bolted using cement capsules. This will hinder depillaring operation with continuous miner, while extracting the roof coal during depillaring operation.

iii. Limited mine evacuation capacity as the seams are being worked by small dia. pits. As per estimate the combined capacity of the four coal winding shafts is about 0.52 MTY only.

iv. About 22% of the block (sector A1, A2, A3 & A4) is having steep gradient (about 1 in 5) and is also separated from the other potential area by a fault of throw 45m - 130m. This area has therefore been kept outside the purview of the present PR.

v. Borehole density of the lower virgin seams in the proposed mining area varies from 3.57 BH/sq. km (seam R-VI) to 1.73 BH/sq. km (seam R-II) which is low.

1.7 Project objectives and target beneficiaries

The objective of the project is as follows:

i. To produce 1.86 MTY grade G-4 to G-6 coal from Tilaboni & Tilaboni Extension blocks, by introduction of Continuous Miner technology.

ii. To depillar the developed seams viz. R-VIII B1/ R-VIII B1(Bot.), R-VII and R-VII A in addition to liquidation of R-VIII T2 and R-VII B seams in Tilaboni block and development and depillaring of the virgin R-VIII T2, R-VIII B1(Bot.), R-VII/R-VII (Bot.) and R-VIIA / R-VIIA&B seams of Tilaboni Extension block.

iii. Continuous Miner technology has been proposed as the method has been proven and showing encouraging result in the company.

iv. The target beneficiaries from the project would be power and other industries.

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Chapter-2

MARKETABILITY

2.1 Demand & Supply Scenario

Demand & availability of coal from ECL (upto 2019-20) is as given below:

(Fig.in Mt)

S.N.	Consumer Sector	2017-18	2018-19	2019-20
1	**Projected Production**	**51.678**	**56.564**	**62.000**
2	**Total Projected Demand**	**56.489**	**62.890**	**70.011**
3	**Shortage/Surplus**	**(-)4.811**	**(-)6.326**	**(-)8.011**

Source: - Production & Demand projection as per Reference no.: ECL/PM/ CMPDI/164 dated 24.04.2015 of General Manager (Project), ECL.

2.2 Utility or Market for the Coal from mine / project

The coal of R-VIII T2, R-VIII B1 (Bot), R-VII, R-VII A, R-VII B and R-VII A&B combined seams being of high grade non coking coal have ready demand for power and other industries.

2.3 Available linkage on firm Fuel Supply Arrangement (FSA)

At present coal from Tilaboni UG is being despatched contractually by truck to Bankola No.1 railway siding, at a distance of about 5 km, for onward transport to customers. For Coal transport a new railway siding has been proposed which would take off from the proposed Jhanjra railway siding, which in turn would take off from Andal Sainthia railway line.

2.4 Justification of opening the Project

From the table it can be seen that there is a gap between demand & availability of coal from Raniganj coalfields. The augmentation in production from Tilaboni UG will help to bridge the gap between demand and availability to some extent. In view of the above, the augmentation of production from Tilaboni UG by introduction of Continuous Miners is justified and proposed.

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Chapter-3

PROJECT SITE INFORMATION

3.1.1 Location

Tilaboni mine is located in the north eastern side of Raniganj Coalfield. It is situated in Burdwan district of West Bengal. It lies between lat. 23° 37' 48" and 23° 40' 14" N and Long 87° 16' 05" and 87° 18' 25" E (Figure-3.1).

3.1.2 The total area of Combined Tilaboni and Tilaboni Extension geological blocks is 10.83 sq.km.

3.1.3 Limiting Boundaries

Boundary of Tilaboni UG project is as under:

North West	:	Kumardih A Colliery
North East	:	Jhanjra Block
South East	:	Tilaboni Extension Block/Fault F9-F9 (throw-15 to 95m)
South West	:	Shyamsundarpur Colliery/Fault F1-F1 (throw- 65m)

3.2 Accessibility and Communications

Nearest Airport	:	Dumdum (Kolkata) about 200 km from the project.
Nearest Railway Station	:	Ukhra on Andal-Sainthia branch line of Eastern Railways
Approach by Road	:	Connected to G.T. Road (14 km) by Andal Madhaiganj road.
Nearest Seaport	:	Kolkata

The mine is well connected by both road and rail. The Andal-Madhaiganj road which joins the G.T Road at Andal traverses through the northern part of the block. The distance to G.T. Road from the southern boundary of block is about 14 km. Ukhra Railway Station on the Andal-Sainthia branch line of the Eastern Railway is situated about 3 km away from the block.

The Durgapur Industrial Complex situated to the South-East of the block is about 28 km by road from the block. The Raniganj township, is about 30 km by road.

3.3 Climate and rainfall data

Humid tropical climate prevails over the area. During the summer months lasting from March to May, the temperature generally varies from 30^0C to 40^0C. In winter (November to February) it drops down to about 10^0C during

the night. The relative humidity varies from 45% to 98%. The average annual rainfall is about 1400 mm, the major part of which precipitates during the period from June to October. The area is often subjected to a cyclonic storm-locally known as “Kal Baisakhi” during the month of April to June.

3.4 Topography with drainage pattern of area

The area forms an alluvial plain with very gently undulating topography. The elevation varies from 80m to 106m above M.S.L. The area is drained by two small nalas which originate within the block. They join the Tumni nala beyond the confines of the block, which finally drain into the river Ajoy which is the main drainage channel of the coalfield.

3.5 Present land use pattern

Most of the land overlying the project area is tenancy land and used for agricultural purpose. Paddy is the main crop of the area which is harvested during late November and early December. There is about 65.8 ha of forest land within the block, which includes 21.1 ha of plantation. About 72.6 ha land has been acquired for construction of mine infrastructure and residential buildings.

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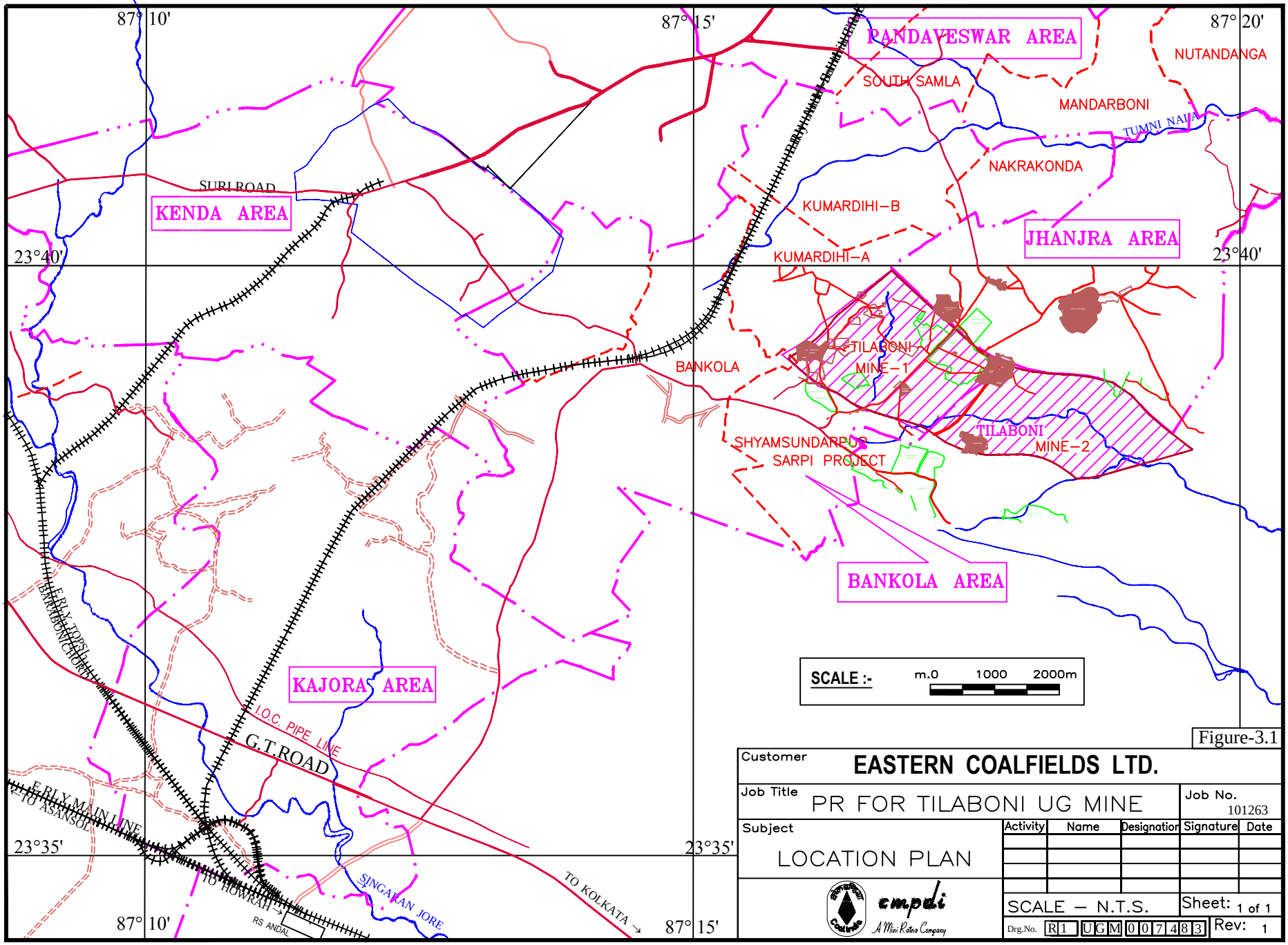

Figure-3.1

Customer	EASTERN COALFIELDS LTD.				
Job Title	PR FOR TILABONI UG MINE				Job No. 101263
Subject	LOCATION PLAN	Activity	Name	Designation	Signature / Date
		SCALE – N.T.S.			Sheet: 1 of 1
		Drg.No. R1 UGM 0 0 7 4 8 3			Rev: 1

cmpdi A Mini Ratna Company

Chapter – 4

GEOLOGY & DEPOSIT APPRAISAL

4.1 Background / Introduction

4.1.1 The Raniganj coalfield is within the command area of ECL and is located in the eastern most part of Damodar Koel valley basin belt covering area of about 1900 sq.km. The area under consideration falls in the Raniganj Coalfield. The Tilaboni combined block comprises the Tilaboni and Tilaboni Ext. geological block covering an area of about 10.83 sq.km.

Present assessment is based on the Geological Report on Tilaboni Block. Raniganj coalfield, Dist.- Burdwan, West Bengal, July, 1984 and Geological report on Tilaboni Ext. Block. Raniganj coalfield, Dist.- Burdwan, West Bengal, May'1991 and both G.R. published by MECL.

4.1.2 Block Boundaries

Geological boundary of Tilaboni combined block is delineated as below:

North	:	Kumardih and Nakrakonda Extension block
West	:	Shyamsundarpur, South Bankola block
South	:	Kunnur and Ichapur block
East	:	Jhanjra block

4.1.3 Relevant details

The present leasehold of the ECL mine consists of 2 units the Tilaboni unit and Shyamsundarpur (Old) designated as SSP (Old) unit. The boundary of Tilaboni UG project is delineated as:

North-west	:	Kumardih 'A' colliery
North-East	:	Jhanjra block
South-west	:	Shyamsundarpur

4.2 Exploration Status

4.2.1 Tilaboni combined block (Tilaboni block and Tilaboni Ext. block) was explored in detailed. 104 BHs were drilled by various agencies, with a total meterage of 28870.25 m drilling. Out of these 104 BHs, 16 boreholes with a total meterage of 4576.39 m are common in both the Tilaboni block and Tilaboni Extension block. In addition to this, data of peripheral boreholes lying in the blocks viz. Jhanjra, Nakrakonda Extension, Kumardih and Shyamsundarpur-South Bankola adjacent to the combined Tilaboni Block have also been taken cognizance of during the course of the geological documentation.

No. of BHs and meterage drilled by various agencies in and around the block area are given in tabulated form as below:

Block	Agency	No. of BHs.	Drilled meterage (m)
Tilaboni Comb. Block Area- 10.83 sq.km.	MECL (TLB & TLB-II series)	90	22990.30
	MECL (SS, JNR, JNP series)	04	1263.30
	GSI	03	1940.05
	NCDC	07	2676.60
	Total	***104***	***28870.25***
Boreholes outside the Block	MECL	10	2969.90
	NCDC	05	1697.51
	Total	***15***	***4667.41***
Grand Total		**118**	**33374.16**

4.2.2 Density of BHs : In addition to 104 nos. of boreholes, 39 nos. of new boreholes were drilled within the Tilaboni Combined block. Considering this density of Boreholes in the combined block workout to be 13.2 boreholes per sq.km. The nos. of boreholes within the area considered for mining i.e. 8.69 sq. km is only 87 (including the new boreholes). Considering the additional 39 nos. of new boreholes, borehole density in the mining area works out to 10.01 boreholes per sq. km. The borehole density for the lower seams is however less.

4.3 Geology & Structure of Block Area

4.3.1 The mentioned investigation was restricted to Raniganj Formation which occupies the Tilaboni Combined Block. The general stratigraphic sequence of Raniganj Coalfield (after Geological Survey of India) is as follows:

General Stratigraphic Sequence of Tilaboni Combined Block

Stratigraphic Units	Formation	L i t h o l o g y
Recent		Alluvium/soil
Sub-recent & Quaternary		Laterite, lateritic gravel, clays, running sand etc.
---------- Unconformity ----------		
	Intrusives (Dykes & Sills)	Dolerite, mica peridotite and lamprophyre
	Supra Panchet	Coarse grained quartzose sandstone with bands of dark red silty shale
	Supra Panchet	Coarse grained quartzose sandstone with bands of dark red silty shale
---------- Unconformity ----------		
Early Triassic	Panchet Formation	Coarse grained greenish grey sandstone bands of red silty shale
Damuda Group	Raniganj Formation	Fine to coarse grained micaceous sandstone, shales, carbonaceous shales and coal seams
	Barren Measures	Black laminated fissile shales with clays and ironstone bands
	Barakar Formation	Coarse grained feldspathic sandstone, shales and coal seams

Stratigraphic Units	Formation	L i t h o l o g y
---------- Unconformity ----------		
Archaeans		Gneiss, granites & schists, shales and coal seams

The entire block is covered either by soil or laterite. The stratigraphic sequence, thickness of different formations and occurrence of different seams have been deciphered on the basis of sub-surface data obtained from exploratory drilling.

4.3.2 Coal bearing formation and their general behavior

The different formations of the block under present investigation are described in brief in the following:

a) Barren Measures Formation:

The lithounits comprising this formation are dark with fine grained sandstone bands. Siderite occurs as disseminated grains within these shales. As a result, these shales are heavily compact. It has been intersected in two boreholes (RJG-2 & NCRJ-10).

b) Raniganj Formation

The rock type of this formation intersected in the boreholes are coarse to fine grained, greenish grey to white, micaceous sandstone, shaly sandstone, intercalation of shale & sandstone, shale, grey shale, dark grey to black shale, carbonaceous shale and coal seams. The arenaceous unit is dominant and is normally hard and friable in nature. Lower portion of this is dominantly coarse to medium grained sandstone. The grey and dark grey shale are fissile and splintery in nature.

c) Panchet Formation

It comprises fine to medium grained sandstone character green colour with occasional greenish grey shale. Chocol shales are characteristics of this formation. It has been in 17 boreholes (TLB-II/1, 4, 12, 15, 16, 24, 27, 30, 38, 41, 46, 53 & 56 and NCRJ-24). The contact with underlying Raniganj formation is traditional.

d) Intrusives

Exploration carried out in Tilaboni Comb. block has revealed that the area is relatively free from igneous intrusives. However, the igneous intrusives in the form of two small dykes of 1.52m and 2.44 m in thickness have been encountered in Tilaboni mines. Considering the data of the block it can be said that igneous activity in the block appears to be negligible.

e) Sub-recent to Quarternary

This comprises of laterite, clays and running sand, clean fine running sand along with quartz pebbles has been encountered in 02 boreholes.

The laterite occurs in five isolated patches. Its thickness as encountered in boreholes varies from 3m to 9m. The laterite is composed of pebbles, gravels, ferruginous nodules cemented loosely within a ferruginous matrix.

f) Recent

The area is mostly covered by alluvium and soil, which ranges in thickness from 1m to 8m and occupy lower grounds which are mostly cultivated.

g) Weathered Mantle

The weathered mantle consists of soil, laterite, running sand as weathered sandstone and shales of either Panchet or Raniganj formations. Its thickness varies from 18m to 40.50m.

4.3.3 Sequence of coal seams and parting within the block area

The sequence of coal seam with their thickness, parting, depth and reserves in the combined block area have been shown in the following table:

Seam	Thickness Range (m)	Depth (m)	Total Geological Reserves (Mt)	Nos. of BH inter-section
R-X A	0.84-2.58	29.50-230.00	2.4261	16
Parting	26.76-41.04			
R-IX Top	0.25-2.73	23.7-269.02	6.5155	49
Parting	1.63-22.53			
R-IX Bot	0.36-2.60	18.0-278.35	5.6843	56
Parting with R-VIII T1	27.65-80.85			
Parting with R-VIII Top	99.63-100.59			
R-VIII Top	1.07-1.32	77.09-154.18	-	4
R-VIII T1	0.07-1.01	37.73-338.45	0.1297	86
Parting	14.30-31.88			
R-VIII T2	0.46-2.92	20.35-369.65	18.8672	105
Parting with R-VIII B1 (Top)	6.00-29.37			
Parting with R-VIII B1 (Comb)	23.76-30.09			
R-VIII B1 (Top)	0.30-1.73	82.22-377.02	11.7127	87
Parting	1.12-8.95			
R-VIII B1 (Bot)	0.90-2.65	84.85-384.20	19.5303	84
R-VIII B1 (Comb)	2.73-5.04	19.10-138.90	21.7650	25
Parting	8.20-21.77			
R-VIII B2	0.30-1.45	29.56-251.70	6.7983	91
R-VIII Bot	1.65-1.84	135.64-159.33	-	3
Parting with R-VII Top	27.14-46.25			
Parting with R-VII Comb	22.00-53.35			
R-VII Top	0.70-2.26	153.10-294.80	4.9806	19
Parting	1.14-14.09			
R-VII Bot	1.84-3.03	156.50-303.97	10.4876	19

Seam	Thickness Range (m)	Depth (m)	Total Geological Reserves (Mt)	Nos. of BH inter-section
R-VII	1.95-6.35	16.75-244.60	55.9201	73
Parting with R-VII A	23.85-48.74			
Parting with R-VII A/B Comb	39.00-61.43			
R-VII A	0.40-3.33	45.75-287.75	24.7062	55
Parting	3.85-27.44			
R-VII B	0.21-3.40	64.35-306.05	29.3868	54
R-VII A/B Comb	3.23-5.18	201.93-368.43	18.5946	22
Parting	12.96-27.50			
R-VII C	0.12-2.20	82.50-395.60	25.0861	68
Parting	18.13-51.08			
R-VI	1.98-6.82	112.0-391.15	82.9607	64
Parting	14.62-63.17			
R-V	1.20-6.35	176.56-359.00	79.6827	44
Parting	0.43-50.40			
R-IV	1.52-12.03	182.90-388.07	140.6427	44
Parting	24.12-41.25			
R-III	0.95-4.65	224.94-441.34	43.8707	37
Parting	9.42-45.52			
R-II	0.45-2.32	257.50-487.19	26.6383	37
Total			**636.3863**	

The sequence of coal seam with their thickness, parting, depth and reserves in the proposed project area have been shown in the following table:

Seam	Thickness Range (m)	Depth (m)	Total Geological Reserves (Mt)	Nos. of BH inter-section
R-X A	0.84-2.22	65.69-90.72	0.6325	5
Parting	26.76-32.95			
R-IX Top	0.98-2.73	23.70-125.30	3.0631	16
Parting	1.63-21.81			
R-IX Bot	0.36-2.23	18.0-128.28	4.6733	22
Parting with R-VIII T1	28.35-80.85			
Parting with R-VIII Top	99.63-100.59			
R-VIII Top	1.07-1.32	77.09-154.18	-	4
R-VIII T1	0.10-1.01	37.73-190.67	-	53
Parting	14.30-31.88			
R-VIII T2	0.50-2.01	20.35-222.91	12.5810	69
Parting with R-VIII B1 (Top)	6.00-27.73			
Parting with R-VIII B1 (Comb)	23.76-27.50			
R-VIII B1 (Top)	0.30-1.47	82.22-231.04	7.5236	54
Parting	1.12-8.95			
R-VIII B1 (Bot)	0.90-2.59	84.85-237.30	13.0029	52
R-VIII B1	3.10-4.82	19.10-104.05	20.5636	22
Parting	8.20-21.77			
R-VIII B2	0.30-1.45	29.56-251.15	4.8036	68
R-VIII Bot	1.65-1.84	135.64-159.33	-	2
Parting with R-VII Top	27.14-42.45			
Parting with R-VII Comb	26.84-53.35			

Seam	Thickness Range (m)	Depth (m)	Total Geological Reserves (Mt)	Nos. of BH inter-section
R-VII Top	0.70-2.26	153.10-279.05	3.7302	17
Parting	1.14-14.09			
R-VII Bot	1.95-2.95	156.50-294.16	8.6470	17
R-VII	1.95-6.18	75.93-211.98	41.9954	50
Parting with R-VII A	23.85-48.74			
Parting with R-VII A/B Comb	39.00-54.55			
R-VII A	1.37-3.33	110.52-243.20	20.1713	34
Parting	3.85-27.20			
R-VII B	0.21-3.40	126.80-260.50	21.0555	35
R-VII A/B Comb	3.23-5.18	201.93-335.55	16.0614	21
Parting	12.96-27.50			
R-VII C	0.12-2.20	149.40-355.03	19.8299	48
Parting	18.13-51.08			
R-VI	1.98-6.58	187.75-391.15	63.8800	46
Parting	19.70-63.17			
R-V	1.20-6.30	216.75-341.25	61.9739	32
Parting	0.92-49.24			
R-IV	1.52-11.45	242.60-366.24	111.3215	34
Parting	24.12-35.34			
R-III	2.05-3.59	270.78-401.00	37.1007	32
Parting	9.42-45.52			
R-II	0.45-2.32	283.25-440.64	21.9464	28
Total			**494.5568**	

4.3.4 Structural Setting within the Project Area

The Tilaboni Combined block is structurally bounded in the north-western side by a narrow trough zone while the north-eastern to eastern and southern part of the reported area are bounded by two major faults, one form the southern limit of the block hade away from the block while the remaining one hade towards the block. Structurally, the reported area is bounded by the following faults:

North	Adjacent blocks are Kumardih & Nakrakonda	Fault F2-F2 upto its intersection with faults F9-F9 & F3-F3.
South	Ichapur & Kunnur	Fault F10-F10
East	Jhanjra	Fault F3-F3
West	Shyamsundarpur & South Bankola	Fault F17-F17 upto its intersection with fault F5-F5.

4.3.5 Dip & Strike

The strike of the bead is generally NE-SW to NW-SE with local variation and the dip varies from 3° to 12° (1 in 5 to 1 in 19) and general dip of the beds is easterly varying with swing in the strike of the beds. However in the central part of the block around boreholes TLB-28, TLB-30 & TLB-II/31 gradient is very gentle and varies from 1 in 30 to 1 in 90.

4.3.6 Incrops of Coal Seams

Only 7 coal seams/sections, i.e. R-X, R-X A, R-IX(Top), R-IX(Bot), R-VIII (T1), R-VIII (T2) and R-VIII (B1) incrop within the reported property. They are however dissected mainly because of swinging nature of the strike of the bed and displacement of coal seams due to faulting.

4.3.7 Faults

In total 17 normal faults were deciphered in the Tilaboni combined block. The faults have been designated as F1-F1, F2-F2 and so on upto F17-F17. The faults deciphered can broadly be classified into two group viz.:

a. faults trending NW-SE and
b. faults trending NNE-SSW to E-W

The dip of the faults has been assumed as 70^{o} except for some few faults. The description of faults with their throw and dip is given in the table below:

Fault No.	General Trend, Dip direction, Throw amount	a. Nature of faults b. Evidences
F1-F1 (F3-F3 of Tilaboni block)	N65^{o}E - S65^{o}W 70^{o} north-westerly 4 m near TLB-8	a. Linear, oblique b. Intersected in borehole TLB-8 at 245 m, resulting in omission of part R-V seam
F2-F2 (F2-F2 of Tilaboni block)	N60^{o}E - S60^{o}W in the western part near TLB-13; N38^{o}E - S38^{o}W east of TLB-8; N50^{o}E - S50^{o}W north of TLB-9; 60^{o} north-westerly dip; 37m near TLB-8, gradually reducing to about 10 m north-west of TLB-15	a. Curvilinear, oblique b. Encountered in the R-VII (Bonbahal) seam workings of Tilaboni pits.
F3-F3 (F6-F6 of Tilaboni block)	N45^{o}W – S45^{o}E & swings to E-W through N50^{o}W – S50^{o}E; 60^{o} southerly; 65m near TLB-1, 95 m near NCRJ-14, 65 m near TLB 23/23A	a. Curvilinear oblique. b. (i) Encountered in the mine workings of Kumardih 'A' Colliery. (ii) Intersected in TLB-23/23A at 240 m. (iii) Intersected in TLB-1 at 243 m (iv) Intersected in NCRJ-14 at 115 m (v) Defines the boundary of the block towards north-east and east.
F4-F4 (F5-F5 of Tilaboni Block)	N60^{o}W - S60^{o}E; 60^{o} north-easterly; 15 near Tilaboni pits gradually reducing and dying out towards south-east	a. Linear, oblique b. Encountered in Tilaboni mine working

Fault No.	General Trend, Dip direction, Throw amount	c. Nature of faults d. Evidences
F5-F5 (F9-F9 of Tilaboni Block)	N50^{o}E – S50^{o}W with minor variations; 60 ^{o} towards NW; 15 m near TLB-21 and NCRJ-3 and reduces to 0m.	a. Almost linear, oblique b. Intersected in TLB- 23/23A at 128 m
F6-F6 (F11-F11 of Tilaboni Block)	N60^{o}E – S60^{o}W; 60 ^{o} South easterly; Variable from 35m to 70m	a. Linear oblique b. Reduction in parting between R-VIII B & R-VII seams, in borehole JNR-II/6 at a depth of 136 m.
F7-F7 (F10-F10 of Tilaboni Block)	N45^{o}E – S 45^{o}W; 60 ^{o} North-westerly; Variable from 45m to 80 m	a. Curvilinear oblique b. Intersected in TLB-17, TLB-21 and in TLB-23/23A
F8-F8 (F8-F8 of Tilaboni Extn.Block)	E-W near TLB-II/3/3A & TLB-4 and then swings to NW-SE; 75 ^{o} southerly; Variable, 5 m near TLB-II/3/3A and gradually increases to 45 m near TLB-II/37	a. Curvilinear oblique fault b. Difference in F.R.L. of seams in RJG-2
F9-F9 (F1-F1 of Tilaboni Block & F4-F4 of Shyam-sundarpur Block)	N50^{o}W – S50^{o}E in the western part; N65^{o}W - S65^{o}E in the southern part; 60 ^{o} south-westerly; 70 m near SS-7, 75 m west of TLB-3 and varies upto 130 m.	a. Curvilinear oblique b.(i) Intersected R-VIIIB1 workings and of Pits -1 & 2 of Shyamsundarpur colliery (ii) Intersected in borehole SS-7 and TLB-3 at a depth of 121 m and 148 m respectively.
F10-F10 (F12-F12 of Tilaboni Block & F10-F10 of Shyam-sundarpur Block)	N75^{o}E – S75^{o}W; 70 ^{o} southerly; Reported to be more than 450 m in Shyamsundarpur block.	a. Linear oblique b. (i) Intersected in boreholes SS-10 in Shyansundarpur and NCRJ-24 at 181 m. bringing the Panchet in Juxtaposition with the Raniganj (ii) Seams younger than R-VIIA omitted in NCRJ-14 (iii) It forms southern block boundary.
F11-F11	NW-SE; 70^{o} south-westerly; Variable 0-25 m	a. Linear oblique
F12-F12	NW-SE; 70 ^{o} north-easterly; Variable 0-15 m	a. Linear oblique

Fault No.	General Trend, Dip direction, Throw amount	a. Nature of faults b. Evidences
F13-F13 (F4-F4 of Tilaboni Extn. Block)	ENE – WSW; 75 ^{o} southerly; Variable 0 m near TLB-II/13 and gradually increases to 40 m near TLB-II / 56	a. Linear dip to oblique fault. b. Intersected in TLB II/4, II/15 & II/56 at a depth of 256m, 252m and 155m respectively resulting in the omission of R-VII(Top), R-VII(Bot) and R-VII A/B seams in TLB-II/4, R-VII(Top) and R-VII(Bot) in TLB-II/15 and R-VIII T1 and R-VIII T2 seams in TLB-II/56
F14-F14 (F10-F10 of Tilaboni Block)	WNW – ESE; 75 ^{o} southerly; Variable 0-15 m	a. Linear oblique fault b.(i) Intersected in TLB-II/17 at about 171 m resulting in the reduction of parting between R-VIII B2 and R-VII seams. (ii) Intersected in TLB-21 at about 198 m resulting in the omission of R-VII seams
F15-F15	WNW – ESE; 70 ^{o} southerly; 15 m	a. Linear oblique
F16-F16	NNE – SSW; 70^{o} north-westerly; 10 m	a. Curvilinear oblique
F17-F17	N35^{o}E - S35^{o}W; 60 ^{o} north-westerly; 10 m east of NCRJ-26 reducing to 5 m towards north-east	a. Almost linear b. (i) Intersected in the working of R-VIII T2 and R-VIII B1 in Shyamsundarpur block (ii) Result in the reduction of parting between R-VII C and R-VI seam in NCRJ-26.

4.3.8. Presence of dyke, sills (igneous intrusive) etc.:

The igneous Intrusives in the form of two small dykes of 1.52m and 2.44 m in thickness have been encountered in Tilaboni mines. However Considering the data of the block the area is relatively free from igneous Intrusives.

4.4 Description of Coal Seams

The geological investigation carried out in the area has proved the existence of nine standard coal horizons (R-X to R-II) out of the ten recognized by Gee (1932) in Raniganj Coalfield. The R-X seam is the youngest of the standard coal horizons present within the block and is followed successively downward by R-IX, R-VIII, R-VII, R-VI, R-V, R-IV, R-III and R-II. Besides few persistent local coal seams, viz. R-VII A, R-VII B & R-VII C between R-VII and R-VI seams and R-X A between R-X and R-IX seams are present. Seams R-IX, R-VIII and R-VII are split into two or more splits and making it a total of 21 sections of coal seams.

4.4.1 Description of individual coal seams of the Project Area

The correlation of these seams and their characteristic behaviour are as follows:

i. A local seam (0.84m – 2.22m), which is the top most coal horizon in the project area, has been correlated as R-XA seam, This seam is in lateral continuity in the adjacent Shyamsundarpur-Bankola Block and has been intersected in 5 nos. of borehole only in the project area.

ii. The R-IX seam, locally known as Upper Kajora seam occurs in two splits viz. R-IX(Top) and R-IX(Bot) within the block. The splitting of the seam has been observed in Shyamsundarpur south Bankola block in borehole SBNK-4. Though the intervening parting between two splits shows a wide variation from 1.63 m to 21.81 m in south-east, in eastern part the parting is less (5 m). The thickness of R-IX(Top) varies from 0.98 to 2.73 m and of R-IX(Bot) from 0.36 m to 2.23 m. the splitting of the seam is thicker than that found in adjacent Jhanjra block in north western part.

iii. The R-VIII seam, locally known as Jambad seam is the most potential seam in the eastern part of the Raniganj Coalfield. It exhibits phenomena of splitting and coalescing. Within the block the seam shows five persistent splits viz. R-VIII T1, R-VIII T2, R-VIII B1(Top), R-VIII B1(Bot) and R-VIII B2 which are in lateral continuity as identified in adjacent Shyamsundarpur south Bankola blocks. R-VIII T1 and R-VIII T2 seams ranges in thickness from 0.10 to 1.01 m and 0.50 to 2.01 m respectively. The intervening parting varies from 14.30 m to 31.88 m. The R-VIII B1(Top) and R-VIII B1(Bot) seams vary in thickness from 0.30 to 1.47 m and 0.90 to 2.59 m respectively. The intervening parting between these splits ranges from 1.12 to 8.95 m. The lower most split viz. R-VIII B2 varies in thickness from 0.30 to 1.45 m and occurs below R-VIII B1(Bot) seam with a parting varying from 8.20 m to 21.77 m.

iv. The R-VII seam, locally known as Bonbahal seam occurs a composite seam in the western half attaining a variable thickness of 1.95 to 6.18m, and splits into R-VII(Top) and R-VII(Bot) seams in the eastern half. The R-VII(Top) varies in thickness from 0.70 to 2.26 m and R-VII(Bot) ranges in thickness from 1.95 m to 2.95 m. The intervening parting between R-VII(Top) and R-VII(Bot) ranges from 1.14 m to 14.09 m.

v. Three local prominent coal seams viz. R-VII A, R-VII B and R-VII C occurring below R-VII have been identified successively downward which are in lateral continuity with the similar local seams as identified in adjacent Jhanjra Block. The R-VII A and R-VII B seams merges to a composite seam in the central and eastern part of the block and ranges from 3.23 to 5.18 m in thickness. This composite seam splits in the western part with an intervening parting thickness ranging from 3.85 m to 27.20 m. Individually, R-VII A seam varies in thickness from 1.37 to 3.33 m, whereas R-VII B seam ranges in thickness from 0.21 to 3.40 m. The R-VIIC seam (0.12 to 2.20 m) is present throughout the block as individual seam as in the surrounding blocks.

vi. The R-VI seam is well developed in and around the block and the thickness varies from 1.98 m to 6.58 m. The parting with overlying R-VII C seam ranges from 18.13 to 51.08 m.

vii. Underlying R-VI seam, four index coal seams viz. R-V, R-IV, R-III and R-II have been developed persistently within the block. The R-V seam varies in thickness from 1.20 to 6.30 m, whole R-IV seam ranges in thickness from 1.52 to 11.45 m. The intervening parting between these two seams varies considerably (0.92 m to 49.24 m). The parting continuously increases from central part of the black to southward and as well as eastward. The R-III and R-II seams underlying R-IV seam, range in thickness from 2.05 to 3.59 m and 0.45 to 2.32 m respectively. The intervening parting between these two seams exhibits a restricted variation (9.42 m to 45.52 m). The continuity of above index seams have been well established in the adjacent block.

4.4.2 Roof & Floor Characteristics

Seam wise details of roof and floor characteristics of the coal seams considered in this report are tabulated below:

Seam	Roof characteristics		Floor characteristics	
	Immediate	3m column	Immediate	1m column
R-XA	Grey to dark grey shale & carb. shale	Shaly Sandstone & coarse to fine grained sandstone (Dominant); Shale & intercalations of shale & sandstone (Subordinate)	Grey shale & shaly sandstone	Grey shale & shaly sandstone (Dominant); Fine grained sandstone (Subordinate)
R-IX (Top)	Grey shale, coarse to fine grained sandstone & carb. shale	Coarse to fine grained sandstone (Dominant); Sandy shale (Subordinate)	Sandy shale, grey shale & shaly sandstone	Shaly sandstone & sandy shale (Dominant); Medium to fine grained sandstone (Subordinate)
R-IX (Bot)	Shale and its variates	Coarse & fine grained & shaly sandstone (Dominant); Sandy shale (Subordinate)	Grey shale & carb. shale & shaly sandstone	Sandstone and its variates (Dominant); Shale and its variates (Subordinate)
R-VIII T2	Medium to coarse grained sandstone & sandy shale	Medium to coarse grained sandstone (Dominant); grey shale, shaly sandstone (Subordinate)	Grey shale, carb. Shale & shaly sandstone	Fine to medium grained Sandstone (Dominant); Shaly sandstone & shale/sst. intercalations (Subordinate)
R-VIII B1 (Top)	Grey to dark grey shale & sandy shale occasionally medium to coarse grained sandstone	Fine grained to coarse grained sandstone (Dominant); Intercalations of shale and sandstone, sandy shale (Subordinate)	Sandy shale, grey shale, sandstone and its variates	Sandy shale, grey shale & shaly sandstone, occasionally intercalations of shale and sandstone

Seam	Roof characteristics		Floor characteristics	
	Immediate	3m column	Immediate	1m column
R-VIII B1 (Bot)	Fine grained sandstone, shaly sandstone, Shale and its variates	Shaly sandstone, grey shale, sandy shale & fine grained sandstone (Dominant); Shaly sandstone, intercalations of shale and sandstone & dark grey shale (Subordinate)	Grey shale, shaly sandstone, sandy shale & intercalations of shale and sandstone	Shaly sandstone (Dominant); Grey shale and sandy shale (Subordinate)
R-VIII B1 (Comb)	Sandstone and shale	Coarse grained sandstone	Shale and sandstone	Shale and its variates
R-VII(Top)	Dark grey shale & intercalations of shale and sandstone	Fine to medium grained sandstone, grey shale & shaly sandstone (Dominant); Dark grey shale & intercalations of shale and sandstone (Subordinate)	Shale and its variates, intercalations of shale & sandstone, shaly sandstone	Shaly sandstone & intercalations of shale and sandstone (Dominant); Medium grained sandstone, grey shale (Subordinate)
R-VII(Bot)	Sandy shale & grey shale	Fine grained sandstone & sandy shale (Dominant); Shaly sandstone, grey shale, intercalations of shale and sandstone (Subordinate)	Sandy shale & grey shale, occasionally sandstone	Fine grained sandstone & shaly sandstone
R-VII	Sandstone, grey to dark grey shale & carb. shale	Medium to fine grained sandstone & intercalations of shale and sandstone (Dominant); Shale/sandstone intercalations and grey shale (Subordinate)	Shaly sandstone, medium grained sandstone, sandy shale	Shaly sandstone (Dominant); Medium to fine grained sandstone (Subordinate)
R-VIIA	Shale and its variates, sandstone	Coarse to medium grained sandstone (Dominant); Sandy shale & intercalations of shale and sandstone (Subordinate)	Grey to dark grey shale, sandy shale & shaly sandstone	Shaly sandstone, fine grained sandstone & intercalations of shale and sandstone
R-VIIB	Fine grained sandstone, sandy shale & grey shale	Coarse to fine grained sandstone (Dominant); Grey shale, sandy shale & intercalations of shale and sandstone (Subordinate)	Sandy shale, grey shale and shaly sandstone	Shaly sandstone & sandy shale
R-VIIA/B	Sandstone, grey to dark grey shale & sandy shale	Medium to coarse grained sandstone (Dominant) Shale and its variates, (Subordinate)	Shaly sandstone, sandy shale & intercalations of shale and sandstone	Shaly sandstone, sandy shale & fine grained sandstone

Seam	Roof characteristics		Floor characteristics	
	Immediate	3m column	Immediate	1m column
R-VIIC	Grey shale to dark grey shale	Shale and its variates (Dominant) ; Dark grey shale, fine grained sandstone (Subordiante)	Grey shale & sandy shale, sandstone	Grey to sandy shale (Dominant); Sh./sst intercalations & shaly sandstone (Subordinate)
R-VI	Grey shale, carb. shale & sandy shale and occasionally sandstone	Grey shale, sandy shale, medium to coarse grained sandstone	Grey to dark grey shale, sandy shale, sahly sandstone occasionally sandstone	Grey to sandy shale shaly sandstone and fine grained sandstone
R-V	Shale and its variates	Grey to dark grey shale (Dominant); Shaly sandstone & Sh./sst intercalations (Subordinate)	Shale and sandstone	Grey shale (Dominant); Shaly sandstone (Subordinate)
R-IV	Shale and its variates	Grey shale (Dominant) Sandy shale (Subordinate);	Shale and occasionally sandstone	Fine grained & shaly sandstone (Dominant); Sandy shale (Subordinate)
R-III	Shale and its variates	Fine to coarse grained sandstone (Dominant); Gr.sh. & sh./sst intercalations (Subordinate)	Sandstone and shale	Fine to coarse grained sandstone (Dominant); Sandy shale and shaly sandstone (Subordinate)
R-II	Shale and its variates	Medium to coarse grained sandstone (Dominant); Sh/sst intercalations (Subordinate)	Shale and its variates	Grey shale (Dominant); Sandy shale (Subordinate)

4.4.3 There is no evidence of burning of coal seam in the project area.

4.4.4 Details of splitting

Out of nine standard coal horizon within the block area, three seams namely, R-IX, R-VIII and R-VII seam have split. Details of seam splits are given as tabulated below:

Seam	Splits seam	Thickness (m)		Remarks
		Min.	Max.	
R-IX	R-IX(Top)	0.98	2.73	Unworkable
	R-IX(Bot)	0.39	2.60	Unworkable
R-VIII	R-VIII T1	0.07	1.01	Unworkable
	R-VIII T2	0.50	2.92	VIRGIN
	R-VIII B1(T)	0.30	1.73	Unworkable
R-VIII	R-VIII B1(B)	1.36	2.65	DEV.IN PROGRESS
	R-VIII B1(Comb)	2.73	4.72	
	R-VIII B2	0.33	1.20	Unworkable
R-VII	R-VII(Top)	0.59	2.26	VIRGIN
	R-VII(Bot)	1.84	3.03	VIRGIN

4.4.5 Details of dirt bands

Seam wise details of dirt bands within the block area are tabulated below:

Seam	No. of Bands	Thickness range (m)	Cumulative Thickness (m)	Lithology
R-XA	1 - 3	0.05-0.45	0.05-0.64	Carb. shale, grey shale, dark grey shale
R-IX(Top)	1	0.05 - 0.45	0.05 - 0.30	Grey shale
R-IX(Bot)	1-2	0.05 - 0.31	0.06 - 0.54	Shale and its variates
R-VIIIT2	1-2	0.05 - 0.33	0.05 - 0.33	Carb. shale & grey shale
R-VIII B1 (T)	1	0.05 - 0.12	0.05 - 0.12	Sandstone & Carb. shale
R-VIII B1 (B)	1	0.05 - 0.73	-	Carb. shale
R-VIII B1 (Comb)	1	0.04 - 0.45	0.07 - 0.53	Shale and its variates
R-VII(Top)	1	0.08 - 0.13	-	Carb. shale, dark grey shale
R-VII(Bot)	1 - 2	-	-	Carb. shale, grey shale, dark grey shale
R-VII	1 - 3	0.03 - 0.98	0.10 - 0.98	Carb. shale, grey shale, dark grey shale
R-VIIA	1 - 2	0.05 - 0.35	0.08 - 0.67	Carb. shale, grey shale
R-VIIB	1 - 2	0.10 - 0.12	0.22	Carb. shale
R-VIIA/B	1 - 2	0.08 - 0.40	0.08 - 0.55	Carb. shale, grey shale, dark grey shale
R-VIIC	1	0.06 - 0.32	0.06 - 0.17	Siderites, Carb. shale
R-VI	1 - 2	0.05 - 0.42	0.05 - 0.42	Shale and its variates
R-V	1	0.07 - 0.30	-	Shale and sandstone
R-IV	1 - 5	0.04 - 0.64	0.11 - 1.89	Shale and its variates
R-III	1	0.08	-	Carb. Shale
R-II	NIL	-	-	-

4.4.6 Quality Parameters

Proximate Analysis:
Seamwise details of Moisture, Ash, Volatile Matter and Fixed Carbon (on 60% RH & at 40^{o} C), of the seams considered in this report, within the block area are tabulated below:

Seam	Parameter	Moisture (%)	Ash (%)	VM (%)	FC (%)
R-VIIIT2	Minimum	6.5	16.2	23.4	30.4
	Maximum	10.1	38.0	31.6	42.8
R-VIII B1 (Bot)	Minimum	7.0	13.2	26.7	37.2
	Maximum	9.9	27.5	32.8	46.2
R-VIII B1 (Comb)	Minimum	7.1	15.0	27.5	38.8
	Maximum	9.8	25.3	31.3	46.2
R-VII (Bot)	Minimum	5.8	24.5	24.9	34.9
	Maximum	8.9	32.0	29.4	39.1
R-VII	Minimum	6.7	12.1	25.4	35.7
	Maximum	10.1	29.1	31.4	47.1
R-VIIA	Minimum	5.9	13.1	26.8	36.2
	Maximum	9.6	30.3	31.5	48.2

Seam	Parameter	Moisture (%)	Ash (%)	VM (%)	FC (%)
R-VIIB	Minimum	6.0	11.3	25.5	31.3
	Maximum	9.5	36.0	32.3	47.3
R-VIIA/B	Minimum	5.3	19.2	25.2	34.2
	Maximum	8.5	33.5	31.3	42.1
R-VIIC	Minimum	5.3	12.6	24.1	34.0
	Maximum	10.7	35.1	30.5	48.2
R-VI	Minimum	6.0	10.3	27.5	38.8
	Maximum	9.2	25.0	33.2	51.5
R-V	Minimum	5.2	12.1	29.2	42.4
	Maximum	9.6	20.6	33.0	48.8
R-IV	Minimum	4.4	11.9	29.8	41.2
	Maximum	8.4	19.0	33.8	49.3
R-III	Minimum	4.7	12.6	28.0	41.0
	Maximum	8.4	24.4	32.5	48.4
R-II	Minimum	5.5	13.4	16.1	41.6
	Maximum	9.7	25.9	30.8	60.4

GCV:

Seamwise GCV grade of the coal seams (in the project area) considered in this report within 25 years of project life are as tabulated below:

Seams	**GCV Grade**	**Remarks**
R-VIIIT2	G-11 to G-7	Virgin, considered for mining under this PR
R-VIII B1/ R-VIII B1 (Bot)	G-4*	Seam has been extensively developed by B&P method with SDL, proposed to be further developed and depillared by CM in this PR.
R-VII/ R-VII (Bot)	G-4*	Seam has been extensively developed by B&P method with SDL, proposed to be further developed and depillared by CM in this PR.
R-VIIA	G-4*	Development by B&P method with SDL is in progress, proposed to be further developed and depillared by CM in this PR.
R-VIIB	G-12 to G-6	Virgin, considered for mining under this PR
R-VIIA/B	G-9 to G-6	Virgin, considered for mining under this PR
R-VIIC	G-10 to G-7	Virgin, workable but beyond the scope of this PR
R-VI	G-7 to G-5	Virgin, workable but beyond the scope of this PR
R-V	G-8 to G-4	Virgin, workable but beyond the scope of this PR
R-IV	G-6 to G-4	Virgin, workable but beyond the scope of this PR
R-III	G-6 to G-4	Virgin, workable but beyond the scope of this PR
R-II	G-7 to G-5	Virgin, workable but beyond the scope of this PR

* The grade of seams R-VIII B1/R-VIII B1 (Bot), R-VII/R-VII Bot and R-VIIA presently being worked at the mine is G-4 as informed by General Manager (Project) vide letter no. ECL/PM/492 dated 30/07/2014 and as per the Final Energy Level GCV (Grade) Notifications issued by, ECL (Annexure-V).

4.4.7 Other Test and Analysis:

Seam wise details of Ash fusion Temperature (ºC) and HGI are as tabulated below:

Seam	Particulars			HGI
	I.D.T.	H.T.	F.T.	
R-XA	1175 - 1215	>1400	>1400	51 - 61
R-IX(Top)	1080 - 1210	1360 - >1400	1400 - >1400	41 - 59
R-IX(Bot)	1160 - 1215	>1400	>1400	52 - 65
R-VIIIT2	1100 - 1210	1350 - >1400	>1400	39 - 63
R-VIII B1 (T)	1100 - 1225	1370 - >1400	>1400	42 - 56
R-VIII B1 (B)	1080 - 1260	1300 - >1400	1350 - >1400	43 - 60
R-VII(Top)	1095 - 1260	1340 - >1400	>1400	47 - 57
R-VII(Bot)	1080 - 1230	>1400	>1400	45 - 61
R-VII	1080 - 1240	1370 - >1400	1400 - >1400	33 - 60
R-VIIA	1080 - 1225	1370 - >1400	>1400	45 - 65
R-VIIB	1120 - 1180	1185 - >1400	>1400	45 - 58
R-VIIA/B	1020 - 1270	1320 - >1400	1360 - >1400	43 - 64
R-VIIC	1070 - 1270	1280 - >1400	1320 - >1400	37 - 63
R-VI	1000 - 1210	1220 - >1400	1260 - >1400	45 - 61
R-V	1000 - 1215	1340 - >1400	1370 - 1400	
R-IV	1070 - 1100	1400 - >1400	>1400	
R-III	1060 - 1120	1380 - >1400	1400 - >1400	

4.5 Geo-technical and Hydro-geological Information

Geo-technical information of the Tilaboni Combined Block is not available. Provision for carrying out scientific/ geo-technical study in Tilaboni Combined Block have been made in this report. Geo-technical study will involve the physico-mechanical properties of rocks, caving characteristics of the roof strata etc.

Tilaboni Colliery is one of the underground mine within the Cluster No. 12 Group of mines constituted for the purpose of Environmental Clearance. Hydro-geological Information for all the mines of Cluster No. 12 is available. However detailed hydrogeological study will be carried out for Tilaboni UG Mine.

4.6 Geological Reserves

4.6.1 Methodology adopted for estimation of coal reserves is as follows:

i. The isochore method has been used to estimate the reserves of the different coal seams. The following formula has been used for this purpose:

$$R = A \times Th \times G.$$

Where, R = Gross reserves in million tonnes.
A = Area in sq. km.
Th = Thickness in m.
G = Specific gravity

ii. Reserves of have been calculated isochore wise, isograde wise and sector wise.

iii. Average values of the isochores have been taken as thickness of the seam between two isochore.

iv. 0.90 m has been taken as the cut-off thickness of a seam for calculation of reserves.

v. Shaly coal (having ash + moisture % more than 40% and upto 55%) occurring at the roof and/or floor of a coal seam has been considered to be a part of the seam while estimating the reserves.

vi. Only in-band reserves have been estimated. These include carbonaceous shale bands upto 0.30 m. in thickness. Obvious dirt bands and non-combustible bands of 0.05m or more in thickness and carbonaceous shale bands of more than 0.30 m in thickness have been excluded from the including band thickness.

vii. In the areas where the seams have been worked viz. R-VIII B_1 (B) and R-VII seams. It has been assumed that 30% of the coal of the workings section has been extracted and the reserves estimated accordingly.

viii. The areas falling within heave zones of faults have been excluded from reserves estimation.

ix. The gross reserves have been reduced by 10% to arrive at the net in situ reserves of coal to make room for geological uncertainties such as, unidentified faults, dykes, abrupt reduction in the thickness of seams etc.

x. Reserves for depillared areas of the mine workings have not been calculated.

xi. As the geological continuity of coal seams is established in the northern part of the block as evidenced in the mine workings and exploratory openings, the reserves have been put in ‘proved’ category though all the boreholes are not spaced at 400 m. grid interval. In the southern part of the block, where the boreholes are widely spaced, the reserves have been put under ‘indicated’ category.

4.6.2 Net Geological Reserve

Seam wise total Net Geological reserves of Tilaboni Combined Block under consideration are tabulated below:

Sl. No.	Seam	Net Geological Reserves (Mt)		
		Proved	Indicated	Total
1	R-X A	2.4261		2.4261
2	R-IX(Top)	6.5155		6.5155
3	R-IX(Bot)	5.6843		5.6843
4	R-VIII T1	0.1297		0.1297
5	R-VIII T2	18.8672		18.8672
6	R-VIII B1(Top)	11.7127		11.7127
7	R-VIII B1(Bot)	19.5303		19.5303
8	R-VIII B1 (Comb.)	21.7650		21.7650
9	R-VIII B2	6.0460	0.7523	6.7983
10	R-VII(Top)	4.9806		4.9806
11	R-VII(Bot)	10.4876		10.4876
12	R-VII	50.6106	5.3094	55.9201
13	R-VII A	23.2453	1.4608	24.7062
14	R-VII B	27.5787	1.8081	29.3868
15	R-VII A/B	18.5946		18.5946
16	R-VII C	23.6345	1.4516	25.0861
17	R-VI	78.5690	4.3917	82.9607
18	R-V	75.7529	3.9298	79.6827
19	R-IV	99.1610	41.4817	140.6427
20	R-III	42.0409	1.8298	43.8707
21	R-II	26.0623	0.5760	26.6383
	Total	**573.3951**	**62.9912**	**636.3863**

4.6.3 Net Geological Reserves of Project Area

Net Geological reserves have been estimated within the proposed Project boundary. Seam wise Net Geological reserves within the proposed Project area are tabulated below:

Sl. No.	Seam	Net Geological Reserves (Mt)		
		Proved	Indicated	Total
1	R-X A	0.6325	-	0.6325
2	R-IX(Top)	3.0631	-	3.0631
3	R-IX(Bot)	4.6733	-	4.6733
4	R-VIII T1	-	-	-
5	R-VIII T2	12.5810	-	12.5810
6	R-VIII B1(Top)	7.5236	-	7.5236
7	R-VIII B1(Bot)	13.0029	-	13.0029
8	R-VIII B1 (Comb.)	20.0639	0.4997	20.5636
9	R-VIII B2	4.5511	0.2525	4.8036
10	R-VII(Top)	3.7302		3.7302
11	R-VII(Bot)	8.6470		8.6470
12	R-VII	36.6860	5.3094	41.9954
13	R-VII A	18.7105	1.4608	20.1713
14	R-VII B	19.2474	1.8081	21.0555
15	R-VII A/B	16.0614		16.0614

Sl. No.	Seam	Net Geological Reserves (Mt)		
		Proved	Indicated	Total
16	R-VII C	18.3782	1.4517	19.8299
17	R-VI	59.4883	4.3917	63.8800
18	R-V	58.0441	3.9298	61.9739
19	R-IV	84.8002	26.5213	111.3215
20	R-III	35.3195	1.7812	37.1007
21	R-II	21.3704	0.5760	21.9464
	Total	**446.5746**	**47.9822**	**494.5568**

4.6.3.1 Thickness wise net geological reserves (in Mt) of various seams within the proposed Project area are as follows:

Seam	0.9m-1.2m	1.2m-1.5m	1.5m-2.0m	2.0m-3.0m	3.0m-5.0m	> 5.0m	TOTAL
R-X A	-	0.2181	0.219	0.1954	-	-	0.6325
R-IX(Top)	0.1655	0.0895	1.7523	1.0558	-	-	3.0631
R-IX(Bot)	0.2711	0.0632	3.7776	0.5614	-	-	4.6733
R-VIII T2	0.0014	10.1341	2.4455	-	-	-	12.5810
R-VIII B1(Top)	1.0207	6.5029	-	-	-	-	7.5236
R-VIII B1(Bot)	-	0.0026	10.471	2.5293	-	-	13.0029
R-VIII B1 (Comb.)	0.4997	-	-	-	20.0639	-	20.5636
R-VIII B2	4.8037	-	-	-	-	-	4.8036
R-VII(Top)	0.0017	2.5129	1.2155	-	-	-	3.7302
R-VII(Bot)	-	-	-	8.647	-	-	8.6470
R-VII	-	-	-	-	32.8805	9.1149	41.9954
R-VII A	-	-	1.7177	18.4536	-	-	20.1713
R-VII B	1.3529	2.4936	0.6389	16.5701	-	-	21.0555
R-VII A/B	-	-	-	-	16.0614	-	16.0614
R-VII C	0.0032	8.1694	11.6573	-	-	-	19.8299
R-VI	-	-	-	-	2.5664	61.3136	63.8800
R-V	-	-	-	-	12.4958	49.4781	61.9739
R-IV	-	-	-	-	-	111.3215	111.3215
R-III	-	-	0.0169	14.9633	22.1205	-	37.1007
R-II	-	0.0754	21.0997	0.7713	-	-	21.9464
Total	**8.1199**	**30.2617**	**55.0114**	**63.7472**	**106.1885**	**231.2281**	**494.5568**

4.6.3.2 Seam wise Grade wise Net Geological reserves within the proposed Project area are tabulated below:

Grade wise Net Geological reserves (in Mt)

SEAM	G-3	G-4	G-5	G-6	G-7	G-8	G-9	G-10	G-11	G-12	G-13	TOTAL
R-X A							0.3547	0.2778				0.6325
R-IX(Top)					0.3719	1.9650	0.7217	0.0045				3.0631
R-IX(Bot)							0.7205	1.5400	1.9343	0.4372	0.0413	4.6733
R-VIII T2				0.0014	0.8904	4.8511	3.2673	1.3035	2.1047	0.1626		12.5810
R-VIII B1(Top)				0.1168	1.7565	4.5197	1.1246	0.0060				7.5236
R-VIII B1(Bot)*		13.0029*										13.0029
R-VIII B1 (Comb.)*		20.5636*										20.5636
R-VIII B2				0.3243	1.7351	1.1035	0.8552	0.3885	0.3970			4.8036
R-VII(Top)			0.0665	1.1019	2.0660	0.4475	0.0483					3.7302
R-VII(Bot)*		8.6470*										8.6470
R-VII*		41.9954*										41.9954
R-VII A*		20.1713*										20.1713
R-VII B		0.0016	1.0351	8.3487	6.6641	1.1594	2.4937	1.0810	0.2705	0.0014		21.0555
R-VII A/B				1.0290	7.2252	5.3223	2.0562	0.1891	0.2396			16.0614
R-VII C			0.6594	3.2777	7.1367	5.0034	3.3627	0.3479	0.0421			19.8299
R-VI	0.4282	9.6947	19.3731	24.6718	8.9721	0.7401						63.8800
R-V		6.2261	34.5169	14.8091	3.2641	3.1577						61.9739
R-IV	5.8070	55.673	47.2117	2.6301								111.3215
R-III		6.3401	14.5382	11.1297	5.0403	0.0524						37.1007
R-II		1.1453	10.1264	7.4221	2.0857	1.0579	0.1090					21.9464
TOTAL	**6.2352**	**183.4607**	**127.5273**	**74.8626**	**47.2081**	**29.3800**	**15.1139**	**5.1383**	**4.9882**	**0.6012**	**0.0413**	**494.5568**

* GCV grade as per the Final Energy Level GCV (Grade) Notification 2017-18 of ECL.

4.6.3 Reserves within hard cover of 7.5 m and 15 m:

About 1.12 Mt reserves lie within 15 m of hard cover in seam R-VIII T2.

4.6.4 Reserves under fire:

There is no report of reserves under fire in the block area.

4.7 Recommendation:

1. Exploration in the entire Tilaboni Block has been carried out in phases at different point of time with different objectives and the subsurface data of all the boreholes drilled in the final phase of operation is not included in this report because the exploration in Tilaboni Block is still continuing.

2. The borehole density for lower pocket of coal seams is very less and additional drilling will have to be done. Capital provision has been kept in this report for additional drilling upto R-II seam.

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Chapter-5

MINE BOUNDARY, RESERVES & MINE LIFE

5.1 Delineation of sectors as per GR and selection of mining area

The Tilaboni Combined block is separated from the earlier explored blocks by faults. In the south-western part, the boundary of the block is demarcated by a line drawn 200 m east of the line joining boreholes NCRJ-26 and SS-6 (Shyamsundarpur block boundary).

The entire block has been divided into 10 sectors (shown in Figure-5.1) for reserve estimation mainly based on the disposition of major faults.

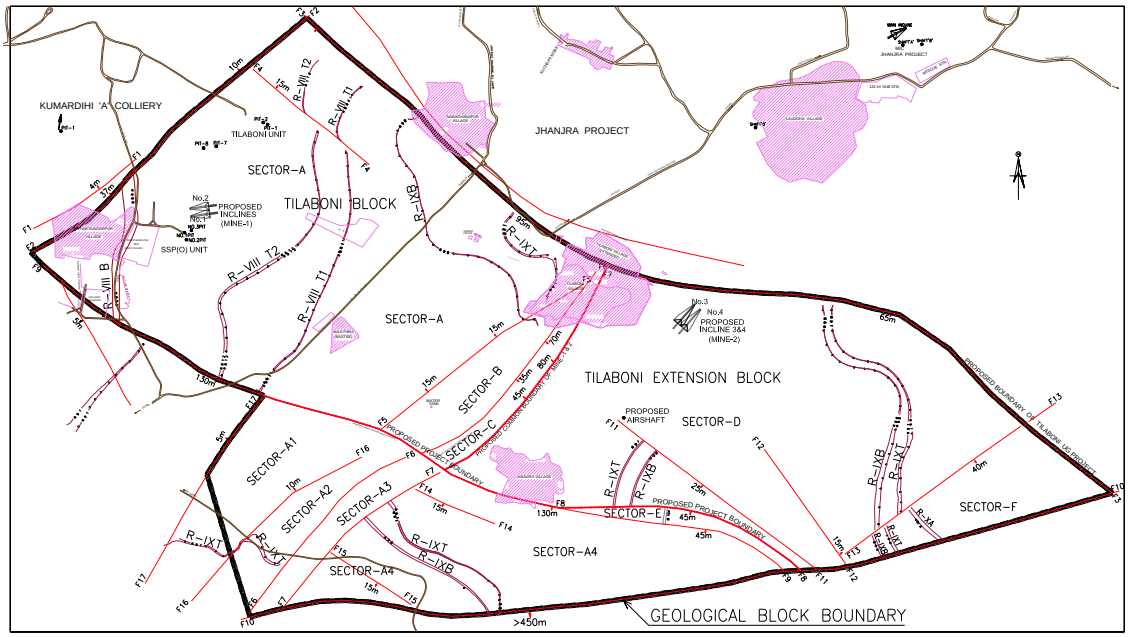

Figure-5.1

The details of different sectors are as follows:-

i) Sector A : This is the largest of all the sectors and lies in the northern part of the block. It is defined by the fault $F_2 – F_2$ in the north-west, fault $F_3 – F_3$ in the north and north-east, fault $F_9 – F_9$ in the south-west and by the fault $F_5 – F_5$ in the south-east.

ii) Sector B : This is a triangular sector lying immediately to the south-east of the Sector A. It is bounded on the north-west by the fault $F_5 – F_5$, on the north-east by the fault $F_6 – F_6$ and on south-west by fault $F_9 – F_9$. NCDC boreholes viz. NCRJ-3 and 11 fall within this sector.

iii) Sector C : This is a small sector, lying immediately to the east of the sector B. It is bounded by the faults $F_6 – F_6$ and $F_7 – F_7$ forming a trough. The other two limits are defined by the faults $F_3 – F_3$ and $F_9 – F_9$. Boreholes viz. TLB-17 and TLB-II/55 fall within this sector.

iv) Sector D : This is the largest of all the sectors. The limits of this sector are defined by the faults $F_7 – F_7$, $F_{13} – F_{13}$, $F_3 – F_3$, $F_9 – F_9$ and $F_8 – F_8$.

v) Sector E : This is a narrow sector, lying immediately to the south of the sector D. This sector is bounded by faults $F_8 – F_8$, $F_9 – F_9$ and $F_{10} – F_{10}$.

vi) Sector F : This is the eastern most sector of the block, lying immediately to the southeast of sector D. The boundary of this sector is defined by the faults $F_{13} – F_{13}$, $F_{10} – F_{10}$ and $F_3 – F_3$.

vii) Sector A1 : This sector is demarcated by the faults $F_{17} – F_{17}$, $F_{16} – F_{16}$ and $F_9 – F_9$. The trace of the line drawn 200 m east and parallel to the line joining the boreholes NCRJ-26 and SS-6 define the western boundary of the sector (Shyamsundarpur block boundary).

viii) Sector A2 : This sector is demarcated by the faults $F_{16} – F_{16}$, $F_6 – F_6$ and $F_9 – F_9$. The trace of the line drawn 200 m east and parallel to the line joining the boreholes SS-6 and NCRJ-2 define the western boundary of the sector (Shyamsundarpur block boundary).

ix) Sector A3 : This sector is demarcated by the faults $F_6 – F_6$ and $F_7 – F_7$ forming a trough. The other two limits are defined by the faults $F_9 – F_9$ and $F_{10} – F_{10}$.

x) Sector A4 : This is the southern most sector of the block and lies to the east of sector A3. Limits of this sector are defined by the faults $F_7 – F_7$, $F_9 – F_9$ and $F_{10} – F_{10}$.

5.1.1 Existing Mine Boundary

The present leasehold of Tilaboni UG mine is confined to Sector-A of Tilaboni Geological Block.

The boundary of the mine is as follows:

North West	:	Kumardih A colliery/Fault F2-F2 (throw 10-37m)
North East	:	Jhanjra Block/Fault F3-F3 (throw 65-95m)
South East	:	Fault F9-F9 (throw 45-130m)/Tilaboni Extn. block
South West	:	Shyamsundarpur colliery/Fault F9-F9 (throw 130m)

5.1.2 Reasons for selecting/omitting sector

The combined block (Tilaboni Block and Tilaboni Extension block) comprises of sectors A, B, C, D, E, F, A1, A2, A3 and A4 as shown in the Geological Plan (Plate No. III)

Sectors A1, A2, A3 and A4 are separated from the rest of the working block by fault F9-F9, having throw of 45m-130m, and the seams are also having steep gradient (about 1 in 5). Hence these sectors have not been considered for mining.

Sector-E (bounded by faults F8-F8 and F9-F9) is a small and narrow sector which has not been considered for mining.

Thus the present report is limited to five sectors i.e. sector A, B, C, D and F only. Out of these five sectors, Sector-C is bounded by faults F6-F6 and F7-F7 which forms the trough zone. As sector-C is a small and narrow sector, mining has not been considered for mining. The other sectors viz. A, B, D and F have been considered for mining under this report.

5.1.3 Reasons for selecting/omitting seams/sections

There are in all 23 seams/sections within the project area in Tilaboni Comb. block, out of which 14 seams/sections viz. R-VIIIT2, R-VIIIB1, R-VIIIB1(Bot), R-VII, R-VII (Bot), R-VIIA, R-VIIB, R-VIIA/B (Comb), R-VIIC, R-VI, R-V, R-IV, R-III and R-II are mineable. Other seams/sections viz. R-XA, R-IX Top, R-IX Bot, R-VIII Top, R-VIIIT1, R-VIIIB1(Top), R-VIIIB2, R-VIII Bot and R-VII Top being thin or occurring in a limited area have not been considered for mining.

In the present PR eight seams/sections viz. R-VIIIT2, R-VIIIB1, R-VIIIB1(Bot), R-VII, R-VII (Bot), R-VIIA, R-VIIB and R-VIIAB have been considered for mining within 25 years of project life in the Tilaboni Combined block. The details of seams within the project area, along with their thickness and the reason for their inclusion or omission for mining is shown below:

Sl. No.	Seam	Thickness Range (m)	Remarks
1	R-XA	0.84-2.22	Seam occurs in one small isolated patch of about 0.3725 sq. km area having reserves of 0.6325 Mt. Unworkable due to limited extent and small reserves as shown in Figure-5.2.
2	R-IX Top	0.98-2.73	a. Seam occurs in three small isolated patches having area of 0.085, 0.966 and 0.142 sq. km respectively. b. This seam has more than 1.5 m thickness in an area of about 0.849 sq. km with a reserves of 2.357 Mt. c. This seam has not been considered for mining due to limited extent and limited reserves as shown in Figure-5.3.
3	R-IX Bot	0.36-2.23	a. Seam occurs in three small isolated patches having area of 0.531, 1.076 and 0.0195 sq. km respectively. b. This seam has more than 1.5 m thickness in an area of about 1.37 sq. km with a reserves of 3.76 Mt. c. This seam has not been considered for mining due to low thickness and limited reserves as shown in Figure-5.4.
4	R-VIII Top	1.07-1.32	Unworkable. Geological parameters not assessed.

Sl. No.	Seam	Thickness Range (m)	Remarks
5	R-VIII T1	0.10-1.01	Unworkable. Geological parameters not assessed.
6	**R-VIII T2**	**0.50-2.01**	**Virgin, Considered for mining under this PR**
7	R-VIII B1 (Top)	0.30-1.47	a. Parting with the underlying R-VIII B1 (Bot) split (Considered under this report) is less than 5 m in major part of the area. b. Around 50 % area is only having thickness of more than 1.2m. c. Unworkable, due to low thickness and limited reserves as shown in Figure-5.5.
8	**R-VIII B1 (Bot)**	**0.90-2.59**	**Development in progress by B&P mechanization, proposed to be further developed and depillared in this PR.**
9	**R-VIII B1**	**3.10-4.82**	
10	R-VIII B2	0.30-1.45	a. Entire area in Mine-2 is having less than 0.90m thickness. b. All most all the area in Mine-1 is in the thickness range of 0.90m 1.2m. c. Only in three small isolated patches in Mine-1 thickness range is more than 1.2m, as shown in Figure-5.6. d. This seam has not been considered for mining due to low thickness and limited reserves.
11	R-VIII (Bot)	1.65-1.84	Occurring in very small area.
12	R-VII (Top)	0.70-2.26	a. R-VII (Top) Split occurs only in the eastern part of Mine-2. b. Around 58% area is having less than 1.2m thickness as shown in Figure-5.7. c. Around 17% area is in the thickness range of 1.2m-1.5m, d. About 13% area is having more than 1.5m thickness and less than 3m parting with the underlying R-VII (Bot) Split, which has been considered under this report. e. Only 0.275 sq. km area have more than 1.5m thickness with a parting of 3 to 9 m from R-VII Bot. seam. Development reserves is only 0.146 Mt. Being contiguous seams, depillaring requires simultaneous extraction. f. This seam section has not been considered for mining due to limited reserves
13	**R-VII (Bot)**	**1.95-2.95**	**Considered for mining under this PR.**

Sl. No.	Seam	Thickness Range (m)	Remarks
14	**R-VII**	**1.95-6.18**	**Development in progress by B&P mechanization, proposed to be further developed and depillared in this PR.**
15	**R-VIIA**	**1.37-3.33**	**Development in progress by B&P mechanization, proposed to be further developed and depillared in this PR.**
16	**R-VIIB**	**0.21-3.40**	**Considered for mining under this PR.**
17	**R-VIIA/B (Comb)**	**3.23-5.18**	**Considered for mining under this PR.**
18	R-VII C	0.12-2.20	Virgin, workable but beyond the scope of this PR.
19	R-VI	1.98-6.58	Virgin, workable but beyond the scope of this PR.
20	R-V	1.20-6.30	Virgin, workable but beyond the scope of this PR.
21	R-IV	1.52-11.45	Virgin, workable but beyond the scope of this PR.
22	R-III	2.05-3.59	Virgin, workable but beyond the scope of this PR.
23	R-II	0.45-2.32	Virgin, workable but beyond the scope of this PR.

5.1.4 Reasons for annexing additional area

Tilaboni colliery is being worked in sector ‘A’ only having a leasehold area of 4.36 sq.km. Tilaboni Extension Block lies on the dip side of Tilaboni Block and is totally virgin. Tilaboni Extension block has been included under the present PR so as to make available a larger area, for planning a large underground mine using mass production technology. Though the two blocks would be approached by separate set of entries, there would be several common service viz. residential buildings, railway siding, workshop etc.

5.2 Mine Boundary

5.2.1 Extent of Seam

The mining area and length along strike & width along dip for different seams proposed to be worked in the two units of the proposed project are as follows:

Seam	Area (km^2)	Length along strike (km)	Width along dip (km)
Mine No.1			
R-VIII T2	2.85	0.3 – 1.8	1.2 – 1.5
R-VIII B1 / R-VIII B1(Bot)	4.08	0.3 – 1.9	1.2 – 2.6
R-VII	4.51	0.3 – 1.9	1.2 – 2.8
R-VII A	4.56	0.3 – 2.0	1.2 – 3.1
R-VII B	4.59	0.3 – 2.0	1.2 – 3.1

Seam	Area (km^2)	Length along strike (km)	Width along dip (km)
Mine No.2			
R-VIII T2	3.88	0.3 – 1.5	0.5 – 2.8
R-VIII B1(Bot)	3.91	0.3 – 1.5	0.5 – 2.9
R-VII / R-VII(Bot)	3.94	0.3 – 1.5	0.5 – 3.0
R-VII A & R-VIIA&B (Comb)	3.96	0.3 – 1.5	0.5 – 3.1

5.2.2 Mining Area

Out of the total block area of 10.83 sq.km of the combined Tilaboni and Tilaboni Extn. blocks, the maximum area considered for mining is 8.69 km^2 in seams R-VIIIB1 and below.

5.2.3 Proposed Mine Boundary

The proposed Tilaboni Project will constitute of two mines, viz. mine No.1 and mine No.2, in the combined Tilaboni & Tilaboni Extn. blocks respectively. The mine boundary for the two mines and for Tilaboni Project as a whole are as follows:

	Mine No.1	Mine No.2
East	Fault F7-F7	Fault F10-F10
West	Fault F2-F2	Fault F7-F7
North	Fault F3-F3	Fault F3-F3
South	Fault F9-F9	Fault F9-F9 / Fault F8-F8

The mine boundary of the whole mine is defined as follows:

East : Fault F10-F10
West : Fault F2-F2
North : Fault F3-F3
South : Fault F9-F9 / Fault F8-F8

5.3 Mineable & Extractable reserves

Seams R-VIIIT2, R-VIIIB1 & Bottom, R-VII, R-VII(Bottom), R-VIIA, R-VIIB and R-VIIA&B (Combined) has been considered for mining by Bord & Pillar method with Continuous Miner technology in this report. These seams constitute a total 47.039 Mt of extractable reserves. Seams R-VIIC, R-VI, R-V, R-IV, R-III and R-II would be extracted only after 25 years. Hence, a review would be made after 25 years to decide the extraction method of these seams by appropriate technology available at that point of time.

5.3.1 Mineable Reserves

The estimated seamwise mineable reserves of the seams under consideration in this PR are as follows:

Seam	Mineable Reserves (Mt)		
	Mine No.1	Mine No.2	Total
R-VIIIT2	0.9612	0.8368	1.7980
R-VIIIB1 & Bottom	7.9651	6.1061	14.0712
R-VII & R-VII(Bot)	14.7707	11.8402	26.6109
R-VIIA	9.9888	3.0573	13.0461
R-VIIA&B (Comb)	0.1518	10.2606	10.4124
R-VIIB	9.4105	-	9.4105
Total	**43.2481**	**32.1010**	**75.3491**

5.3.2 Extractable reserves

The estimated seamwise extractable reserves of the seams (for an extraction height upto 4.6 m) under consideration in this PR are as shown below:

Seam	Extractable Reserves (Mt)		
	Mine No.1	Mine No.2	Total
R-VIIIT2	0.6924	0.5459	1.2383
R-VIIIB1	4.5059	-	4.5059
R-VIIIB1 Bottom	0.9784	4.3210	5.2994
R-VII	8.8315	3.6215	12.4530
R-VII(Bot)	-	3.5248	3.5248
R-VIIA	6.0784	2.1274	8.2058
R-VIIA&B (Comb)	0.0479	6.1624	6.2103
R-VIIB	5.6015	-	5.6015
Total	**26.7360**	**20.3030**	**47.0390**

Extractable reserves after considering the geological, mining and mineable losses of the seams (for an extraction height upto 4.6 m and gallery width of 4.8m/6.0m) under consideration in this PR are as tabulated below:

Seam	Geological Reserves (Mt)	Total Geological & Mining losses (Mt)	Mineable Reserves (Mt)	Mineable losses (Mt)	Extractable Reserves (Mt)
R-VIIIT2	12.5810	10.7830	1.7980	0.5597	1.2383
R-VIIIB1	20.5636	13.1641	7.3995	2.8936	4.5059
R-VIIIB1 Bot	13.0029	6.3312	6.6717	1.3723	5.2994
R-VII	41.9954	20.4351	21.5603	9.1073	12.4530
R-VII(Bot)	8.6470	3.5963	5.0507	1.5259	3.5248
R-VIIA	20.1713	7.1252	13.0461	4.8403	8.2058
R-VIIA&B (Comb)	16.0614	5.6490	10.4124	4.2021	6.2103
R-VIIB	21.0555	11.6450	9.4105	3.8090	5.6015
Total	**154.0781**	**78.7289**	**75.3492**	**28.3102**	**47.0390**

Seam wise, GCV band-wise extractable reserves for the combined Tilaboni UG Project is summarized below:

Seam	GCV band-wise extractable reserves (Mt)								Total
	G-11	G-10	G-9	G-8	G-7	G-6	G-5	G-4	
TILABONI (MINE-1)									
R-VIIIT2			0.2206	0.4718					**0.6924**
R-VIII B1 & Bot								5.4843	**5.4843**
R-VII								8.8315	**8.8315**
R-VIIA								6.0783	**6.0783**
R-VIIA&B (Comb)					0.0480				**0.0480**
R-VIIB					1.2039	3.8158	0.5818		**5.6015**
Total Mine-1	**-**	**-**	**0.2206**	**0.4718**	**1.2519**	**3.8158**	**0.5818**	**20.3941**	**26.7360**
TILABONI (MINE-2)									
R-VIIIT2			0.0727	0.3575	0.1157				**0.5459**
R-VIII B1 & Bot								4.3210	**4.3210**
R-VII & R-VII (Bot)								7.1463	**7.1463**
R-VIIA								1.9128	**1.9128**
R-VIIA&B (Comb)	0.0637	0.0777	0.4918	3.0227	2.4445	0.2766		-	**6.3770**
Total Mine-2	**0.0637**	**0.0777**	**0.5645**	**3.3802**	**2.5602**	**0.2766**	**-**	**11.4673**	**20.3030**
GRAND TOTAL	**0.0637**	**0.0777**	**0.7851**	**3.8520**	**3.8121**	**4.0924**	**0.5818**	**31.8614**	**47.0390**

5.4 Production target and life of the mine

5.4.1 Production target

It is proposed to work one normal and one low height Continuous Miner set each in Mine No.1 and Mine No.2. The deployment of machines would depend upon the thickness of the seam being worked from top downwards. The production envisaged from normal height CM is 0.51MTY (1700tpd) and that from low height CM is 0.36MTY (1200tpd).

The full thickness of the seams R-VIIIB1 and R-VII are 2.85m–4.72m and 3.75m-5.67m respectively in the developed area of Tilaboni colliery (Mine No. 1). Developed galleries in these seams have to be heightened for maximizing the extraction percentage prior to the introduction of Continuous Miner Technology. Additionally 400tpd would be obtained from heightening of those developed galleries in R-VIIIB1 and R-VII seams in Mine No.1.

For maximizing extraction of R-VII seam in virgin area, development would be done along the roof by Standard height CM where seam thickness is more than 4.6m. Same Standard height CM may be deployed for taking the floor coal at the time of depillaring by sumping into floor.

The target production of the mine would be 1.86 MTY, which would be reached in the 7th year of mining operation. The peak production from the mine would be 2.14 MTY. The deployment of machinery and production for the first twenty five years of the life of the mine is shown in Para 9.2. The production level would not be uniform as it would depend upon the type of machine deployed, which in turn would depend upon the seam thickness.

5.4.2 The total extractable reserves considered in this PR being 47.039 Mt (upto R-VIIB seam), the life of the mine @ 1.86 MTY would be more than 25 years. The construction period would be 3 years and production built up period of 4 years due to reasons mentioned above.

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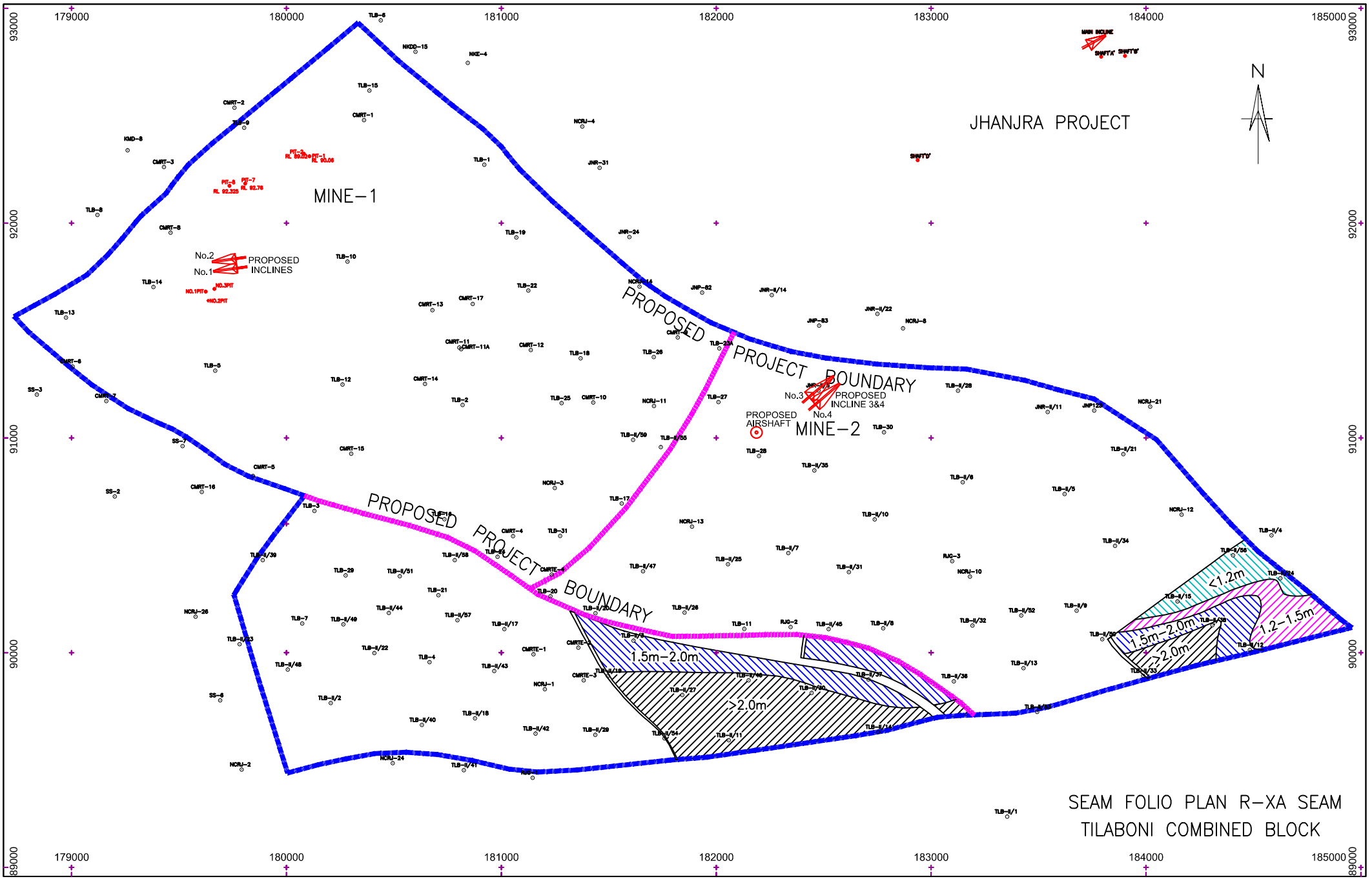
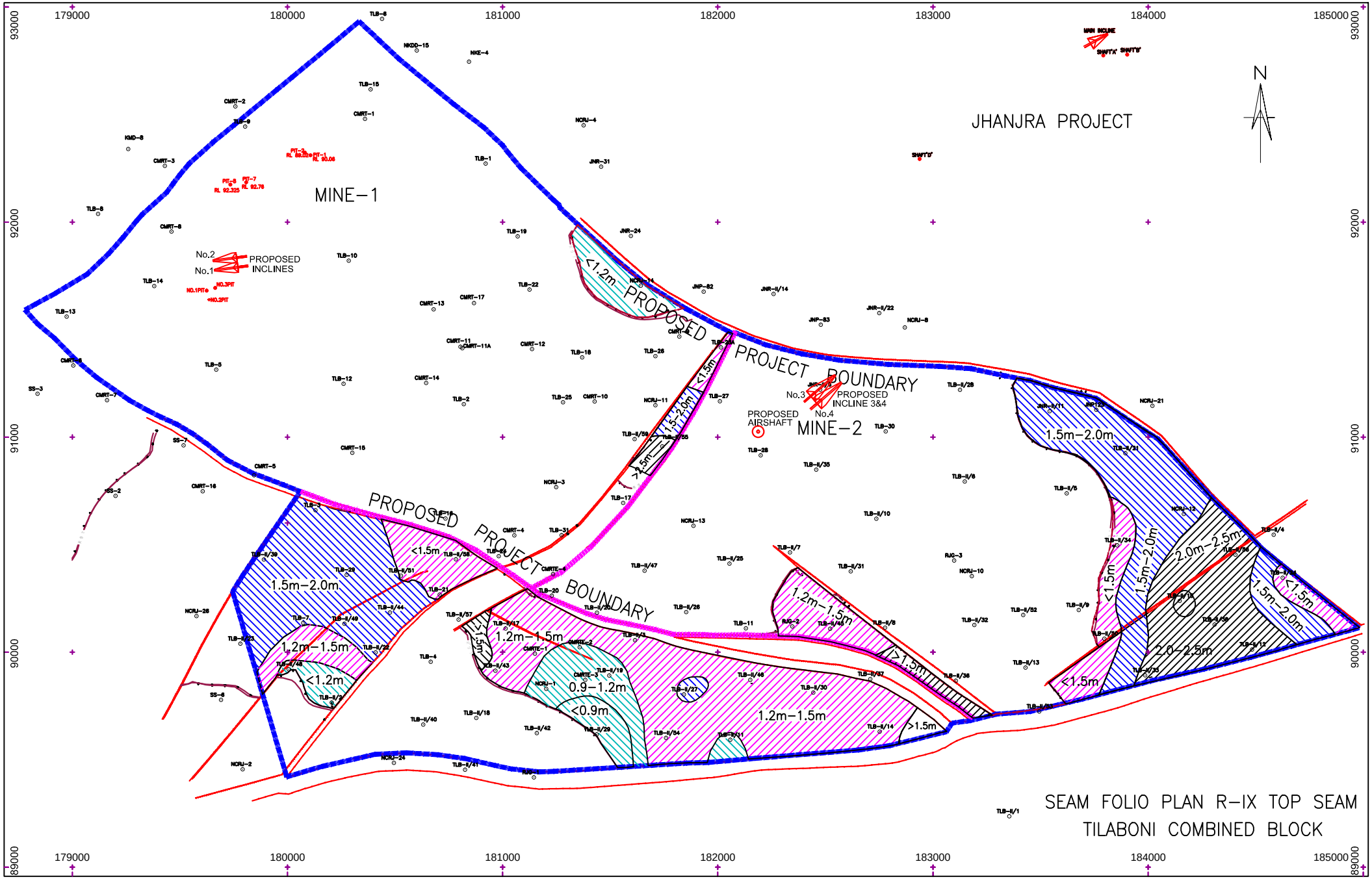
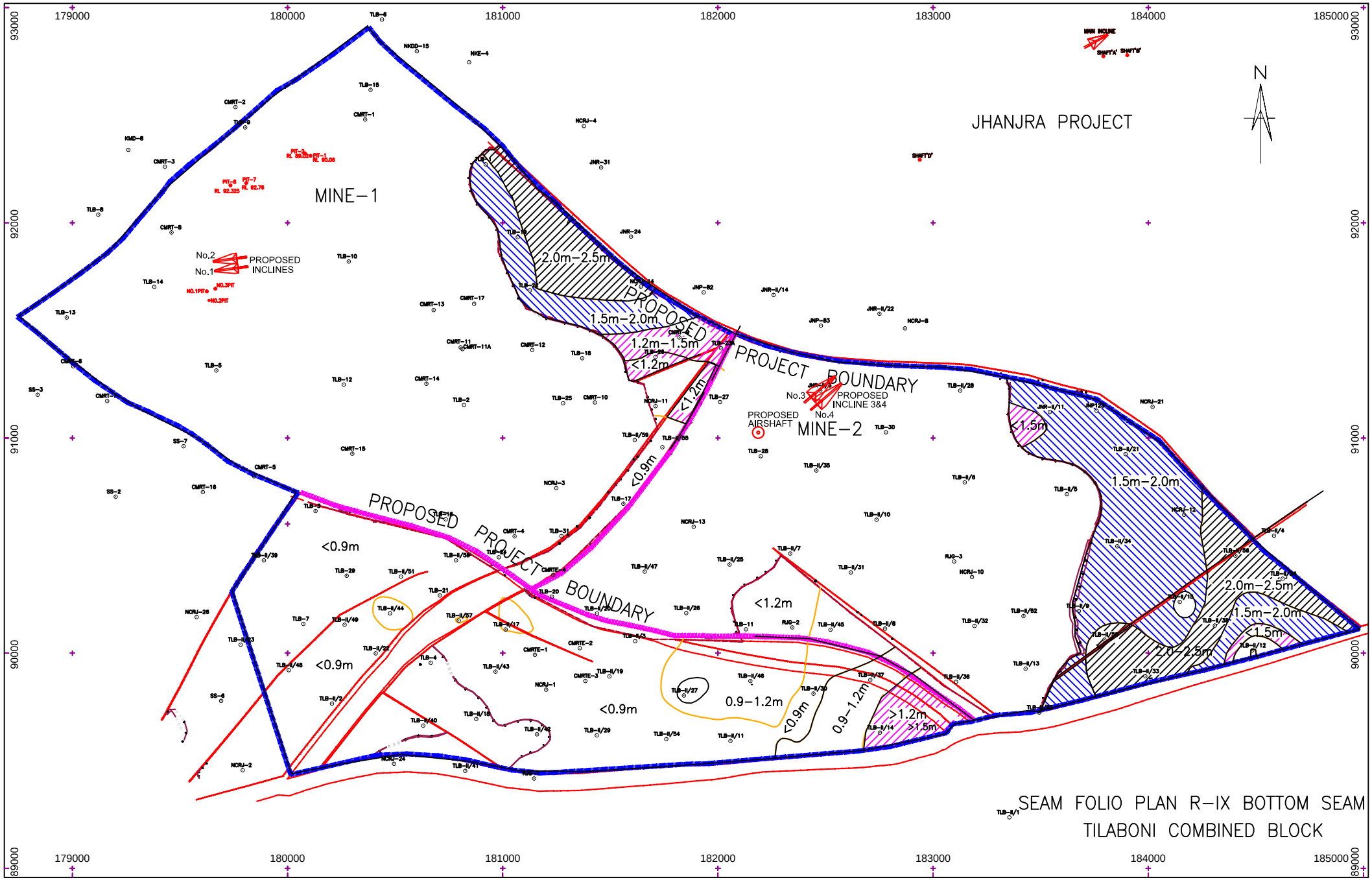
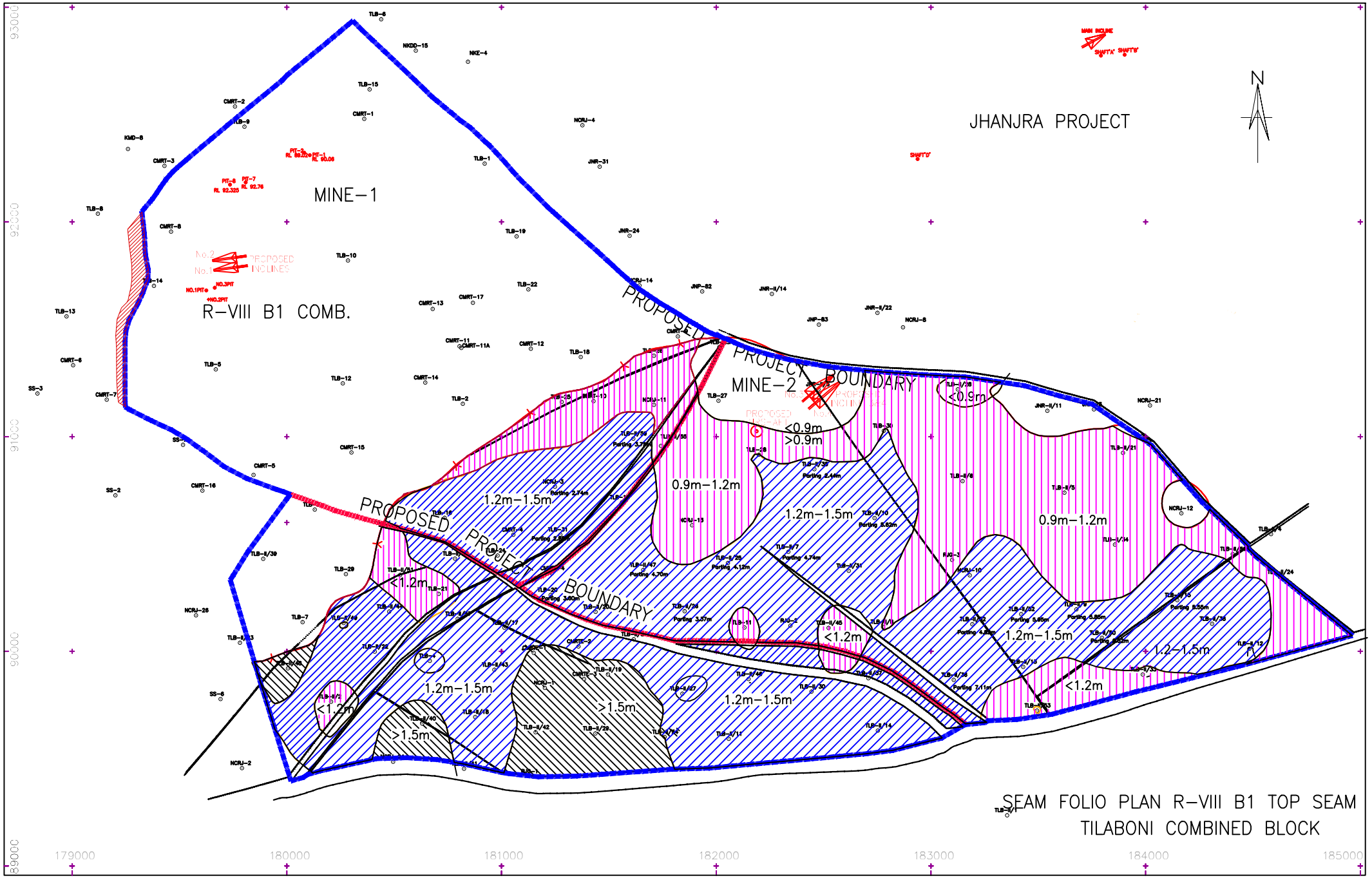
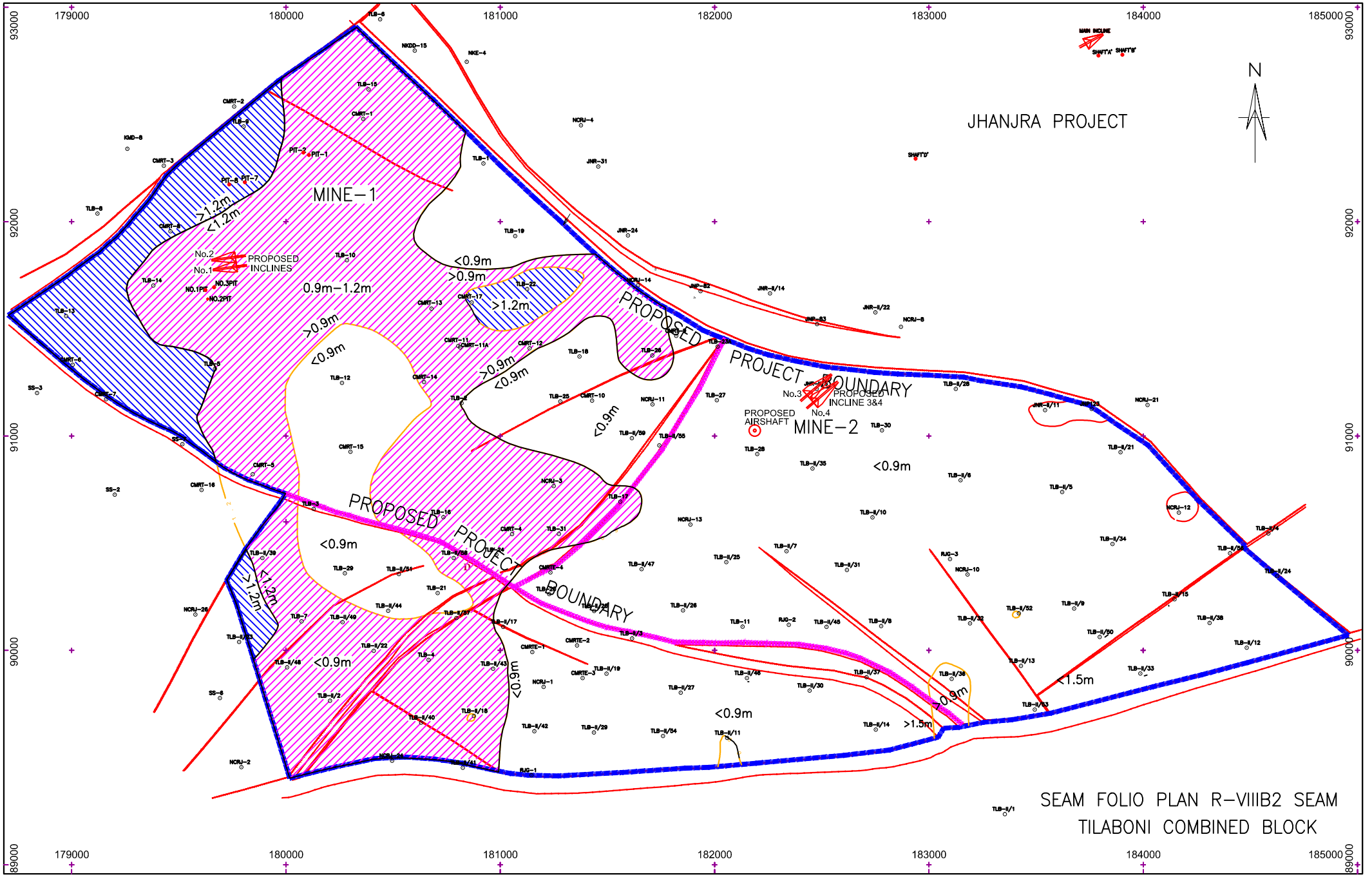

JHANJRA PROJECT
MINE–1
MINE–2
PROPOSED PROJECT BOUNDARY
PROPOSED PROJECT BOUNDARY
No.1
No.2
PROPOSED INCLINES
No.3
No.4
PROPOSED INCLINE 3&4
PROPOSED AIRSHAFT
MAIN INCLINE
SHAFT'A'
SHAFT'B'
SHAFT'D'
N
<1.2m
1.2–1.5m
1.5m–2.0m
1.5m–2.0m
>2.0m
1.5m–2.0m
SEAM FOLIO PLAN R–XA SEAM
TILABONI COMBINED BLOCK
179000
180000
181000
182000
183000
184000
185000
93000
92000
91000
90000
89000

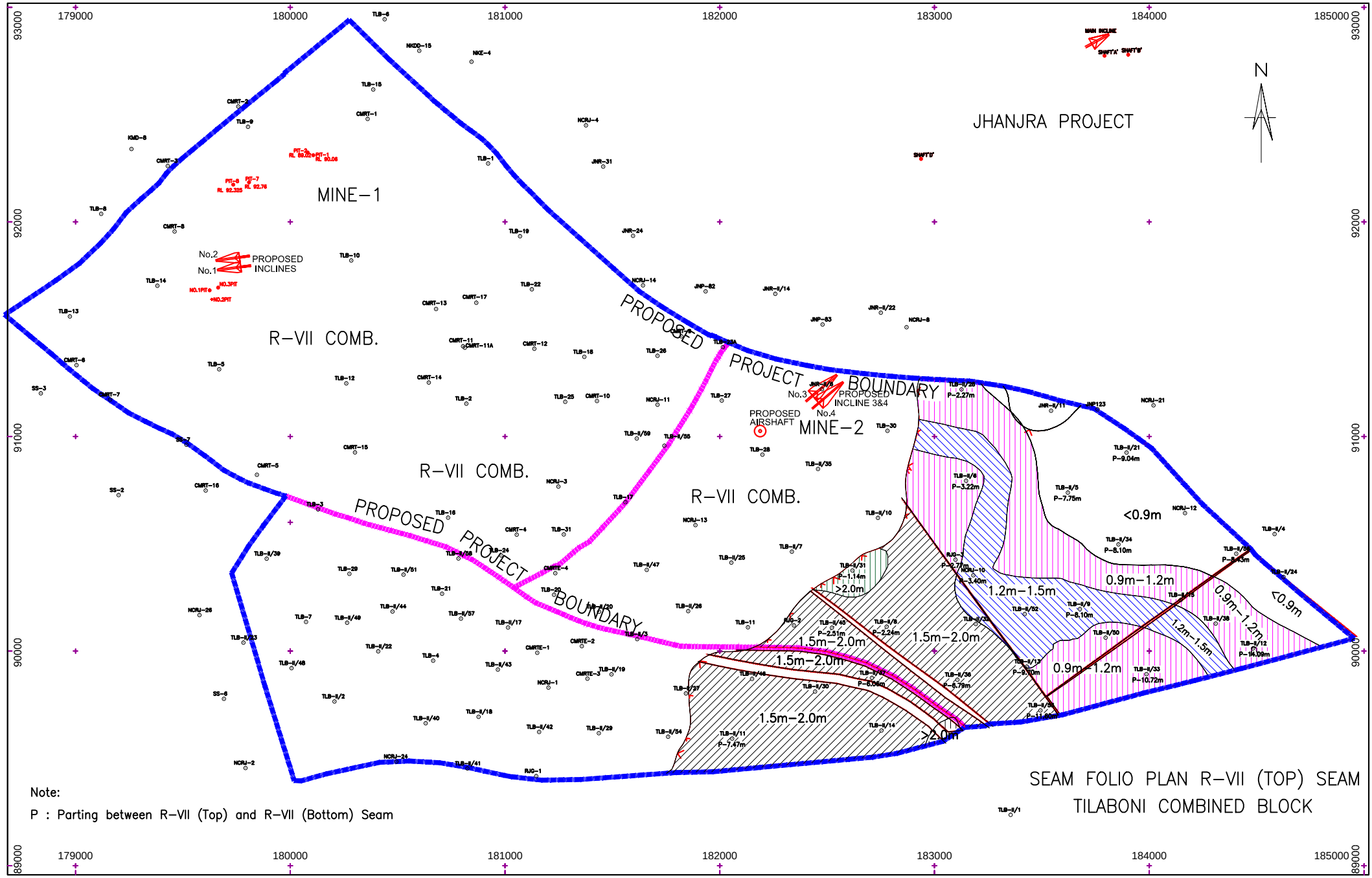

JHANJRA PROJECT
N
MINE–1
MINE–2
PROPOSED INCLINES
No.1
No.2
No.3
No.4
PROPOSED INCLINE 3&4
PROPOSED AIRSHAFT
PROPOSED PROJECT BOUNDARY
PROPOSED PROJECT BOUNDARY
<1.2m
1.5m–2.0m
1.2m–1.5m
<1.5m
<1.2m
0.9–1.2m
<0.9m
>1.5m
2.0–2.5m
SEAM FOLIO PLAN R–IX TOP SEAM
TILABONI COMBINED BLOCK
179000
180000
181000
182000
183000
184000
185000
93000
92000
91000
90000
89000


JHANJRA PROJECT
MINE–1
MINE–2
PROPOSED INCLINES
No.1
No.2
No.3
No.4
PROPOSED INCLINE 3&4
PROPOSED AIRSHAFT
PROJECT BOUNDARY
PROPOSED PROJECT BOUNDARY
2.0m–2.5m
1.5m–2.0m
1.2m–1.5m
<1.2m
<0.9m
0.9–1.2m
>1.2m
>1.5m
1.5m
2.0–2.5m
N
SEAM FOLIO PLAN R–IX BOTTOM SEAM
TILABONI COMBINED BLOCK


JHANJRA PROJECT
MINE–1
R–VIII B1 COMB.
PROPOSED INCLINES
PROPOSED PROJECT BOUNDARY
MINE–2
PROPOSED PROJECT BOUNDARY
N
<0.9m
>0.9m
0.9m–1.2m
1.2m–1.5m
<1.2m
>1.5m
SEAM FOLIO PLAN R–VIII B1 TOP SEAM
TILABONI COMBINED BLOCK
179000
180000
181000
182000
183000
184000
185000



SEAM FOLIO PLAN R–VIIIB2 SEAM
TILABONI COMBINED BLOCK


JHANJRA PROJECT
MINE–1
MINE–2
R–VII COMB.
R–VII COMB.
R–VII COMB.
PROPOSED PROJECT BOUNDARY
PROPOSED PROJECT BOUNDARY
PROPOSED INCLINES
No.1
No.2
PROPOSED INCLINE 3&4
No.3
No.4
PROPOSED AIRSHAFT
MAIN INCLINE
SHAFT'A'
SHAFT'B'
N
<0.9m
0.9m–1.2m
1.2m–1.5m
1.5m–2.0m
>2.0m
SEAM FOLIO PLAN R–VII (TOP) SEAM
TILABONI COMBINED BLOCK
Note:
P : Parting between R–VII (Top) and R–VII (Bottom) Seam

Chapter-6

MINE ENTRIES

6.0 Existing entries

Tilaboni colliery is being worked through two units namely, Tilaboni Unit and Shyamsundarpur (Old) unit known as SSP (Old) unit. The existing entries in the two units are as shown below:

Unit	Mine Entry	Landing at	Depth of pit (m)	Dia. of Pit (m)	Specification of winder/Fan	Purpose
Tilaboni Unit	No. 1 pit	R-VIII B1 (Jambad)	46.56	4.2	Steam winder 30 cm x 60 m, Single tub cage, Fan - PV-200, 130 HP	Man & Material winding, Up cast
	No. 2 pit	R-VII (Bonbahal)	94.71	4.2	Steam winder 30 cm x 60 m, Single tub cage	Man & Material winding, Down cast
S.S.P. (Old) Unit	No.1 pit	R-VIII B1 (Jambad)	24.00	4.2	40 HP electric Double drum winder, Single tub cage	Man & Material winding, Down cast
	No. 2 pit	R-VIII B1 (Jambad)	28.00	4.2	No winding installation, Fan - PV-200, 130 HP	Fan drift, Up cast
	No. 3 pit	R-VIIA (Kenda)	120.00	4.2	75 kW electric winder, Single tub cage	Man & Material winding

6.1 Selection of Mine Entries

The estimated combined winding capacity of all the four pits is about 0.52 MTY. It has been planned to produce a maximum of 1 MTY coal from each units by introduction of mass production technology. For the purpose two inclines has been proposed in each units i.e. Mine No.1 and Mine No.2.

In Mine No.1, the proposed inclines (No.1 and No.2) would be in apparent dip rise direction upto R-VI seam & thereafter, it would be in the reverse direction, so as to intersect the lowermost R-II seam. The total length of the incline would be 1665m. The length of the incline upto the target seam i.e. R-VIIB seam, would be 828m. The cross section of the incline proposed is 5.5mx3.5m.

Incline no.2 is proposed for the men and material transport. For ventilation of mine no.1, No. 2 Pit of Tilaboni Unit and are proposed to be widened (from 4.2m to 6.0m) and deepened upto R-II seam. Presently Pit No. 2 of Tilaboni

Unit is sunk upto R-VII seam. Although the shafts are proposed to be sunk upto the lower most R-II seam, capital provision for sinking upto R-VIIB seam only has been proposed, that is the seam upto which mining has been proposed upto 25 years in this PR.

In Mine No.2 the proposed inclines (No.3 and No.4) would be in the strike direction upto R-VI seam and thereafter in the dip rise direction to intersect the lowermost R-II seam. The total length of the inclines would be 1905m. The length of the inclines upto the target seam i.e. R-VII A&B seam, would be 960m. The cross section of the inclines proposed is 5.5mx3.5m.

In Mine No. 2 a new shaft, 6.0 m dia. and 415m depth (upto R-II seam), has been proposed. However the capital provision has been proposed for sinking upto R-VIIA&B seam only that is the seam upto which mining has been proposed upto 25 years in this PR.

Like wise the proposed inclines would also be driven upto R-II seam. Capital provision for drivage upto R-VIIB/ R-VIIA&B seams only have been made in this report, as the mining has been proposed upto R-VIIB/ R-VIIA&B within 25 years of project life.

6.2 Justification for location of Mine Entries

The location of the proposed incline no.1 in Mine No.1 has been so selected that it lies within the land in the possession of ECL. This would save time that would otherwise be required for acquisition of land. The shaft selected for widening and deepening has been so decided so that the production from the mine is not hampered.

The mine entries from Mine No. 2 have been selected to the east of Tilaboni village, which is almost free of surface constraints as on date. The inclines lying on the rise side of the property, would also intersect all the seams of the block. A separate air shaft has been proposed to cater to the need of all the seams of the block. Land for the proposed entries would however have to be purchased, which is tenancy in nature.

6.3 Dimension and purpose of proposed mine entries

The dimension and purpose of proposed mine entries is shown in the table overleaf.

6.4 Drifts and strata bunker

Three nos. of fault namely F5-F5 (throw 5-15m), F12-F12 (throw 5-15 m) and F13-F13 (throw 30-40) have to be negotiated in all the seams. The location of faults and drifts have been shown in the respective layout plans. Details of drifts and the capital provision have been shown in Appendix-A.8.1.

R-VIII T2 seam has been proposed to be approached through three nos. of rising drift (2 intake and one return) from underlying R-VIII B1/ R-VIII B1 Bot seam. Rising drifts have been proposed from (-)3L in between 43D to 45D of R-VIII B1 seam for approach to R-VIII T2 seam in Mine-1. R-VIII T2 seam in Mine-2 has been proposed to be approached through drift across fault F12-F12 from R-VIII B1 Bot seam.

Seams R-V, R-IV, R-III and R-II would be accessed through drifts from R-VI seam driven in the rise-dip direction intersecting all the seams. Direction of the drift may be reviewed before actual drivage operation at that point of time.

Provision for strata bunker (2 nos. of 500 t each) between R-VIIIB1 and R-VII seams and between R-VII and R-VIIA seams has been made in this PR. Provision has also been made in this report for advance boring prior to the incline drivage and shaft sinking.

Dimension of the proposed entries:

Sl. No.	Mine entry (incline / Shaft)	X-section (W x H/ dia.) (m2/ m.)	Length / Depth (m)	Gradiant	Purpose & mode of transport / ventilation
	Mine No. 1				
1	Incline No. 1 & 2	5.5 m x 3.5 m (finished section)	Normal upto R-VI seam- 1145m, (Upto R-VII B seam – 828m); Reverse (From R-VI to R-II seam- 520m) **Total – 1665m**	1 in 4.5	Coal (belt conveyor) (Inc. No. 1), man riding and material transport (haulage) (Inc. No. 2), intake
2	Pit no.2 (of Tilaboni Unit)	Widening (4.2 m dia to 6.0 m dia)	Deepening upto R-VII B seam (94.7m to 155 m), 340 m (upto R-II seam)	Vertical	Air return
	Mine No. 2				
1	Incline no.3 & 4	5.5 m x 3.5 m (finished section)	Normal upto R-VI seam- 1180m (Upto R-VII A&B seam – 960m); Reverse (From R-VI to R-II seam- 725m) **Total – 1905m**	1 in 4.5	Coal (belt conveyor) (Inc. No. 3), man riding and material transport (haulage) (Inc. No. 4), intake
2	Air shaft	6.0 m	220 m (upto R-VII A&B seam) 415 m (upto R-II seam)	Vertical	Return

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Chapter-7

MINING STRATEGY

7.1 Surface constraints in mine development

The surface constraints in mining Tilaboni & Tilaboni Extension Blocks are as follows:

i. A number of residential quarters of ECL lie near the rise side of the property in Tilaboni block.

ii. Ukhra Loudoha DB road passes through the middle of Tilaboni block. Additionally there are a number of other village roads.

iii. Majhi Basti, Shyamsundarpur village (part) lies over Tilaboni block and Tilaboni village (part) and Jhanjra village lies over Tilaboni Extension block.

iv. There are a number of seasonal nallas and ponds.

v. High Tension line (11 kV) passes along the strike length of the block.

vi. Reserve forest and forest office over Tilaboni block.

7.2 Geo-mining Characteristics

7.2.1 Seams to be Worked

All the seams (except R-XA and R-IX) are to be worked either fully or in split(s). The seams proposed to be worked are R-VIIIB1/R-VIIIB1(Bot), R-VII, R-VII (Bot), R-VIIA, R-VIIB, R-VIIA/B (Comb), R-VIIC, R-VI, R-V, R-IV, R-III and R-II. Additionally R-VIIIT2 seam has been proposed to be worked in a limited area. The minimum and maximum thickness proposed to be worked is 1.5m and 6.0m respectively.

7.2.2 Seams not to be worked

The seams/splits not to be worked are R-IX Top, R-IX Bot, R-VIIIT1, R-VIII B1(Top), R-VIIIB2 and R-VII Top due to low thickness or due to workable thickness occurring in a very limited area or in isolated patches. Refer Tables in Para 5.1.3.

7.2.3 Geo-mining Parameters

The Geo-mining parameters of the seams proposed to be worked are as follows:

Sl. No.	Parameters	Unit	Seam R-VIIIT2	Seam R-VIIIB1	Seam R-VIIIB1 (Bot)	Seam R-VII	Seam R-VIIA	Seam R-VIIB/ VIIA&B (Comb.)	Seam R-VIIC	Seam R-VI	Seam R-V	Seam R-IV	Seam R-III	Seam R-II
	MINE NO. -1 (TILABONI BLOCK)													
1	Area within mine boundary	sq.km	2.89	4.20		4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66	4.66
2	Mining area considered	sq.km	0.32	2.38	0.50	3.97	3.94	3.48	3.70	4.66	4.66	4.66	4.66	4.66
3	No. of borehole intersection within mine boundary		34	23+15=38		34	26	26 / 2	26	26	23	25	23	21
4	Borehole density.	BHs/sq.km	11.76	9.05		7.30	5.58	6.01	5.58	5.58	4.94	5.36	4.94	4.51
5	General thickness in working area	m	1.7	4.0	2.3	5.3	2.5	2.5	2.0	6.0	5.0	10.0	2.75	2.0
6	Depth range	m	18-135	19-164		76-212	109-196	127-228	149-239	176-269	208-338	243-345	271-388	283-415
7	Gradient (range/ average)		1 in 5 to 1 in 10	1 in 5 to 1 in 10		1 in 5 to 1 in 10	1 in 5 to 1 in 10	1 in 5 to 1 in 10	1 in 5 to 1 in 10	1 in 5 to 1 in 10	1 in 5 to 1 in 10	1 in 5 to 1 in 10	1 in 5 to 1 in 10	1 in 5 to 1 in 10
8	Present status of mining		Virgin	Being worked by mechanised B&P method				Virgin	Virgin	Virgin	Virgin	Virgin	Virgin	Virgin
	MINE NO. 2 (TILABONI EXTN, BLOCK)													
Sl. No.	**Parameters**	**Unit**	**Seam R-VIIIT2**	**Seam R-VIIIB1 (Bot)**		**Seam R-VII**	**R-VII (Bot)**	**Seam R-VIIA/ VIIA&B(Comb.)**	**Seam R-VIIC**	**Seam R-VI**	**Seam R-V**	**Seam R-IV**	**Seam R-III**	**Seam R-II**
1	Area within mine boundary	sq.km	4.03	4.03		4.03		4.03	4.03	4.03	4.03	4.03	4.03	4.03
2	Mining area considered	sq.km	0.39	1.56		1.35	1.95	3.27	0.82	3.23	4.03	4.03	4.03	4.03
3	No. of borehole intersection within mine boundary		35	37		16	17	8/19	22	20	9	9	9	7
4	Borehole density.	BHs/sq.km	8.68	9.18		8.19		6.70	5.46	4.96	2.23	2.23	2.23	1.74
5	General thickness in working area	m	1.7	2.0		4.5	2.5	2.0 / 4.4	1.5	5.2	5.5	9.5	3.0	1.8
6	Depth range	m	55-223	88-237		139-294		184-336	224-355	251-391	295-341	324-366	368-401	403-441
7	Gradient (range/ average)		1 in 5 to 1 in 10	1 in 5 to 1 in 10		1 in 5 to 1 in 10		1 in 5 to 1 in 10	1 in 5 to 1 in 10	1 in 5 to 1 in 10	1 in 5 to 1 in 10	1 in 5 to 1 in 10	1 in 5 to 1 in 10	1 in 5 to 1 in 10
8	Present status of mining		Virgin	Virgin		Virgin		Virgin	Virgin	Virgin	Virgin	Virgin	Virgin	Virgin
9	Roof and floor characteristic		Mentioned in Para 4.4.2 (Chapter-4)											

Note: In two borehole (CMRT001 and CMRT003) within the Tilaboni Combined Block, seam R-V and R-IV is combined and the total thickness varies from 17.00m to 17.55m.

7.2.4 Geological disturbances

Tilaboni and Tilaboni Extension blocks are highly faulted. Most of the faults forming block boundary are having throw ranging from 5 m to 450 m. Only four faults (one in Tilaboni block and three in Tilaboni Extension block) having throw from 5-35m lie within the area proposed to be mined. Details of faults have been shown at para no. 4.3.7 of Chapter 4.

Two dykes of 1.2m thickness have been encountered in actual mine working in sector A. Occurrence of other minor faults & dykes however cannot be ruled out.

7.2.6 Cavability Characteristics

R-VIIIB1 seam has been depillared by caving in the past in a limited area in 2-3 panel. The seams are virgin in the rest of the block. Cavability index of the seams is not available. The cavability index of roof rock would be determined before commencement of operation.

7.2.7 Incubation Period

Barring 2-3 panels, the seams are either standing on pillars or virgin and as such incubation period of the coal is not available. For planning purpose, it has been assumed as 9 months, based on experience of the neighboring collieries. However it has been proposed to freshly determine the incubation period of the coal and do sub-panelling accordingly.

7.2.6 Water bearing strata/wateriness of seam

The weathered mantle is likely to be a water bearing strata. Nos. of old and abandoned pits are likely to be water logged and may be a source of water inflows to the mine. There is no evidence of water inflows from the strata and their contribution to mine water is likely to be minimal.

Proposed Tilaboni UG Project is one of the mines within the Cluster No. 12 Group of mines under the cluster concept. Hydrological data for the Cluster No. 12 is available. However detailed hydrological investigation is required to estimate the likely water bearing strata in the Tilaboni Combined block.

7.3 Underground constraint in mine development

i. Top most seams (R-VIIIT2) in this virgin, which has to be liquidated before commencement of depillaring operation in the lower seams.

ii. The next three seams viz. R-VIIIB1, R-VII and R-VIIA, have been partly or fully developed and bolted at places. This will hinder depillaring operation with continuous miner, while extracting the roof coal during depillaring operation.

iii. Limited mine capacity as the seams are being worked by smaller diameter pits. As per estimate the mine capacity of existing Tilaboni colliery is about 520 TPD (0.159 MTY).

iv. Sector-A1, A2, A3 & A4 is separated from the other potential area by a fault having throw of 45m to 130m. Part of sector-A4 is also having steep gradient (about 1 in 5). Hence these sectors have been kept outside the purview of the present PR.

v. Borehole density of the lower virgin seams in the proposed mining area varies from 3.57 BH/sq. km (seam R-VI) to 1.73 BH/sq. km (seam R-II) which is low.

7.4 Selection of mining method

7.4.1 Existing method of mining

The mine is being developed by manual/mechanized Bord & Pillar method in R-VIIIB1, R-VII and R-VIIA seam. SDLs have been deployed in the mechanized panels.

7.4.2 Suggested methods to improve production and productivity

In this project report it has been envisaged to introduce Continuous Miner Technology to improve production and productivity. The production envisaged from each normal and low height CM panel is 0.51 MTY and 0.36 MTY respectively. The SDLs deployed in the mine at present would be gradually phased out and ultimately production would be obtained from CM panels only.

7.4.3 Opencast potentiality

R-IX(Top), R-IX(Bot), R-VIII(T1), R-VIII(T2) & R-VIII(B1) seams incrop in Tilaboni Block where as R-XA, R-IX(Top) & R-IX(Bot) seams incrop in Tilaboni Extension block. These seams are mostly thin and occur over a limited area. The top most fully developed seam is R-VIIIB1 but occurs at a depth range of 22-385m. Hence there is no much potentiality of opencast mining.

Considering R-IX Bottom seam as the base seam for opencast mining in the Tilaboni Extension Block, the initial and final depth of quarry works out to be around 30m and 60m respectively. The mineable reserves have been estimated as 2.24 Mt with an OBR of 27.99 Mm^3 at an average stripping ratio of 12.49 m^3 per tonne upto a depth of 60m. Thus there is no potentiality of working R-XA, R-IX Top and R-IX Bottom seam by opencast working.

Considering R-IV seam as the base seam for opencast mining, the initial and final depth of quarry works out to be around 280m and 340m respectively with the length of access trench around 4.4 km. The mineable reserves have been estimated as 99.66 Mt with an OBR of 847.5 Mm^3 at an average stripping ratio of 8.5 m^3 per tonne upto a depth of 340m. The implementation of the opencast

option may not be feasible due to physical constraints such as shifting of villages, DB Road and non-availability of land for external dumping.

7.4.4 Mine Development Strategy

(a) Exploration and geological assessment of area within the block(s) and adjoining potential areas

Although both the blocks considered for mining has been geologically explored, the reserves lying at larger depths are still in the indicated category. The borehole density for the upper and lower workable seams are about 11.39/sq. km (R-VIII T2 seam) and 2.59 BH/sq. km (R-II seam) respectively.

(b) Formation/availability of moderate/large mining area for moderate/ high capacity underground project

The total area of combined Tilaboni & Tilaboni Extension blocks is 10.83 sq. km. out of which 8.69 sq. km. has been considered for mining. The balance area lying in the south has not been considered for mining due to the fact that it is separated from the rest of the property by large parallel faults F8-F8/F9-F9 with throws varying from 45m-130m and also due to the steep gradient (about 1 in 5)

Four CM panels have been planned to work simultaneously forming a high capacity underground mine. Additionally one LHD panel would be operated for 15 years in seam R-VIIIB1 and R-VII seams for roof heightening of developed galleries.

(c) Formation of Trunk Roadways:

It has been proposed to approach the seams through normal inclines upto R-VI seam and thereafter through reverse inclines upto R-II seam. Initially from the point of intersection of the inclines with the seam, panels would be opened. For working the dip side reserves, main trunk heading would be driven towards the dip, where from panels would be opened. The trunk roadways in each seam are proposed from the point of intersection of the inclines/reverse drifts with the seam. Development of trunk roadways would be done by CM.

Workable zone of R-VIII T2 seam is developed in patches. UG mining operations have been proposed in the area having more than 1.5m thickness. However development of Trunk roadways in less than 1.5m thick zone for approaching to other workable zone in mine-1 is essential, which will be carried out by low height Continuous Miner having cutting range of 1.3m to 3.7m. Roof heightening, atleast for one of the galleries in thin zone, have been proposed for ease of man and material transport for which capital provision have been made in this report.

(d) Panel Projections:

Panel projections have been proposed on one/both side(s) of the main/ auxiliary trunk headings, as per the strike length of the seams. Self draining panels have been proposed for the project as far as practicable. The panel projections have been shown in the layout plan of the respective seams.

(e) Dimension of Pillar and Galleries:

Seams R-VIIIB1, R-VII and R-VIIA which are already fully/partly developed in Mine-1 with different pillar sizes (21m – 35m). In Mine-2, depth of workings of the seams considered in this report in the proposed mining area varies from 60m to 345m. As per the CMR'2017, sizes of pillar for a gallery width of 4.8 m should not be less than the pillar size as mentioned below:

Depth (m)	Pillar size (m x m)
<90m	21.0m x 21.0m
90m to 150m	25.5m x 25.5m
150m to 240m	34.5m x 34.5m
240m to 360m	45.0m x 45.0m

The gallery width may be increased subject to scientific investigation & with due approval of DGMS. Capital provision have been made in this report for the scientific study.

(f) Panel Layout:

Seven heading panel for a pillar size of 21mx21m to 26mx26m has been proposed in general to minimize losses in panel barriers, avoid frequent shifting of equipment from a panel and better coal availability. However, for the pillar size of 35m and above, five heading panel have been considered due to increase in overall tramming length and cable length.

The already developed seams viz. R-VIIIB1, R-VII and R-VIIA where development has been done without giving due consideration to panelisation, would be sectionalized to form panels of suitable size.

(g) Working below surface features:

Majhi Basti has been proposed for rehabilitation under this report. Ukhra-Laudoha D.B. road has also been proposed to be diverted. After rehabilitation of Majhi Basti and Ukhra-Laudoha D.B. road diversion depillaring with caving operation would be done. Depillaring below surface features, which has to be protected, has not been proposed. Depillaring below Tilaboni Village and Jhanjra Village has not been proposed. Protective pillars would be left below surface features which has to be protected viz. Nala, Tilaboni Village, Jhanjra Village, Inclines, Shafts etc.

(h) Working near/below HFL:

Itak nala (about 2 km length) which is seasonal is flowing in south-north direction in the western part of the property in Mine-1. This nala has not been proposed for diversion under this report. Protective pillars would be left below HFL of Jore/Nala in all the seams as per the angle of draw.

In Mine-2 one seasonal nala (about 5 km length) is flowing from west to east direction in the central part of the property. This nala has been proposed to be diverted and the low lying area would be backfilled from the external OB dump of nearby OCP. Caving operation would be carried out in that part of Mine-2 after diversion of the nala. Protective pillars/barriers would be left in all the seams against the nala after diversion as per the angle of draw.

(i) Coal Evacuation System:

For coal evacuation from underground, belt conveyor system of transport has been proposed. Underground bunkers as well ground bunkers have also been proposed for proper storage & handling. This will provide a cushion in production during breakdown of outbye conveyors and non availability wagons at siding and will minimize running of belt conveyors, thereby saving energy cost.

(j) Man / Material Supply System:

It is proposed for introduction of suitable man riding system in the underground workings of all the seams proposed for working, considering the extent of proposed mine working, inclination of the proposed mine entries, necessity of faster means of transport to increase the available time for actual working at the face, to reduce the human drudgery and minimize loss of time in traveling to and from working panels. Man riding systems have also been proposed in the incline no. 2 and 4 of Mine No. 1 and Mine No. 2 respectively. The length of the inclines (upto R-VIIB / R-VII A&B seam) being 828m and 960m respectively.

Man-riding system is also desirable considering economic benefit, long term utility, reduction in manpower requirement and modernization of underground mines. It has immense benefit in terms of available time and efficiency of worker which may lead to enhance a productivity of man & machine. Accordingly, provision has been made in the report.

(k) Underground Ventilation:

It is proposed to widen (6.0m from 4.2m) and deepen No. 2 Pit of Tilaboni unit (upto 340m) so as to approach R-II seam for mine ventilation. Presently the No. 2 Pit of Tilaboni unit is upto R-VII seam. In Mine No. 2 a new shaft of 6.0 m dia. and 415m depth (upto R-II seam) has been proposed.

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Chapter-8

METHOD OF MINING / MINING SYSTEM & EQUIPMENT

8.1 Proposed Mine Development

8.1.1 Approach to Seams

There are in all 13 mineable seams/sections in Mine No.1 viz. R-VIIIT2, R-VIIIB1, R-VIIIB1(B), R-VII, R-VIIA, R-VIIB, R-VIIA/B (Comb), R-VIIC, R-VI, R-V, R-IV, R-III and R-II are mineable. In Mine No.2 there are 12 mineable seams/sections viz. R-VIIIT2, R-VIIIB1(B), R-VII, R-VII(Bot), R-VIIA, R-VIIA/B(Comb), R-VIIC, R-VI, R-V, R-IV, R-III and R-II.

In the present PR six seams/sections have been considered for mining in Mine No. 1 viz. R-VIIIT2, R-VIIIB1, R-VIIIB1(B), R-VII, R-VIIA and R-VIIB and six seams/sections in Mine No. 2 viz. R-VIIIT2, R-VIII B1(Bot.), R-VII, R-VII (Bot.), R-VIIA and VIIA&B(Comb).

In Mine No.1, the proposed inclines would be in apparent dip rise direction upto R-VI seam & thereafter it would be in the reverse direction, so as to intersect the lowermost R-II seam. In Mine No.2 the proposed inclines would be in the strike direction upto R-VI seam and thereafter in the dip rise direction to intersect the lowermost R-II seam. The alignment of the proposed inclines has been so selected that it intersects all the seams in the two blocks.

8.1.2 Trunk Road Development in seams

It is proposed to drive main trunk heading nearly in the center of the property as far as practicable for formation of panels. As the property is faulted it is also proposed to drive auxiliary trunk heading depending upon the orientation of faults so as for catering to the whole property.

The broad parameters of the trunk/auxiliary trunk roadways are:

(i)	Working height of main trunk roadways	:	LHCM-1.5m (min^{m}.) SHCM-4.6m or seam thickness, whichever is less
(ii)	Av. width of main trunk roadway	:	4.8m/6.0m
(v)	Method of development (main & auxiliary)	:	B&P with CM
(vi)	Method of final extraction	:	B&P with CM (caving)
(vii)	No. of headings (main & auxiliary)	:	7/5
(viii)	Pillar size (main & auxillary)	:	26.0 m x 26.0 m, 35.0 m x 35.0 m, 45.0 m x 45.0 m
(ix)	Panel length	:	up to 1200m
(x)	Panel width (main / auxiliary)	:	up to 180m

8.1.3 Panel Development in seams:

The panels are proposed to be developed by low height or standard height continuous miner (two sets in each mines), depending upon the seam thickness. In order to achieve maximum percentage extraction the standard height CMs selected in the 4th and 6th year for mine no. 1 and 2 respectively should have a working range of 2.4 – 4.6m.

R-VII seam is in the thickness range of 1.95-6.18m in the project area. For maximizing extraction of R-VII seam in virgin area, development would be done along the roof by Standard height CM where seam thickness is more than 4.6m. Same Standard height CM may be deployed for taking the floor coal at the time of depillaring by sumping into floor.

8.1.4 Sequence of mine /seam development

The sequence of mine /seam development, to achieve a targeted production of 1.86MTY for the first 25 years of mining operation is shown in Para 9.2.

8.2 Proposed Method of Mining

Bord and Pillar method of mining with Continuous Miner technology has been proposed in the seams considered under this PR, for the first 25 years of operation. After that a relook would be given as to the most appropriate method of mining the then practiced, and the method would then be suitably revised. The methods have been described in detail hereunder.

8.3 Board and Pillar with Continuous Miner

8.3.1(A) DEVELOPMENT AND DEPILLARING BY CM

8.3.1 Mining Parameters:

i)	Depth of working panels	:	21m to 345m
ii)	Seam thickness in working area	:	1.5m – 5.67m
iii)	Av. pillar size (Centre to Centre)	:	
	a) Up to 150m depth	:	26.0m x 26.0m
	b) 150m to 240m depth	:	35.0m x 35.0m
	b) 240m to 360m depth	:	45.0m x 45.0m
iv)	No. of Headings in a panel	:	5 / 7 headings
v)	Panel width	:	up to 180m
vi)	Panel length	:	up to 1200m
vii)	Development height	:	1.5m – 4.6m
viii)	Extraction height	:	1.5m – 4.6m
ix)	Roadway / gallery width	:	4.8m/6.0m
x)	Cut out distance for CM (assumed)	:	15m in development 10 m in depillaring
xi)	Cutting Width (assumed)	:	3.0-3.5 m

The above parameters may vary depending upon actual mining conditions.

8.3.2 Method of Panel Development

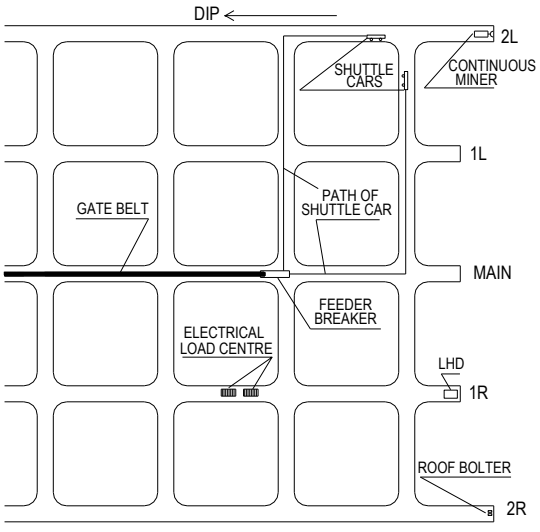
***Panel Layout & System of Panel Development*:**

It is proposed to develop Continuous Miner panels by driving seven / five headings galleries at a distance equal to applicable pillar size, from main trunk roadways, in a similar manner as currently practised in Indian underground coal mines. The heading would be joined at regular intervals, at a distance equal to applicable pillar size, by driving level galleries. In a panel, the pillar sizes would be 26.0m or 35.0m or 45.0m (centre to centre) with gallery width of 4.8m. As per the practice of Jhanjra Continuous Miner districts, the gallery width may be increased subject to scientific investigation & with due approval of DGMS. Uniform pillar size & gallery width have been envisaged in the panels for smooth operation. Permission has to be taken for enhanced gallery width. During development of a panel, height of extraction would be the seam height upto a maximum of 4.6m. The layout of panel has been so designed so as to facilitate self drainage, as far as practicable.

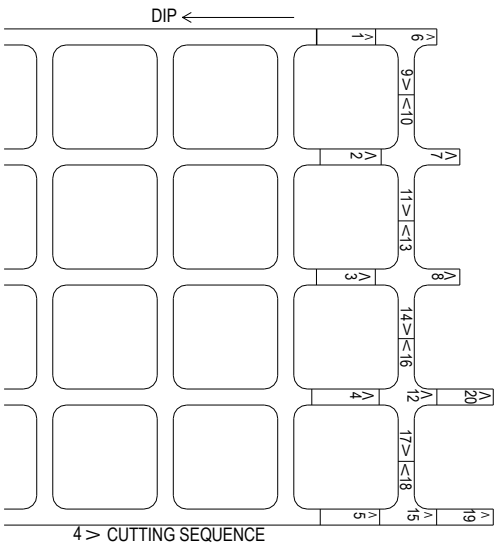
The distribution of work load in the headings would be as follows:

- One heading for Continuous Miner operation
- One heading ready for cutting operation
- One heading under supporting operation
- One heading under cleaning operation by LHD
- One heading having the ventilation and direction of line extension.

The standard layout for development using Continuous Miner is shown in the following figure -8.1 and 8.2:



SCHEMATIC DEVELOPMENT
USING CONTINUOUS MINER.
FIGURE-8.1



SKETCH SHOWING CUTTING SEQUENCE
USING CONTINUOUS MINER IN DEV. PANEL
FIGURE-8.2

The method of Development of Continuous Miner district with 5 headings of 35.0 m x 35.0 m pillar size is explained as follows:

a. One drive for the Continuous Miner for cutting
i.e. Drive 2 left (2L on the plan)

b. One drive being roof bolted (2R on the plan)

c. One drive being cleaned (1R on the plan)

d. One drive having the ventilation and direction lines extended (Main on the plan)

e. One drive ready for cutting (1 L on the plan)

Sequence of Panel Development:

- ❖ The continuous miner will cut for a specific distance (i.e., cut out distance) of about 10-15m from the last row of support using remote control.
- ❖ In one cut, the width of cut may be around 3.0-3.5m. For 6.0m wide gallery, two passes of cut may be required.
- ❖ After completion of one cut, the continuous miner would be shifted to another face/heading for next cut while heading is supported by roof bolter.
- ❖ In headings, (other than the headings in which CM is in operation of the panel), preparatory work for redeployment of continuous miner should be done. This preparatory work includes supporting, cleaning, centerline extension etc.

This layout ensures that the Continuous Miner always gets a supported face to cut and there is no idling of equipment due to shortage of working face. No doubt, availability of supported face is subject to the support requirement and the capability of the bolting machine.

The CM cuts for a specific distance say, 10-15m beyond the last row of support. A lesser or greater distance may be advanced at the discretion of operators and supervisors on the job, depending on the geological conditions. The cut out distance may change depending upon the geo-mining condition. Operator at the faces should always be engaged under the supported roof.

The operator controls the machine using a hand held radio remote control device and stands in a position of safety at all times. On completion of cutting at a face the CM moves to next heading and the roof at the face is supported by roof bolter. In this manner both the CM and roof bolter operate independently and hence there is greater flexibility for both cutting and bolting operation.

If the CM cutting head is less than 4.8m two parallel cuts may be taken one after the other so as to get the desired width of the gallery. The gallery width may be increased subject to scientific investigation & with due approval of DGMS.

The development height for standard height CM would be 4.6m or the seam thickness whichever is less. In case of low height CM, minimum development height would be 1.5m. Permission from DGMS is required for exemption in mining height of more than 3.0m during development phase.

8.3.3 Method of Panel Extraction

Once the continuous miner panel is developed up to the end of the panel, the extraction of the developed pillar would be commenced from the boundary end of the panel and gradually retreats towards the main trunk headings. The equipment which is proposed for panel development will be used during final extraction of a panel. Extraction of pillar below surface features (villages) is not proposed. While extracting the pillars, straight-line method of extraction may be followed. This method reduces cable length and tramming distance to a minimum, thus, optimizing the tramming routes.

In case of developed pillars the extraction of pillars would be done as in the case of freshly developed pillars. In case the size of pillar is odd or is of a smaller size each pillar would be dealt separately, keeping in view the factor of safety of the split pillars.

Layouts for Pillar Extraction:

There are many layouts for extraction of the developed pillars by continuous miner like:

- Navid Method
- Split and Fender Method
- Pocket and Fender Method
- Christmas Tree (Single / double Pillar) Method

(a) Navid Layout

Navid Layout is suitable for smaller size pillar. For extraction of larger size pillars, the layout already being practiced in other mines of CIL, i.e. Split and Fender layout has been proposed. The proposed layout may change after detailed studies conducted by scientific body.

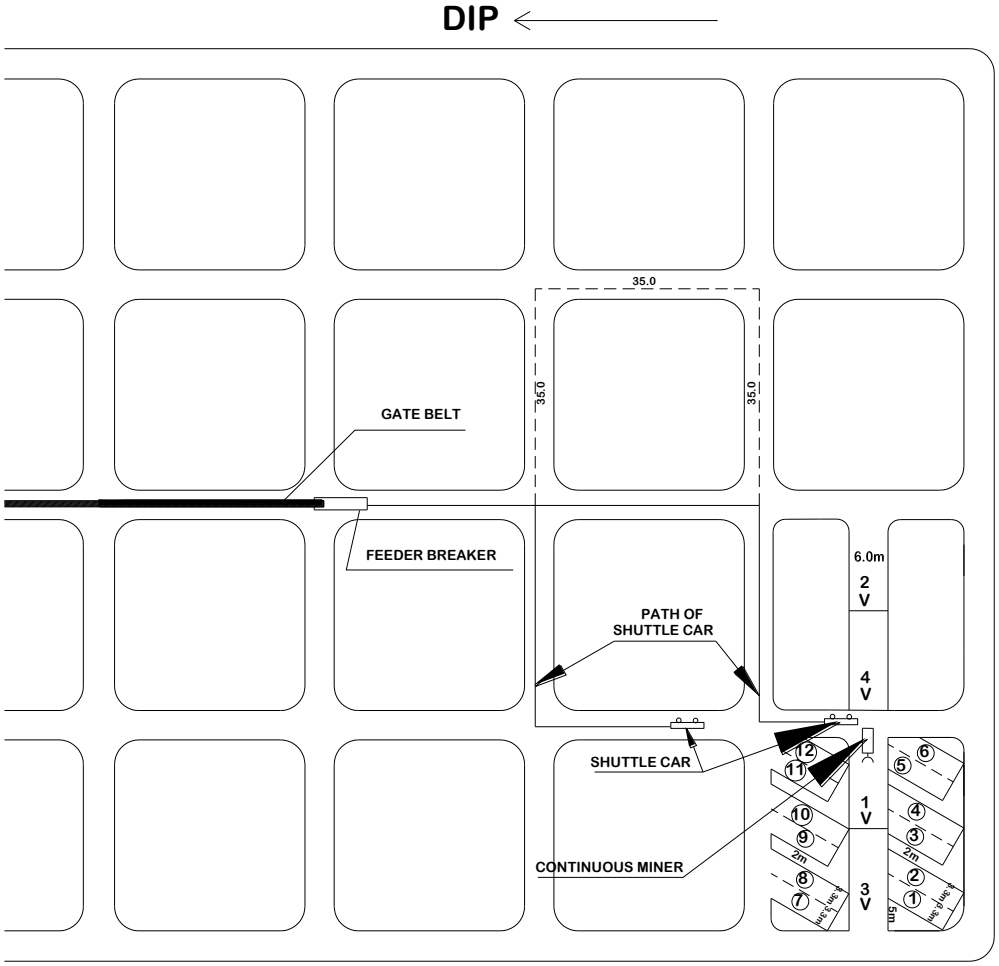
(b) Split and Fender:

The Split and Fender process is also known as Split and Pillar process. It is the most commonly used and acceptable method of extraction. The simplicity of the sequence ensures that the sequence of operation will be followed properly. Split and fender can be practiced with conventional mining equipment and virtually for all continuous miners.

The basic concept of the split and fender process is to mine through a splitting pillar generally parallel to the pillar’s long side. This process forms a split through the pillar and creates two fenders of standing coal on either side of the split. The roof within the split is to be supported. The fenders on either side are to be sliced.

The split-and-fender method generally involves mining simultaneously at two pillars. The main advantage with this layout is that it is very similar to conventional Split and Slice method of depillaring in Bord and Pillar method of mining. It has been successfully practiced in some other mines of CIL (like in

Chirimiri UG, SECL and Tandsi UG of WCL and Jhanjra UG, ECL. The schematic method of extraction showing sequence of slicing for split and fender layout using Continuous Miner is shown in the following figure -8.3:



4 > CUTTING SEQUENCE OF CM DURING SPLITTING OPERATION

① CUTTING SEQUENCE OF CM DURING SLICING OPERATION

SCHEMATIC DEPILLARING WITH CUTTING SEQUENCE USING CONTINUOUS MINER.

FIGURE-8.3

Sequence of operation in Pillar Extraction:

The details of sequence of operation of the seams may be as below:

- Cut 1 is driven in a split gallery up to a maximum distance of 14m or as permitted by DGMS.

- After that the Continuous Miner should be trammed for Cut-2 in second pillar for splitting of a pillar and while cutting in Cut-2, the Roof Bolter Machine will supports Cut-1.

- Once the CM completes Cut-2 in second pillar and Roof bolting is completed in Cut-1, CM will commence Cut-3 operation in first split gallery.

- When Cut-3 in 1st split gallery is in progress, the roof bolter should be deployed for supporting the Cut-2 and it should be supported in advance of completion of Cut-3.

- As the cutting operation in Cut-3 is completed. CM will again be trammed to 2nd split for Cut-4 subject to earlier cut of split gallery i.e. Cut-2 is supported by the roof bolter.

- When Cut-4 in 2nd split gallery is in progress, the roof bolter shall be deployed for support of the Cut-3.

- When Cut-4 is complete and Cut-3 is supported by the roof bolter, then CM shall be trammed to first split to take the slice-1 at an angle of 60 degree from the horizontal in the fender and Cut-4 shall be supported by the roof bolter.

- Number of slices in a fender may depend upon the size of the fender which is to be extracted.

- This process shall be repeated as and horizontal line of extraction is to be maintained while extracting the pillar.

(c) Christmas Tree:

This practice involves taking two fenders from the same split. Two sequences are prevalent. The first involves the extraction of a single pillar. The second method involves the extraction of two pillars from the same gallery. This layout will permit extraction of two pillars from the same gallery. Advantage of this layout is that slices are to be made from the already supported gallery and no need of split gallery support. Hence, bolting may not be constraint while depillaring these pillars. The disadvantage of this layout is that extraction of the final stump may be difficult. Often this stump may be sacrificed.

Sequence of operation in Pillar Extraction:

- Cut 1 may be driven in a pillar from the existing supported gallery at an angle of 60 degree from the horizontal. First cut may be at a distance of 5m from corner of the pillar.
- After that the Continuous Miner may be re-positioned in the same gallery for Cut-2 in the same pillar at same angle as that of in Cut-1, after leaving a rib pillar of 1.8m.
- After completion of Cut-2 in one pillar, CM may be trammed to next dip-rise gallery to commence Cut-3 in the same pillar.
- When Cut-3 is completed, the machine may be shifted to another level gallery for making Cut-4 in the same pillar. Keeping the position of the machine same, Cut-5 should be made in the next pillar in the similar fashion, which is to be extracted after extraction of the first pillar.

- When Cut-5 is completed, the machine may be positioned in another location after leaving a solid coal barrier of 1.8m and Cut-6 should be made in the first pillar and cut-7 should be made in the next pillar.
- After completion of Cut-6 & 7, the machine (i.e. Continuous miner) may be shifted to earlier Dip-Rise gallery and Cut-8 may be made in the first pillar. In this way, there may be around eight Cut in a pillar.
- Number of cuts in a pillar depends upon the size of the pillar, which is to be extracted.

This process shall be repeated and straight line of extraction is to be maintained while extracting the pillar

In the present case, the layout already being practiced in other mines of CIL, i.e. Split and Fender layout has been proposed. The proposed layout may change after detailed studies conducted by scientific body.

8.3.4 Face Equipment

A list of face equipment in each of Continuous Miner panel is given below:

1.	Continuous Miner	:	1
2.	Coal Hauler / Shuttle Car	:	2
3.	Roof Bolter	:	1
4.	Portable Bolter	:	1 (standby)
5.	LHD	:	1
6.	Feeder Breaker	:	1
7.	Auxiliary Fan	:	3 (1 standby)
8.	Face pump	:	2
9.	Set of electrical distribution Equipment	:	1 set
10.	Communication Equipment	:	1 set

A brief description of the face equipment is as under:

Continuous Miner:

It is an equipment, which cuts and loads coal in a single operation. It is equipped with remote controlled dust scrubber and methane monitor approved by DGMS. The average daily production is expected to about 1200 tpd from low height CM (LHCM) and 1700 tpd from standard height CM. The suggested operational parameters of a Continuous Miner may be as under:

Cutting Head Width	: 3.0 – 3.5m
Cutting Height	: 1.3 – 3.7m (for LHCM)/ 2.4-4.6m (for SHCM)*
Gallery width	: 6.0m
Max. Cut out Distance (single pass)	: 10.0 – 15.0m

** For maximizing extraction of R-VII seam in virgin area, development would be done along the roof by Standard height CM where seam thickness is more than 4.6m. Same Standard height CM may be deployed for taking the floor coal at the time of depillaring by sumping into floor.*

Coal Hauler / Shuttle car:

It transports the extracted coal from the Continuous Miner loading conveyor to a self-propelled feeder breaker. From the feeder breaker, coal is discharged to the gate belt and gate belt feeds coal to the trunk belt conveyor. The rated load capacity of low to medium capacity coal hauler varies from 9-15 t.

Feeder Breaker:

It receives the coal from coal haulers / shuttle cars and after crushing it to the desired size say (-)100 mm, feeds it to the conveyor at consistent controlled rate. It is mounted on tracks. The Feeder Breaker should have a hopper sufficient to hold a complete coal hauler.

Roof Bolter:

The roof bolter is used for supporting roof, after coal is cut by Continuous Miner to a specific distance (cut-out distance). Roof Bolter supports the developed roadways by installing roof bolts. During depillaring roof bolts are required to be installed for forming breaker line support. The size and other specification of bolting material shall be of approved type.

Load Haul Dumper (low/normal height depending upon the seam thickness):

It has the following operations to perform in the Continuous Miner district.

- Cleaning the spillage coal from Coal hauler***/*** Shuttle car.
- Cleaning and sweeping up the heading of Continuous Miner after it has completed cutting and thereby reducing time.
- Transport materials and consumable goods.
- Moving switchgear and transformer and also assisting installation of main HT feeder cables.

Other equipment like Endless Haulage, Gate Belt Conveyor, etc. would be working in the panel for uninterrupted operation.

8.3.5 Support System

The RMR of R-VIIIB1, R-VII and R-VIIA seams is 47.2, 46.8 and 53.5 respectively, which comes under fair category of roof. The roof support shall predominantly be roof bolting with resins. The support system may be supplemented by conventional support as and when required. A tentative support system has been suggested assuming fair categories of roof. However, the detailed support system shall be formulated after detailed scientific study where CM is proposed.

i) Support System during panel development by Continuous Miner:

The roof bolting may be a full column resin bolt.

For Permanent roadways: Five bolts in a row with spacing of 1.2m for a gallery width of 6.0m

For Permanent roadways junction: Five bolts in a row with spacing of 1.2m at the junction of the permanent gallery width of 6.0m

For Temporary / Panel roadways: Four bolts in a row with spacing of 1.5m for gallery width of 6.0m

For Temporary Road ways junction: Five bolts in a row with spacing of 1.2m at the junction of the temporary roadways, where gallery width is 6.0m.

(ii) Support System during panel depillaring by Continuous Miner:

Support System in Split and slice:

The tentative support system in split galleries may be resin grouted roof bolt having four bolts in a row with row spacing of 1.2m. Slices may not be required to be supported as it is to be extracted with remote operated Continuous Miner.

Support of Goaf Edges:

- All the goaf edges shall be supported by resin grouted roof bolt at an interval of 0.60m. It should be supplemented with conventional support like chock/ cogs as and when required. The length of such bolts shall not be less than 1.8m. Such goaf edge support shall be provided in the split/original gallery, as the case may be, at the start of the slice cut by the Continuous Miner.
- Each such goaf edge support shall have three parallel rows of bolts across the original/split gallery for form the breaker line.
- At least two wooden props shall be installed near the goaf edge on the rib side as indicator type.

(iii) Support System for Geologically disturbed area:

Smaller geological disturbances, wherever feasible, shall be kept supported by roof bolts on both sides of the disturbances along with W-strap at suitable intervals. Geological disturbances, when encountered, during development of the property, will be supported by roof bolts supplemented with conventional support or any suitable type of support as suggested by the DGMS. Additional supports shall be erected as and when required.

The above envisaged roof bolt system of support should be supplemented with the conventional system of support as and when required. The above specification may change depending upon the results of the scientific study. In addition to above, the provisions of Reg. 123 of CMR, 2017 together with related circulars are to be complied. The support system for the development galleries shall be as per the approved Systemic Support Rules.

(iv) Monitoring of Roof Bolts:

All the recommendations of DGMS Technical Circular No.3 of 1996 and other applicable regulations and circulars regarding roof

bolting/floor bolting shall be effectively complied whenever and wherever applicable in this mine for safe working.

(v) Support Material

Roof Bolts (Tor steel/MS IS:1786-1985/IS:226-1975/IS:1570) **:**

Type	:	TMT Steel
Length of rod	:	1.8m
Dia. of rod	:	22mm
Threaded Length	:	125-150mm

Bearing Plate (IS:226-1975):

Material	:	MS
Thickness	:	6mm
Size	:	150 x 150 mm^2

Nut (IS: 1363, Part-3, 1984)**:**

Shape	:	Hexagonal
Height	:	20mm

Resin Capsule

Length	:	Not exceeding 450mm
Dia	:	24mm
Type	:	Combination of fast setting and slow setting resin capsule. The fast set resin should provide a minimum anchorage of 5 tonnes in 2 minutes.

While doing the bolting operation in any roadways / workings of the mine, the provisions of CMR 2017 and various DGMS Circulars (viz. Cir. Tech 3/1996) shall be effectively complied for safe working of the mine.

The roof support pattern described above is only indicative in nature. The actual roof support would be decided only after fresh determination of RMR for each seams proposed to be worked. The Systematic Support Rule should be framed for each seam by the colliery/scientific body and approved by DGMS, which would be final, and would be implemented.

8.3.1(B) HEIGHTENING OF EXISTING GALLERIES

Proposal for Heightening of Galleries

The R-VIIIB1 and R-VII seams have already been fully developed in Tilaboni colliery (Mine No. 1) upto a height of 2.7m-3.0m along the floor and supported by roof bolts with cement capsules. The full thickness of the seams R-VIIIB1 and R-VII are 2.85m–4.72m and 3.75m-5.67m respectively in the developed area of Tilaboni colliery (Mine No. 1). The development width of galleries is about 4.8m. As CM would not be able to cut the bolted roof it is proposed to heighten the roof by drilling and blasting the roof and re-supporting the same by a separate roof bolter, provision of which has been made. Where required the gallery may also be widened by drilling and blasted and side supported by Glass Fiber Reinforced Polymer (GFRP) roof bolts.

There would be separate remote controlled LHD panel for heightening of the developed galleries. The heightening of developed galleries is proposed up to 4.6m or full seam thickness whichever is less. 0.3-0.6m coal is proposed to be left in the roof, where required, due to adverse roof conditions. The height will be increased beyond 3.0m taking due permission by DGMS.

a) Layout of Panels

The mine is almost fully developed by Bord & Pillar method of mining in R-VIIIB1 and R-VII seams along the floor of the seam manually/by SDL. Sectionalisation of workings would be done by construction of isolation stoppings, so as to create panels of suitable dimension.

b) Manner of Heightening and Widening

Heightening of galleries will be done by drilling and blasting up to 4.6m or full seam thickness whichever is less, leaving at least 0.3m-0.6m coal in the roof, where required, due to adverse roof conditions.

The gallery may be widened where required by drilling and blasting and sides supported by Glass Fiber Reinforced Polymer (GFRP) roof bolts which have been approved by DGMS. The bolts are suitable for side bolting as it would not adversely affect cutting by CM during extraction of split & slice.

c) Face Equipment

The coal obtained due to heightening of coal shall be loaded by remote controlled LHDs. Two numbers of remote controlled LHDs shall be deployed in heightening panel.

d) Coal Evacuation from Panel

The coal shall be loaded onto pony belt conveyor by remote controlled LHD. The pony belt conveyors will feed coal to gate belt conveyor for coal evacuation from panels.

e) Ventilation of Panels

Heightening panels comprise of 4 to 6 headings, which is already developed. In five headings panel, three headings in the dip side of the panel shall act as the intake airway and two headings on the rise shall act as the return airway of the panels. In case of other panels, the number of galleries for intake and return airway would be decided on case to case basis, so as to provide adequate ventilation.

f) Face Ventilation

Auxiliary Fans with ducting shall be used for face ventilation.

g) Support System

As remote controlled LHD is envisaged for loading of coal in the panels, it is necessary that supports should be so designed that clear space is available for movement of the machineries. At present, the panel is developed upto 2.7-3.0m in height and is supported as per the approved SSR. Now as it is to be heightened fresh SSR should be prepared and approved by the DGMS and should be effectively complied. Side bolting may also be done where required after widening.

The bolt density for three types of roof classified on the basis of RMR value as recommended is as below:

Poor roof - 1.2 to 1.5 bolts/m^2
Fair roof - 1.0 bolt/sq.m.
Good roof - 0.7 bolt/m^2

As per the RMR value, the roof of the seams falls under fair category. So, the density of roof bolts in the heightened panels should be 1.0 bolt/sq.m.

The bolt angle should generally be normal to the bedding plane in the roadways/galleries. This also holds good for other panels of the mine.
Support materials should be as per DGMS Cir, no. 3/1996.

Support of Heightened Gallery:

In every place wherein roof coal is taken, the newly exposed roof and sides in the vicinity should be supported as per Reg. 123 and 124 of CMR, 2017.

Support of Heightened Gallery:

* After heightening of galleries, the roof shall be re-supported with roof bolts by roof bolter.
* Four bolts in a row shall be installed. The spacing between the bolts in a row and between the rows shall be 1.2m.
* Some additional roof bolts shall be installed to increase the density of roof bolts, as and when required.
* The spacing between the sides of the pillar and the bolts in a row shall be 0.6m on the both sides of the pillar corner.
* Bolts shall not be less than 1.8m/2.4m in length and 22mm in diameter.

Support at Junction: The bolt density should be at least 25% more than the bolt density of heightened gallery.
Support at Disturbed Places: In addition to the roof bolts, the geological disturbed area of the heightening panel shall be supported by cross-bars, cogs, W-straps and other suitable means as and when required.

Supports on Loose Floor: Props shall be set on solid floor and not on loose packing material. The support shall be kept tight against the roof.

For legged steel cogs of 1.2m x 1.2m piece shall be set on solid floor and not on loose material. They shall be kept tight with timber sleepers against the roof to ensure maximum contact between the timber and the roof. The provisions for support on loose floor shall also hold for other working panels of the mine.

Support near split zone: Near the split zone the roof is expected to deteriorate, hence support has to be specially designed for that region.

Support Material: The support material shall be as proposed in DGMS Circular Tech. 3/1996 and other statutory guidelines brought out from time to time.

h) Production Proposed

The production proposed from the heightening panel is 0.12 MTY (400 tpd from two remote controlled LHDs producing 200 tpd each).

All the mining operations in Continuous Miner panel should be in accordance with the various regulations of CMR 2017 and various circulars issued by DGMS for safe working of the mine.

Before going for heightening or widening of galleries in a panel in any of the seams or section, prior permission from DGMS should be obtained. All the mining operations in the Heightening panel should be in accordance with the various regulations of CMR 2017 and circulars issued by DGMS for safe working of the mine. The final support system also should be designed as per requirement and approved by DGMS, which should be strictly complied with

8.4 Auxiliary Services

8.4.1 Coal Evacuation System in a Panel

Continuous Miner Panel: The Continuous miner would cut and simultaneously load the coal by its inbuilt stage conveyor in the coal hauler directly. The loaded coal hauler would discharge coal on to feeder breaker. Feeder Breaker would size the coal to less than (-)100 mm size. Crushed coal will be uniformly discharged on to gate belt conveyor. The gate belt conveyor will in turn discharge the coal on the trunk belt conveyor for onward transport of coal to surface by belt conveyors and strata bunker. The purpose of underground strata bunker is to provide production cushioning and to minimize the running of outbye belt conveyors.

8.4.2 Men and Material Transport

In underground workmen will travel along in the trunk roadways, other than the haulage roadways. Walking of men to the work place not only consumes the time but also makes the work persons weak. Since, Continuous Miner are planned to achieve high production levels, the availability of men and machinery is an important factor in achieving the targets. To avoid wastage of time in traveling and to increase the effective working hours and efficiency of the workforce, Diesel/ Battery operated Free steered vehicles has been proposed in all the working districts. However arrangement/ layout and type of man-riding system to be provided in the mine would be finalized after a detailed geo-technical assessment.

Materials will be transported from the surface to the working place by Diesel/ Battery operated Multi utility Vehicles. Beside this existing rope haulages (direct, endless and tugger haulage) of Tilaboni Colliery may also be utilized for the material transport in Mine-1 wherever required.

8.4.3 Ventilation System in a Panel:

In general B&P panels with CM comprises of five headings. It is propose that three headings on the dip side of the panels may be used as intake airway and two headings on the rise side of the panel may be preferably used for return airway of the panel. The faces would be ventilated by auxiliary fans using flexible ducting. Other means of ventilation which may improve the ventilation of the panel / district may also be adopted as and when required.

8.5 Subsidence

The minimum and maximum depth of working of different seams proposed to be worked is 21m-345m. In this report proposed method of extraction is Bord and Pillar with caving using Continuous Miner where there is no surface constraint like villages, nala, H.T. line etc. Where surface features are to be protected depillaring will not be done and pillars would be left intact.

It is expected that caving in underground will cause subsidence at surface. Hence, it is proposed to undertake ‘Subsidence Prediction Study’ by a scientific body for appropriate evaluation. The recommendations made in the Subsidence Prediction Study Report would be followed so as to cause minimum damage to the surface.

It has been proposed for acquisition of land falling in the block, below which caving has been proposed. Rehabilitation of villages is not proposed as depillaring would not be carried out below villages as described above.

8.6 Production Parameters

In Bord & pillar method with CM, the estimates of production depends mainly upon the layout, evacuation capacity and/or bolting capacity during

development of a panel as Continuous Miner has adequate cutting capacity. During depillaring, the estimates of production depend on the layout in the panel and the evacuation capacity, as the workload of roof bolting is significantly reduced.

8.6.1 B&P panel with low height Continuous Miner:

In the proposed project, considering average extraction height to be about 2.75m, the width of the gallery to be about 6.0m and average specific gravity of 1.52, the production capacity of the low height Continuous Miner panel with seven headings has been assessed as follows:

a) Total tonnage of coal at a place for a cut out distance of 12.0m = 6.0 x 2.75 x 12.0 x 1.52
= 301 t,
Say 300 t.

b) Anticipated no. of cuts per day = 5 cuts (As per the experience of UG mines where Continuous Miner is presently under operation)

c) Production per day = 300 t x 5 cuts x 0.85 (prodn. factor)
= 1275 t; Say 1200 t.

The above production is the production during development stage. However, it is anticipated that the same production is achieved during depillaring with caving. Therefore in this report, the proposed target capacity of the low height Continuous Miner panel has been envisaged as 1200 tpd or 0.36 Mty.

8.6.2 B&P panel with standard height Continuous Miner:

Considering the average extraction height to be about 3.85 m, the width of the gallery to be about 6.0 m and average specific gravity of 1.52, the production capacity of the standard height Continuous Miner panel with five headings has been assessed as follows:

a) Total tonnage of coal at a place for a cut out distance of 12.0m = 6.0 x 3.85 x 12.0 x 1.52
= 421.34 t,
Say 420 t.

b) Anticipated no. of cuts per day = 5 cuts

c) Production per day = 420 t x 5 cuts x 0.85 (prodn. factor)
= 1785 t; Say 1700 t.

The above production is the production during development stage. However, it is anticipated that the same production is achieved during depillaring with caving. Therefore in this report, the proposed target capacity of the standard height Continuous Miner panel has been envisaged as 1700 tpd or 0.51 Mty.

As per the isochore plan of different seams, there is large variation in working height in different panels. Average annual output has been considered as 0.51 Mt (1700TPD) for standard height Continuous Miner and 0.36 Mt (1200TPD) for low height Continuous Miner.

8.6.3 Heightening and widening of existing galleries:

The production proposed from the heightening panel is 0.12 MTY (400 tpd) from two remote controlled LHD districts.

8.7 Selection of Equipment

8.7.1 Trend of Mechanization in the Area

All the eight operating underground mines in Bankola Area are semi-mechanised. At the faces, blasted coal is loaded using SDLs/LHDs on to haulage/belt conveyor for coal evacuation.

8.7.1 Schedule of Equipment Procurement

Detailed schedule of procurement of equipment is shown in Appendix-A.3. Schedule of procurement of major equipment is as under:

Mine	Particulars of Major Equipment	Deployment in Seam	Population		Year of Phasing						
			Existing	New	Yr-1	Yr-2	Yr-3	Yr-4	Yr – 5	Yr-6	Yr-7
Mine No.1	C.M. (Low height)	R-VIIIT2/ R-VIIIB1(Bot.)/ R-VIIA/ R-VIIB	Nil	1				1			
	C.M. (Std. height)	R-VIIIB1/ R-VII/ R-VIIB		1				1			
	Remote controlled LHD	R-VIIIB1/ R-VII	Nil	2		1	1				
	Sub Total			**4**		**1**	**1**	**2**			
Mine No.2	C.M. (Low height)	R-VIIIT2/ R-VIIIB1(Bot.)/ R-VII(Bot.)/ R-VIIA	Nil	1				1			
	C.M. (Std. height)	R-VII/ R-VIIA&B (Comb.)		1						1	
	Sub Total			**2**				**1**		**1**	
	Total			**6**		**1**	**1**	**3**		**1**	

8.8 Explosive and Magazine

The explosives will be used only for roof heightening in developed panels of R-VII seam. However for coal winning from the face, explosives and detonators would not be required, in the proposed technology.

Assuming a powder factor around 4 t/kg of explosive, the daily requirement of explosive, for a production of 400tpd, will be around 100 kg and one-week requirement will be around 600 kg.

The mine is having a magazine of 3.6te capacity explosives and 50,000 detonators, which is sufficient for the mine.

8.9 Stowing Arrangement

As pillar extraction would be done by caving hence stowing arrangement is not required.

8.10 Any Specific Scientific Study to be carried out:

(a) Scientific Study for Support requirement:

Tentative support design for the project has been given on assumed RMR. Hence final support plan should be prepared only after detailed scientific study for the support design and support plan should be prepared in accordance with the scientific study and got approved by the DGMS.

(b) In addition to above, the following scientific study may also be conducted to:

(i) Ascertain the hydro-geological regime.
(ii) To undertake the physico-mechanical properties of rocks for designing the support system & caving characteristics of the roof strata.
(iii) Ascertain the existence of any potential source of danger, which may endanger the safety of the mine.
(iv) Ascertain the connectivity of fault etc. to any other water bodies.
(v) Re-organisation the ventilation system.
(vi) Ascertain the physico-mechanical properties of strata for the introduction of Continuous Miner Technology.
(vii) Investigate the subsidence over the proposed depillaring panel.
(viii) Determination of cavability index and incubation period.
(ix) Ascertain the support requirement for depillaring with CM.
(x) Roof heightening by drilling and blasting and re-support by Roof bolter and loading by remote controlled LHD.

8.11 Prior Permission & Boundary Adjustment Required:

Prior permission from DGMS is required for the following:

- Permission for deployment of Continuous Miner for panel development and depillaring.

- Working below any surface features such as road, water body/HFL, village, H.T. line etc. These surface features include all the features, which may endanger the safety of mine.

- Permission for deployment of diesel/ battery operated equipment in underground.
- Permission for enhanced gallery width and height.
- Permission for deployment of Continuous Miner and diesel/battery operated equipment shall be sought in consultation with the Supplier.
- In addition to above, routine mining operations, which require prior permission from DGMS and other permission for safe working has also to be obtained.
- Seam wise boundary adjustment, with Jhanjra Colliery, Kumardih 'A' Colliery and Shyamsunderpur Colliery for extraction upto fault F3-F3, F2-F2 and F9-F9 respectively.

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Chapter-9

MINING SCHEDULE

9.1 Extractable Reserves

Project Report of Tilaboni UG Project proposes the extraction of Seams R-VIII T2 , R-VIII B1/R-VIII B1(Bot), R-VII/R-VII(Bot), R-VIIA/R-VIIA&B (Comb) and R-VIIB by Bord & Pillar method with Continuous Miner Technology. The proposed project consist of two mine viz. Mine-1 & Mine-2. Two CM districts would be worked in each unit. Beside this two LHD districts would be worked in seam R-VII in mine-1 for heightening the developed working upto a maximum height of 4.6m. Considering the above factors extractable reserves for the seams to be worked in the first 25 years of the Project has been estimated.

The seams considered in this PR constitute a total 47.039 Mt of extractable reserves. The underlying seams i.e. R-VIIC, R-VI, R-V, R-IV, R-III and R-II would be worked only after extraction of overlying seams i.e. after 25 years of the proposed project. However, a review would be made after 25 years to decide the extraction method of these seams by appropriate technology available at that point of time.

Extractable reserves have been estimated based on the seam and the technology adopted for the mining. Details of estimation of panel wise / seam wise extractable reserves have been given in Annexure-VII.

Mine wise / seam wise extractable reserves are summarised below:

Mine / Unit	Seam	Extractable Reserves (Mt)		
		Development	Depillaring	Total
Mine no.1	R-VIIIT2	0.3814	0.3100	0.6924
	R-VIIIB1 & Bottom	1.6963	3.7880	5.4843
	R-VII & R-VII(Bot)	2.5714	6.2601	8.8315
	R-VIIA	2.9561	3.1223	6.0784
	R-VIIA&B (Comb)	0.0380	0.0099	0.0479
	R-VIIB	3.0417	2.5598	5.6015
	Total	**10.6849**	**16.0501**	**26.7360**
Mine no.2	R-VIIIT2	0.3417	0.2042	0.5459
	R-VIIIB1 & Bottom	2.3152	2.0058	4.3210
	R-VII & R-VII(Bot)	3.5946	3.5517	7.1463
	R-VIIA	1.0654	1.0620	2.1274
	R-VIIA&B (Comb)	2.7249	3.4375	6.1624
	R-VIIB	-	-	-
	Total	**10.0418**	**10.2612**	**20.3030**

Mine / Unit	Seam	Extractable Reserves (Mt)		
		Development	Depillaring	Total
Combined	R-VIIIT2	0.7241	0.5142	1.2383
	R-VIIIB1 & Bottom	4.0115	5.7938	9.8053
	R-VII & R-VII(Bot)	6.1660	9.8118	15.9778
	R-VIIA	4.0215	4.1843	8.2058
	R-VIIA&B (Comb)	2.7629	3.4474	6.2103
	R-VIIB	3.0417	2.5598	5.6015
	Total	**20.7277**	**26.3113**	**47.0390**

9.2 Production Schedule

Based on the above considerations, extractable reserves and the production schedule for the seams to be worked in the 25 years of the Project have been estimated. Seam wise, GCV band wise extractable reserves (in Mt) for the proposed project upto 25 years of the project life are summarized below:

Figures in Mt

Seam	**GCV band-wise extractable reserves (Mt)**								**Total**
	G-11	**G-10**	**G-9**	**G-8**	**G-7**	**G-6**	**G-5**	**G-4**	
TILABONI (MINE-1)									
R-VIIIT2			0.2206	0.4718					**0.6924**
R-VIII B1 & Bot								5.4843	**5.4843**
R-VII								8.6111	**8.6111**
R-VIIA								6.0783	**6.0783**
R-VIIA&B (Comb)					0.0480				**0.0480**
R-VIIB						0.3399			**0.3399**
Total Mine-1	**-**	**-**	**0.2206**	**0.4718**	**0.0480**	**0.3399**	**-**	**20.1737**	**21.2540**
TILABONI (MINE-2)									
R-VIIIT2			0.0727	0.3575	0.1157				**0.5459**
R-VIII B1 & Bot								4.3210	**4.3210**
R-VII & R-VII (Bot)								7.1463	**7.1463**
R-VIIA								1.1026	**1.1026**
R-VIIA&B (Comb)	0.0637	0.0777	0.4918	2.3956	1.4776	0.1278			**5.7368**
Total Mine-2	**0.0637**	**0.0777**	**0.5645**	**2.7531**	**1.5933**	**0.1278**	**-**	**12.5699**	**17.7500**
GRAND TOTAL	**0.0637**	**0.0777**	**0.7851**	**3.2249**	**1.6413**	**0.4677**	**-**	**32.7436**	**39.0040**

Note:- Balance extractable reserves of R-VII & R-VII(Bot) seam (15.9778 Mt – 15.7574 Mt = 0.2204 Mt), R-VIIA & R-VIIA&B (Comb.) seam (14.4160 Mt – 11.8631 Mt = 2.5529 Mt) and R-VIIB seam (5.6015 Mt – 0.3399 Mt = 5.2616 Mt) would be extracted beyond 25 years of the project life by appropriate technology available at that point of time.

9.2.1 Based on the technology and method of mining, year wise productions in the scenario considered under this report are as follows:

Figures in Mt

Year	Existing UG	Height-ening	CM-1 (Mine-1)	CM-2 (Mine-1)	CM-3 (Mine-2)	CM-4 (Mine-2)	**Total**
Year 1	0.138						**0.138**
Year 2	0.138	0.06					**0.198**
Year 3	0.138	0.12					**0.258**
Year 4		0.12	0.25	0.36	0.25		**0.980**
Year 5		0.12	0.36	0.51	0.36		**1.350**
Year 6		0.12	0.36	0.51	0.36	0.25	**1.600**
Year 7		0.12	0.36	0.51	0.36	0.51	**1.860**
Year 8-17		0.12	0.36	0.51	0.36	0.51	**1.860**
Year 18		0.10	0.36	0.51	0.36	0.51	**1.840**
Year 19-25			0.36	0.51	0.36	0.51	**1.740**

9.2.2 Year wise/ Mine wise UG production and the corresponding GCV grade considered under this report within 25 years of project life are as follows:

Year	**Mine-1**		**Mine-2**		**Total Prodn. (Mt)**
	Prodn.(Mt)	**Grade**	**Prodn.(Mt)**	**Grade**	
1	0.138	G-4	-	-	0.138
2	0.198	G-4	-	-	0.198
3	0.258	G-4	-	-	0.258
4	0.73	G-5	0.25	G-4	0.98
5	0.99	G-6	0.36	G-6	1.35
6	0.99	G-4	0.61	G-6	1.60
7	0.99	G-4	0.87	G-4	1.86
8	0.99	G-4	0.87	G-4	1.86
9	0.99	G-4	0.87	G-4	1.86
10	0.99	G-4	0.87	G-4	1.86
11	0.99	G-4	0.87	G-4	1.86
12	0.99	G-4	0.87	G-4	1.86
13	0.99	G-4	0.87	G-4	1.86
14	0.99	G-4	0.87	G-4	1.86
15	0.99	G-4	0.87	G-4	1.86
16	0.99	G-4	0.87	G-5	1.86
17	0.99	G-4	0.87	G-6	1.86
18	0.97	G-4	0.87	G-6	1.84
19	0.87	G-4	0.87	G-6	1.77
20	0.87	G-4	0.87	G-6	1.74
21	0.87	G-4	0.87	G-6	1.74
22	0.87	G-4	0.87	G-6	1.74
23	0.87	G-4	0.87	G-6	1.74
24	0.87	G-4	0.87	G-6	1.74
25	0.87	G-5	0.87	G-6	1.74
Total	**21.254**	**G-4**	**17.75**	**G-5**	**39.004**

The target production with four sets of Continuous Miner and two heightening districts would be 1.86 Mty. Mine wise and Seam wise liquidation plan of extractable reserves for first 25 years is shown in next page.

Seam	Seam Thickness (m)	Extr. Reserves (Mtes)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
MINE NO. 1 (TILABONI BLOCK)																											
R-VIIIT2	1.5 - 1.7	0.6925				0.25	0.36	0.08																			
R-VIIIB1 & R-VIIIB1(BOT)	2.2 - 2.5	0.8584						0.28	0.36	0.2209																	
	Roof heightening	0.7204		0.06	0.12	0.12	0.12	0.12	0.12	0.06																	
	2.5 - 4.6	3.9055	0.069	0.069	0.069	**0.36**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	0.51	0.28														
	SEAM TOTAL	**5.4843**																									
R-VII	Roof heightening	1.2441								0.06	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.10							
	4 - 5.6	7.5874											**0.23**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**
	SEAM TOTAL	**8.8315**																									
R-VIIA	1.5 - 2.5	2.3566	0.069	0.069	0.069					0.14	0.36	0.36	0.36	0.36	0.36	0.21											
	2.5 - 3.4	3.7697														0.15	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	**0.02**	
	SEAM TOTAL	**6.1263**																									
R-VIIB	1.5 - 3.4	5.6015																								0.34	
	SEAM TOTAL	**5.6015**																									
GRAND TOTAL (MINE NO.1)		**26.7361**	**0.138**	**0.198**	**0.258**	**0.73**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.97**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**
Overall Grade (Mine No.1)			**G-4**	**G-4**	**G-4**	**G-5**	**G-6**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-5**
MINE NO. 2 (TILABONI EXTENSION BLOCK)																											
R-VIIIT2	1.5 - 1.9	0.5459					0.18	0.36	0.01																		
R-VIIIB1 (BOT)	1.5 - 2.4	4.3210				0.25	0.18		0.35	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.30								
R-VII & R-VII(BOT)	2.0 - 2.5	2.0463																	0.06	0.36	0.36	0.36	0.36	0.36	0.18		
	2.5 - 5.5	5.1000						0.25	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.26									
	SEAM TOTAL	**7.1463**																									
R-VIIA&B & R-VIIA	1.7 - 2.5	1.7070																							0.18	0.36	0.36
	2.5 - 4.6	6.5828																0.25	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
	SEAM TOTAL	**8.2898**																									
GRAND TOTAL (MINE NO.2)		**20.3030**				**0.25**	**0.36**	**0.61**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**	**0.87**
Overall Grade (Mine No.2)						**G-4**	**G-6**	**G-6**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-4**	**G-5**	**G-6**	**G-6**	**G-6**	**G-6**	**G-6**	**G-6**	**G-6**	**G-6**	**G-6**
GRAND TOTAL (MINE NO.1+ MINE NO.2)		**47.0391**	**0.138**	**0.198**	**0.258**	**0.98**	**1.35**	**1.60**	**1.86**	**1.86**	**1.86**	**1.86**	**1.86**	**1.86**	**1.86**	**1.86**	**1.86**	**1.86**	**1.86**	**1.84**	**1.74**	**1.74**	**1.74**	**1.74**	**1.74**	**1.74**	**1.74**

9.3 ROM Quality

Year wise overall grade of coal has been assessed as G-4 to G-6 during the first 25 years of the project life.

9.4 Zero date:

Zero date for the proposed project would be the date of PR approval.

9.5 Time schedule for Incline Drivage and Shaft Sinking:

The rate of incline drivage and shaft sinking has been considered as 80m/month and 20m/month respectively.

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Chapter-10

HORIZONTAL & VERTICALTRANSPORT

10.1 VERTICAL TRANSPORT SYSTEM

10.1.1 **MINE – 1**

Tilaboni colliery is being worked through two units namely, Tilaboni Unit and Shyamsundarpur (Old) unit known as SSP (Old) unit. The existing entries in the two units are as shown below:

Table No. 10.1

Unit	Mine Entry	Landing at	Depth of pit (m)	Dia. of Pit (m)	Specification of winder/Fan	Purpose
Tilaboni Unit	No. 1 pit	R-VIII B1 (Jambad)	46.56	4.2	Steam winder 30 cm x 60 m, Single tub cage, Fan - PV-200, 130 HP	Man & Material winding, Up cast
	No. 2 pit	R-VII (Bonbahal)	94.71	4.2	Steam winder 30 cm x 60 m, Single tub cage	Man & Material winding, Down cast
S.S.P. (Old) Unit	No.1 pit	R-VIII B1 (Jambad)	24.00	4.2	40 HP electric Double drum winder, Single tub cage	Man & Material winding, Down cast
	No. 2 pit	R-VIII B1 (Jambad)	28.00	4.2	No winding installation, Fan - PV-200, 130 HP	Fan drift, Up cast
	No. 3 pit	R-VII A (Kenda)	120.00	4.2	75 KW electric winder, Single tub cage	Man & Material winding

Proposal has been made in this report for deepening of existing Pit No.2 of Tilaboni Unit from 94.71 m to 340.00m depth and its widening from 4.2 m to 6.0 m upto R-II seam with inset facilities at all upper seams viz. R-VIIIB1, R-VII, R-VIIA etc. for the purpose of ventilation.

10.2 HORIZONTAL TRANSPORT SYSTEM

10.2.1 EXISTING ARRANGEMENT :

Presently mining activity is going on in R-VIII B1(Bot), R-VII & R-VIIA seams through Pits of Tilaboni Unit and Old SSP unit. SDL is loading coal onto tubs. Tubs are then hauled from face to Pit Bottom by no. of Endless Haulages/Direct Haulages. Both loaded and empty tubs are raised or lowered by means of winders.

10.2.2 BASIC DATA :

The coal produced at coal faces in the underground needs to be transported effectively, economically to surface for despatching to customers. Similarly required materials have to be transported from surface to the place of usage in underground. The equipment which needs repairing has to be transported from underground to surface. New equipment and repaired equipment have to be transported from surface to underground. For performing the above jobs an efficient u/g transport system is required. Man riding system is required for transport of men to improve the production and productivity of the mine.

S.N.	DESCRIPTION	UNIT	MINE No. – 1	MINE No. – 2
i.	Targeted Production	Mty	0.99	0.87
II.	Seams/sections up to 25th year	Nos.	6 viz. R-VIIIT2, R-VIIIB1 & R-VIIIB1(Bot), R-VII, R-VIIA & R-VIIB	7 viz. R-VIIIT2, R-VIIIB1 & R-VIIIB1(Bot), R-VII & R-VII(Bot), R-VIIA & R-VIIA&B (Comb)
iii.	Shifts/day	Nos.	3	3
iv.	Production/day	tpd	3300 (maxm).	2900 appx. (maxm).
v.	System Capacity	tph (avg.)	400 (after Strata Bunker)	400 (after Strata Bunker)
vi.	Mode of transportation of coal		By Belt Conveyors	By Belt Conveyors
vii.	Mode of transportation of material		By Multi utility vehicle	By Multi utility vehicle
viii.	No. and Capacity of Strata Bunker.		Initially, 1 of 350 t capacity between R-VIII B1 & MICN1 conveyor. Later, 1 of 1000 t capacity in between R-VIIIB1 & R-VII seams and 2 of 500 t capacity in between R-VII and R-VIIA seams.	1 of 1100 t capacity between R-VIIIB1 & R-VII seams and 2 of 450 t capacity in between R-VII & MIC2 conveyor
ix.	Man riding system	Sets	Free Steered Vehicles (2 nos.)	Free Steered Vehicles (2 nos.)

10.2.3 PROPOSED ARRANGEMENT :

There are four workable seams/sections up to 25th year of life of the mine viz. R-VIIIT2, R-VIIIB1 & R-VIIIB1 (Bot.), R-VII & R-VII (Bot.), R-VIIA & R-VIIA&B (Com.) in **MINE-1 unit of Tilaboni U/G** Mine. As the parting between the seams varies, separate transport arrangements have been provided for R-VIIIB1 & R-VIIIB1 (Bot.), R-VII & R-VII (Bot.), R-VIIA & R-VIIA&B (Com.) seams. For R-VIIIT2 seam coal evacuation will be carried out through R-VIIIB1/R-VIII B1 (Bot) seam. Later on, after exhaustion of said seams, underground transport arrangement would be shifted to lower seams as per the requirement. Two inclines namely Incline No.1 and Incline No.2 have been proposed in MINE-1. Incline No.1 will be used for coal transportation and Incline No.2 will be used for man and material transportation.

Initially Pit No 1 and 3 of Old SSP unit will be used for transportation of man and light materials. Later on, Multi utility vehicle will also be used for the transportation of heavy material.

In **MINE No.-2 i.e. Tilaboni Extension Unit,** five workable seams/sections viz. R-VIIIT2, R-VIIIB1 & R-VIIIB1(Bot), R-VII & R-VII(Bot) and R-VIIA & R-VIIA&B (Com) are proposed to be worked up to 25th year of mining operation. As the parting between the seams varies, separate transport arrangement has been provided for each seam. For R-VIIIT2 seam coal evacuation will be carried out through R-VIII B1 seam. Later on, after exhaustion of said seams underground transport arrangement would be shifted to lower seams as per the requirement. Two inclines namely Incline No.3 and Incline No.4 have been proposed in MINE-2. Incline No.3 will be used for coal transportation and Incline No.4 will be used for man and material transportation.

Details of entries are as under :-

Sl. No.	Mine entry (incline / Shaft)	X-section (W x H/ dia.) (m2/ m.)	Length / Depth (m)	Gradient	Purpose & mode of transport / ventilation
	Mine No. 1				
1	Incline No. 1 & 2	5.5 m x 3.5 m (finished section)	Normal upto R-VI seam- 1145m, (Upto R-VII B seam – 828m); Reverse (From R-VI to R-II seam- 520m) **Total – 1665m**	1 in 4.5	Coal (belt conveyor) (Inc. No. 1), man riding and material transport (haulage) (Inc. No. 2), intake
2	Pit no.2 (Tilaboni Unit)	Widening (4.2 m dia to 6.0 m dia)	Deepening upto R-VII B seam (94.7m to 155 m), 340 m (upto R-II seam)	Vertical	Air return
	Mine No. 2				
1	Incline no.3 & 4	5.5 m x 3.5 m (finished section)	Normal upto R-VI seam- 1180m (Upto R-VII A&B seam – 960m); Reverse (From R-VI to R-II seam- 725m) **Total – 1905m**	1 in 4.5	Coal (belt conveyor) (Inc. No. 3), man riding and material transport (haulage) (Inc. No. 4), intake
2	Air shaft	6.0 m	220 m (upto R-VII A&B seam) 415 m (upto R-II seam)	Vertical	Return

In MINE-1 targeted production has been envisaged as 0.99 Mty by deploying 2 nos. of Continuous Miner. Initially, 1 no. low height Continuous Miner will be deployed for development / depillaring panels in R-VIIIT2 seam and 1 no. standard height Continuous Miner will be deployed for development/ depillaring of R-VIIIB1 & R-VIIIB1 (Bot) seam. Two LHD panels would also be worked in R-VIIIB1 & R-VII seam for heightening of developed galleries. After exhaustion of the said seams continuous miner would be deployed in lower seams. The entire coal produced from the mine will be evacuated through Incline No.1, proposed to be used for coal transport. It is proposed to use Incline No.2 for man and material transport from surface to u/g and vice versa. In MINE-2 targeted production has been envisaged as 0.87 Mty by deploying 2 nos. Continuous Miners. 1 no. low height Continuous Miner will be deployed

for development /depillaring panels in R-VIIIT2 seam and R-VIIIB1 & R-VIIIB1 (Bot) seams. 1 no. standard height Continuous Miner will be deployed for development/ depillaring of R-VII & R-VII (Bot) seam. After exhaustion of the said seams continuous miner will be deployed in lower seams. The entire coal produced from the mine will be evacuated through the incline No.3, proposed to be used for coal transport. It is proposed to use Incline No.4 for man and material transport from surface to u/g and vice versa.

The proposed u/g transport system for both the units i.e. MINE-1 and MINE-2 has been planned for effective handling of targeted coal production of the mine.

10.2.4 TRANSPORT IN TRUNK ROADWAYS :

10.2.4.1 MINE-1

In MINE-1, Incline No.1 has been proposed to be used for coal and Incline No. 2 for man & material transport. It has been proposed to install 2 nos. of belt conveyors i.e. MICN1 of 1200mm width, 390 m length in 1 in 4.5 gradient & MICN2 of 1200mm width, 385 m length also in 1 in 4.5 gradient for transportation of ROM coal from R-VIIIB1, R-VII & R-VIIA seam directly to the proposed coal handling plant at surface. Incline No.2 has been proposed for transportation of men and material from surface to the underground and vice versa through Free Steered Vehicles and Multi Utility Vehicles respectively. Man & light material transportation may also be carried out through the existing systems for seam R-VIII B1, R-VII and R-VIIA if required.

After crossing the touching point of the R-VIIIB1 seam Incline No.1 belt conveyor MICN1 will be extended further followed by MICN2 in tandem. A strata bunker designated as SB1 of 350 t capacity has been proposed at the floor of R-VIIIB1 seam for receiving coal from R-VIIIT2 & R-VIIIB1 seams and thereafter delivering coal onto the incline belt conveyor MICN1 with the help of a mechanical vibro-feeder MVF1 provided at the bottom opening of SB1. Incline belt conveyor MICN1 will be used for onward transportation of coal up to surface & at the same time delivering coal to the Coal Handling Plant.

R-VIIIT2, R-VIIIB1 and R-VIIIB1(Bot) SEAM

After touching R-VIIIB1 seam (which is extensively developed) in the inclines, at about 165m from incline mouth and on reaching the panel no.13 of the already developed seam, two LHD panels will be worked in R-VIIIB1 seam for heightening and widening of developed galleries. Then depillaring activity will be started by 1 no. standard height Continuous Miner at R-VIIIB1 seam. Simultaneously, development/ depillaring activity will also be started in the overlying R-VIIIT2 seam which is virgin by deploying a Low height continuous miner. Approach to R-VIIIT2 seam is proposed to be made through drifts from R-VIIIB1 seam, location of which has been shown in the transport layout drawing of R-VIIIB1 seam. The main transport arrangement has been planned at R-VIIIB1 seam, however, coal produced at R-VIIIT2 will be brought to R-VIIIB1 seam by drift belt conveyor TBC12 for onward transportation up to

main incline. After exhaustion of R-VIIIT2 seam the same Low height CM will be shifted to R-VIIIB1(Bot) seam for development/ depillaring at south-eastern side of the mine.

For development/depillaring of R-VIIIT2 & R-VIIIB1 seam of MINE-1 the different Trunk Belt Conveyors designated as TBC1, TBC2, TBC3, TBC4, TBC5, TBC6, TBC7, TBC8, TBC9, TBC10, TBC11, TBC12, TBC13, TBC14, TBC15 and TBC16 will be installed at R-VIIIT2/ R-VIIIB1 seam at different locations for effective transportation of coal in the various trunk roadways. All the trunk belt conveyors mentioned above will also be used for transportation of coal while heightening and widening of existing developed galleries.

Initially, trunk belt conveyors designated as TBC1, TBC2, TBC3, TBC4 will be installed at R-VIIIB1 seam which will receive coal from two nos. Continuous miner panel and two LHD panel (for heightening the gallery) for directly feeding coal to main incline conveyor. Once the construction of strata bunker SB1 is complete over the main incline conveyor MICN1 near panel no. 41, the trunk belt conveyors TBC1, TBC2 will be withdrawn and the entire coal of R-VIIIB1seam will be delivered to the strata bunker via TBC3 for feeding coal to the main incline conveyor. The capacity of the strata bunker has been considered as 350 t. This strata bunker will have its opening in R-VIIIB1 seam and its discharge end is on the Main Incline belt conveyor MICN1.

R-VII seam will be started from 8th year. So, a strata bunker SB2 of 1000 t capacity will be constructed in 8th year in the parting between R-VIIIB1 and R-VII seams. After construction of SB2, existing conveyors will be arranged to discharge coal produced from R-VIIIB1 seam into strata bunker SB2. This strata bunker will have its opening in R-VIIIB1 seam and its discharge end is on the Main Incline belt conveyor MICN2. MICN2 will discharge coal on the Main Incline belt conveyor MICN1 for further transportation of coal up to surface & at the same time delivering coal to the Coal Handling Plant.

The specifications of all the trunk belt conveyors stated above has been shown in table No. 10.2.

Free steered vehicles will be used for men transport whereas multi utility vehicles will be used for the transportation of the material in the seam.

R-VII SEAM

For development/depillaring of R-VII seam the different trunk Belt Conveyors designated as TBC17, TBC18, TBC19, TBC20, TBC21, TBC24, TBC25 will be installed in addition to already provided trunk belt conveyors viz. TBC1, TBC2, TBC3, TBC4, TBC5, TBC8, TBC9, TBC10, TBC11, TBC12, TBC15 in R-VIIIB1 seam. The trunk belt conveyors from R-VIIIB1 seam will be shifted phase wise in the R–VII seam at different locations as per the requirement for effective transportation of coal in the various trunk roadways. All the trunk belt conveyors mentioned above will also be used for transportation of coal while heightening and widening of existing developed galleries.

Initially, trunk belt conveyors designated as TBC4, TBC17, TBC18, TBC19, TBC20, TBC21 will be installed at R-VII seam which will receive coal from two LHD panels (for heightening of gallery) and one no. Continuous miner panel for directly feeding coal to main incline conveyor MICN2. Once the construction of strata bunker SB3 (from R-VII to R-VIIA seam) is complete near panel no. 1, the entire coal of R-VII seam will be delivered to the strata bunker SB3. Coal from SB3 will be fed to main incline conveyor MICN2 with the help of a mechanical vibro-feeder MVF3 installed at the bottom opening of SB3. The capacity of the strata bunker has been considered as 500 t. This strata bunker will have its opening in R-VII seam & its discharge end is at R-VIIA seam for delivering coal to MICN2. MICN2 will discharge coal on the Main Incline belt conveyor MICN1 for further transportation of coal up to surface & at the same time delivering coal to the Coal Handling Plant.

The specifications of all the trunk belt conveyors stated above has been shown in table No. 10.2.

Free steered vehicles will be used for men transport whereas multi utility vehicles will be used for the transportation of the material in the seam.

R-VIIA/R-VIIA & B SEAM

For development/depillaring of R-VIIA seam the different trunk Belt Conveyors designated as TBC22, TBC23, TBC26, TBC27, TBC28 will be installed in addition to already provided trunk belt conveyors viz. TBC1, TBC3, TBC7, TBC13, TBC14, TBC16, TBC21, TBC24 in other seams. The trunk belt conveyors from R-VIIIB1/ R-VII seam will be shifted phase wise in the R–VIIA seam at different locations as per the requirement for effective transportation of coal in the various trunk roadways.

Initially, trunk belt conveyors designated as TBC13 TBC16, TBC14, TBC23, TBC7, TBC22 will be installed at R-VIIA seam which will receive coal from one no. Continuous miner panel for directly feeding coal to main incline conveyor MICN2. MICN2 will discharge coal on the Main Incline belt conveyor MICN1 for further transportation of coal up to surface & at the same time delivering coal to the Coal Handling Plant.

The specifications of all the trunk belt conveyors stated above has been shown in table No. 10.2.

Free steered vehicles will be used for men transport whereas multi utility vehicles will be used for the transportation of the material in the seam.

10.2.4.2 MINE 2

For Mine-2, Incline no.3 has been proposed to be used for coal transport and Incline no. 4 for man & material transport. Proposal has been made to install 2 nos. belt conveyors in Incline no. 3 i.e. MIC1 of 1200mm width, 550 m length in 1 in 4.5 gradient, MIC2 of 1200mm width & 550 m length also in 1 in 4.5 gradient for evacuation of ROM coal from R-VIIIB1, R-VII & R-VIIA&B

seam up to the surface for delivering coal onto the belt conveyor C2 of the proposed coal handling plant at surface. Incline No.4 has been proposed for transportation of men and material from surface to the underground and vice versa through Free Steered Vehicles and Multi Utility Vehicles respectively.

In Incline no. 3, conveyor MIC2 will receive coal from trunk conveyors of R-VIII B1 (Bottom) in the initial period of mining operation and discharge on MIC1. MIC1 will carry coal up to the surface. After completion of strata bunker designed as SB1, the ROM coal of R-VIIIB1 (Bottom) seam will be routed through strata bunker SB1 and coal will be fed to Main incline belt conveyor MIC2. SB1 will discharge coal on MIC2 with the help of a mechanical vibro feeder MVF1 provided at the bottom of the strata bunker. MIC2 will discharge coal on MIC1 for onward transportation of coal to surface.

R-VIII T2 & R-VIIIB1(Bot) SEAM

For development/depillaring of R-VIII T2, R-VIIIB1 & R-VIIIB1 (Bot) seams of MINE 2 the different Trunk Belt Conveyors designated as TB1, TB2, TB3, TB4, TB5 TB6, TB7, TB8, TB15, TB16 will be installed at different locations of the trunk roadways for effective transportation of coal from gate roadways up to the Main incline belt conveyor MIC2. However, coal produced in R-VIIIT2 will be brought to R-VIIIB1 & R-VIIIB1 (Bot) seam by drift belt conveyor TB5 for onward transportation up to main incline through successive gate and trunk belt conveyors. A strata bunker designated as SB1 has been proposed along the main incline in R-VIII B1 seam. Till the construction of strata bunker is not complete, entire production of R-VIII B1 seam will be conveyed to main incline conveyor through preceding trunk conveyors. Once the construction of strata bunker SB1 is complete over the main incline conveyor, Trunk Conveyor TB2 / TB6 will deliver coal onto SB1 for feeding coal to the main incline conveyor. The capacity of the strata bunker is around 1100 t. This strata bunker will have its opening in R-VIII B1 (Bottom) seam and its discharge end is on the Main Incline belt conveyor MIC2 in R-VII seam.

For coal from R-VIII T2 seam, transportation will be by a set of conveyors GB1 (gate belt), TB6 (Trunk belt, R-VIII T2 seam), TB5 (Trunk belt from R-VIII T2 seam to R-VIII B1 seam), TB4, TB3, TB2, TB1, MIC2, MIC1. For coal from panels P9 to P14 in R-VIII B1 seam, transportation will be by a set of conveyors GB1 (gate belt), TB6 (shifted from R-VIII T2 seam), TB2, SB1, MVF1, TB7 (R-VII seam), MIC2, MIC1. For panel P1, P2, transportation will be by GB1, TB5, TB2, TB1, TB6, SB1, MVF1, TB7, MIC2, MIC1. For panel P3, transportation will be by GB1, TB3, TB2, TB1, TB6, SB1, MVF1, TB7, MIC2, MIC1. For panels P4 to P8, transportation will be by GB1, TB4, TB3, TB2, TB1, TB6, SB1, MVF1, TB7, MIC2, MIC1. For panels P15, P16, transportation will be by GB1, TB5, TB4, TB3, TB2, TB1, TB6, SB1, MVF1, TB7, MIC2, MIC1. For panels P17, P18, transportation will be by GB1, TB8, TB5, TB4, TB3, TB2, TB1, TB6, SB1, MVF1, TB7, MIC2, MIC1.

The specifications of all the trunk belt conveyors stated above has been shown in table No. 10.2.

Free steered vehicles will be used for men transport whereas multi utility vehicles will be used for the transportation of the material in the seam.

R-VII & R-VII (Bot) SEAM

For development/depillaring of R-VII seam the different trunk Belt Conveyors designated as TB9, TB10, TB11, TB12, TB13, TB14 will be installed.

A strata bunker SB2 of about 450t capacity will be provided. Opening of SB2 will be in R-VII seam to receive production from R-VII seam which will discharge coal onto main incline conveyor MIC2. For panels P2 to P5, production from standard height CM will be discharged on gate belt conveyor GB2. GB2 will discharge coal on trunk belt conveyor TB11. TB11 will discharge coal on another trunk belt conveyor TB109 which will discharge coal into strata bunker SB2. SB2 will discharge coal on MIC2 with the help of a mechanical vibro feeder MVF2 provided at the bottom of the strata bunker. MIC2 will discharge on MIC1 for further transportation of coal to surface. For panels P6, P7, transportation will be by GB2, TB10, TB11, TB9, SB2, MVF2, MIC2, MIC1. For panels P8, P9, P10, P11, P12, P13, transportation will be by GB2, TB12, TB10, TB11, TB9, SB2, MVF2, MIC2, MIC1. For panels P14, P15, P16, transportation will be by GB2, TB13, TB12, TB10, TB11, TB9, SB2, MVF2, MIC2, MIC1.

In 17th year, CM will shift to R-VII A & R-VIIA&B seam for development and depillaring. Low height CM from R-VIII B1 will shift in R-VII seam. During development and depillaring of panels by low height CM, transportation will be by GB2, TB14, TB13, TB12, TB10, TB11, TB9, SB2, MVF2, MIC2, MIC1.

For panel 19 (R-VIIIB1 seam), transportation will be by GB1, TB2 (R-VIIIB1), TB3 (across fault in a drift from R-VIIIB1 to R-VII seam), TB14 (R-VII), TB13, TB12, TB10, TB11, TB9, SB2, MVF2, MIC2, MIC1.

The specifications of all the trunk belt conveyors stated above has been shown in table No. 10.2.

Free steered vehicles will be used for men transport whereas multi utility vehicles will be used for the transportation of the material in the seam.

R-VIIA&B & R-VIIA SEAM

Existing trunk belt conveyors of R-VIIIB1, R-VII seam will be installed at trunk roadways phase wise at different locations for conveying coal from R-VIIA&B & R-VIIA seam to the surface.

10.2.5 TRANSPORT IN GATE ROADWAYS:

10.2.5.1 MINE-1

In the gate roadways of two Continuous Miner panel viz. with standard height/ low height CM deployed in R-VIIIT2, R-VIIIB1/R-VIIIB1 (Bottom), R-VII & R-

VIIA seams of MINE1, 1000 mm wide gate belt conveyors GBC7, GBC8, GBC9, GBC10 & GBC11 will be used for the transportation of coal from faces up to trunk roadways. The length of gate belt conveyor has been considered based on the longest panel length. After exhaustion of coal from said seams gate belt conveyors will be used in the lower seams. Detailed specifications of the proposed Gate Belt Conveyors have been furnished in Table 10.2.

6 nos. 800mm wide gate belt conveyors i.e. GBC1 to GBC6 have been envisaged in the gate roadway of RI-VIIIB1, R-VII & R-VIIA seams for the transportation of coal from two LHD panels, where heightening of gallery will be done with the help of LHDs.

Free steered vehicles will be used for men transport whereas multi utility vehicles will be used for the transportation of the material in the seam.

10.2.5.2 MINE-2

In the gate roadways of each Continuous Miner Panel viz. with standard height / low height CM deployed in R-VIIIT2, R-VIIIB1 & R-VIIIB1 (Bottom), R-VII & R-VII (Bottom), R-VIIA & R-VIIA&B (Com) seams of MINE-2, 1000 mm wide gate belt conveyors GB1 & GB2 will be used for the transportation of coal from faces up to trunk roadways. The length of gate belt conveyor has been considered based on the longest panel length. After exhaustion of coal from said seams gate belt conveyors will be used in the lower seams. Detailed specifications of the proposed Gate Belt Conveyors have been furnished in Table 10.2.

Free steered vehicles will be used for men transport whereas multi utility vehicles will be used for the transportation of the material in the seam.

10.2.6 TRANSPORT ARRANGEMENT AT FACE:

At the coal face of depillaring/development panels of R-VIIIT2, R-VIIIB1/R-VIIIB1(Bottom), R-VII, R-VIIA etc. seams of MINE-1 and R-VIIIT2, R-VIIIB1 & R-VIIIB1 (Bottom), R-VII & R-VII(Bottom), R-VIIA & R-VIIA&B (Com) etc. seams of MINE-2 , coal mined by continuous miners will be loaded onto shuttle cars. Shuttle car will ply at the faces for delivering coal on to feeder breaker. Feeder breaker will uniformly crush the coal to (-)100 mm size for feeding the same to gate belt conveyor. The scopes of supply of shuttle cars are in the package of continuous miner supplier.

At the coal face of LHD panel for heightening of existing developed galleries in MINE-1, coal mined by LHDs will be loaded to gate belt conveyors.

10.2.7 DETAILS OF UNDERGROUND BELT CONVEYORS:

The particulars of belt conveyors proposed to be used in underground are as given below in table 10.2:-

Table 10.2

Detail of Belt conveyors

S. N.	Particulars	Seam	Location	Belt width (mm)	Length (m)	Av. Capacity tph	App. Speed m/s	Motor Power kW
A.	**MINE - 1**							
1	Incline No.1 Conveyor, MICN1	Surface & Incline	Main Incline	1,200	410	400	2.5	2x110 [NFLP]
2	Incline No.1 Conveyor, MICN2	Incline	Main Incline	1,200	385	400	2.5	2x110 [FLP]
3	Trunk belt conveyor TBC1	R – VIIIB1	Trunk roadway	1,000	430	250	2	90 [FLP]
4	Trunk belt conveyor TBC2	R – VIIIB1	Trunk roadway	1,000	190	250	2	55 [FLP]
5	Trunk belt conveyor TBC3	R – VIIIB1	Trunk roadway	1,000	375	400	2	90 [FLP]
6	Trunk belt conveyor TBC4	R – VIIIB1	Trunk roadway	1,000	380	400	2	90 [FLP]
7	Trunk belt conveyor TBC5	R – VIIIB1	Trunk roadway	1,000	160	250	2	55 [FLP]
8	Trunk belt conveyor TBC6	R – VIIIB1	Trunk roadway	1,000	450	250	2	90 [FLP]
9	Trunk belt conveyor TBC7	R – VIIIB1	Trunk roadway	1,000	460	250	2	90 [FLP]
10	Trunk belt conveyor TBC8	R – VIIIB1	Trunk roadway	1,000	340	250	2	90 [FLP]
11	Trunk belt conveyor TBC9	R – VIIIB1	Trunk roadway	1,000	620	250	2	90 [FLP]
12	Trunk belt conveyor TBC10	R – VIIIB1	Trunk roadway	1,000	140	250	2	55 [FLP]
13	Trunk belt conveyor TBC11	R – VIIIB1	Trunk roadway	1,000	120	250	2	55 [FLP]
14	Trunk belt conveyor TBC12	R – VIIIB1	Trunk roadway	1,000	220	250	2	55 [FLP]
15	Trunk belt conveyor TBC13	R – VIIIB1	Trunk roadway	1,000	560	250	2	90 [FLP]
16	Trunk belt conveyor TBC14	R – VIIIB1	Trunk roadway	1,000	450	250	2	90 [FLP]
17	Trunk belt conveyor TBC15	R – VIIIB1	Trunk roadway	1,000	350	250	2	90 [FLP]
18	Trunk belt conveyor TBC16	R – VIIIB1	Trunk roadway	1,000	365	250	2	90 [FLP]
19	Trunk belt conveyor TBC17	R – VII	Trunk roadway	1,000	530	250	2	90 [FLP]
20	Trunk belt conveyor TBC18	R – VII	Trunk roadway	1,000	280	250	2	55 [FLP]
21	Trunk belt conveyor TBC19	R – VII	Trunk roadway	1,000	550	250	2	2x90 [FLP]
22	Trunk belt conveyor TBC20	R – VII	Trunk roadway	1,000	575	250	2	90 [FLP]
23	Trunk belt conveyor TBC21	R – VII	Trunk roadway	1,000	270	250	2	55 [FLP]
24	Trunk belt conveyor TBC22	R – VIIA	Trunk roadway	1,000	40	250	2	37 [FLP]
25	Trunk belt conveyor TBC23	R – VIIA	Trunk roadway	1,000	380	250	2	90 [FLP]

S. N.	Particulars	Seam	Location	Belt width (mm)	Length (m)	Av. Capacity tph	App. Speed m/s	Motor Power kW
26	Trunk belt conveyor TBC24	R – VII	Trunk roadway	1,000	340	250	2	55 [FLP]
27	Trunk belt conveyor TBC25	R – VII	Trunk roadway	1,000	530	250	2	90 [FLP]
28	Trunk belt conveyor TBC26	R – VIIA	Trunk roadway	1,000	540	250	2	90 [FLP]
29	Trunk belt conveyor TBC27	R – VIIA	Trunk roadway	1,000	600	250	2	90 [FLP]
30	Trunk belt conveyor TBC28	R – VIIA	Trunk roadway	1,000	540	250	2	90 [FLP]
31	Gate belt conveyor GBC1	R-VIIIB1/ R-VII	Gate roadway	800	750	20	2	55 [FLP]
32	Gate belt conveyor GBC2	R-VIIIB1/ R-VII	Gate roadway	800	90	20	2	37 [FLP]
33	Gate belt conveyor GBC3	R-VIIIB1/ R-VII	Gate roadway	800	230	20	2	37 [FLP]
34	Gate belt conveyor GBC4	R-VIIIB1/ R-VII	Gate roadway	800	350	20	2	37 [FLP]
35	Gate belt conveyor GBC5	R-VIIIB1/ R-VII	Gate roadway	800	400	20	2	37 [FLP]
36	Gate belt conveyor GBC6	R-VIIIB1/ R-VII	Gate roadway	800	80	20	2	37 [FLP]
37	Gate belt conveyor GBC7	R-VIIIT2 /R-VIIIB1/ R-VIIA	Gate roadway	1000	800	200	2	90 [FLP]
38	Gate belt conveyor GBC8	R-VIIIB1/ R-VII	Gate roadway	1000	750	200	2	90 [FLP]
39	Gate belt conveyor GBC9	R-VIIIB1/ R-VII	Gate roadway	1000	270	200	2	55 [FLP]
40	Gate belt conveyor GBC10	R-VIIIB1/ R-VII	Gate roadway	1000	80	200	2	37 [FLP]
41	Gate belt conveyor GBC11	R-VIIIB1/ R-VIIA	Gate roadway	1000	200	200	2	37 [FLP]
B.	**MINE - 2**							
1	Incline No. 3 Conveyor, MIC1	Surface & Incline	Main Incline	1,200	550	400	2.5	2x150 [NFLP]
2	Incline No. 3 Conveyor, MIC2	Incline	Main Incline	1,200	550	400	2.5	2x150 [FLP]
3	Trunk belt conveyor TB1	R-VIIIB1	Trunk roadway	1,000	70	200	2	37 [FLP]
4	Trunk belt conveyor TB2	R-VIIIB1	Trunk roadway	1,000	540	200	2	90 [FLP]
5	Trunk belt conveyor TB3	R-VIIIB1	Trunk roadway	1,000	430	200	2	90 [FLP]
6	Trunk belt conveyor TB4	R-VIIIB1	Trunk roadway	1,000	910	200	2	2x90 [FLP]
7	Trunk belt conveyor TB5	R-VIIIT2, R-VIIIB1	Trunk roadway	1,000	860	200	2	2X90 [FLP]
8	Trunk belt conveyor TB6	R-VIIIT2, R-VIIIB1	Trunk roadway	1,000	690	200	2	2x90 [FLP]
9	Trunk belt conveyor TB7	R-VIIIB1	Trunk roadway	1,000	80	200	2	37 [FLP]
10	Trunk belt conveyor TB8	R-VIIIB1	Trunk roadway	1,000	1320	200	2	2x90 [FLP]

S. N.	Particulars	Seam	Location	Belt width (mm)	Length (m)	Av. Capacity tph	App. Speed m/s	Motor Power kW
11	Trunk belt conveyor TB9	R-VII	Trunk roadway	1,000	60	200	2	37 [FLP]
12	Trunk belt conveyor TB10	R-VII	Trunk roadway	1,000	320	200	2	90 [FLP]
13	Trunk belt conveyor TB11	R-VII	Trunk roadway	1,000	750	200	2	2x90 [FLP]
14	Trunk belt conveyor TB12	R-VII	Trunk roadway	1,000	1020	200	2	2x90 [FLP]
15	Trunk belt conveyor TB13	R-VII	Trunk roadway	1,000	800	200	2	2x90 [FLP]
16	Trunk belt conveyor TB14	R-VII	Trunk roadway	1,000	1320	200	2	2x90 [FLP]
17	Trunk belt conveyor TB15	R-VIIIB1	Trunk roadway	1,000	180	200	2	90 [FLP]
18	Trunk belt conveyor TB16	R-VIIIB1	Trunk roadway	1,000	250	200	2	90 [FLP]
19	Gate belt conveyor GB1	R-VIIIB1	Gate roadway	1,000	1060	200	2	2x90 [FLP]
20	Gate belt conveyor GB2	R-VII	Gate roadway	1,000	1040	200	2	2x90 [FLP]

10.2.8 UNDERGROUND STRATA BUNKER:

10.2.8.1 A strata bunker (SB1) of 350 t capacity (appx.) will be constructed over the Main Incline Conveyor, MICN1 from R-VIIIB1 in MINE-1. Two more Strata Bunkers, SB2 of 1000 t capacity (in the parting between R-VIIIB1 & R-VII seams) and SB3 of 500 t capacity (in the parting between R-VII & R-VIIA seams) will be constructed in MINE-1. 2nos. Strata Bunker SB1 (1100t cap-in the parting between R-VIIIB1, R-VII seam) and SB2 (450 t cap-in the parting between R-VII seam and MIC2) have been considered for MINE-2.

10.2.8.2 Proper communication will be provided with strata bunker operation point and various other operating points of trunk belt conveyors for better operation of the system.

10.2.9 MAN & MATERIAL TRANSPORT

RCC Flooring (M-40 grade) will be provided in Incline No.2 of MINE-1 and Incline No.4 of MINE-2 for the movement of Free Steered Vehicles/ Multi Utility Vehicles. For the purpose of men transport, one Diesel/Battery operated Free steered vehicle has been proposed for each Continuous Miner district.

Additionally existing Pit No. 3 & Pit No.2 of Old SSP unit and Pit No. 1 of Tilaboni unit may also be utilized for man and material transport in MINE-1 for seam R-VIII B1, R-VII and R-VIIA if required.

Diesel/Battery operated Multi Utility Vehicle has been proposed for each Continuous Miner districts for material transport from surface to the working place and vice-versa.

10.2.10 CAPITAL REQUIREMENT :-

The list of equipment along with brief specifications and capital requirement are shown at Appendix A.3.1.1 & A.3.1.2 for MINE-1 and MINE-2.

10.2.11 Tentative layout of seamwise underground transport system of have been shown in Transport Layout drawing (Plate No. VIIA, VIIB and VIIC).

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Chapter-11

VENTILATION

11.1 Degree of Gassiness

Tilaboni UG mine (Mine-1) is a working mine and is degree-II in gassiness. The proposed Mine-2 is virgin and it is assumed to be degree-II in gassiness as it is an extension block of existing Tilaboni UG mine. For the calculation of total air quantity for both the mines, gas emission rate has been assumed as 10.0 m^3/t of coal produced.

11.2 Air Quantity Requirement in LVC of Panel

As per Coal Mines Regulation 2017, the following air quantities are required at the LVC of each panel/district, on the basis of the different criteria as given below:

11.2.1 Production:

CM Panel

Air quantity of 2.5m^3/min per tonne of daily coal output is required to reach the last ventilation connection (LVC) of the district. According to this norm, air quantity required in the LVC's of each low Continuous Miner district is 50m^3/sec (1200 x 2.5m^3/min/60) and standard Continuous Miner 70.83m^3/sec (1700 x 2.5m^3/min/60)

LHD Panel

For LHD district (for heightening), production from which each district has been assumed to be 200tpd, the requirement of air would be 8.35m^3/sec. (200tpd x2.5m^3/min /60)

11.2.2 Gas Emission:

Coal Mines Regulation 2017 stipulates the requirement of minimum air velocity at different locations, which are as follows:

- Immediate outbye ventilation connection: Coal Mines Regulation 2017 stipulates that the minimum air velocity at the immediate outbye ventilation connection from the face i.e. LVC of the district should be 30 m/min i.e. 0.5m/sec. The cross sectional area of the roadways in the districts has been considered as 18m^2 (6.0mx3.0m). Hence the air quantity required at the immediate outbye ventilation connection i.e. LVC of the districts is 9.0m^3/sec. (18m^2 x 0.50m/sec.)

- From the LVC of the districts, air is to be coursed upto the faces by using auxiliary ventilators. Minimum velocity of air required at 7.5m outbye of the discharge end of air pipe is 15m/min. i.e. 0.25 m/sec. Considering 18.0m^2 area of roadways, the air quantity required at 7.5m outbye of the discharge end of the air pipe is about 4.5m^3/sec (18m^2 x 0.25m/sec).

Assuming 10% leakages in coursing of air through duct, air to be handled by the auxiliary fan for district is 4.95m^3/sec. (4.5m^3/sec x 1.1). Hence, air requirement at LVC (where auxiliary fan is to be installed) of each district is 9.90m^3/sec, as the auxiliary fan should not suck more than 50% of the air quantity available near the fan.

11.2.3 Temperature:

As per CMR 2017, the wet bulb temperature at any working place should not exceed 30.5^{0}C, and where the wet bulb temperature exceeds this value, arrangement should be made to ventilate the same with a current of air moving at a speed of not less than 1 m/sec.

As a new mine is being planned and it is envisaged that the wet bulb temperature will be below 30.5^{o}C in most of the project area. Hence no provision need be made for above regulation.

11.2.4 Manpower:

Total underground manpower requirement per day for Mine-1 and Mine-2 would be about 407 and 329 respectively. Hence, in each production shift maximum manpower of about 136 and 110 will be deployed. During general shift, (i.e. the largest shift) additional 20% manpower has been considered and so, the total manpower in the largest shift is estimated to be about 163 and 132 respectively.

As per statute a minimum air quantity @ 6m^3/min per person in largest shift should reach the last ventilation connection of the panel. On this basis, the quantity of air to be circulated is estimated as 978m^3 /min (163x6 m^3/min/60) i.e. 16.3 m^3 /sec and 792m^3 /min (132x6 m^3/min/60) i.e. 13.2 m^3/sec for Mine-1 and Mine-2 respectively.

On the basis of above estimation the required statutory total air quantity in districts is summarized below:-

Table No. 11.1

Parameter	Unit	MINE-1	MINE-2
Production	TPD	(1700+1200+200x2) =3300	(1700+1200) =2900
UG Manpower/shift (largest)	Nos.	163	132
X-section	m x m	6.0 x 3m (avg.)	
Gas emission	m^3 /t	10.0	
Air quantity requirement			
Production	m^3/sec	137.53	120.83
Gassiness	m^3/sec	19.80	19.80
Temperature	m^3/sec	Not considered	
Manpower	m^3/sec	16.3	13.2

Thus, it emerges from the above considerations that the air quantity requirement is maximum from the Production point of view in all the panels. The total maximum air requirement is 137.53 m^3/sec for one low height Continuous Districts, one standard height Continuous Miner district and two LHD panel.

As air quantity requirement from production point of view is not feasible as it will require an enormously large sized fan and air from such a fan will raise excessive dust during its movement. For a mass production technology producing more than 600 tpd, air quantity based on production cannot be supplied and relaxation in air quantity has to be obtained from DGMS. DGMS gives relaxation on case to case basis. However, an air quantity of 25m^3/sec at LVC of the district seems to be feasible and is expected to be accepted by DGMS. Hence, an air quantity of 25m^3/sec has been considered for all the districts. In case of LHD district an air quantity of 15m^3/sec at LVC has been considered in this report for the planning purpose.

Total quantity requirement :

As it is proposed to work two CM and two LHD district at a time in Mine-1 and two CM districts in Mine-2, the total quantity requirement would be about (25x2 + 15x2) = 80 m^3/sec (4800 m^3/min) at the LVC in Mine-1and that for Mine-2 would be about (25x2) = 50 m^3/sec (3000 m^3/min) at the LVC. The total quantity of air necessary for ventilating the mine will be 1.3 x K x Q m^3/min.

Where,

1.3 = Reserve factor

K = Total safety factor, which is necessary to take into account the underground leakage, the ventilation of reserve faces, various rooms, old workings, inequality of rate of emission & output, number of panels etc. In this case it is taken as 1.5.

Q = Maximum air quantity required as per various norms and stipulations, which comes to 4020 m^3/min for Mine-1 and 3000 m^3/min for Mine-2 .

Therefore,

The total quantity of air required for two CM districts and one LHD district in Mine-1

= 1.3 x 1.5 x 4800 m^3/min
= 9360 m^3/min
= 156 m^3/sec (say), and

The total quantity of air required for two CM districts district in Mine-2

= 1.3 x 1.5 x 3000 m^3/min
= 5850 m^3/min
= 100 m^3/sec (say)

11.3 Ventilation System Design

At least, three drifts should be driven across every fault to minimize the pressure losses. Those panels providing access to the other panels shall be sectionalized leaving only 3-4 connections for air-flow in order to gainfully utilize the intake air at the working faces and also maintain higher VEQ.

To ensure a good and comfortable environment below ground, the ventilation stoppings in the continuous miner district will have to be made leak proof. The rate of advance in the continuous miner district will require the construction of atleast two ventilation stoppings in every week of development in each panel. This is the requirement when the ventilation layout is such that both the return galleries of a 7/5 heading panels are on one side only.

Ventilation system has been designed to assess the ventilation requirement of the project for the Mine-1 and Mine-2.

(A) Mine-1: Following stages of ventilation have been analysed for designing ventilation system in the project for Mine-1:

Stage – I (For R-VIIIB1/ R-VIIIB1(Bot) seam,R-VIII (T2) seam)

This pertains to the ventilation of one CM districts and two LHD districts in the R-VIIIB1/ R-VIIIB1(Bot) seam and other CM districts in the R-VIII(T2) seam(Refer Figure-11.1). Pit No.1, Pit No.3 and proposed Incline No. 1 & 2 of SSP(Old) Unit being the intake airways and Pit No.2 of SSP(Old) Unit and Pit No.2 of Tilaboni Unit being the return airways.

Input:

(i) Pit No. 1, Pit no.3 and proposed Incline No. 1 & 2 of SSP(Old) Unit being the intake airways and Pit No.2 of SSP(Old) Unit and Pit No.2 of Tilaboni Unit being the return airways.

(ii) Underground workings being ventilated by PV-200 fan at fan blade angle set at 22.5^0 in the fan drift connected to Pit No.2 of SSP(Old) Unit and by VF-2500 fan at fan blade angle set at 17.5^0 in the fan drift connected to Pit No.1 of Tilaboni Unit

(iii) Resistance of air route considered for the operation of CMs & LHD districts operating in the farthest panel.

(iv) Three/two intake and two return airways assumed in the trunk roadways.

(v) In LHD districts, regulators in the return airway considered for having desired airflow in districts.

Proposed ventilation network has been analysed on with the help of "VNETWORK" software and the results obtained are provided in D:TLB7RE.DAT (shown in Annexure-VI).

Name of District	Tech. / Method of Mining	Desired airflow in LVC (m^3/s)	Expected airflow in LVC (m^3/s)
CM Panel 1	B&P by CM	25.0	26.36
CM Panel 2	B&P by CM	25.0	36.82
LHD-1	Heightening by LHD	15.0	24.54
LHD-2	Heightening by LHD	15.0	16.68

The operating point of the fan as per the analysis is as follows:

Particulars	Fan-1	Fan-2
Quantity	99.57	82.15
Pressure	683.7	118.5
Mine resistance	0.068962	0.017559

Comments: The air quantity in all the districts is as per the requirement.

Stage – II (For R-VII/R-VIIASeam at the end of 20th year)

This pertains to the ventilation of the lower seams viz. R-VII and below (Refer Figure-11.2). The proposed Incline No. 1 & 2 and Pit No.3 of SSP(Old) Unit being the intake airways and Pit No.2 of Tilaboni Unit being the return roadway.

Input:

(i) The proposed Incline No. 1 & 2 and Pit No.3 of SSP(Old) Unit being the intake airways and Pit No.2 of Tilaboni Unit being the return roadway.

(ii) Underground workings being ventilated by VF-2500 fan and fan blade angle set at 17.5^0.

(iii) Resistance of air route considered for the operation of CMs districts operating in the farthest panel.

(iv) In CM-2 district, regulator in the return airway considered for having desired airflow in LVC of panels.

(v) Three intake and two/three return airways assumed in the trunk roadways.

Ventilation Network has been analysed and the results obtained are provided in D:TLB21RE.DAT (shown in Annexure-VI).

Name of District	Tech. / Method of Mining	Desired airflow in LVC (m^3/s)	Expected airflow in LVC (m^3/s)
CM Panel 1	B&P by CM	25.0	28.46
CM Panel 2	B&P by CM	25.0	34.34

The operating point of the fan as per the analysis is as follows:

Quantity = 101.06 m^3/sec
Pressure = 567.2 Pascal
Mine resistance = 0.055536 Gaul.

Comments: The air quantity in the districts is as per the requirement.

(B) Mine-2:

Stage – I (For R-VIII B1seam,R-VII seam at the end of 7th year)

This pertains to the ventilation of one CM district in R-VII B1(Bottom) and other CM districts in the R-VII seam (Refer Figure-11.3). Proposed Incline No. 3 & 4 being the intake airways and proposed air shaft being the return airways.

Input:

(i) Incline No.3 & 4 being the intake airways and an Air Shaft being the return airways.

(ii) Underground workings being ventilated by VF-2500 fan at fan blade angle set at 17.5^0 in the fan drift connected to the Air Shaft.

(iii) Resistance of air route considered for the operation of CM districts operating in the farthest panel.

(iv) Three intake and two/three return airways assumed in the trunk roadways.

(v) In CM Panel districts, regulators in the return airway considered for having desired airflow in CM districts.

Proposed ventilation network has been analysed on with the help of "VNETWORK" software and the results obtained are provided in D:TLB28RE.DAT (shown in Annexure-VI).

Name of District	Tech. / Method of Mining	Desired airflow in LVC (m^3/s)	Expected airflow in LVC (m^3/s)
CM Panel 1	B&P by CM	25.0	34.18
CM Panel 2	B&P by CM	25.0	34.88

The operating point of the fan as per the analysis is as follows:

Quantity = 109.81 m^3/sec
Pressure = 395.9 Pascal
Mine resistance = 0.032832 Gaul.

Comments: The air quantity in the districts is as per the requirement.

Stage – II (For R-VII seam, R-VIIAB seam at the end of 22th year)

This pertains to the ventilation of one CM district in R-VII seam and other CM districts in the R-VIIAB seam (Refer Figure-11.4). Proposed Incline No. 3 & 4 being the intake airways and proposed air shaft being the return airways.

Input:

(i) Incline No.3 & 4 being the intake airways and an Air Shaft being the return airways.

(ii) Underground workings being ventilated by VF-2500 fan at fan blade angle set at 17.5^0 in the fan drift connected to the Air Shaft.

(iii) Resistance of air route considered for the operation of CM districts operating in the farthest panel.

(iv) Three intake and two/three return airways assumed in the trunk roadways.

Proposed ventilation network has been analysed on with the help of "VNETWORK" software and the results obtained are provided in D:TLB28RE.DAT (shown in Annexure-VI).

Name of District	Tech. / Method of Mining	Desired airflow in LVC (m^3/s)	Expected airflow in LVC (m^3/s)
CM Panel 1	B&P by CM	25.0	28.80
CM Panel 2	B&P by CM	25.0	31.99

The operating point of the fan as per the analysis is as follows:

Quantity = 115.91 m^3/sec
Pressure = 276.1 Pascal
Mine resistance = 0.020551 Gaul.

Comments: The air quantity in the districts is as per the requirement

The ventilation requirement of the lower seams would be assessed after the exhaustion of reserves of the upper seams.

11.4 Air Velocity In Mine Entries

As per statute the maximum permissible air velocity in the belt conveyor roadway is 4.0 m/sec and that in winding shaft is 12m/sec. The cross-section of the proposed incline fitted with belt conveyor will be 5.5 m x 3.5 m and diameter of the winding shaft i.e. Pit No.2 of Tilaboni Unit and air shaft of Mine-2 is 6m. Air velocity in the inclines and shafts at these cross-sections, should be less than the maximum permissible air velocity limit as per statute.

11.5 Auxiliary Ventilation

To ensure comfortable working environment at the faces, auxiliary ventilation using forcing fans is proposed. Auxiliary fans of duty 12 m^3/sec at 100 mm water gauge operated with a 22 kW motor are proposed for the Continuous Miner district. Heavy duty semi-rigid ducting for these fans will be of 700 mm diameter.

Provisions of 3 nos. auxiliary fan (two in operation and one stand bye) and ventilation ducting have been made in this report for proper ventilation of each CM districts.

11.6 Recommendations

For proper ventilation of the mine the following recommendations have been made.

- Fan drift cross-section should be properly designed, so that, it does not pose any ventilation problem.
- Further, for better ventilation of the mine, choking of return, leakage through fan drift air lock, proper setting of fan blades and maintenance of stopping will be examined carefully and adequate steps have to be taken against high temperature and humidity.
- At least, five drifts (three for intake airway and two for return airway) should be driven across every fault.
- Arrangements should be made for constructing good quality ventilation stoppings at a faster rate as per the advance of CM panel.
- Adequate numbers of auxiliary ventilators with ducting should be provided to maintain the air velocity at the working places as per statute.

11.7 Conclusion

Two Main Mechanical Ventilators delivering 80-120 m^3/sec at 100-67 mm water gauge have been proposed in this report for Mine-1 (Pit No.2 of Tilaboni Unit) and Mine-2 (Proposed Air Shaft). Fan should be installed in the properly designed fan drift attached to the airshaft. The each fan will be operated by a 250 kW motor, which in turn will operate at 6.6 kV. The fan to be procured for this project should be of variable rpm type and have adjustable blades so that the blade angle and/or rpm can be changed at different stages to ensure that the fan works at a reasonably high efficiency throughout the life of the mine. The existing two PV-200 fans will be continued to operate for ventilation of R-VIIIB1/R-VIIIB1(Bot) seam after that these fans will be shifted to other mine of ECL.

For better ventilation of the mine, inspection of return airways, leakage through fan drift, air lock, proper setting of fan blades, ventilation stoppings will be examined carefully and adequate steps would be taken accordingly during actual mining operation. Adequate steps would also be taken against high temperature and humidity.

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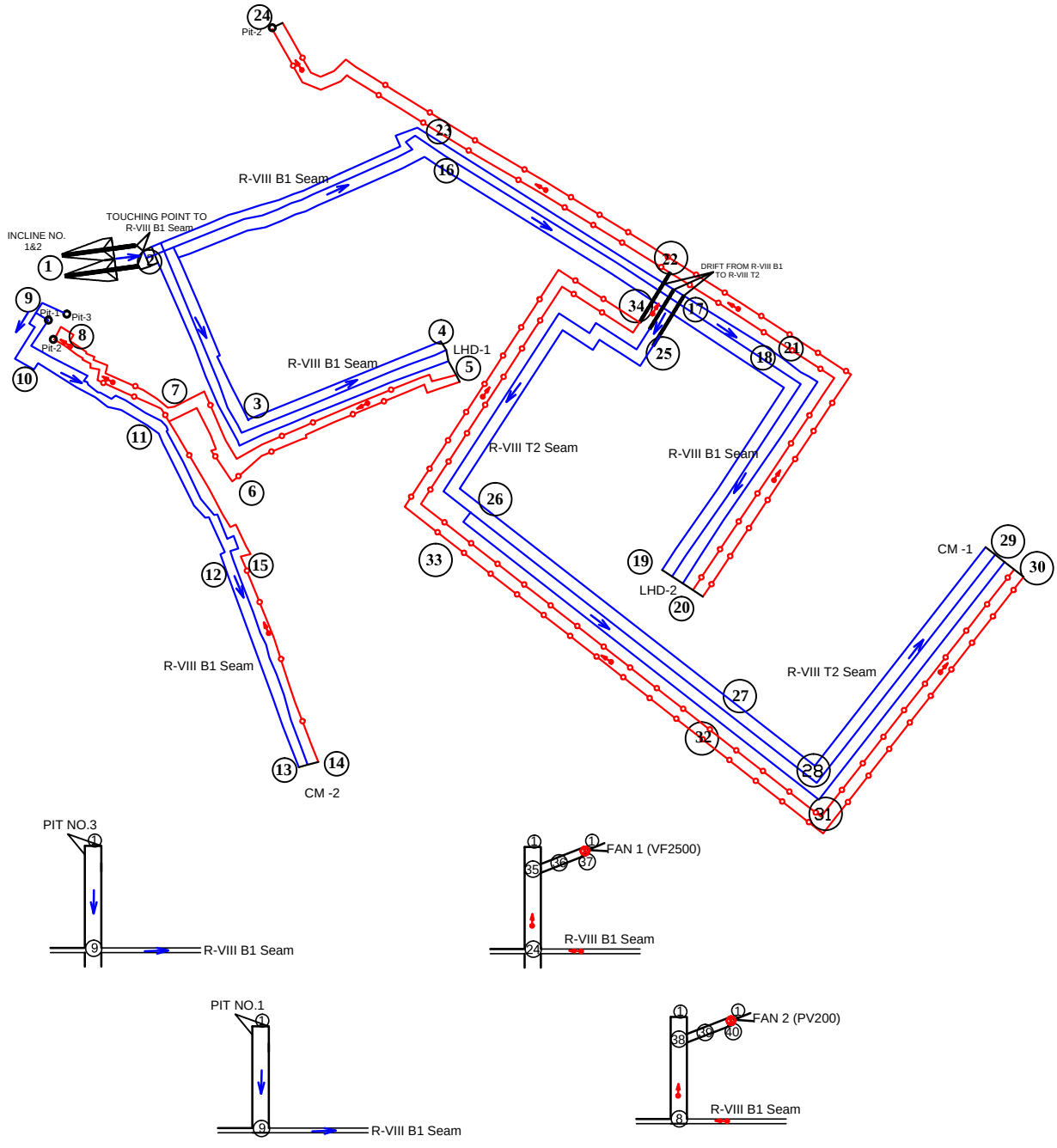

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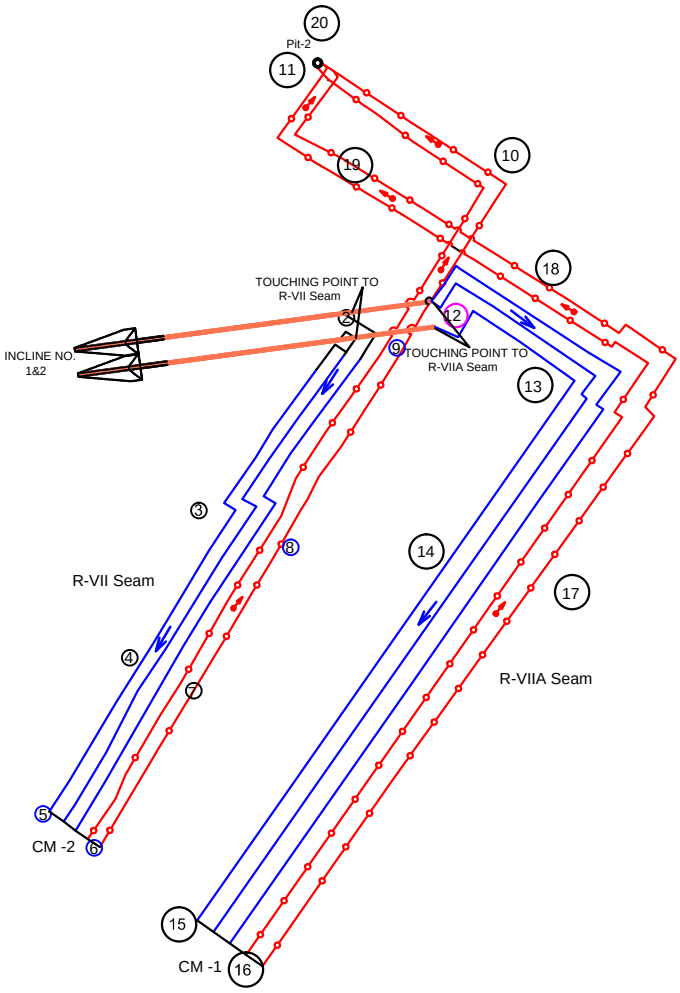
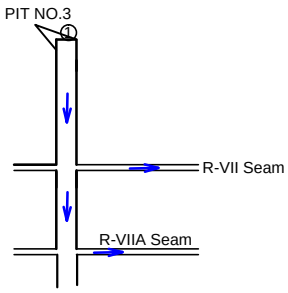
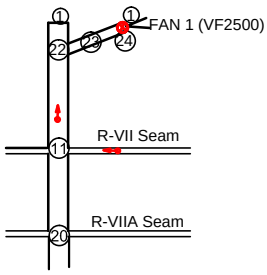
NODES	(15)
INCLINE	
INTAKE AIRWAY	
RETURN AIRWAY	

STAGE–1(MINE–1)

SCHEMATIC LINE DIAGRAM OF VENTILATION NETWORK(MINE–1) FOR SEAM R–VIII B1,R–VIII T2.







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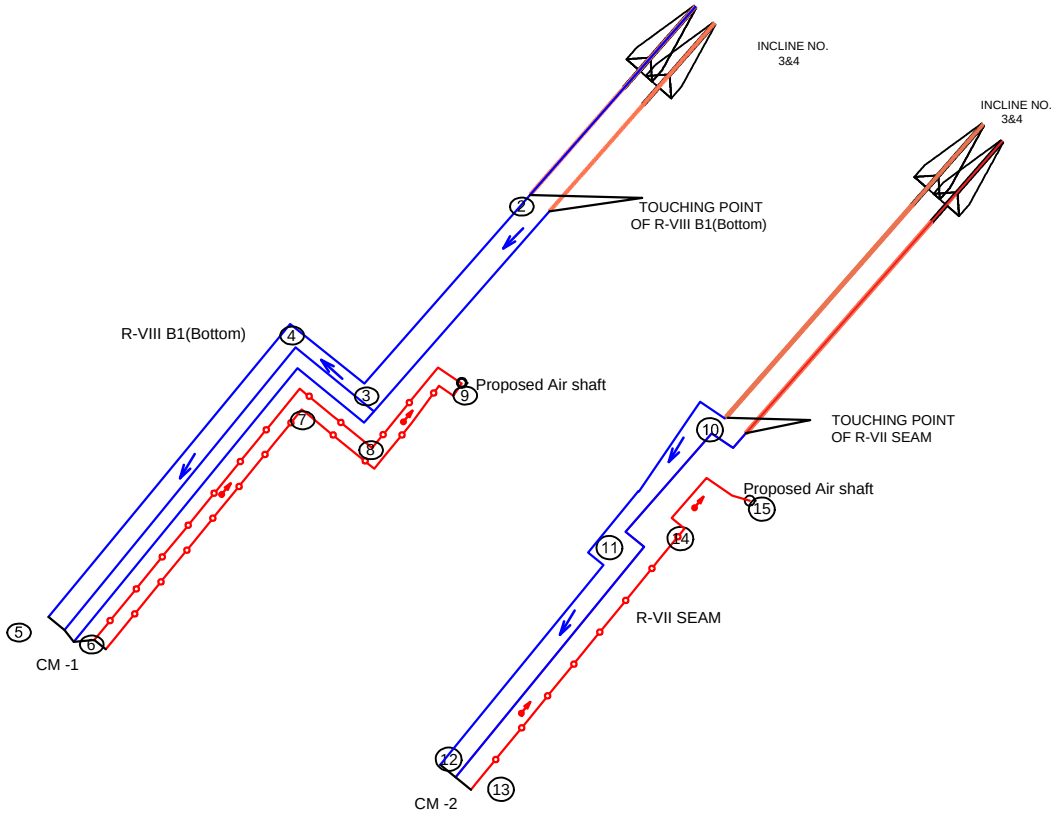
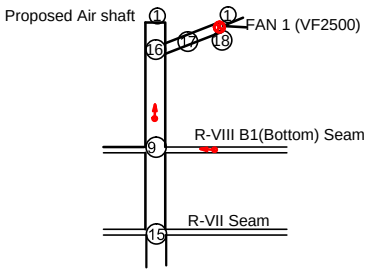
NODES	15
INCLINE	
INTAKE AIRWAY	
RETURN AIRWAY	

STAGE–2(MINE–1)

SCHEMATIC LINE DIAGRAM OF VENTILATION NETWORK(MINE–1) FOR SEAM R–VII,R–VIIA.





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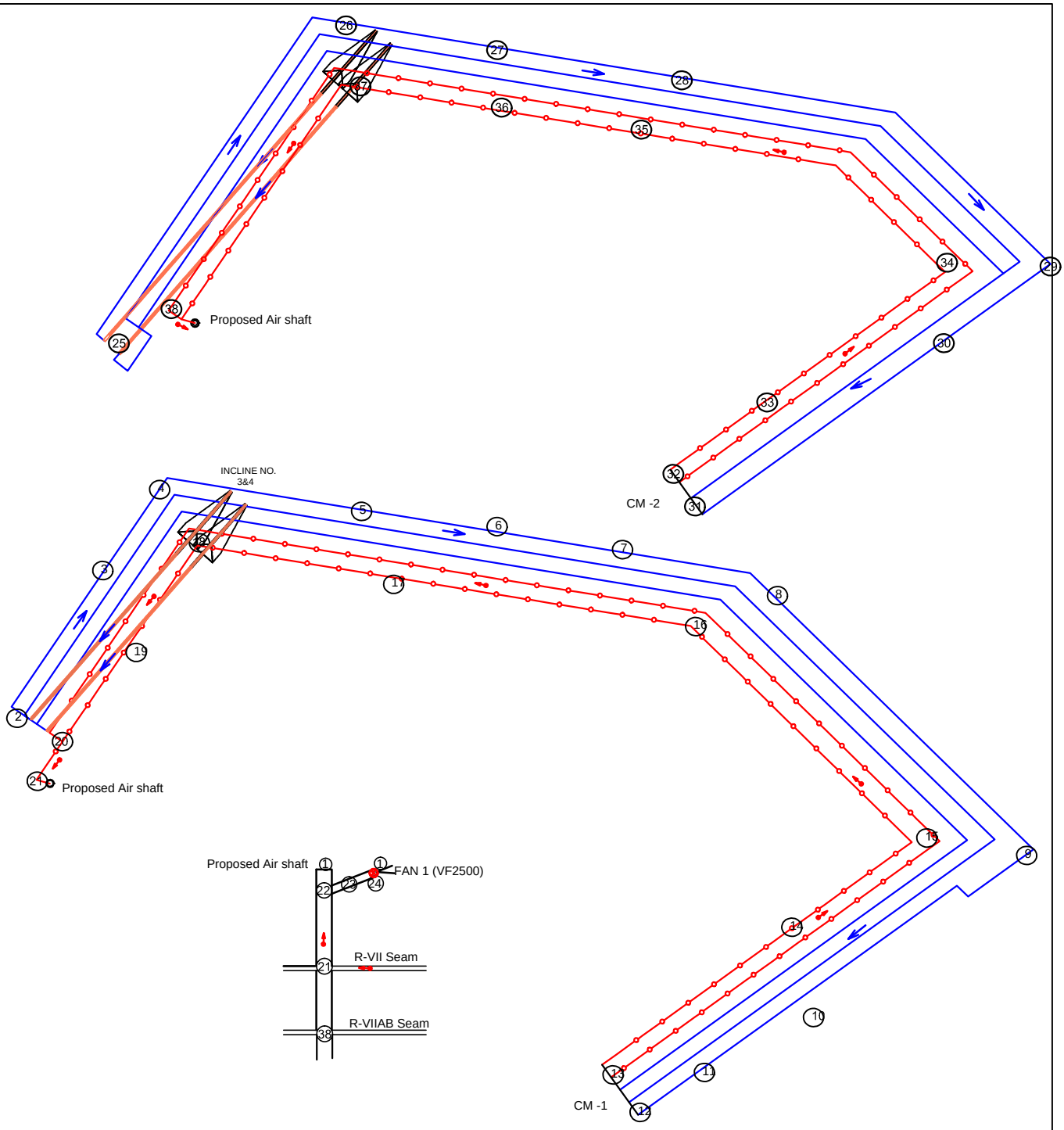
NODES	(15)
INCLINE	
INTAKE AIRWAY	
RETURN AIRWAY	

STAGE–1(MINE–2)

SCHEMATIC LINE DIAGRAM OF VENTILATION NETWORK(MINE–2) FOR SEAM R–VIII B1(BOTTOM),R–VII.



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NODES	(15)
INCLINE	
INTAKE AIRWAY	
RETURN AIRWAY	

STAGE–2(MINE–2)

SCHEMATIC LINE DIAGRAM OF VENTILATION NETWORK(MINE–2) FOR SEAM R–VII,R–VIIAB.

Chapter-12

WATER MANAGEMENT, PUMPING & DRAINAGE

12.1 Introduction

This report envisages coal production from Mine-1 & Mine-2 of Tilaboni UG for a total coal production of 3300 TPD and 2900 TPD respectively. The pumping system for Mine–1 and Mine-2 has been calculated based on the developed/virgin area proposed to be extracted.

Sedimentation tanks will be provided on surface at both the mines so that the mine water passes through these tanks before being discharged into the natural drainage system of the area. These may be provided on surface at a convenient place where the mine water shall be discharged on the surface.

12.2 Source of water

In general the sources of water in the underground mine would be as per below:

i) Percolation of rain water into under-ground workings
ii) Seepage/in rush of water from the water bearing areas
iii) Seepage from the water bodies like springs, ponds etc. on the surface
iv) Spraying of water at faces to suppress the dust generated during the operation of Continuous Miner.

12.3 Proposed Pumping System

12.3.1 General Considerations:-

The following general considerations have been adopted for calculating the make-of water and the pumping requirements in the underground mine.

a) On an average, it has been observed that the maximum rainfall in Bankola area during monsoon period is to the tune of 1500 mm.
b) The duration of monsoon period is taken as 120 days.
c) Spraying of water at the face due to operation of Continuous Miner.
d) 1/3rd of rain water falling in catchment area of the mine will percolate down the mine.
e) Also, existing pumping of the Tilaboni Colliery has been considered for deciding the number of pumps.
f) Make of water has been calculated based on the catchment area of the seam. During the development, effective catchment area has been considered as 50 % of seam area.

g) Effective Pumping Hours have been considered as 18.

12.4 Make of Water

12.4.1 Make of water for the property which is virgin is determined by the following method:

V = 1/3 (A x 10^6 x B/100) cum. per year.
A = Area of mine in sq. km.
B = Annual rainfall in cm.

Maximum inflow of water Q = 2V/120 cum/day

12.4.2 Water used for spraying purpose at continuous miner face.

12.5 PUMPING CAPACITY FOR EACH SEAM OF MINE-1 & MINE-2

12.5.1 Make of water = Q1 in cum/min.
Pump operating period/day = 18 hrs.
Pumping capacity = Q1 x 1.1 x 24/18 cum/min
Where Q1 = Maximum inflow of water in cum/min and 1.1 is a factor for wear in service

12.5.2 The Total Make of Water for Mine 1 is shown in the table below:

S. N.	Particulars	Unit	For R-VIII T2 Seam	For R-VIII B1 Seam	For R-VII Seam	For R-VIIA Seam
1	Average annual rainfall	cm	150	150	150	150
2	Monsoon season in a year	days	120	120	120	120
3	Average rainfall in a day during rainy season	cm	1.25	1.25	1.25	1.25
4	Effective catchment area (appx.)	sq. km	0.1899	1.848	2.08315	2.1081
5	Total inflow of water in a day including percolation of rain water, seepage water, ground water, stowing water, spraying water (24 hours basis)	cum	2007.79 [including spraying water requirement of 180.00 cum]	17300.66 [including spraying water requirement of 360.00 cum]	19275.54 [including spraying water requirement of 180.00 cum]	19504.25 [including spraying water requirement of 180.00 cum]
6	Pumping Capacity required including wear and tear losses at 18 Hrs. pumping	cum/ hr.	122.72	1057.43	1178.19	1192.16
		lps	34.09	293.73	327.27	331.16
7	Capacity of Pump Selected	lps	38	38	38	38
8	No. of Working Pumps		0.90	7.73	8.61	8.71
			Say, 1	Say, 8	Say, 9	Say, 9
9	Standby Pumps		0	4	5	5
10	Total No. of Main Pumps		1	12	14	14

Based on maximum catchment area of R-VII A & maximum spraying water for CM, make of water of the mine would be about 19504.25 cum/day and the

total pumping capacity would be 1192.16 cum/hr or 331.16 lps. So, no. of 38 lps capacity working pumps would be 9 and no. of standby pumps would be 5. So, total nos. of pumps would be 14.

12.5.3 The Total Make of Water for Mine 2 is shown in the Table below:

S. N.	Particulars	Unit	For R-VIII T2 Seam	For R-VIII B1 Seam	For R-VII/ R-VII Bot Seam	For R-VIIA Seam
1	Average annual rainfall	cm	150	150	150	150
2	Monsoon season in a year	days	120	120	120	120
3	Average rainfall in a day during rainy season	cm	1.25	1.25	1.25	1.25
4	Effective catchment area (appx.)	sq. km	0.215	1.63	1.685	1.74
5	Total inflow of water in a day including percolation of rain water, seepage water, ground water, stowing water, spraying water (24 hours Basis)	cum	2249.37 [including spraying water requirement of 180.00 cum]	15121.66 [including spraying water requirement of 180.00 cum]	15625.84 [including spraying water requirement of 180.00 cum]	16310.00 [including spraying water requirement of 360.00 cum]
6	Pumping Capacity required including wear and tear losses at 18 Hrs. pumping	cum/ hr.	137.49	924.29	955.10	966.92
		lps	38.19	256.75	265.31	276.92
7	Capacity of Pump Selected	lps	38	38	38	38
8	No. of Working Pumps		1.01	6.76	6.98	7.29
			Say, 1	Say, 7	Say, 7	Say, 8
9	Standby Pumps		0	4	4	4
10	Total No. of Main Pumps		1	11	11	12

Based on maximum catchment area of R-VII A & maximum spraying water for CM, make of water of the mine would be about 16310.00 cum/day and the total pumping capacity would be 966.92 cum/hr or 276.92 lps. So, no. of 38 lps capacity working pumps would be 8 and no. of standby pumps would be 4. So, total nos. of pumps would be 12.

12.6 Selection of Pumps & Pumping System

[A]. FOR MINE–1.

12.6.1 For dewatering of R-VIIIT2 seam existing 1 no. Pump of 38 LPS x 150 m Head x 90 kW will be installed at the dip side of the property. While working in R-VIII B1 seam, 1 no. of 38 LPS x 150 m Head x 90 kW, 550V, FLP, 2 nos. of 38 LPS x 300 m Head x 200 kW, 3.3 kV, FLP and 1 no. of 38 LPS x 250 m Head x 150 kW, 3.3 kV, FLP electrical main pumps have been proposed to be installed at 4 different locations of the seam. Existing 1 no. of 38 LPS x 150 m Head x 90 kW pump will be installed in the dip side of panel no. 13, 2 nos. of 38 LPS x 300 m Head x 200 kW pump will be

installed in the dip side of panel P2, 1 no. of 38 LPS x 250 m Head x 150 kW pump will be installed in the dip side of panel no. P4.

All these main pumps will be located at different pump stations. All pumps will discharge water directly to the surface through separate boreholes. In addition to this, 1 no. pump of 38LPS x 300m Head x 200 kW and 1 no. pump of 38LPS x 250m Head x 150 kW will be kept as standby purpose.

12.6.2 For dewatering of R-VII seam, 2 nos. of 38 LPS x 150 m Head x 90 kW, 1 no. 38 LPS x 200m x 110 kW and 1 no. of 80 LPS x 200 m Head x 280 kW, 3.3 kV, FLP electrical main pumps have been proposed to be installed at 3 different locations of the seam. Existing 2 nos. of 38 LPS x 150 m Head x 90 kW pump will be installed in the dip side of panel no. 2. 1 no. of 80 LPS x 200 m Head x 280 kW pump (existing) will be installed in the dip side of trunk route T2. 1 no. of 38 LPS x 200 m Head x 110 kW pump will be installed in the dip side of trunk route T3.

All these main pumps will be located at different pump stations. All pumps will discharge water directly to the surface through separate boreholes. In addition to this, 1 no. pump of 38LPS x 150m Head x 90 kW and 1 no. pump of 38LPS x 200m Head x 110 kW will be kept as standby purpose.

12.6.3 After liquidation of R-VIII T2, R-VIII B1 seams, the pumps will be shifted to the lower seam R-VII A and installed suitably for dewatering from this seam. A 38 LPS x 150m x 90 kW working pump along with the standby pump, will be installed in the touching point of Main Incline with the R-VIIA seam. This pump will discharge water through the incline

12.6.4 Suction and delivery ranges selected for Main Pumps will be 200mm and 150mm respectively.

12.6.5 Four nos. of face pumps have been provided to handle the accumulated water in the faces, out of which 2 nos. will be in operation and 2 nos. will be standby.

12.6.6 Two nos. pumps of 11 LPS x 30 m head x 7.5 KW has been proposed to be installed at the surface near the Filter Plant for supplying spraying water for Continuous Miner operation.

12.6.7 The details of the pump selected for the purpose of dewatering has been given in Appendix-A.3.3.

[B]. <u>FOR MINE–2.</u>

12.6.8 For dewatering of R-VIIIT2 seam 1no. Pump of 38 LPS x 150 m head x 110 kW will be installed at the dip side of the property. While working in R-VIII B1 seam, 2 nos. of 38 LPS x 150 m Head x 110 kW, 1 no. of 38 LPS x 300 m Head x 200 kW, and 1 no. of 38 LPS x 400 m Head x 260 kW, 3.3 kV, FLP electrical main pumps have been proposed to be installed at 4 different locations of the seam. 1 no. of 38 LPS x 150 m Head x 110 kW pump will be

installed in the dip side of trunk route T2 near panel no. P14, 1 no. of 38 LPS x 300 m Head x 200 kW pump will be installed in the dip side of trunk route T7, 1 no. of 38 LPS x 400 m Head x 260 kW pump will be installed in the dip side of trunk route T3 near panel no. P1 (later to be shifted in the dip side of trunk route T4 near panel P8 and finally to dip side of trunk route T5). 1 no. 38 LPS x 150 m Head x 110 kW Pump will be installed at the Incline bottom of R-VIII B1 seam.

All these main pumps will be located at different pump stations. All pumps, except the one located at the Incline bottom, will discharge water directly to the surface through separate boreholes. The pump located near the Incline bottom will discharge water through the incline. In addition to this, 1 no. pump of 38LPS x 150m Head x 110 kW and 1 no. pump of 38LPS x 400m Head x 260 kW will be kept as standby purpose..

12.6.9 For dewatering of R-VII/R-VII (Bot.) seam, 1 no. of 38 LPS x 150 m Head x 110 kW, 1 no. 38 LPS x 200m x 110 kW and 2 nos. of 38 LPS x 300 m Head x 200 kW, 3.3 kV, FLP electrical main pumps have been proposed to be installed at 4 different locations of the seam. 1 no. of 38 LPS x 300 m Head x 200 kW pump will be installed in the dip side of trunk route T2 near panel no. P5 (later to be shifted in the dip side of trunk route T4 near panel P13 and finally to dip side of trunk route T5). 1 no. of 38 LPS x 300 m Head x 200 kW pump will be installed in the dip side of trunk route T3 near panel P6. 1 no. of 38 LPS x 150 m Head x 110 kW pump will be used for pumping water from one sump (dip side of Trunk route T7 near panel P20) to sump in dip side of trunk route T5 in R-VII seam. 1 no. 38 LPS x 200 m Head x 110 kW Pump will be installed at the Incline bottom of R-VII seam.

All these main pumps will be located at different pump stations. All pumps, except the one located at the Incline bottom, will discharge water directly to the surface through separate boreholes. The pump located near the Incline bottom will discharge water through the incline. In addition to this, 1 no. pump of 38LPS x 200m Head x 110 kW and 1 no. pump of 38LPS x 300m Head x 200 kW will be kept as standby purpose.

12.6.10 After liquidation of R-VIII T2, R-VIII B1 (Bot), R-VII/R- VII (Bot) seams, the pumps will be shifted to the lower seams and installed suitably for dewatering of the lower seams.

12.6.11 Suction and delivery ranges selected for Main Pumps will be 200mm and 150mm respectively. Suction and delivery ranges selected for Face pumps as well as Spraying water Pumps will be 100mm and 80mm respectively.

12.6.12 Four nos. of face pumps have been provided to handle the accumulated water in the faces, out of which 2 nos. will be working and 2 nos. will be standby.

12.6.13 Two nos. pumps of 11 LPS x 30 m head x 7.5 KW has been proposed to be installed at the surface near the Filter Plant for supplying spraying water for Continuous Miner operations.

12.6.14 The details of the pumps selected for the purpose of dewatering has been given in Appendix-A.3.3.

12.7 Sump/Water Lodgment

12.7.1 One no. Main sump will be located near the touching point of Main Incline with R-VII A seam in MINE-1. 3 nos. dip most sumps are to be provided at three different locations in R-VIII B1 and at three different locations in R-VII seam. Sump will consist of minimum two water galleries to facilitate periodic cleaning. Sump galleries will be connected by cross galleries leading to good suction in pump house. Sluice valve will be provided to isolate sump galleries from one to other to facilitate cleaning.

One no. Main sump will be located near the touching point of Main Incline with R-VIII B1 seam. One no. Main sump will be located near the touching point of Main Incline with R-VII & R-VII (Bot.) seam in MINE-2. In addition to this, 5 nos. dip most sumps are also to be provided at five different locations in R-VIII B1 (Bot) seam and at five different locations in R-VII/R-VII (Bot) seam. Sump will consist of minimum two water galleries to facilitate periodic cleaning. Sump galleries will be connected by cross galleries leading to good suction in pump house. Sluice valve will be provided to isolate sump galleries from one to other to facilitate cleaning.

12.7.2 The suggested sump capacity should be such that it can hold at least 16 hours make of water.

12.7.3 The actual capacity of sump galleries for both the mines is calculated as below:

V = 60 QTR cum

Where, Q = water inflow in cum per min (6.92 cum/min from item12.5.2)
T = 16 hrs.
R = A reserve factor of 1.2 to account for silting of sump galleries

Mine 1

V = 60 x 2.0453 x 16 x 1.2 cum = 2356 cum.(for R-VIII T2 seam)
V = 60 x 17.6238 x 16 x 1.2 cum = 20303 cum.(for R-VIII B1 seam)
V = 60 x 19.6365 x 16 x 1.2 cum = 22621 cum.(for R-VII seam)
V = 60 x 19.8693 x 16 x 1.2 cum = 22889 cum.(for R-VII A seam)

Mine 2

V = 60 x 2.2915 x 16 x 1.2 cum = 2640 cum.(for R-VIII T2 seam)
V = 60 x 15.4048 x 16 x 1.2 cum = 17746 cum.(for R-VIII B1 seam)
V = 60 x 15.9183 x 16 x 1.2 cum = 18338 cum.(for R-VII seam)
V = 60 x 16.6153 x 16 x 1.2 cum = 19141 cum.(for R-VII A seam)

12.7.4 The cross sectional area of sump galleries should be kept as 4.8m x 3m. The floor should be graded at 3 in 1000 for easy drainage of water.

12.7.5 SEDIMENTATION PONDS

Required capacity sedimentation ponds will be provided near the discharge of mine water from the mines. After treatment of mine water the same will be discharged into the natural drainage of the area.

12.8 CAPITAL REQUIREMENT

The details of pumps and pipes along with brief specifications estimated cost and phasing for both the MINE-1 and MINE-2 are given in Appendix A.3.3.

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Chapter-13

COAL HANDLING PLANT & SURFACE DESPATCH ARRANGEMENT

13.1 Introduction

Separate coal handling arrangement has been envisaged on surface near incline mouth of the Incline No.1 of Mine-1 and incline mouth of Incline No. 3 at Mine-2 for transporting R.O.M coal to the proposed railway siding. At the railway siding wagons will be loaded with the help of pay loaders for despatching to consumers by rail.

Coal from CHP near incline mouth of Incline No.1 will be transported to the proposed railway siding by surface belt conveyors. At Mine-1 the CHP will have facility of receipt of R.O.M coal (from UG) through a 1200 mm wide main incline conveyor i.e. MICN1. This main incline conveyor will discharge coal in a reversible belt conveyor C1 which will deliver coal onto 4 nos. 250 t overhead steel fabricated hoppers. Series of belt conveyors will be provided on surface to receive coal from below hoppers in CHP (near incline mouth of the Incline No.1 of Mine-1) and to transport to railway siding. The tentative distance of proposed Tilaboni railway siding from Mine-1 is 1.5 km.

Coal transportation from Mine-2 through belt conveyor is not feasible, as it has to pass through two big villages (Tilaboni and Nabaghanapur) and caved zone of Jhanjra UG Mine. Therefore road transport have been considered under this report for the surface transport of coal from Mine-2. Coal loaded trucks will be transported to proposed railway siding after the weighment of trucks at 100t capacity electronic road weighbridge. At Mine-2 the CHP will have facility of the receipt of R.O.M coal on 1200 mm wide reversible belt conveyor C2 from main incline conveyor i.e. MIC1. This reversible belt conveyor C2 will deliver coal onto 2 nos. of 2 x 250t capacity overhead steel fabricated hoppers. The tentative distance of proposed Tilaboni railway siding from Mine-2 is 4.5 km. The details are described in the subsequent paras.

13.2 Basic Data:

The basic data considered for planning and designing of the coal handling arrangement is as given below:

S.N.	DESCRIPTION	UNIT	MINE-1	MINE-2
1	Av. target output from the mine	Mty	0.99	0.87
2	Life of the mine	Years	>25	>25
3	Mine and CHP operation	Shifts/Day	3	3
4	Daily working time	Hours	18	18
5	Quality of coal	Grade	G-4 to G-6	G-4 to G-6
6	Product size	mm	ROM (-) 100	ROM (-) 100

S.N.	DESCRIPTION	UNIT	MINE-1	MINE-2
7	Customers		Misc.	Misc.
8	Weighment		Belt Scale	On 100 t road weigh bridge
9	Despatch		By Rail	By Rail

13.3 Scope:

13.3.1 For MINE-1 & MINE-2

The scope of work in the coal handling arrangement is as follows:

i) Receipt of ROM coal from u/g at 2 nos. of 2x250 t capacity overhead steel hoppers.
ii) Storage of ROM coal in the overhead steel hoppers.
iii) Loading of surface belt conveyor with the help of mechanical vibro feeder below the hoppers for Mine-1 only. Loading of trucks below the hoppers for Mine-2.
iv) Weighment of coal on surface belt conveyor (receiving from below hoppers) with the help of belt scale for Mine-1. Weighment of trucks on 100 t capacity pit less electronic road weigh bridge at Mine 2.
v) Dust suppression and fire fighting arrangement.
vi) Power supply, Illumination.
vii) Associated civil and structural works.

13.4 System Description

13.4.1 **EXISTING SYSTEM**:

At present coal evacuation from seams R-VIIIB1, R-VII and R-VIIA is being done through coal tubs with the help of winder installed at Pit No.1 and 3 of SSP Unit and Pit No.1 and 2 of Tilaboni Unit. At the Pit top tubs are unloaded for loading into trucks with the help of tub tippler. At Tilaboni unit tubs are also unloaded through tippler onto conveyor for storage into hopper and then for onward transportation to siding by trucks. The trucks are being used for transporting the coal to Bankola No.2 siding.

13.4.2 **PROPOSED SYSTEM**:

13.4.2.1 COAL FLOW (MINE-1):

1200 mm wide Main Incline belt conveyor (MICN1) from underground will deliver ROM coal onto 1200 mm wide reversible belt conveyor C1. Reversible belt conveyor C1 will discharge ROM coal directly into 2 nos. of 2x250 t capacity overhead steel hoppers.

Surface belt conveyor S1 (1000 mm wide) will receive coal from below overhead hoppers with the help of mechanical vibro feeders provided at the bottom opening of hoppers. A series of surface belt conveyors S1 to S3 will be used for transportation of coal from CHP to railway siding. The distance of the railway siding from MINE-1 will be about 1.5 km.

13.4.2.3 COAL FLOW (MINE-2):

1200 mm wide Main Incline belt conveyor (MIC1) from underground will deliver ROM coal onto 1200 mm wide reversible belt conveyor C2. Reversible belt conveyor C2 will discharge ROM coal directly into 2 Nos. of 2x250 t capacity overhead steel hoppers.

Trucks will be loaded below the hoppers with the help of sector gates fitted at the bottom of the hoppers. The coal loaded trucks will be transported to the proposed Tilaboni Railway siding after weighment of trucks at 100 t capacity electronic road weighbridge for further dispatch by rail wagons to distant consumers. The distance of the railway siding from MINE-2 would be about 4.5 km.

If hoppers are full and there is no off take, trucks will discharge coal at a suitable location on ground thus creating a ground stock. This ground stock can be liquidated, as and when necessary, and loaded into trucks by contractual means.

13.4.2 STORAGE:

The total self- flowing bunkerage both in underground and on surface is about one shift production in both the mines i.e. MINE-1 and MINE-2 and is considered reasonable. In case of emergency when the bunkers are full and there is no off take, loaded trucks will discharge coal at a suitable location on ground thus creating a ground stock. The stock will be liquidated as and when required.

13.5 Weighment

Belt scale provided below surface belt conveyor will be used for weighing of coal being transported by conveyors from Mine-1 to Railway Siding.

Pit less type electronic weighbridge of 100 t capacity will be provided at convenient location near the coal handling arrangement of MINE-2 for weighment of empty and loaded trucks. The weigh bridge will have printout facility. This will facilitate in keeping the records of dispatch. The cabin will be located as close to the road as possible for easy communication between the driver and the weigh bridge operator.

13.6 Surface Belt Conveyor Transport for Mine-1

A set of three surface belt conveyors has been provided for transport of coal from CHP at Mine-1. First surface belt conveyor S1 will receive coal from

below 2 Nos. of 2 x 250t capacity overhead hoppers with the help of mechanical vibro-feeders provided at the bottom opening of hoppers. One belt scale will be provided in this conveyor for weighing of coal from CHP. A set of three belt conveyors S1 to S3 will be used for surface transport of coal from CHP to railway siding. Last conveyor S3 will spread coal on railway siding from a height with the help of ploughs thus creating several ground stocks as required. Second belt scale will be provided in this conveyor S3 for weighing of coal reaching railway siding. At railway siding, these ground stocks will be liquidated with the help of pay loaders and loaded into railway wagons.

13.7 Dust Suppression

In order to suppress dust generated at transfer points at the truck loading hoppers, water will be sprayed in atomized condition with the help of nozzles.

13.8 FIRE FIGHTING:

Fire extinguishers and sand buckets will be provided as primary fire fighting equipment near the electric drives to put off the fire immediately.

13.9 POWER SUPPLY, ILLUMINATION, CONTROL:

The electrical system shall comprise of –

- Power reception and distribution system
- Centralized sequence control–cum–interlocking, automation, signaling and instrumentation system
- Illumination of plant and adjacent area
- Earthling

13.10 Railway Siding

Presently coal evacuated from Tilaboni colliery is being transported to the Bankola No.1 railway siding by trucks, which is at a distance of about 5 km from the mine.

For coal transport a new railway siding line has been proposed which would take off from the Andal-Sainthia railway line. Further the point of take off will be about 1.5 km from the proposed incline of Mine No. 1 and about 4.5 km from that of Mine No. 2.

So, it has been envisaged to construct a railway siding (having one load line and one escape line for engine) on the same loop line along with a 650 m long wharf wall. Coal evacuated from the proposed MINE-1 and MINE-2 of Tilaboni UG mine shall be transported to the proposed railway siding.

Arrangement shall be made to dispatch two rakes of coal per day by loading wagons with the help of pay loaders. Provision of capital for the railway siding has been made in Appendix-A.5.

13.11 MANPOWER:

The details of the manpower required for maintenance and operation are shown in Appendix B.

13.12 Capital Estimate

The details of the equipment along with brief specifications and estimated cost are shown at **Appendix A.3.4** and **A.3.4.1** for MINE-1 and MINE-2 respectively.

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Chapter-14

WORKSHOP, STORES & MAGAZINE

14.1 Workshop

As the proposed mines are mechanised, and more over the distance between two units is approximately 6 km, so a new unit workshop and a new unit store have been proposed to be constructed near both the mines to deal with the requirements of day to day maintenance and incidental minor repairs of the plant and machinery. The major repairs, overhauls of the equipment needs special machinery, skilled manpower etc. so it is proposed to carry out the same at Regional Workshop/Area Workshop of the area or Central Workshop where these facilities will be available.

Equipment like LHD, Continuous Miner, Coal haulers/Shuttle Cars, Feeder Breaker, Belt conveyors, Drill machines, Roof bolting equipment, Pumps, Ventilation fans, CHP equipment, Vehicles, Associated Electrical equipment etc. proposed in the mines have been considered for planning of separate workshops at MINE-1and MINE -2.

14.1.1Scope of work & facilities

The unit workshops would deal with the following jobs:

i) Incidental minor repairs, replacement of components/ sub assemblies/ assemblies of mining equipment, transport equipment, pumps, ventilation equipment, CHP equipment etc.

ii) Incidental minor repairs, preventive maintenance, periodical lubrication, replacement of components/sub assemblies/assemblies of motor vehicles.

iii) Manufacturing of spares to a limited extent which are in short supply.

iv) Reconditioning of spares to the extent possible.

v) Washing of vehicles, mining equipment as per requirement.

vi) Incidental minor repairs, replacement of components of electrical equipment such as switch gears, motors, transformers, starters, gate end boxes, dynamos, light fittings etc.

vii) Motor winding to a limited extent

viii) Testing of relays, finding the cable fault locations etc.

ix) Smithy related jobs

x) Structural fabrication jobs

xi) Battery charging, preparation of distilled water

xii) Scheduling the major repairs/overhauls to be undertaken at area workshop or central workshop

14.1.2 Facilities:

The following shops and other facilities have been proposed in the unit workshop to meet the scope of work as proposed above.

i) Machine shop

ii) Electrical repair shop

iii) Equipment/Hydraulic repair shop

iv) Structural shop

v) Smithy shop

vi) Light vehicle repair shop

vii) Washing platform/station

viii) Supporting facilities such as small store, cycle shed, toilet, security and time office, sump alongwith pump house, firefighting equipment, grease trap etc.

ix) Open bituminous hard stand

x) Environmental control measures

xi) Required drainage facilities

14.1.3 Shop Functions:

The various shops are fully equipped to undertake the jobs as mentioned below:

i) Machine shop :- In this shop manufacturing of spares which are in short supply will be undertaken in a limited way. In this shop, machining and reconditioning of spares will also be undertaken. Sharpening of drill bits will also be undertaken in this shop. A pedestal grinder will also be provided near the incline mouth for sharpening of the drill bits.

ii) Electrical Repair Shop :- In this shop, winding of the burnt out motors will be undertaken to a limited extent. Minor repairing of all the electrical equipment such as motors, circuit breakers, transformers, gate end boxes, starters, dynamos etc. will also be undertaken. Testing of relays etc. will also be done here. Transformer oil filtration machine has been proposed for filtration of the transformer oil as and when necessary.

iii) Equipment and Hydraulic Repair Shop :- The underground equipment (excluding electrical items) received in this shop will be dismantled, washed and then thoroughly checked. The worn-out spares, defective sub-assemblies/assemblies will be replaced by new ones. Hydraulic equipment test bench has been provided for checking the hydraulic equipment. Further minor repairs of the equipment will also be undertaken in this shop.

iv) Structural and Fabrication Shop :- In this shop the fabrication work of new structures, repair of old structures, building up of materials on worn out parts, repairing of rollers ,pulleys and coal tubs will be undertaken.

v) Smithy Shop :- In this shop all smithy related works will be undertaken. In this shop repairing of mine tubs will also be undertaken.

vi) Light Vehicle Shop :- In this shed repairing, scheduled maintenance of all the light vehicles such as cars, jeeps, cash vans, pickup vans, ambulance etc. will be under taken.

vii) Washing Platform :- Most of the equipment, specially, transport vehicles have to work in adverse conditions full of dust and mud etc. which have dangerous effects on the health on these equipment. It is therefore, essential to ensure quick and high quality of cleaning of the equipment. For this purpose, high pressure washing machine along with washing platform will be provided. A ground water reservoir along with a pump house will be provided near washing platform to supply water at high pressure. Mine water will be used for washing.

viii) Environmental Control :- The effluents from the washing platform will be passed through grease trap to arrest the oils and grease. Before allowed to pass into the natural drainage, the water will be passed through sedimentation ponds.

ix) Lifting tackles :- Electric hoist block (3t cap.), chain pulley blocks (3t cap.) will be provided in the workshop shed for lifting and movement of the equipment etc. during repair in the workshop shed .

x) Miscellaneous :- Necessary provision for fire fighting facilities and ventilation of the sheds have been made.

14.1.4 MANPOWER

The details of manpower required for performing different works is shown in Appendix 'B'

14.2 UNIT STORE

A unit store will be provided at mine to meet the requirements. Sufficient open space will be provided for storage of structural steel and other big equipment. Open space for scrap will also be provided. Required bins, racks etc. will be provided for storage of spares. Lifting tackles will be provided to lift the loads.

14.3 MAGAZINE

The mine is having a magazine of 3.6 t capacity explosives and 50,000 nos. detonators. However in the proposed technology explosives and detonators would not be required except for heightening of developed galleries. Assuming a powder factor around 4 t/kg of explosive, the daily requirement of explosive, for a production of 400tpd, will be around 100 kg and one-week requirement will be around 600 kg.

The present magazine capacity is sufficient to meet this requirement; hence provision for new magazine has not been made.

14.4 CAPITAL REQUIREMENT

The list of equipment along with brief specifications and cost are shown in Appendix-A.3.2.1 and Appendix-A.3.2.2 for MINE-1 and MINE-2 respectively.

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Chapter-15

POWER SUPPLY, ILLUMINATION & COMMUNICATION

15. Power supply & communication

15.1 Source of supply

At present the project is receiving power at 11 KV by one single circuit over head line (length 5 km) from Loudua Substation of WBSEB. In the proposed stage also the project will receive power at 33 KV by drawing two single circuit over head lines from this substation.

15.1.1 Existing Stage

In the existing stage there are two substations in the project- one in SSP(O) section and one in Tilaboni section.

15.1.2 Proposed stage

In the proposed stage there will be 2 nos. sub stations one of 2X5 MVA, 33/6.6 KV substations, for Mine-1 located near the proposed inclines of Mine-1 and 2X4 MVA,33/6.6KV for Mine-2 located near the proposed inclines of Mine-2. The substation for Mine No-I will be called Substation No.-1 and the substation for Mine No.-II will be called Substation No.-2.

These two substations will receive power at 33 KV by two single circuit over head lines from Loudua Substation of WBSEB.

15.1.2.1 Main Substation

MINE-1: The main receiving substation for Mine-1 shall be located near the proposed Incline of Mine-1. In this substation, 33 KV shall be stepped down to 6.6KV by two numbers of 5 MVA, 33/6.6KV transformer and feed to ventilation fan, MIC Belt Conveyor, other surface loads & underground loads. Power supply to the colony shall be made from this substation through 6.6 KV O/H line and will be stepped down to 230 Volt by 100 KVA 6.6/0.230 KV lighting transformers. Supply to the surface light is proposed from a 100KVA 33KV/230 volt (L-L) lighting transformer. This transformer will be installed in the main surface substation.

Power supply to surface coal handling plant, main incline belt conveyor and workshop has been proposed to be fed at 415V from a 750 KVA 6.6/0.415KV transformer. This proposed transformer is to be installed in the main surface substation.

The ventilation fan will be located near no. 2 pit of Tilaboni unit and power will be supplied here at 6.6 KV from the main sub-station by 6.6 kV O/H Line.

Outdoor Installations

1. 2 nos. 5 MVA 33/6.6KV transformers
2. 33 KV O/H Line
3. 6.6 KV O/H line
4. 33 KV VCB
5. 1 no. 100 KVA 33/0.230 KV (L-L) lighting transformer

Indoor Installations

1. 1 no. 750 KVA 6.6/0.415 KV transformer
2. 1 no. 6.6 KV switch board panel comprising of 18 nos. vacuum circuit breakers.
3. 2 nos. 6.6 KV 3 x 500 KVAR capacitor bank with automatic PF correction
4. 415 volt panel comprising of 7 nos. Air circuit breakers.

6.6 KV Indoor Switch Board

There will be one no. 6.6 kV switch board panel comprising of 18 nos. vacuum circuit breakers of which two are incoming, one is bus coupler, two are supplying power to capacitor bank, one ventilation fan, one 100 KVA lighting transformer, one colony light, four underground loads, one 750KVA 6.6/0.415 KV transformer, two spares.

LT Switch Board

There will be a 415 volt LT switch board having one incoming, 6 nos. of outgoing (one for CHP, one for workshop, one incline's conveyor and spares).

Lighting Switch Board

There will be a lighting switch board getting power from the secondary side of the 100 KVA lighting transformer.

Connected Load and Maximum Demand

The estimated Maximum Demand of the project at ultimate stage after power factor improvement by capacitors with automatic PF correction shall be as follows:

i) Installed KW in operation : 8281.25
ii) Maximum Demand in KW : 4501.50
In KVA : 4593.37

MINE-2: The main receiving substation for Mine-2 shall be located near the proposed Inclines of Mine-2. In this substation 33 KV shall be stepped down to 6.6KV by two numbers of 4 MVA 33/6.6KV transformers and will feed to ventilation fan, MIC Belt Conveyor, other surface loads & underground loads. Power to the lighting shall be made from this substation through 100 KVA 33/0.230 KV (L-L) lighting transformers. This transformer will be installed in the main surface substation.

Power supply to surface coal handling plant and workshop has been proposed to be fed at 415V from a 750 KVA 6.6/0.415KV transformer. This proposed transformer is to be installed in the main surface substation.

Outdoor Installations

1. 2 nos. 4 MVA 33/6.6KV transformers
2. 33 KV O/H Line
3. 6.6 KV O/H line
4. 33KV VCB
5. 1 no. 100 KVA 33/0.230 KV (L-L) lighting transformer

Indoor Installations

2. 1 no. 750 KVA 6.6/0.415 KV transformer
3. 1 no. 100 KVA 6.6/0.230 KV (L-L) lighting transformer
4. 1 no. 6.6 KV switch board panel comprising of 17 nos. vacuum circuit breakers.
5. 2 nos. 6.6 KV 3 x 400 KVAR capacitor bank with automatic PF correction
6. 415 volt panel comprising of 7 nos. Air circuit breakers.

6.6 KV Indoor Switch Board

There will be one no.6.6KV switch board panel comprising of 17 nos. vacuum circuit breakers of which two are incoming, one are bus coupler, two are supplying power to capacitor bank, one ventilation fan, one colony light, four underground loads, one 750KVA 6.6/0.415 KV transformer, two spares.

LT Switch Board

There will be a 415 volt LT switch board having one incoming, 6 nos. of outgoing (one for CHP, one for workshop, and spares).

Lighting Switch Board

There will be a lighting switch board getting power from the secondary side of the 100 KVA lighting transformer.

Connected Load and Maximum Demand

The estimated Maximum Demand of the project at ultimate stage after power factor improvement by capacitors with automatic PF correction shall be as follows:

i) Installed KW in operation : 7557
ii) Maximum Demand in KW : 3262.31
in KVA : 3328.89

Protection of substation, Interlocking & Earthing (MINE-1 & MINE-2)

Protection:

All the circuit breakers will have over current, short circuit and earth leakage protections.

Interlocking:

The two incomers and the two couplers are so interlocked that when the two incomers are ON, then at least one coupler will be OFF. But if one incomer is OFF, then the two couplers can be made ON.

Earthing:

Effective earthing system has been envisaged to ensure safety to working personnel and prevention of shock hazards. Restricted Earthed neutral system has been chosen for 550 volt restricting the fault current limited to 750 mA. On the surface, there shall be an earthing grid surrounding the main substation. The equivalent resistance of earthing grid shall preferably be kept below one ohm. In the underground, earth continuity shall be maintained by the armouring of the cables which in turn shall be connected to the main earth grid on the surface. Lightning protection system with separate earthing shall also be provided.

15.1.2.2 Energy Consumption

The estimated annual energy consumption at target year is as follows:

COMBINED (MINE-1 & MINE-2) RISK-GAIN SHARING OPTION

Annual energy consumption has been estimated at target year for the separately for Mine-1 & Mine-2 mine. Details of annual energy consumption for the two options considered in this report are as tabulated below:

Estimated annual energy consumption of Mine-1

Sl. No.	Power Consumer	Annual energy consumption (KWH x 10^6)		Energy consumption / te. of prodn. (KWH/te)		Power cost / te of production (₹)	
		Option-I	Option-II	Option-I	Option-II	Option-I	Option-II
1	Welfare	16.27	11.42	16.44	11.53	129.03	90.51
2	Pumping	3.27	3.27	3.30	3.30	25.92	25.92
3	Production	4.56	3.45	4.61	3.48	36.19	27.34
4	**Total**	**24.10**	**18.13**	**24.35**	**18.32**	**191.13**	**143.78**

Estimated annual energy consumption of Mine-2

Sl. No.	Power Consumer	Annual energy consumption (KWH x 10^6)		Energy consumption / te. of prodn. (KWH/te)		Power cost / te of production (₹)	
		Option-I	Option-II	Option-I	Option-II	Option-I	Option-II
1	Welfare	14.13	9.86	16.24	9.96	127.48	78.16
2	Pumping	2.89	2.89	3.33	2.92	26.12	22.95
3	Production	0.43	0.43	0.49	0.43	3.85	3.39
4	**Total**	**17.45**	**13.18**	**20.06**	**13.31**	**157.45**	**104.49**

15.1.2.3 System Voltage

The following are the operating voltages required for the various equipment.

S.N.	Name of equipment	Operating voltage(V)
1	Ventilation Fan	6600
2	CHP, Main Incline belt conveyor	6600/415
3	Workshop	415
4	Pump	6600/550
5	Other underground face &equipment	6600/550
6	Surface light	230
7	Underground light	110

15.1.2.4 Power Factor Improvement (MINE-1 & MINE-2)

Capacitor Bank with automatic power factor improvement facility has been envisaged to improve PF to the desired level. Improvement of power factor will reduce the maximum KVA demand. In this proposed system, power factor will be improved at 0.98 (lag).

Capacitors required at 6600 volt : 3 X 500 KVAR (2 sets) for Mine-1
3 X 400 KVAR (2 sets) for Mine-2

15.1.2.5 Underground Power supply (MINE-1 & MINE-2)

Underground power supply has been envisaged at 6.6KV. The main underground substation located near the incline at R-VIIIB1 seam shall receive power at 6.6KV from the surface substation by 6.6KV, 240 sq.mm. PVCDWA mine type copper cable feeders. The size of the cables have been so chosen that in case of failure of one cable feeder, the other cable feeders shall be able to cater to the full underground load. The 6.6KV Distribution

centre will be located at a convenient place at RVIIIBI seam & shall receive power at 6.6KV from the main underground substation. Three cables of 240 sq.mm will receive power at 6.6 KV from the main U/G Substation at RVIIIBI seam & will feed power to the U/G installations of R-VII seam substation. From the R-VIIIB1 seam U/G Sub-station two nos. of 120 sq.mm PVCDWA cable feeders will feed power to the R-VIIA seam U/G sub-station.

All the underground substations and the Distribution centre shall be used to feed power at 6.6KV to the 315 KVA 6.6/0.55KV transportable district substations. The transportable district substations shall, in turn, step down the voltage to 550 volt and shall feed power to various loads i.e., belt conveyors and face equipment. The continuous miners will operate at 1100 volts. This 1100 volt supply will be obtained from the load centres supplied with them.

The main pumps & intermediate pumps will be fed at 6.6 KV (for pumps having capacities more than 100 KW) & also at 550 volt from the 315 KVA 6.6/0.550 KV transportable district substations. The sizes of the cables which are feeding power to the pumps are so chosen that they will be able to cater the required load.

15.2 Illumination (MINE-1 & MINE-2)

Surface Illumination

Power supply to the colony will be made at 6.6 KV from the Main substation and there it will be stepped down to 230 Volt (L-L) by 100 KVA 6.6/0.230 (L-L) Volt lighting Transformer. Power supply to the surface will be made by one no. 100KVA 33KV/230V (L-L) transformer which is proposed to be installed in the main surface substation. Mine site surface area including all buildings and roads shall have to be sufficiently illuminated for which necessary provisions have been made.

Underground Illumination

Adequate level of illumination shall be provided in the underground near substation, pump house, junction of roads and all other important locations by FLP light fittings, where power shall be supplied by 5 KVA, 550/110 volts FLP Lighting Transformers.

15.3 Power Balance, Annual Energy Consumption and year wise energy Consumption.

Power Balance, Annual Energy Consumption for the Mine-1 and Mine-2 are as follows:

15.3.1 Power Balance, Annual Energy Consumption of Mine-1 is shown below:

MIne-1

Description	Voltage (kV)	POP	OP	Unit Load (kW)	Conn-ected Load (kW)	Total Load in Opera-tion (kW)	DF	PF	Active Power (kW)	Reactive Power (KVAR)	KVA	Work-ing hours	Annual Energy Consumption (KWH x 10^6)
Surface :													
Ventilation Fan	6.6	1	1	250	250	250	0.8	0.8	200	150	250	8760	1.75
Micn1	6.6	1	1	220	220	220	0.8	0.8	176	132.00	220.00	3600	0.63
Workshop	0.44	1	1	230	230	230	0.5	0.7	115	117.32	164.29	1800	0.21
Chp	0.44	1	1	274	274	274	0.6	0.7	164.4	167.72	234.86	3600	0.59
Pump (Spray)	0.44	2	1	7.5	15	7.5	0.7	0.8	5.25	3.94	6.56	3600	0.02
Surface Light	0.44	1	1	130	130	130	0.9	0.9	117	56.67	130.00	3650	0.43
Colony	0.23	1	1	1081.45	1081.45	1081.45	0.9	0.9	973.305	471.39	1081.45	4250	4.14
Colony (Existing)	0.23			1387.2			0.9	0.9				4250	
TOTAL SURFACE				3580.15	2200.45	2192.95			1750.96	1099.04			7.77
UNDERGROUND													
FACE EQUIPMENT (LHCM1)													
Continuous Miner Equipment	1.1												
Cutting power	1.1	1	1	340	340	340	0.65	0.7	221	225.47	315.71	3600	0.80
Marching & Tramming	1.1	1	1	250	250	250	0.65	0.7	162.5	165.78	232.14	1200	0.20
Roof Bolter	1.1	1	1	74	74	74	0.65	0.7	48.1	49.07	68.71	4500	0.22
Feeder Breaker	1.1	1	1	112	112	112	0.65	0.7	72.8	74.27	104.00	2400	0.17
Shuttle Car	1.1	1	1	282	282	282	0.65	0.7	183.3	187.00	261.86	2400	0.44
Auxiliary Fan	0.55	1	1	45	45	45	0.65	0.7	29.25	29.84	41.79	3600	0.11
LHD	0.55	1	1	37	37	37	0.65	0.7	24.05	24.54	34.36	2400	0.06
Face Pump	0.55	1	1	7.5	7.5	7.5	0.65	0.7	4.875	4.97	6.96	3600	0.02
TOTAL CM Equipment				**1147.5**									

Description	Voltage (kV)	POP	OP	Unit Load (kW)	Conn-ected Load (kW)	Total Load in Opera-tion (kW)	DF	PF	Active Power (kW)	Reactive Power (KVAR)	KVA	Work-ing hours	Annual Energy Consumption (KWH x 10^6)
FACE EQUIPMENT (SHCM2)													
Continuous Miner Equipment	1.1												
Cutting power	1.1	1	1	340	340	340	0.65	0.7	221	225.47	315.71	3600	0.80
Marching & Tramming	1.1	1	1	281	281	281	0.65	0.7	182.65	186.34	260.93	1200	0.22
Roof Bolter	1.1	1	1	74	74	74	0.65	0.7	48.1	49.07	68.71	4500	0.22
Feeder Breaker	1.1	1	1	112	112	112	0.65	0.7	72.8	74.27	104.00	2400	0.17
Shuttle Car	1.1	1	1	438	438	438	0.65	0.7	284.7	290.45	406.71	2400	0.68
Auxiliary Fan	0.55	1	1	45	45	45	0.65	0.7	29.25	29.84	41.79	3600	0.11
LHD	0.55	1	1	37	37	37	0.65	0.7	24.05	24.54	34.36	2400	0.06
Face Pump	0.55	1	1	7.5	7.5	7.5	0.65	0.7	4.875	4.97	6.96	3600	0.02
TOTAL CM Equipment				1334.5									
SDL	0.55			48			0.65	0.7				4500	
UDM	0.55			37			0.65	0.7				2700	
Remote control LHD 3 m^3	0.55	2	2	75	150	150	0.65	0.7	97.5	99.47	139.29	3600	0.35
Hand held Drill	0.55	4	4	15	60	60	0.65	0.7	39	39.79	55.71	2700	0.11
Hydraulic Roof Bolter	0.55	2	2	22	44	44	0.65	0.7	28.6	29.18	40.86	4500	0.13
													4.86
BELT CONVEYOR													
R-VIII SEAM													
TB1	0.55			90			0.7	0.7				3600	
TB2	0.55	1	1	55	55	55	0.7	0.7	38.5	39.28	55.00	3600	0.14
TB3	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB4	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB5	0.55	1	1	55	55	55	0.7	0.7	38.5	39.28	55.00	3600	0.14
TB6	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23

Description	Voltage (kV)	POP	OP	Unit Load (kW)	Conn-ected Load (kW)	Total Load in Opera-tion (kW)	DF	PF	Active Power (kW)	Reactive Power (KVAR)	KVA	Work-ing hours	Annual Energy Consumption (KWH x 10^6)
TB7	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB8	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB9	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB10	0.55	1	1	55	55	55	0.7	0.7	38.5	39.28	55.00	3600	0.14
TB11	0.55	1	1	55	55	55	0.7	0.7	38.5	39.28	55.00	3600	0.14
TB12	0.55	1	1	55	55	55	0.7	0.7	38.5	39.28	55.00	3600	0.14
TB13	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB14	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB15	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB16	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
GB1	0.55	1	1	55	55	55	0.7	0.7	38.5	39.28	55.00	3600	0.14
GB2	0.55	1	1	37	37	37	0.7	0.7	25.9	26.42	37.00	3600	0.09
GB3	0.55	1	1	37	37	37	0.7	0.7	25.9	26.42	37.00	3600	0.09
GB4	0.55	1	1	37	37	37	0.7	0.7	25.9	26.42	37.00	3600	0.09
GB5	0.55	1	1	37	37	37	0.7	0.7	25.9	26.42	37.00	3600	0.09
GB6	0.55			37			0.7	0.7				3600	
GB7	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
GB8	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
GB9	0.55	1	1	55	55	55	0.7	0.7	38.5	39.28	55.00	3600	0.14
GB10	0.55	1	1	37	37	37	0.7	0.7	25.9	26.42	37.00	3600	0.09
GB11	0.55	1	1	37	37	37	0.7	0.7	25.9	26.42	37.00	3600	0.09
MICN2	6.6	1	1	220	220	220	0.8	0.8	176	132.00	220.00	3600	0.63
R-VII SEAM													
TB17	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB18	0.55	1	1	55	55	55	0.7	0.7	38.5	39.28	55.00	3600	0.14
TB19	0.55	1	1	180	180	180	0.7	0.7	126	128.55	180.00	3600	0.45
TB20	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB21	0.55	1	1	55	55	55	0.7	0.7	38.5	39.28	55.00	3600	0.14

Description	Voltage (kV)	POP	OP	Unit Load (kW)	Conn-ected Load (kW)	Total Load in Opera-tion (kW)	DF	PF	Active Power (kW)	Reactive Power (KVAR)	KVA	Work-ing hours	Annual Energy Consumption (KWH x 10^6)
TB24	0.55	1	1	55	55	55	0.7	0.7	38.5	39.28	55.00	3600	0.14
TB25	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
R-VII A SEAM													
TB22	0.55	1	1	37	37	37	0.7	0.7	25.9	26.42	37.00	3600	0.09
TB23	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB26	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB27	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB28	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
Total Belt Conveyor													7.44
Haulage	0.55			37			0.7	0.7				4500	
MVF SYSTEM													
MVF	0.55	1	1	11	11	11	0.7	0.7	7.7	7.86	11.00	3600	0.03
MVF	0.55			22			0.7	0.7				3600	
TOTAL MVF SYSTEM													0.03
PUMP													
Main pump 280KW	6.6	1	1	280	280	280	0.8	0.8	224	168.00	280.00	3600	0.81
Main pump 200KW	6.6	3	2	200	600	400	0.8	0.8	320	240.00	400.00	3600	1.15
Main pump 150KW	6.6	1	1	150	150	150	0.8	0.8	120	90.00	150.00	3600	0.43
Main pump 110KW	6.6	3	1	110	330	110	0.8	0.8	88	66.00	110.00	3600	0.32
Main pump 90KW	0.55	5	2	90	450	180	0.8	0.8	144	108.00	180.00	3600	0.52
Face pump 7.5KW	0.55	4	2	7.5	30	15	0.8	0.8	12	9.00	15.00	3600	0.04
TOTAL PUMP													3.27
U/G light	0.11	1	1	95	95	95	0.9	0.9	85.5	41.41	95.00	8760	0.75
TOTAL UNDERGROUND				**8062**	**6453.5**				**4099.025**	**3843.12**	**5618.86**		**16.34**
80% Div. on B					**5162.8**				**3279.22**	**3074.50**	**4495.09**		**16.34**
Surface + U/G					**7363.25**				**5030.175**	**4173.54**	**6536.14**		**24.10**
80% div. on C					**5890.6**				**4024.14**	**3338.83**	**5228.91**		
Imp PF to 0.98								**0.98**	**4533.428**	**920.55**	**4625.95**		
Reqd. Capacitor									**2X3**	**403.05**			

15.3.2 Power Balance, Annual Energy Consumption of Mine-2 is shown below:

Description	Voltage (kV)	POP	OP	Unit Load (kW)	Conn-ected Load (kW)	Total Load in Opera-tion (kW)	DF	PF	Active Power (kW)	Reactive Power (KVAR)	KVA	Work-ing hours	Annual Energy Consumption (KWH x 10^6)
Surface :													
Ventilation Fan	6.6	1	1	250	250	250	0.8	0.8	200	150	250	8760	1.75
MIC 1	6.6	1	1	300	300	300	0.8	0.8	240	180.00	300.00	3600	0.86
Workshop	0.44	1	1	210	210	210	0.5	0.7	105	107.12	150.00	1800	0.19
CHP	0.44	1	1	100	100	100	0.6	0.7	60	61.21	85.71	3600	0.22
Pump (Spray)	0.44	2	1	7.5	15	7.5	0.7	0.8	5.25	3.94	6.56	3600	0.02
Surface light	0.44	1	1	130	130	130	0.9	0.9	117	56.67	130.00	3650	0.43
Colony	0.23	1	1				0.9	0.9				4250	
TOTAL SURFACE				997.5	1005	997.5			727.25	558.94	922.28		3.47
UNDERGROUND													
FACE EQUIPMENT (LHCM1)													
Continuous Miner Equipment	1.1												
Cutting power	1.1	1	1	340	340	340	0.65	0.7	221	225.47	315.71	3600	0.80
Marching & Tramming	1.1	1	1	250	250	250	0.65	0.7	162.5	165.78	232.14	1200	0.20
Roof Bolter	1.1	1	1	74	74	74	0.65	0.7	48.1	49.07	68.71	4500	0.22
Feeder Breaker	1.1	1	1	112	112	112	0.65	0.7	72.8	74.27	104.00	2400	0.17
Shuttle Car	1.1	1	1	282	282	282	0.65	0.7	183.3	187.00	261.86	2400	0.44
Auxiliary Fan	0.55	1	1	45	45	45	0.65	0.7	29.25	29.84	41.79	3600	0.11
LHD	0.55	1	1	37	37	37	0.65	0.7	24.05	24.54	34.36	2400	0.06
Face Pump	0.55	1	1	7.5	7.5	7.5	0.65	0.7	4.875	4.97	6.96	3600	0.02
TOTAL CM Equipment				1147.5									

Description	Voltage (kV)	POP	OP	Unit Load (kW)	Conn-ected Load (kW)	Total Load in Opera-tion (kW)	DF	PF	Active Power (kW)	Reactive Power (KVAR)	KVA	Work-ing hours	Annual Energy Consumption (KWH x 10^6)
Continuous Miner Equipment	1.1												
Cutting power	1.1	1	1	340	340	340	0.65	0.7	221	225.47	315.71	3600	0.80
Marching & Traming	1.1	1	1	281	281	281	0.65	0.7	182.65	186.34	260.93	1200	0.22
Roof Bolter	1.1	1	1	74	74	74	0.65	0.7	48.1	49.07	68.71	4500	0.22
Feeder Breaker	1.1	1	1	112	112	112	0.65	0.7	72.8	74.27	104.00	2400	0.17
Shuttle Car	1.1	1	1	438	438	438	0.65	0.7	284.7	290.45	406.71	2400	0.68
Auxiliary Fan	0.55	1	1	45	45	45	0.65	0.7	29.25	29.84	41.79	3600	0.11
LHD	0.55	1	1	37	37	37	0.65	0.7	24.05	24.54	34.36	2400	0.06
Face Pump	0.55	1	1	7.5	7.5	7.5	0.65	0.7	4.875	4.97	6.96	3600	0.02
TOTAL CM Equipment				1334.5									4.27
BELT CONVEYOR							0.65	0.7					
R-VIII SEAM													
TB1	0.55	1	1	37	37	37	0.7	0.7	25.9	26.42	37.00	3600	0.09
TB2	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23
TB3	0.55			90			0.7	0.7				3600	
TB4	0.55	1	1	180	180	180	0.7	0.7	126	128.55	180.00	3600	0.45
TB5	0.55	1	1	180	180	180	0.7	0.7	126	128.55	180.00	3600	0.45
TB6	0.55	1	1	180	180	180	0.7	0.7	126	128.55	180.00	3600	0.45
TB7	0.55			37			0.7	0.7				3600	
TB8	0.55	1	1	180	180	180	0.7	0.7	126	128.55	180.00	3600	0.45
TB15	0.55			90			0.7	0.7				3600	
TB16	0.55			90			0.7	0.7				3600	
GB1	0.55	1	1	180	180	180	0.7	0.7	126	128.55	180.00	3600	0.45
MIC2	6.6	1	1	300	300	300	0.8	0.8	240	180.00	300.00	3600	0.86
R-VII SEAM													
TB9	0.55	1	1	37	37	37	0.7	0.7	25.9	26.42	37.00	3600	0.09
TB10	0.55	1	1	90	90	90	0.7	0.7	63	64.27	90.00	3600	0.23

Description	Voltage (kV)	POP	OP	Unit Load (kW)	Conn-ected Load (kW)	Total Load in Opera-tion (kW)	DF	PF	Active Power (kW)	Reactive Power (KVAR)	KVA	Work-ing hours	Annual Energy Consumption (KWH x 10^6)
TB11	0.55	1	1	180	180	180	0.7	0.7	126	128.55	180.00	3600	0.45
TB12	0.55	1	1	180	180	180	0.7	0.7	126	128.55	180.00	3600	0.45
TB13	0.55	1	1	180	180	180	0.7	0.7	126	128.55	180.00	3600	0.45
TB14	0.55	1	1	180	180	180	0.7	0.7	126	128.55	180.00	3600	0.45
GB2	0.55	1	1	180	180	180	0.7	0.7	126	128.55	180.00	3600	0.45
Total Belt Conveyor											922.28		6.04
MVF SYSTEM													
MVF 1,MVF2	0.55	1	1	11	11	11	0.7	0.7	7.7	7.86	11.00	3600	0.03
TOTAL MVF SYSTEM													0.03
PUMP													
Main pump 260KW	6.6	2	1	280	560	280	0.8	0.8	224	168.00	280.00	3600	0.81
Main pump 200KW	6.6	4	3	200	800	600	0.8	0.8	480	360.00	600.00	3600	1.73
Main pump 110KW	6.6	2	1	110	220	110	0.8	0.8	88	66.00	110.00	3600	0.32
Face pump 7.5KW	0.55	4	2	7.5	30	15	0.8	0.8	12	9.00	15.00	3600	0.04
TOTAL PUMP													2.89
U/G light	0.11	1	1	95	95	95	0.9	0.9	85.5	41.41	95.00	8760	0.75
TOTAL UNDERGROUND				**5846.5**	**4070**				**2575**	**2299.11**	**3452.04**		**13.98**
80% Div. on B				**4677.2**	**3256**				**2060**	**1839.29**	**2761.63**		**13.98**
Surface + U/G				**5674.7**	**4261**				**2787.25**	**2398.23**	**3676.99**		**17.45**
80% div. on C				**4539.76**	**3408.8**				**2229.8**	**1918.58**	**2941.59**		
Imp PF to 0.98								**0.98**	**2229.8**	**452.78**	**2275.31**		
Reqd. Capacitor									**2x3**	**244.30**			

15.3.4 Phasing of energy Cost of mine1 & mine2

Year	Cost (₹ Lakhs) Mine1		Cost (₹ Lakhs) mine2	
	Risk Gain	Hiring	Risk Gain	Hiring
1	490.98	74.45		
2	978.22	561.69	58.79	58.79
3	988.00	571.47	58.79	58.79
4	1341.00	918.08	661.05	503.87
5	1383.92	961.01	856.04	698.87
6	1153.40	818.04	1204.52	869.16
7	1456.36	1033.44	1092.55	757.20
8	1700.21	1277.30	1137.77	802.41
9	1754.98	1332.07	1162.89	827.54
10	1847.76	1424.84	1234.36	899.00
11	1640.16	1217.25	1234.36	899.00
12	1636.60	1213.68	1189.15	853.79
13	1811.81	1388.90	1224.75	889.40
14	1779.37	1356.45	1331.58	996.22
15	1892.21	1469.30	1260.36	925.00
16	1845.13	1422.21	1331.58	996.22
17	1777.47	1354.56	1262.76	927.41
18	1806.16	1383.24	1199.71	864.36
19	1755.71	1332.80	1369.84	1034.48
20	1673.59	1250.68	1200.11	864.75
21	1548.96	1126.05	1268.78	933.43
22	1644.91	1221.99	1367.30	1031.94
23	1579.82	1156.91	1369.84	1034.48
24	1330.28	994.92	1341.55	1006.19
25	1191.80	856.45	1031.12	695.76

15.4 Salient Electrical Features and Cost Estimate

15.4.1 Salient Electrical Features

S. N.	Description	**MINE-1**	**MINE-2**
1	Installed KW	8281.25	7557
2	Maximum Demand in KVA	4593.37	3328.89
3	Annual energy consumption (KWH)	24.10 (Ultimate)	17.45 (Ultimate)
4	PF	0.98 (lag)	0.98 (lag)

15.4.2 Cost Estimate (MINE-1 & MINE-2)

The total cost estimate of the project and Phased requirement of electrical items is given in **Appendix A.3.1.**

15.5 Communication (MINE-1 & MINE-2)

Coal production has become highly capital intensive due to large scale mechanization for production and transportation using the modern technology. To cope with mechanization, to maintain safety and to improve the efficiency there is a need to establish an efficient means of voice and data communication. The effectiveness and reliability of decision making process depends on a reliable means of information exchange among the different units of surface and underground which totally depends upon the integrated telecommunication systems for voice and data.

In order to improve operational efficiency of the mine, it is necessary to integrate its operational units, in underground and at surface, service units, maintenance units, stores, workshops, administration deptt., road and rail despatches etc. with efficient and reliable communication links which may provide all facilities to be made available for quick decision making, for safety, production and transportation.

15.5.1 Proposed Communication System

The proposed communication system should cater the need of voice communication among personnel related to mine operation, administration and equipment maintenance. The system also takes into account the data communication requirement for mine operation and planning along with the latest office automation facilities.

While preparing the system, due consideration has been given to the state-of-art networking architecture involving the communication of voice, data and multimedia over the same network path, so as to avoid duplicated investment in network and proper conservation of bandwidth.

15.5.2 Communication for underground

A CDS system having 30 lines is proposed for UG communication. The system consists of surface unit, isolator and IS underground unit including IS telephones. The underground units should be intrinsically safe and DGMS approved to use in the underground Indian coal mines. The system should have facility to interlink with the surface exchange so that the persons from any location of the important surface units can communicate to the persons working in different location of underground and vice-versa to meet the main requirement of safety and production.

15.5.3 Surface/Administrative Communication

To meet all the requirements of data and voice communication, 128 lines of IP Enabled Exchange is proposed having the following main features:

15.5.4 IP Enabled Exchange

A 250 line automatic telephone exchange has been envisaged for the effective communication between the various units on the surface. The

EPABX will preferably employ PCM-TDM technique with a non-blocking structure. The EPABX shall have all the latest features like E1 port, LAN/WAN port, etc. EPABX shall be interfaced with BSNL exchange for extending external communication having STD & ISD facility. Self-diagnostic facility shall be provided for EPABX extensions. Sufficient no. of junction lines is to be provided for terminating BSNL, Tie and Trunk lines.

A. Technical Specification of EPABX:

- The exchange shall be microprocessor based stored programme control and PCM-TDM switching with state of art technology.
- Exchange shall be suitable to be operated with DP, DTMF, digital and IP telephones.
- The line cards slots/channels in the main cabinet must be universal type, so that any type of line can be used in any line slot/channel and there shall be no limitation in slot position.
- Exchange shall have both voice and data switching capacity.
- Krone type MDF having capacity equivalent to ultimate capacity of the exchange with GD tubes for high voltage protection and poly switches for current protection on all extensions and trunks.
- System software shall have auto-diagnostic programme to detect the faults and localize them.
- The exchange should support multi-media application as per latest trend. It should be possible to connect PC's, host computers etc. without modem through Digital/ISDN line.
- Exchange shall be DoT/TRC approved with ISDN facility.
- The IP Gateway port of the exchange can be connected with the LAN backbone network for VOIP communication.=

B. Networking Facility:

Exchange is required to operate in any one of the following and shall be suitable for both.

i) BSNL junction and extension exclusively for BSNL lines.
ii) Exchange should also be able to inter-face directly with OFC/DECT systems, if required.

System should be capable to network with the following types of lines:

a) Loop disconnected tie lines.
b) Ring down hot line.
c) Direct inward dialing trunk and outward dialing trunk. (2W/4W E&M Trunks).
d) ISDN line.

C. Features:

a) Flexible numbering scheme
b) Privacy of calls
c) DTMF DID facility junctions.
d) Conferencing
e) Automatic call back on busy extn.
f) Call transfer and Call pick up.
g) Last number radial.

15.5.5. BSNL Communication

It is proposed to provide 20 nos. BSNL telephone extensions to the Mine Office in order to facilitate external communication and to link the Mine with the BSNL's national telephone network. The BSNL telephones shall be provided at the offices and residences of important officials. The BSNL communication facility can be extended by terminating about 5 BSNL lines on the proposed IP enabled EPABX and configuring the same. Besides fixed line BSNL telephone, 10 nos. of BSDL cell one Mobile connection with sets may also be provided to important personnel of the project.

15.5.6 BSNL 2 MBPS leased line

A BSNL 2 Mbps leased line is proposed for communication with area HQ. This leased line shall be used both for voice and data communication with area HQ. A multi service voice and data router shall be used in this network. The router will be equipped with 2 nos. of WAN port and one 1 no. of LAN port minimum.

15.5.7 Specification for Router

Data Interface	:	2 nos. high speed data interface With DOT-35. 1 no. ₹ 232 Sync/Asynchro port, 1 no. Ethernet LAN port.
Link protocol	:	V.35/x.21, SDLC and TCP/IP
Protocol support	:	TCP/IP, RIP
Management	:	SNMP
Power Supply	:	230V AC + /- 10% single phase.

15.5.8 LAN and INTERNET

It is proposed to deploy electronic data processing facilities for production planning, control and project management etc. The system envisages to play a key role in establishment of highly effective Data Base Management System (DBMS) and Management Information System (MIS) etc.

The type of computer would be small business computer with broad facilities and also have specific facilities to carry out:

- Pay rolls
- Financial accounting
- Inventory control
- Material management
- Production, dispatch schedule and variances.
- Accident records etc.
- Resource utilization & MIS.

Before initiating action for installation and implementation of the above EDP system, a detailed system study would have to be carried out, with clearly defined system objectives for identifying the data processing needs and management information system needs of the project. Based on the results and findings of the study, the system configuration and specification have to be decided.

A Local Area Network with 10 PCs is proposed for this project. There shall be an L3/L4 switch centrally located, which h shall be connected to L2 switches which are proposed for desktop connection. The L2 switches at distant locations shall be connected to the L3/L4 switch through the gigabit uplink port. Suitable OS and other application software will be provided. Suitable printers, plotters CD/DVD writer shall be provided. A server with Windows XP/Windows/VISTA shall also be provided.

Internet connection shall also be provided.

15.5.9 L3/L4 Switch:

The L3/L4 switch shall have 24 nos. of 10/100 ports and gigabit ports for connecting to the distantly located L2 switches. The switch shall have sufficient backplane and throughput along with QoS features for both voice and data.

15.5.9.1 Technical Specification :

- 24, 10/100 base autosensing ports + Expansion module slot for Gigabit module for connecting to L2 switches
- Standards compliance – support IEEE 802.3 (flow control), IEEE 802.1p (prioritization), IEEE 802.1Q (V-LAN Trunking), IEEE 802.1d (spanning tree protocol)
- Management – Have built-in SNMP, Web based and Command Line Interface for Management. SNMP v1/v2/v3, RMON.

15.5.10 24 Port L2 switch

The managed L2 switch shall be a workgroup switch 24 port 10/100 having a gigabit uplink port. The switch shall have sufficient backplane and throughout along with QoS features for both voice and data connectivity.

15.5.10.1Technical Specification

- Configuration: 24 nos. 10/100 Autosensing Ports + 1 gigabit Uplink port.

- The switch should support QoS classification of incoming Packets for QoS flows based on Layer 2, Layer 3 and Layer 4 Fields.
- Standard Compliance-support IEEE 802.3 x (Flow control, IEEE 802.1p), IEEE 802 1Q(V-LAN Trunking), IEEE 802.1d (Spanning tree protocol)
- Management- Have built-in SNMP, Web based and Command Line interface for Management. SNMP v1/v2/v3, RMON.

15.5.11 Electronics Attendance system

This system shall be for attendance monitoring and evaluation. The whole attendance system consists of card reader/data collection terminals, hardware and support software with inbuilt clock and timer. The plastic card with contactless chip/magnetic stripe having the unique identification will be read by special reader unit, installed at attendance room. The card can be personalized by digital printing, thermo printing or by embossing.

15.5.11 Master slave digital clock

Four-digit display units indicating hours and minutes, shall be installed at key location in the administrative building project office, pit office and other selected areas. These will be controlled from a master station located in the dispatcher control room. Digits should be readable in day and night from a distance of at least 25 meters.

15.5.12 Specification of UPS

a) Capacity : 2 KVA, Single phase
b) AC Input voltage : 220/230V, 1 phase ± 15-20% variation
c) Frequency : 50 Hz ± 5%
d) AC output voltage : 230 VAC, 1 phase
e) Power factor : 0.8 lagging to unity
f) Regulation : both line and load ± 1%
g) Wave form : Sinusoidal, < 5% THD
h) Noise level : 55 db
i) Charger : Constant voltage limited current type, charging time of 90% discharged battery maximum 10 Hrs.
j) Battery : Sealed Maintenance free (of total capacity around 3100 watt hours)
k) Battery Back-up : 4 hrs. at full load
l) Certifications : EU/EN/UL/ISO 9001
m) Rack mount Design : 19” mountable with sliding guides
n) Communication : RS232 interface port and Ethernet port with Web management supports.

Features :

a) The 2 KVA UPS with 4 hrs. battery back-up and accessories shall have the facility of input voltage cut off device to protect the 2 KVA UPS with 4 hrs. battery back-up ad accessories against excessive over/under voltage conditions at the input side.

b) The system shall have surge suppression to prevent hardware damage.

c) The system shall have facility for continuous display of load and battery charging conditions and automatic cut off device to avoid over loading and over charging.

d) The 2 KVA UPS with 4 hrs. battery back-up and accessories system shall be true on-line sate of the art based system capable of providing precise sine wave output to the load.

15.5.13 Testing & Measuring Equipment :

a) Digital Multimeter :

Hand-held and compact type with necessary probes, covers etc. 4 ½ digit with sharp LCD display

	Function	Range	Accuracy
a	DC voltage measurement	500mV to 1000V	± 0.025%
b	DC current measurement	500mA to 10A	± 0.2%
c	AC voltage measurement	500mV to 750V	± 0.3%
d	AC current measurement	500mA to 10A	
e	Resistance measurement	500W to 50MW	
f	Eassy calibration facility		
g	Over load protection in all ranges		
h	Power supply	Battery (6V or 9V) operated	
i	Frequency	0.6 Hz to 500 KHz ± 0.03%	
j	Capacitance measurement	50 nF to 50 micro F, ± 1.0% for diode & transistor	
K	Component test	Continuity Buzzer	
L	Continuity test	Test lead, Rubber Holster	
m	Standard Accessories		

b) Power supply :

The DC power supply of different range is proposed for testing and calibrating of the electronic cards and equipment. The variable DC output from 0 to 30V and fixed DC output of +5 V and ± 12V are proposed in the same power supply unit. The specifications are as under:

Input voltage : 220V AC + 5%, 50 Hz

Output voltage : a) 0 – 30V @ 0-5 A (variable)

b) 5V (fixed output) @ 3A
c) ± 12 (fixed output) @ 1.5A

Display	: Digital, for voltage current
Output polarity	: Positive & negative
Protection	: Overload
Ripple voltage	: Less than 1 mV p-p

c) Tools & accessories :

Suitable tool sets such as screw drivers of different sizes, soldering iron, de-soldering pump solder, wire cutter, wire stripper etc. are required for proper maintenance of the system

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Chapter-16

CIVIL CONSTRUCTION

16.1 General

The life of Tilaboni mine has been estimated as more than 25 years. Permanent specifications have therefore been adopted for the construction of residential and service buildings.

The civil construction envisages the estimated capital requirement of the project for 1.86 MTY target capacity of coal production. Specifications and cost estimates towards the civil construction are based on BPE guidelines, CMPDI norms and practice for planning of coal mines.

16.2 Cost Index

Based on prevalent rate of different building materials in the project area, the cost index for this project comes to 4159 with respect to base 100 as on 1.10.1976 in Delhi. The details of cost index have been furnished in Appendix-A.2.3.

16.3 Service Building

16.3.1 As per the requirement of the project, Agent Office, workshops, stores, haulage room, winder engine house, substations, pit head bath, fire fighting stations and other statutory buildings have been proposed.

16.3.2 The locations of the proposed buildings have been earmarked near Mine-1 and Mine-2. The detailed break up has been shown in Appendix-A.2.1.

16.3.3 Salient features of Service Buildings:

16.3.3.1 Agent Office, Mine Office

Provision has been made for Agent Office, Mine Office. These buildings have been envisaged as RCC-cum-brick masonry structures.

16.3.3.2 Workshop and Stores

In this report, provisions have been made for workshop and store to cater the needs of all requirements including washing. The area of various shops and facilities are envisaged on the basis of technological and operational requirements.

The buildings are envisaged to be of structural steel constructions with RCC foundation, 22G CGI sheeting on roof and 24G CGI sheeting as side

cladding, cubicle for shop-in-charge, small toilet facility, cage ladder for access to roof etc.

16.3.3.3 Sub-Stations

Two sub-stations at Mine-1 and one sub-station at Mine-2 have been considered as per the requirement. These will be brick masonry, RCC beam and slab construction with RCC louvers for ventilation and ducts with proper size for electric cables.

16.3.4 The list of service buildings with their estimated cost has been given in Appendix-A.2.1.

16.4 Residential Buildings

16.4.1 For carrying out depillaring activity at Mine-1, the existing quarters (about 730 nos. of different types) of Tilaboni colliery are to be demolished. New quarters (only for the requirement of Project) are to be constructed in lieu of the old ones at a suitable proposed location. The details of the quarters which are required for this Project are shown in Appendix-A.2.2.

No additional residential buildings have been taken into consideration as the requirement for additional manpower would be met from the surplus manpower of the area/company.

16.4.2 The land for the proposed buildings will be identified by the colliery authorities.

16.4.3 The tentative estimated cost towards these residential buildings has been shown in Appendix-A.2.2.

16.5 Roads & Culverts

16.5.1 Approach Road

Since Mine-1 is well connected with the road network, provision has been kept for strengthening and widening of existing road. For Mine-2 an approach road of length 1 km has been provided which is shown in Appendix-A.8.2.1.

For approaching the new Tilaboni Township, provision has been kept for new approach road for a length of about 2 km which is shown in Appendix-A.8.2.2.

16.5.2 Colony Roads & Culverts

The lengthy of colony road has been estimated as 4.9 km. The specification has been given in Appendix-A.8.2.3.

16.5.3 Coal Transport Road

A new railway siding has been proposed for this project. To transport the coal from Mine-1 to the proposed siding an existing single lane will be used after proper strengthening and widening to double lane.

For Mine-2, a double lane road of length 3 km has been envisaged. The details have been shown in Appendix-A.8.2.4.

16.5.4 Road Diversion

A road length of 3 km is proposed for diversion of Ukhra-Laudoha DB road with estimated amount as detailed in Appendix-A.8.2.5.

16.5.4 Capital requirement

The capital requirements for approach road, colony road and coal transport road have been furnished in Appendices-A.8.2.1, A.8.2.2, A.8.2.3 & A.8.2.4.

16.6 Water Supply and sewage disposal arrangement

Underground water is the main source of water required for the Project and residential colony. The requirement of potable water and industrial water for the two options considered under this report are as follows:

Requirement	Risk-Gain Sharing	Equipment Hiring
Potable water (klpd)	470	318
Industrial water (klpd)	1045	1045

16.6.1 Colony Water Supply

Since the proposed location of the shifted colony will be identified later, at present well water has been kept as water source. It is also proposed to construct water treatment plant, ground reservoir and overhead reservoir at the colony site.

The estimated capital investment towards this purpose has been detailed in Appendix-A.8.3.1.

16.6.2 Sewerage system of proposed shifted colony

Colony sewerage has been proposed to be dealt through septic tanks and soak pits. The details have been given in Appendix-A.8.3.2.

16.5.3 Industrial Water Supply

Water from underground mine has been considered as the source of water. Water treatment plants have been envisaged for treatment of mine water, for both Mine 1 and Mine 2 to supply water to continuous miner

panels. Clean water ground reservoirs have also been provided for both the mines. The estimated capital has been worked out and given in Appendix-A.8.3.3.

16.6.4 Industrial Sewerage

It has been considered that the industrial wastes from workshop and other industrial establishments would be led through oil and grease traps.

The effluent coming out of the industrial premises is proposed to be treated and led to the settling tank and to be cycled for various industrial uses for this project. The domestic sewage generated in industrial premises has been considered to be dealt in septic tanks and soak pits.

The details have been furnished in Appendix – A.8.3.4.

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Chapter-17

MANPOWER, PRODUCTIVITY AND TRAINING

17.1 Existing Status

The manpower deployed at Tilaboni Colliery as on 01/03/2018 is as under:

Sl. No.	Classification	Manpower
1	Underground	754
2	Surface	150
	Total	**904**

17.2 Manpower requirement

Manpower (grade-wise) requirement as given in Appendix-B for the proposed project has been estimated for operating two units i.e. Mine-1 and Mine-2. Manpower has been assessed for operating four Continuous Miner and one LHD district (for roof heightening). Manpower has been assessed for the target production of 1.86 MTY keeping in view the location of working districts, work culture and work load norms in the Continuous Miner district of Jhanjra UG mine. Total manpower requirement (designation-wise and category/scale-wise) of the project has been depicted in Appendix-B.

Total number of manpower including 16% absenteeism under different heads i.e. face, transport, ventilation, safety, welfare, CHP etc. has been worked out as 1203 and 799 in Risk-Gain Sharing option and Equipment Hiring option respectively in the target year. In addition to this, Security Personnel (33 nos.), civil maintenance, Light vehicle and canteen facilities are proposed to be outsourced, hence provision for manpower have not been made against those heads. Break up of manpower for underground and surface jobs in the target year are as tabulated below:

Manpower	Risk-Gain Sharing option	Equipment Hiring option
Underground	887	503
Surface	316	296
Total	**1203**	**799**

Requirement of the tenancy land and the employment under CIL R&R policy for the two options considered under this report are as tabulated below:

Particulars	Risk-Gain Sharing option	Equipment Hiring option
Tenancy land (in ha)	713.92	711.92
Employment (in nos.)	883	880

As per the CIL R&R policy, employments would have to be provided @ 2/acre of land. Those persons may be suitably absorbed in this project or in the nearby collieries/ areas after providing necessary training. Surplus manpower, in case of Equipment Hiring Option, would be deployed for operating the nearby collieries of the area/company.

17.2 Manpower phasing:

It is expected that the existing underground production from Tilaboni Colliery will continue upto 3rd year and the existing manpower will be deployed for that. Considering the existing production, total manpower requirement has been worked out. The project is envisaged to achieve the target production in the 7th year when all the CM panels will become fully operative.

Following table shows the phasing of manpower, considered in this report (Appendix-B1), as per the Project Implementation Schedule and building up of production capacity:

Risk-Gain Sharing Option

Manpower	1st year	2nd year	3rd year	4th year	5th year	6th year	7-18th year	19-25th year
UG	754	754	754	746	764	887	887	808
Surface	150	150	150	316	316	316	316	316
Total	**904**	**904**	**904**	**1062**	**1080**	**1203**	**1203**	**1124**

Equipment Hiring Option

Manpower	1st year	2nd year	3rd year	4th year	5th year	6th year	7-18th year	19-25th year
UG	754	754	754	438	446	503	503	491
Surface	150	150	150	296	296	296	296	296
Total	**904**	**904**	**904**	**734**	**742**	**799**	**799**	**787**

17.3 Productivity

With the present high wage structure and with wages forming the main bulk of the cost structure, it is essential to improve the productivity to a reasonable limit. With this prime consideration, appropriate mechanization has been envisaged in this report, to improve the productivity for the project.

The project will be worked on three shift basis with 8 hours duration of each shift and 300 working days has been envisaged while planning. The yearwise manpower at the end of the year has been tabulated in Appendix-B.1. The overall productivity of the target year works out to 5.90 t and 8.88 t in Risk-Gain Sharing option & Equipment Hiring option respectively.

17.4 Training

The investment on expensive plant and machinery combined with human resources all add to the cost of production. Return on such investment can be justified by productivity alone which, however, depends on capacity utilization of the machines and the men deployed for the purpose. The most important factors amongst others, influencing capacity utilization of a machine is its reliability to perform the duty envisaged which is once again fully dependent on the quality and technical skill available at the user's end to ensure that the machines perform at the expected level. For the application of intermediate technology as envisaged in this report, it is essential to impart proper training to the operators, the maintenance staff and in building up a culture towards a healthy maintenance engineering organization and team spirit. The project will require a relatively high proportion of skilled workers.

With safety and above objective in view, it is proposed to train the operators and other workmen at training centre and at existing mines where CM and LHDs have been introduced for development and depillaring. Likewise, the technicians need to be guided on 'preventive maintenance measures' and use of other modern scientific aids for maintenance work so that 'down time' on machine is minimum. The implementation of a suitable incentive scheme for face workers will go a long way in ensuring the success of this project.

Managerial and supervisory staff will need to be exposed to the new technology (mechanized B&P with Continuous Miner) by outside or in house training in order to make them competent for the new responsibility they will have to competent for the new responsibility they will have to shoulder.

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Chapter–18

SAFETY & CONSERVATION

18.0 The report has been drawn up keeping all the safety aspects in view. All the precautions that have been laid in Coal Mines Regulations, 2017 under the Mines Act, 1952 and the conditions imposed by DGMS on various operations have to be followed strictly without any deviation.

18.1 Degree of Gassiness

The seams of the mine is degree–II in gassiness. Study should be conducted for seams in Mine No. 2 as and when they are approached for mining to ascertain the gassiness of the seam.

- Regular gas survey should be carried out as per statute. If the change in gassiness is recorded, the provisions have to be modified accordingly. Emission of CH_4 should be monitored regularly to take precautions against accumulation of inflammable gas in the working faces.

- Adequate provisions of filter type self rescuers has been made to enable everybody to carry it underground. These should be weighed regularly on a sensitive balance and replaced as and when required.

- Stone dust barriers have to be provided as per statute.

- Provision has been made in the report for telemonitoring system, mobile gas chromatograph, methanometer & other appliances related with mine environment for regular monitoring of methane and carbon monoxide in the mine.

- Development should be done using auxiliary fans for providing adequate quantity of air upto the faces. Quantity of air provided for the B&P districts should be adequate to keep the percentage of CH_4 below statutory limit.

- Interlocking of auxiliary fans with face machinery should be practiced.

18.2 Inundation

- It is well known fact that the prospecting boreholes can be a source of danger, because later on these get connected with UG workings. Therefore, it is of paramount importance that these boreholes do not get connected with UG galleries. In case some boreholes do get connected, these should be suitably plugged preferably with cement

grout. The boreholes from the surface should also be suitably plugged, so that water from the surface does not find its way through these boreholes.

- Proper precautions should be taken to prevent eruption of water from the workings of upper seams. Any place in a seam approaching a fault passing through top seam which may contain accumulation of water, adequate precautions should be taken against such eruption of water.

- To prevent mine disaster from inundation, suitable cadre structure for mine surveyors should be evolved and up-gradation of their skill by availing facilities at various institutes, appointment of qualified surveyors. At area level infrastructure including computerized facility should be provided to oversee survey work of the mine. R & D efforts should be made to develop a system for construction of water tight chamber as last refuge below ground in case of inundation.

- A careful assessment of the danger of inundation from surface water should be made before the onset of every rainy season & adequate precautions against such danger should be clearly laid down & implemented.

- During rainy season, blockage of nalla or stream may occasionally occur on the upstream side. It is therefore necessary to keep a constant watch on the upstream of river/nalla & take suitable precautions.

- Part of the proposed mine workings falls within the HFL of nalas. All the mine openings should be kept at least 3m above the HFL.

- No working shall be made in the seam, which is within 60m of waterlogged working of the same seam or other seam(s), in any direction or any overlying seam, which may be waterlogged. In case of occurrence of water in any direction, no work should be done except dewatering. While approaching any old and abandoned area which may contain water, use of safety boring apparatus must be done.

- As a precaution from underground inundation, provision for two safety boring apparatus has been made in the Project Report.

- Working plans of adjacent mines should be properly maintained and updated regularly so that before approaching towards depillared/ waterlogged area of adjacent mines adequate precautions could be taken.

- The panels would be rising as far as practicable. This will ensure self drainage of panels and prevent likely accumulation of water in the goaf.

- Depillaring of panels would be done from dip to rise within the panel and in panels within the property, as far as practicable. In case

depillaring is done in the rise of the property due to any reason what so ever, permission of DGMS has to be taken, and all the conditions stipulated in the permission should be strictly complied with.

- Pumping capacity and number of pumps has been worked out so as to take care of increased dewatering required during the rainy season and dewatering of the upper water logged seams.

- The main sump has been proposed of adequate size and sufficient numbers of standby pumps have been provided.

- Sufficient barrier would be left against fault planes. Precaution would be taken while working near such fault planes against passage of water along such fault planes from surface/ overlying seams.

- Proper precautions would be taken to prevent eruption of water from the workings of upper seams. Any place in a seam approaching a fault passing through top seam which may contain accumulation of water, adequate precautions should be taken against such eruption of water.

- To prevent mine disaster from inundation, suitable cadre structure for mine surveyors should be evolved and up-gradation of their skill by availing facilities at various institutes, appointment of qualified surveyors. At area level infrastructure including computerized facility should be provided to oversee survey work of the mine. R & D efforts should be made to develop a system for construction of water tight chamber as last refuge below ground in case of inundation.

- Periodical inspection of the possible sources of surface/underground inundation, especially during rainy season, will be ensured.

- All the precautions under Reg. 150 & 151 of CMR, 2017 and DGMS circulars should be strictly complied with.

18.3 Dust Suppression

- The most effective method of dust suppression is to suppress the dust at the source of generation, before the dust becomes airborne.

- Dust suppression by spray is an integral part of B&P mining with blasting technology. Water should be provided to the working faces through pipes for which PR has provided adequate capital provisions.

- Workings away from the active areas should be stone dusted as per the statute.

- For monitoring the level of dustiness and quality of dust, regular sampling and analysis of mine dust has to be done as per statute.

- Pneumatically operated roof bolters also use water for flushing out the cuttings from the drill holes. This automatically suppresses the dust and also increases life of the drill rods and drill bits.

- From surface to railway siding, transportation of coal should be in covered manner so that dust generation can be prevented.

18.4 Fire and Spontaneous Heating

In underground working places, arrangements for dealing with fire occurrence have to be provided. At the fire stations, water hoses, fire extinguishers, sand etc. shall be stacked and shall be readily available. Provisions for isolating the worked out goaf and dealing with any heating shall be done by providing suitable fire stopping. For dealing with underground fire following precautions shall be taken:

- Size of panels shall be such that it can be extracted within the incubation period. As the incubation period of the seams are not known, a period of 9 months has been considered for planning purpose as incubation period. Accordingly sub-panelling has to be provided during depillaring operation.

- Minimum width of the pillars according to the depth shall be maintained in order to avoid any possible crushing etc.

- Doors and regulators etc. would be sited in stable ground.

- Roads, crossing faults etc. would be adequately supported and lined.

- Preparatory stoppings shall be kept ready with sufficient material in store in the development headings at the out-bye end of the sub-panel so that in case of outbreak of any UG fire, the sub-panel can be abandoned & sealed off by constructing fire stoppings in the minimum possible time.

- Before commencement of depillaring operation, all the inflammable material should be cleaned and removed from the face. Before moving out of a liquidated panel, timber and other extraneous material would be withdrawn as far as possible.

- Preparatory isolation stopping must be completed in the development headings needed for ventilation and transport before starting splitting operation.

- Every panel must be quickly & effectively sealed off by isolation stoppings in development headings in the pillars adjacent to the main dips after completion of extraction and salvaging of material from the panel.

- Underground workman shall be supplied with self rescuer for meeting occasional emergency situation of heating and fire if any.

- Stone dust barrier/water barriers shall be provided in the roads of the districts as per requirement of the statutory requirement.

- Environmental monitoring is envisaged to ascertain the UG environmental condition. Any indication of heating shall be timely dealt with.

- It is also proposed to continuously monitor the environment inside the goaved out areas especially near the isolation stoppings and working areas with the help of continuous environment monitoring system. This will help to keep track of temperature, CO, CO/O_2 ratio etc., so that appropriate steps to control eruption of fire can be taken. Adequate provision for continuous environment monitoring system with properly trained manpower is envisaged in this report.

- To deal with surface fires, in office buildings, CHP, workshop, stores, etc. portable fire extinguishers shall be maintained at suitable places.

- Considering the risk of fire, producing company should rank its coal mines on a uniform scale according to its risk from fire on the basis of scientific study/guidelines as framed by DGMS.

- Producing company shall also formulate and implement structured training programme for development of awareness and increasing effectiveness of emergency response in case of fire amongst work persons, officials and management.

- During depillaring some coal left in goaf may cause spontaneous heating. Provision of nitrogen flushing plant has been made in this PR for dealing with spontaneous heating.

18.5 Roof Control

- This report envisages Bord & Pillar mining with CM in different seams. For supporting the roadways and exposed roof, roof bolting with resin capsules shall be used as a primary means of support for freshly exposed roof in development as well as in the depillaring districts.

- For the roof category ‘poor’ having value of RMR of 40 or less or where there is excessive seepage of water from the roof strata, additional roof bolts exclusively with resin capsules shall be used to ensure adequate and immediate reinforcement of the strata.

- For effective roof control, steel supports in the form of Roof Bolts, W-straps/ wire mesh with Resin/ Cement capsules is necessary. As this is a new project, RMR of the roof strata has to be determined. The mine management will prepares SSR on the basis of generated RMR and gets it approved by DGMS before adopting the same for implementation.

- It is suggested that monitoring of roof movement should be carried out regularly and based on the analysis of roof movement data, the roof bolting pattern would change.

- Improved strata control will enable increase in gallery width during development. Wider galleries will ensure smoother movement of loading machines and increased safety of persons who have to work near the machines.

- The main dips and panels will have to be super-imposed as far as practicable.

- On account of contiguity of Seam R-VIIA and Seam R-VIIB during depillaring operations, regular test holes are to be drilled to confirm the parting between these seams. All the precautions that have been laid in CMR 2017, have to be followed during simultaneous extraction of the contiguous seams.

- As per the recommendation of the 8th Safety Conference, it is proposed to have a 'STRATA CONTROL CELL' at corporate and area levels to assist mine managers for formulation of systematic Support Rules, monitoring strata control measures in a scientific way to ensure efficiency of support system and for procurement / supply of quality supporting materials. Such cell shall be manned by adequate number of technical personnel headed by senior officers.

- Due emphasis shall be given to support the sides of galleries while framing systematic support rules. Suitable steps shall be taken by the coal producing company to inculcate a culture of "no work at face other then supporting work", till the roof is supported by roof bolts upto at least 0.6 m from the face. To ensure proper drilling for roof bolting in all types of roof strata, suitable fit for use roof bolting machine should be used.

- Risk assessment exercise shall be carried out in the mine for assessing the risk from the hazards of roof & side falls and identifying the control mechanism with specific responsibility for implementation coal producing company should take steps to impart structured training to officials, supervisors and support personnel on roof bolting.

- Before adopting depillaring in this mine necessary permission has to be taken from DGMS and conditions as stipulated in the DGMS permission should be strictly followed. Separate support rules, as per DGMS statutory provisions, shall be strictly adhered to.

18.6 Subsidence

- This report envisages depillaring with caving in the area free from surface constraints. So there is likelihood of subsidence at the surface due to proposed depillaring operation. Due to caving of strata, subsidence cracks will reach the surface. In order to protect the surface features like villages, trestle of HT line overlying the mine, it is proposed to leave coal in the form of solid pillars below and within safe distance of surface feature defined by angle of draw which has been observed to be about 32^{o} in some mines of ECL.

- It is proposed to acquire the land, below which caving shall be done and the area would be fenced off during and after extraction. The subsidence cracks, which would reach the surface, will have to be packed tightly with soil, mud and non-carbonaceous debris and regularly dozed so that the topography does not change substantially and artificial water bodies are not created.

- Surface cracks / pot holes found as a result of extraction of pillars shall be filled up expeditiously and the filling material shall be well rammed into the cracks/pot holes and kept topped up as often as necessary thereafter to prevent breathing of air/seepage of water into the mine.

- Surface infrastructure which would be affected by caving operation have been proposed to be shifted / diverted or sufficient protective pillars would be left in underground to protect such structure from damage. Surface cracks formed due to mining activity would be suitably reclaimed so as to restore the original topography as far as possible. All other conditions stipulated by MOEF in the approved EMP should be complied with.

- Subsidence study in the area proposed for caving will be carried out. Pillars will be extracted accordingly. Regular monitoring of the filled up surface area over the panel shall be done so as to ensure that no accumulation of water takes place at the surface over the panel and the filling remains intact.

- Provision has been made for a strata monitoring cell, as mentioned above, to monitor strata behavior during depillaring at the mine.

18.7 Conservation of Coal

Coal is scarce and non-renewable energy source. Coal is also much in demand from mainly power sector for electricity generation. Its utility vis-à-vis conservation is the main concern and need of the time of coal producing company. Technology adopted for exploitation of coal should be as optimum as to extract the coal, not to waste the coal in below ground.

Present report envisages Continuous Miner technology for exploitation of coal. This technology extracts maximum coal from below ground and leaving some percentage of coal below ground. The rate of extraction by continuous miner being high, it will be possible to create larger panels and thus reduce the coal blocked in pillars for sub-panelisation. However, studies should be carried out to maximise coal extraction percentage from below ground.

In order to conserve coal, if DGMS permits, then pillars falling within the angle of draw of the surface features, partial extraction methods can be adopted.

From surface to railway siding, transportation of coal should be in covered manner so that the extracted coal gets conserved to maximum.

18.8 Scientific Studies

It is necessary to undertake the following scientific studies for proper implementation of this report:-

- Scientific studies related to this project report should be in view of RMR study, subsidence prediction study and ventilation system design.

- Scientific studies for pillar size with enhanced gallery width, development height, split gallery and slice width more than that stipulated in the statute.

- Scientific studies for determining 15m hard cover line.

- To undertake the physico-mechanical properties of rocks for designing the support system & caving characteristics of the roof strata. It will be necessary to determine 'Rock Mass Rating' for preparing the support plan so that systematic support rules can be framed.

- To determine the load bearing capacity of floor of seams as shale floor may pose problem for heavy crawler mounted machine like continuous miner, particularly where there is a chance of water percolation.

- To determine the maximum unsupported cut-out distance during development and extraction stage.

- To undertake subsidence prediction studies for extraction of multi seams and their effect on the surface.

- To undertake hydrogeological studies for quantifying ground water and to assess impact of caving on existing ground water regime.

- It is necessary to undertake the anchorage tests for roof bolts to find out their efficacy.

Adequate capital provision for conducting above mentioned studies have been kept in the report and is shown at Appendix-A.8.5.

18.9 Additional permission/relaxations required from DGMS

This report envisages introduction of continuous miner panel. Additional permission/relaxations from certain provision of CMR from DGMS would be required for maximizing the extraction percentage. Some of the exemptions specific to the continuous miner technology are as follows:-

i) Increasing development height to more than 3.0m in seams where thickness permits i.e. seams R-VIII B1 and R-VII.

ii) To circulate quantity of air required at LVC of the Continuous Miner district as per the international standard of 25 m^3/sec instead of

2.5m^3/min/t of daily output.

iii) Increasing bord width to more than 4.8m for ensuring full utilisation of the machine & preventing cutting of corners of the pillars.

iv) Working in slices without support during depillaring with CM.

v) Corners of the pillars to be rounded to allow easier vehicular access.

vi) Use of two or more number of auxiliary ventilation fans in a district.

vii) Deployment of battery/ diesel operated equipment in underground.

Other exemptions may also be required to approve the machinery and/or mining system.

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Chapter-19

ENVIRONMENT MANAGEMENT

19.0 Introduction

Environmental Clearance for Tilaboni UGP based on the project report of 1990 was granted by MoEF for a capacity of 1.17 MTY vide letter no. J-11015-35/89-IA.II(M) dated 29.10.92. However, the above PR was not approved and the project did not go on-stream.

The present project report envisages expansion in coal production capacity from present EC capacity of 1.17 MTY to 1.86 MTY (Normative) and 2.14 MTY (Peak) with expansion in leasehold area from 436 ha to 869 ha i.e. involvement of additional 433 ha of land. The life of the mine at rated capacity will be more than 25 years.

Proposed Tilaboni UG Project is one of the mines within the Cluster No. 12 Group of mines for which Environmental Clearance has been granted by MoEF vide letter no. J-11015-76/2011-IA-II.(M) dated 09.02.2015. Again cluster no. – 12 was amended in view of 1 BT production target of CIL by 2019-20. The amended EC was obtained on vide even letter no. dated 03.03.2016. There was no change in leasehold area as well as production capacity of Tilaboni UG in amended EC.

19.1 Existing Environmental Scenario

19.1.1 Ambient Air Quality

Routine Environmental Monitoring is carried out from 2nd fortnight of May, 2015 in compliance of EC condition for Cluster 10. The summarised data for air quality stations located near to the project from 1st fortnight of November, 2015 to 2nd fortnight of October, 2016 is shown in the table given below:

Name of monitoring equipment & method used			PM_{10} Respirable Dust Sampler with glass µ fiber filter		$PM_{2.5}$ Fine Dust Sampler with 47mm PTFE Teflon filter		SO_2 Modified West & Gaeke Specto-photometer		NO_x Modified Jacob & Hocheiser Method	
Equipment sensitivity			1.0 µg/ m^3		1.0 µg/ m^3		4.0 µg/ m^3		4.0 µg/ m^3	
Permissible NAAQ standard (CPCB), 2009			100		60		80		80	
Monitoring Location	No. of Samples Drawn	Category* (R- I, S)	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kumardihi village	24	R-I	62.7	118.3	18.7	56.5	<10	<10	12.4	18.3
Ichhapur village	12	R-I	62.1	124.8	17.4	50.3	<10	<10	9.6	18.4
Madhaiganj village	12	R-I	63.6	105.2	17.9	40.4	<10	<10	14.3	19.6
Bankola village near railway siding	20	R-I	68.6	168.9	20.1	78.1	<10	<10	14.3	22.8

Observations:

In **residential & industrial areas,** the maximum values for PM_{10} have exceeded NAAQS, 2009 standards at all nearby stations on a few occasions and the maximum value of $PM_{2.5}$ have exceeded NAAQS, 2009 standards at 1 station while the maximum values of SO_2 and NO_X are within the standards. The concentration levels of PM_{10} are within limit as per G.S.R. 742(E) dated 25.09.2000 for old coalfields of Raniganj and Jharia. Both the standards are given in the tables below. Appropriate mitigation measures have been implemented to bring the level within the standards as mentioned in section 19.3.

ENVIRONMENTAL STANDARDS:

(I) Environmental standard for Raniganj Coalfield vide MOEF, Govt. of India, Gazette Notification No. GSR 742 (E) dated 25.09.2000 for 24 hourly samples at 500 meters from dust generating point:

Station Category	**Pollutant Concentration (µg/m^3)**			
	TSPM	PM_{10}	SO_2	NOx
Industrial	700.0	300.0	120.0	120.0
Residential	200.0	100.0	80.0	80.0

Station Category	**Limits for noise (Leq) dB(A)**	
	Day Time (6am-10pm)	Night Time (10pm-6am)
Industrial	75.0	70.0
Residential	55.0	45.0

(II) National Ambient Air Quality Standards (NAAQS), 2009 for residential, industrial and rural areas for 24 hourly samples:

Pollutant	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**NO_X**
Concentration (µg/m^3)	100.0	60.0	80.0	80.0

19.1.2 Water Quality

For the studies of water quality samples of drinking/ground water, mine discharge and surface water are being collected and analysed and the results are shown in the table below:

Mine Discharge Quality

Cluster	12	**Effluent Water (MOEF Schedule-VI Standard)**
Station No	12MW11	
Station Name	Tilaboni UG	
Month	December	
Fortnight	First	
Date of Sampling	14-Dec-15	
Colour	3	Unobjectionable
Odour	Unobjectionable	Unobjectionable
TSS	16	100.0
pH	8.0	5.5-9.0

Temperature (Deg C)	21.9	Shall not exceed 50C above the receiving water temp
Oil & Grease	<2.0	10.0
Total Residual Chlorine	0.03	1.0
Ammonical Nitrogen	0.52	50.0
Total Kjeldahi Nitrogen	1.23	100.0
Free Amonia	<0.4	5.0
BOD	4	30.0
COD	32	250.0
Arsenic	<0.005	0.2
Lead	<0.005	0.1
Hexavalent Chromium	0.03	0.1
Total Chromium	0.04	2.0
Copper	0.03	3.0
Zinc	0.04	5.0
Selenium	<0.005	0.05
Nickel	<0.10	3.0
Fluoride	0.66	2.0
Dissolved Phosphate	1.64	5.0
Sulphide	0.009	2.0
Phenolics	<0.001	1.0
Manganese	0.26	2.0
Iron	0.14	3.0
Nitrate Nitrogen	3.9	10.0
Cadmium	<0.001	0.003
Total Dissolved Solids	572	Not Specified

Ground Water Quality

Cluster No	12	**Indian Drinking Water Standard (IS-10500)**
Station No	12GW8	
Station Name	Dugwell at Kumardih "A" colliery	
Month	May'16	
Fortnight	Second	
Date of sampling	11-May-16	
Colour,Hazen unit Max	3	5
Odour	Unobjectionable	Unobjectionable
Taste	Agreeable	Agreeable
Turbidity,NTU Max	4.4	5
pH	7.87	6.5-8.5
Total Hardness	210	300.0
Iron	<0.06	0.30
Chlorides	98	250.0
Res Free chlorine	0.04	0.20
Dissolved Solids	638	500.0
Calcium	64	75.0
Copper	<0.03	0.05
Manganese	<0.02	0.10
Sulphate	93	200.0
Nitrate	14.17	45.0
Fluoride	0.26	1.0
Selenium	<0.005	
Arsenic	<0.005	0.05
Lead	<0.005	0.05
Zinc	0.04	5.00

Hex Chromium	<0.01	0.05
Boron	<0.01	1.00
Coliforms (MPN)	Nil	Nil
Phenolics	<0.001	0.001
Alkalinity	164	200.0
Cadmium	<0.001	

NOTE: All parameters are in mg/l unless specified otherwise.

- General ground water quality in the area represented through well water at Kumardihi A colliery have been found to be fresh with lower level of hardness, pH value slightly basic within quite normal range, less iron content, fluoride content within desirable limit. Other various parameters of the samples are found to be within the permissible limits.
- Mine water quality of mine adjacent to project has been found within the prescribed as per MoEF schedule-VI standard for effluent water.

19.1.3 Ambient Noise level

Noise level measurement has been carried out from the pit top located at the mine. The results are given below:

Noise Level Observations

Cluster No	Station No	Station Name	Month	Fortnight	Date of Sampling	Noise Level dB(A)
12	12N11	Pit-top Tilaboni UG	November	First	04-Nov-15	68.2
12	12N11	Pit-top Tilaboni UG	November	Second	30-Nov-15	71.4
12	12N11	Pit-top Tilaboni UG	December	First	10-Dec-15	69
12	12N11	Pit-top Tilaboni UG	December	Second	28-Dec-15	67
12	12N11	Pit-top Tilaboni UG	January	First	14-Jan-16	62
12	12N11	Pit-top Tilaboni UG	January	Second	30-Jan-16	64
12	12N11	Pit-top Tilaboni UG	February	First	03-Feb-16	62
12	12N11	Pit-top Tilaboni UG	February	Second	18-Feb-16	67
12	12N11	Pit-top Tilaboni UG	March	First	04-Mar-16	61
12	12N11	Pit-top Tilaboni UG	March	Second	16-Mar-16	67
12	12N11	Pit-top Tilaboni UG	April	First	12-Apr-16	66
12	12N11	Pit-top Tilaboni UG	April	Second	30-Apr-16	67
12	12N11	Pit-top Tilaboni UG	May	First	03-May-16	67
12	12N11	Pit-top Tilaboni UG	May	Second	30-May-16	68
12	12N11	Pit-top Tilaboni UG	June	First	10-Jun-16	67
12	12N11	Pit-top Tilaboni UG	June	Second	16-Jun-16	69
12	12N11	Pit-top Tilaboni UG	July	First	12-Jul-16	66
12	12N11	Pit-top Tilaboni UG	July	Second	30-Jul-16	64
12	12N11	Pit-top Tilaboni UG	September	Second	20-Sep-16	67
12	12N11	Pit-top Tilaboni UG	October	First	05-Oct-16	69
12	12N11	Pit-top Tilaboni UG	October	Second	19-Oct-16	66
12	12N11	Pit-top Tilaboni UG	August	First	08-Aug-16	62
12	12N11	Pit-top Tilaboni UG	August	Second	17-Aug-16	65

It can be concluded that present values of ambient noise level are within permissible limits prescribed by CPCB except at few occasions.

19.1.4 Flora and Fauna

Vegetation Pattern

The general vegetation is essentially tropophilous but with a tendency towards xerophytes. The flora of the area is characterized by the arborescent species such as Simul (Salmalia malabarica Schott. & Endl.), Neem (Azadirachta indica), Amlaki (Phyllanthus embica), Lannea coromandelica Merr., Narikel (cocos nucifera), Khejur (Phoenix dactylifera L.), Tal (Borassus flabellifer L.), Bat (Ficus bengalensis L.), Asvattha (Ficus religiosa L.), Palas (Butea frondosa) , Krishnachuda (Caesalpinia Pulcherrima), Am (Mangifera indica L.) and shrubby species such as ashsheoda (Glycosmis pentaphylla Corr.), Pianj, Rasun, Rajanigandha (Polyanthes tuberosa Willd.), Ghentu or Bhat (Clerodendron infortunatum Gaertn.), Kurabaka (Barleria Cristata), Gulancha (Tinospora cordifolia), Tulsi (Ocimum sanctum), Solanum torvum SW., S. Verbascifolium L., Trema orientalis Bl., Shiora (Streblus asper Lour.) and Dumur (Ficus hispida L.). The uplands of Asansol subdivision and the laterite area of the district are in places covered with Sal (Shorea robusta Gaertn.), Mohua (Madhnea latifolia),Palas (Butea monosperma), Bans (Bambusa arundinacea), Shireesha (Albizzia lebbek), Arka (Calotropis gigantea), Kend Diospyros melanoxylon), Arjun (Terminalia Arjuna) and Ashan (T. tomentosa). The common plants in hedges and wastelands are lal-bharenda (Jatropha gossypifolia L.), Ban-okra (Urena lobata L.), Heliotropium strigosum Wild, Hati-soond (H. indicum L.), Ulu (Imperata arundinecea), Sida veronicifolia Lam., S.cordifolia L., etc. (Source : District Website).

Trees of economic importance are to be found in abundance all around and these could be classified in three groups – fruit-bearing trees, trees for timber and fuel and flowering trees. Among fruit-bearing trees, Mango, Jacktree, date-palm, imli, plum (ber), Wood Apple (Angle mamelos), custard apple; Avla, Black plum and papaya are commonly found and jack fruit and mango are relatively in greater number. The timber trees are mostly Mahua (basis latifolia) Gamhar (genelina arborea), Asan (Terminalia tomentosa) Murga (Ptercarpus marsupium), Shisham (Dahbergia sissso), Sal (Shorearobusta), Bamboos (Dendrocalamus strictus) and the Margosa tree etc. Besides trees like Siris, Semar (Silk Cotton) and Sahjan (Morniga aneiphera) etc. are also available.

Low lands of the area are cultivated by Paddy, Maize, Arhar and Kulthi. Vegetables like Brinjal, Tomato, Potato, Chili, Bean (Sem), Jhinga, Parol are cultivated.

Fauna

The carnivora of the area comprise jackal and other smaller species. Monkeys abound including the variety known as Hanuman. Poisonous snakes include several kinds of cobra, the karait and the deadly Russell's viper. Other most frequently seen varieties are the Dhamna and various species of harmless grass snakes.

The avifauna are pea-fowl, jungle-fowl, jungle crow, house crow, treepie, common babbler, common jora, gold-fronted chloropsis, red-vented babul, red-whiskered bulbul, red spotted bluethroat, brown-backed robin, Shama, Tickell's blue flycatcher, paradise flycatcher, wood shrike, black drongo, tailor bird, streaked fantail warbler, golden oriole, common mayna, pied mayna, white-backed munia, white-throated munia, spitted munia, red munia, yellow-throated sparrow, house sparrow, woodpecker, India cuckoo, pied crested cuckoo, koel, parakeet, nilkantha, bee-eater, kingfisher, hornbill, hoopoe, horned owl, spotted owlet, jungle owlet, griffon vulture, long-billed vulture, scavenger vulture, lagger falcon, small spotted eagle, brahminy kite, pariah kite, sparrow hawk, various types of pigeon and dove, goose, duck, teal, lapwing, white necked stork and some varieties of egret and heron.

19.1.5 Ground Water

Two seasonal nallah flow within the project boundary. The subsidence caused due to mining will alter the surface topography and run-off pattern. Surface drains will be made to discharge water accumulating in troughs created by subsidence. Suitable measures have been envisaged to control flooding, siltation and pollution of surface water bodies in this project report. A number of ponds are scattered throughout the area.

Ground water in the area occurs under both unconfined and confined conditions. The permeable formations i.e. sand and sandstone within Gondwanas behave as aquifer units. The coal seams and shales developed act as impermeable beds i.e. aquiclude. The area is covered by Raniganj Formation with recent soil, alluvium and laterite capping.

The average annual rainfall in this area is around 1400 mm. As recommended in GEC Report 1997, 13% of the rainfall will go as potential annual infiltration and the rest 87% of rainfall will go as runoff. Few dug wells and hand pumps in the phereatic aquifer are found in the region which are used mainly for domestic water supply.

Rainfall is the major source of recharge for ground water. Additionally, groundwater is also being recharged from other sources such as from mine discharge, irrigation water ponds etc.

19.1.5 Land

The total lease area considered for mining is 869 ha. Present leasehold area is 436 ha. Additional 433 ha will be required for expansion. Although, it is an extension of an existing mine (Mine No. 1), separate infrastructure like Inclines, service building, approach roadways, power supply arrangement, residential buildings (for statutory and essential persons) would have to be developed as the extended mine (Mine No. 2) will have different entries and coal transport routes. About 21.5 ha land outside of mine boundary will be required for shifting of existing township/ colony, construction of siding, coal transport road etc. About 3 ha land will be required for driving of two pair of

inclines, one air shaft, construction of service buildings, coal handling plant, approach roads etc. About 749.20 ha of additional land would be required for caving operation which includes 38.44 ha of forest land.

3 big settlement viz. Shyamsundarpur, Jhanjra and Tilaboni village along with a number of ECL colonies fall within the area considered for mining. One small village Majhi Basti also falls within the project area. Nabaghanapur village falls partially within the area.

Details of land use within the Tilaboni UGP is as tabulated below:

Sl. No.	Particulars	Tilaboni Block/ Mine No. 1			Tilaboni Extn. Block/ Mine No.2	Total
		Within ECL Leasehold*	Outside ECL Leasehold	Total Tilaboni Block	Outside ECL Leasehold	
1	Road	3.16		3.16	1.05	4.21
2	Builtup Area	27.20		27.20	36.26	63.46
3	Nala/tank	8.18		8.18	21.35	29.53
4	Forest Land**	36.14		36.14	2.30	38.44
5	Danga/Wasteland	121.37		121.37	34.15	155.52
6	Agricultural land	239.95	30.00	269.95	308.94	578.89
	Total	**436.00**	**30.00**	**466.00**	**403.00**	**869.00**

*Figures of ECL Leasehold as per colliery record.

19.2 Impact Assessment

19.2.1 Air Pollution

There is no natural source of air pollution in the area. However, manmade sources due to industrial and mining activities are present. The air pollutants are mainly particulates and gases (SO_2 & NO_X). Following are the anticipated sources of air pollution due to the proposed mine:-

1) Coal handling activities at Pit head CHP
2) Coal transportation from CHP to the proposed Railway Siding
3) Storage and Wagon loading of coal at the Railway Siding.

Since coal will be required to be transported only small distances of 1.5 km from Mine No. 1 and 3 km from Mine No. 2, there will not be a very significant rise in Air pollution. The present ambient air quality status is given at section 19.1.1.

19.2.2 Water Pollution

Sources of water pollution are:

i. Discharge of mine Water.
ii. Discharge of Liquid effluent in the form of oil, grease, etc mixed with water.
iii. Suspended materials, solid as well as liquid and dissolved materials mixed with surface run off.
iv. Contaminated Storm water
v. Domestic sewage from residential colony and service buildings.

19.2.3 Noise Pollution

The main noise sources identified in the project are as follows:

i. Coal unloading.
ii. Bunker & Transfer Points in the CHP.
iii. Coal transportation by truck from CHP to railway siding.
iv. Ventilation fan

19.2.4 Land Degradation

An additional land area of 749.20 ha would be required for the caving purpose in this project. This includes 38.44 ha of forest land. Besides this 21.5 ha land would be required for Railway Siding, various infrastructural facilities, rehabilitation of Majhi Basti and residential buildings. Development of infra-structural facilities and subsidence may cause some land degradation and alter the land use pattern. Further any lowering of water table due to subsidence may affect water availability in the villages falling over the mine or in its vicinity leading to lowered soil fertility.

19.3 Environmental Control Measures

19.3.1 Air Pollution Control Measures

Appropriate air pollution control measures will be taken to contain the air pollution for maintaining the ambient air quality within the stipulated standards besides making the mining operation eco-friendly in the project. These measures (both preventive and suppressive) are enumerated below:

Loading and transport

The following measures will be taken:

- Surfacing of all service roads/permanent roads with asphalt.
- The length of coal transportation road will be reduced to the minimum possible. The permanent coal transportation road will be properly constructed and maintained.
- The un-metalled roads shall be kept free of ruts, potholes etc.
- Regular maintenance of pay-loaders and truck engines to limit emission of harmful exhaust fumes.
- Frequent water spraying along the length of the coal transportation roads from the mine to the proposed Railway Siding.
- Provision of fine nozzle mounted fixed sprinklers at Railway siding.
- Physical removal of dust from the roads.
- Greenbelt around industrial sites, service building area and residential colony besides avenue plantation along roads.
- Proper loading of coal on trucks and covering by tarpaulin to prevent spillage during transportation.

Coal handling plant

The following control measures will be adopted in the CHP:

- Suppression of coal dust at CHP by provision of fine nozzle mounted fixed sprinklers.
- Provision of dust extraction system.
- Minimization of the height of coal-fall at transfer points to reduce the dust generation and if necessary, provision of dust suppression measures.
- Improved maintenance of plant and machinery.
- Proper enclosure of CHP will be provided.

Fire at coal stockyards

Limiting the amount of stock by giving close attention to marketing besides following the "first-in and first-out" sequence.

Attention to the following while stacking of coal:

- Proper dimensions of stack (height to be limited to not more than 8m).
- Dozing/compaction to make the stock semi-consolidated.
- Regular and strict supervision of stacks.
- Provision of firefighting arrangement with supply of adequate quantity of water at sufficient pressure.

At workshops and stores

Proper ventilation system in workshop and stores.

19.3.2 Water Pollution Control Measures

Effective water pollution control measures shall be taken as necessary keeping in view the following points.

- Sufficient safeguards during the planning stage to make the project eco-friendly from water pollution control point of view.
- Recycling of wastewater to the extent possible after appropriate treatment to achieve "zero discharge".
- Conforming to the limits of the Environment (Protection) Amendment Rules, 2000 ("Schedule-VI", General Standards for discharge of environmental pollutants, Part-A) for the quality of the treated effluents.
- Sanitary wastewater will be treated mainly for total suspended solids (TSS) and bio-chemical oxygen demand (BOD) by providing septic tanks and soak pits.
- Drains will be provided around the coal stack to collect run-off for diverting into settling pond before discharge into natural water courses.

19.3.3 Noise Pollution Control measures

- Proper designing of plant & machinery by providing in-built mechanisms like silencers, mufflers and enclosures for noise generating parts and shock absorbing pads at the foundation of vibrating equipment.
- Routine maintenance of equipment.
- Rational deployment of noise generating plant and machinery.
- Greenbelts around the industrial area, infrastructure sites, service building area and township besides avenue plantation on both sides of the roads to maintain noise level at night time within the limit for the inhabited localities situated at a very close proximity.
- HEMMs with sound proof cabins.
- Chute linings in CHP.
- Personal protective devices to all the persons working in high noise areas.
- Regular monitoring of noise levels at various points.
- Green belt development in all vacant spaces. The trees planted shall act as buffers and shock absorber against dusts and noise. The trees in the green belt will be tall, wind firm, broad leaved and evergreen.

19.3.4 Land Degradation Control measures

- Filling of potholes and cracks.
- Plantation of trees on degraded land.
- Filling and re-grading of subsided area after caving.
- Efforts to restore the subsided land to agricultural purposes.
- Provision of garland drains to drain the water from the troughs created by subsidence.

19.4 Manpower for Environmental Management

To carry out various pollution control measures and compliance of statuary regulations, following project level environment personnel are proposed to be deployed.

Sceintific Assistant	-	1
Drivers for 10 KL Water Sprinkler	-	3
Helper for above	-	3
General Mazdoor, Category-II for Maintenance of Dust Suppression and Dust Extraction System at Railway Siding and CHP	-	2
TOTAL	-	9

The above personnel will report to the Project Civil Engineer. For implementation and monitoring of pollution control measures and for overall environmental management, Environmental Cell at the Area and Corporate level will also take necessary steps.

It is proposed to get the jobs like plantation and land rehabilitation done contractually. So no manpower has been considered under that head.

19.5 Total Capital Requirement

A total capital investment of ₹ 208.00 lakh has been envisaged for various environmental management activities. Details of capital investment are as given in Appendix A.8.4(A).

19.6 Operating Cost for Environmental Control Measures

In addition to above, a revenue expenditure @ ₹ 6.00/te of coal produced (at 100% capacity utilization) is suggested for carrying out environmental control measures.

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Chapter-20

MINE CLOSURE PLANNING

20.1 Introduction

Mining activities leave long lasting impacts on the landscape, ecology and on local inhabitants. These activities disturb the delicate environmental and social equilibrium that exists in its area of influence. Hence, it becomes imperative on part of the mine operator to restore the equilibrium in the mine affected area that existed in the pre-mining period. Thus, any mining venture must have a proper closure plan, aimed at rehabilitation of disturbed area, which should be acceptable to local community as well as regulatory authority.

Mine closure encompasses rehabilitation process designed to restore physical, chemical and biological quality disturbed by the mining activities. Mine closure is not just something that happens at the end of a mine's life rather it is an ongoing series of planned decisions and activities beginning in the pre-mining stage of mine and ending with a sustainable site that can be returned to the community for gainful utilization.

Thus, a Mine closure plan needs to define the liabilities, responsibilities and authorities of the different agencies like the mine management, other regulatory bodies, Central and State Governments local bodies during the course of mining and also during the post closure period. Various objectives of the advance mine closure planning are as follows:

- To allow 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 eliminate environmental damage and thereby encourage environmental sustainability
- To minimize adverse socio-economic impacts of mining activities
- To protect the flora and fauna of the area affected by the mining
- Effective use of the assets created in course of mining

As stipulated in the Mine Closure guidelines dated 07-01-2013 of MOC, the Mine Closure Plans will have two components viz. Progressive Mine Closure Plan and Final Mine Closure Plan.

The Progressive Mine Closure Plan identifies and includes the mine closure & other allied activities required to be executed continuously and sequentially during the entire period of mining operation since the inception of the Project. The primary aim of progressive Mine Closure Plan is to limit the disturbance as early as possible after it is created by mining activities.

The Final Mine Closure Plan identifies and includes the mine closure & other allied activities required to be executed towards the end of mine life and may continue even after the final closure of mining activities till a self-sustained ecosystem is created in and around the project area.

20.2 Present Mine Closure Plan

As mentioned earlier, there would be two components of Mine Closure Plan, namely Progressive Mine Closure Plan and Final Mine Closure Plan:

A. Progressive Mine closure plan

The present PR envisages working all the workable seams in the blocks from R-VIII T2 to R-II in succession. However, Mining projections, equipment and capital has however been provided up to 25 years only up to R-VIIB seam.

The seams below R-VIIB seam would be worked beyond the 25 years of the proposed project life. A review would be made towards the end of 25 years period to decide the extraction method for seams below R-VIIB seam by appropriate technology available at that point of time. After a thorough review of the prevailing circumstances, a detailed scheme/proposal for mining the lower seams would be prepared. The newly drawn scheme/proposal for mining the lower seams shall essentially carry a special chapter on future mine closure aspects including the 5 yearly progressive mine closure plans for next phase.

In view of the above, the present progressive mine closure plan has been prepared for 25 year period in first phase in which there will be 4 nos. of 5-yearly progressive mine closure plan periods covering UG workings.

The progressive mine closure activities to be executed by the project during various 5 year periods have been identified on the basis of anticipated progress in mining activities and other related developments likely to occur within the project area.

Mine closure planning is an ongoing process needing periodic fine tuning because of constantly changing conditions in the mining area. Hence, the identified progressive mine closure activities shall be reviewed at the time of each 5-yearly monitoring of progressive mine closure plan. The revised list of mine closure activities shall also include the balance progressive mine closure activities, if any, which could not be completed in the preceding 5 year period. This process will continue till the end of mine life.

20.2.1 Progressive Mine Closure activities

Subsidence management

The present project report envisages introduction of mass production technology viz. Continuous Miner with caving. The method of mining is depillaring with caving where the surface is free of constraints. Where surface

features are to be protected depillaring will not be done and pillars would be left intact.

The project take area is about 869 Ha. The minimum and maximum depth of working of different seams proposed to be worked by caving is 21m-345 m. It is expected that caving in underground will cause subsidence at surface. Hence, it is proposed to undertake 'Subsidence Prediction Study' by a scientific body for appropriate evaluation. The recommendations made in the Subsidence Prediction Study Report would be followed so as to cause minimum damage to the surface.

It is expected that there would be cases of surface subsidence due to caving of roof below ground. The proposed programme of subsidence management during the various 5 year PMCP periods would be:

a. To protect the surface features, such as nallas, roads, HT lines, buildings/building area etc. coal pillars would be left un-extracted vertically below and within the adjoining area so that the effects of subsidence do not reach up to the surface features to be protected. The left pillars and barriers would be of appropriate size to ensure long term stability and no reduction shall be made in the size of these pillars so as to reduce their factor of safety.

b. Surface cracks and depressions due to subsidence would be filled up properly by sand, stone chips and clay to achieve original drainage pattern in the area, as far as possible. After laying top soil, wherever required, the entire reclaimed area would be planted with herbaceous plants/shrubs/grass to prevent erosion.

c. Final plantation of trees shall take place after the entire coal reserve is extracted and the underlying strata settles to an acceptable level, which may take 6 to 12 months after the completion of extraction in the underlying seams.

d. Surface drains would be made outside of the subsidence area to prevent the surface water of adjoining area from coming into the active subsidence area.

e. The subsidence areas, which are potentially dangerous, shall be kept fenced till the filling job is over and area does not remain potentially dangerous.

Air Quality Management

Following mitigation measures would be taken up to control the air quality during mining operation:

a. Water sprinklers are to be provided for dust suppression on roads and industrial area.

b. Creation of green belt along roads and plantation in vacant land.

c. Air Quality of mine shall be analyzed on a regular interval.

Water Quality Management

a. The proposed mine water discharge details are as under:

- Mine water would be pumped out in a settling tank. Clean water coming out from the settling tank would be used for dust suppression and other industrial uses.

- Excess pumped out mine water is allowed to flow into the surface water bodies after passing through settling pond.

- Drains would be provided around the coal stock to collect run-off for diverting into settling pond before discharge into the natural water courses.

b. Following water Quality protection measures are also suggested:

- Industrial effluent treatment plant

- Sedimentation pond for treatment of mine water

- Soak Pits and STPs

c. Samples of mine water, drinking water and dug well water shall regularly be taken and tested to keep an eye on the effects of mining on the water quality regime.

d. The Colliery area has many surface water bodies. The quality of water contained in these water bodies shall be checked at regular intervals. If the test results show any deterioration in the quality beyond the prescribed limits, appropriate remedial action shall immediately be taken. The source of contamination shall be identified and removed. The contaminated water bodies shall be suitably treated.

e. No cases of AMD have been detected in the area so far. However, a system of regular checks shall be installed for early detection of any potential source of AMD. If any such case is detected, such potential AMD material shall adequately be dealt with to avoid occurrence of AMD and subsequent contamination of surface and ground water.

f. Various options of ground water recharge, which are feasible in the area, shall be studied and adopted to recharge ground water. Some of the ground water recharge techniques, which may be adopted, are roof top rain water harvesting, ground water recharge through village tanks by de-silting them, proper use of existing de-coaled voids, constructing percolation tanks etc.

De-commissioning of redundant Infrastructures

Any structure (residential/non-residential), which becomes redundant for current or future use, shall be demolished. The useable materials shall be re-used, the recyclable materials shall be sent for recycling and the balance debris shall be appropriately disposed off. The freed area shall be cleared of contamination (spillage of hydrocarbon, explosives etc.), if any, before going for biological reclamation.

The unused overhead transmission lines, UG cables, pipelines etc. shall be removed and the disturbed area shall be restored appropriately.

Reclamation of redundant Shafts/Inclines/Roads/Drains/Coal dumps

The redundant vertical shafts shall be filled up with inert debris, which shall be adequately stabilized before final sealing. The sealing cover of suitable thickness shall be laid on the hard rock strata below the top loose cover of earth and unconsolidated strata. Thereafter, the balance part of the shaft above the concrete cover shall be filled up to the surface. Finally the entire freed area including the surrounding area shall be planted with suitable species of plants in consultation with State Government agency suitable for the purpose.

The redundant inclines shall be sealed in such a manner as to ensure stability of overlying surface and to prevent future access of the illegal miners to the UG workings. The entire are shall be biologically reclaimed

The redundant drains/settling tanks and other such areas shall be filled with inert material, appropriately graded and topped by at 1 m of sub soil overlain by at least 100 mm of top soil. Finally the entire freed area including the surrounding area shall be planted with suitable species of plants in consultation with State Government agency suitable for the purpose. If concrete or brick wall has been used for such construction, it shall be ensured that no such material remains within 1.5 meters depth from the surface.

The redundant roads/areas freed from redundant coal stocks shall be loosened and topped with at least 100 mm of top soil, where needed. Finally the entire freed area including the surrounding area shall be planted with suitable species of plants in consultation with State Government agency suitable for the purpose.

Waste Management

Small quantities of solid waste mostly pieces of shale and sandstone mixed with coal, will be produced by the mine and removed from coal by manual picking. This will be disposed off as landfill. Also, some hazardous wastes like old cap-lamp and automobile lead batteries, burnt oil, used cotton waste etc. will be disposed off every year in suitable manner.

Disposal of surveyed-off Machinery

All machines, which have will be surveyed-off and grounded, shall be removed from their area of use and placed at a proper place. It shall be ensured that there are no leakages of contaminants from these equipment. All such equipment shall be auctioned as per Company's norms.

Safety & Security

While carrying out mining and allied activities, all statutory rules and regulations in force will be observed and all appropriate safety measures would be taken. Circulars issued from time to time regarding safety to the personnel and equipment of the mine and to improve the working conditions of the mine would be adhered to.

It will be ensured that roof in the goaf caves easily and sufficiently to fill-up the void. This will minimize the adverse impacts of subsidence on surface. If needed, some induced method of caving shall also be adopted.

All the protective pillars and barriers (to be left un-extracted) would be of appropriate size to ensure long term stability and no reduction shall be made in the size of these pillars so as to reduce their factor of safety. Where needed, the UG workings shall be appropriately stabilized by artificial means to provide long term stability to the overlying surface.

The goaved out area and disused workings shall be effectively sealed-off to prevent leakage of gas and transfer of danger, if any, into the active working areas. Effective sealing of goaf is also necessary for avoiding chances of spontaneous heating within the goaf.

Any occurrence of fire shall be dealt immediately and appropriately by adopting suitable firefighting methods such as isolation of fire area, nitrogen flushing, use of fire sealants etc. If needed, the entire affected area shall be sealed off to restrict the transfer of danger to other areas. Leakage of dangerous gases, if any shall be appropriately dealt with.

Any area, which is dangerous for persons working nearby, shall be suitably protected and adequately fenced off. All the mine entries shall be kept suitably protected and fenced. Prohibitive orders and guards shall be posted at suitable places to restrict entry of common people in the active areas of the mine. Unstable areas, if any, on the surface shall be suitably protected and fenced off in such a manner as to eliminate any potential of danger to life and limbs.

Entrepreneurship development Program

As the mine progresses, more and more local people gets indirectly dependent on the mine for their sustainable income. After closure of mine there would be no source of income for these people. In order to ensure that these people do not suffer in the post closure period, the Project authorities in

consultation with ECL (HQ) shall make efforts to develop entrepreneurial skills in the local people by imparting skill development/vocational training programs. It is expected that after developing adequate entrepreneurial skills, the local people would be able to run their own business in the post closure period and maintain a sustainable income for their livelihood.

Plantation

Greenbelt around industrial sites, service building area and residential colony is being developed along with avenue plantation along roads. Plantation of trees on vacant land in project area is being/shall be taken up during various 5 year plan periods.

Miscellaneous activities

In future, the prevalent geo-mining/environmental conditions in and around the project area may require execution of some other progressive mine closure activities not covered in the preceding paragraphs. Such activities may be carried out by the mine after observing the needful formalities and obtaining approval of the appropriate authority of the Company.

20.2.2 Maintenance of records pertaining to Progressive Mine Closure

Following plans and records shall be maintained at the mine for every 5 year period of progressive mine closure:

a. A Progressive mine closure plan for surface activities:

   This plan shall be maintained at a suitable scale showing the entire progressive mine closure activities (surface) carried out on yearly basis. The plan shall be updated on annual basis and shall be signed and approved by the appropriate authority.

b. A Progressive mine closure plan for UG activities:

   A progressive mine closure plan showing the UG activities shall be maintained. This plan shall also be updated on annual basis and signed by the appropriate authority.

c. A proper record of the executed progressive mine closure activities along with expenditures incurred shall be maintained at Colliery level. Such records shall be signed and approved by the appropriate authority.

B. Final Mine Closure Plan

The present PR envisages working all the workable seams in the blocks from R-VIII T2 to R-II in succession. However, Mining projections, equipment and capital has however been provided up to 25 years only up to R-VIIB seam.

The seams below R-VIIB seam would be worked beyond the 25 years of the proposed project life. A review would be made towards the end of 25 years period to decide the extraction method for seams below R-VIIB seam by appropriate technology available at that point of time. After a thorough review of the prevailing circumstances, a detailed scheme/proposal for mining the lower seams would be prepared. The newly drawn scheme/proposal for mining the lower seams shall essentially carry a special chapter on future mine closure aspects including the 5 yearly progressive mine closure plans for next phase.

At this point of time, it is practically very difficult to comprehend the exact conditions that would prevail at the time of final closure of mining activities in the Project. That is why, the final mine closure plan has been prepared on the basis of presently available inputs and the anticipated broader conditions, which are likely to develop in course of mining till the end of mine life.

Thus, the final Mine Closure planning would initially be a conceptual exercise, which would subsequently undergo regular revisions as more and more authentic information are gathered in course of mining. In conceptual stage, the plan would communicate on a broader basis, the outcomes of mining, goals of Mine Closure plan and various mine closure activities to be carried out for attaining the identified goals. It will also tentatively estimate the cost involved in successful completion of mine closure activities on the basis of MOC guidelines.

The final mine closure plan would be reviewed periodically as more and more reliable information would be gathered from the mine and surrounding environment. In the process, the Final mine closure plan would gradually become more realistic.

As stipulated in the MOC guidelines, the detailed Mine Closure Plan would be prepared at least 5 years before the intended final closure of the mine. This detailed Mine Closure Plan would reflect item-wise activities, milestones, schedule and also an accurate estimate of the cost involved.

20.2.3 Final mine closure Activities

In view of the above, the final mine closure plan cannot be rigidly prepared at this point of time. However, the broad mine closure activities towards the end of mine closure can be grouped under the following heads:

Management of mined out area

As coal extraction is to be carried out with caving of overlying roof, there would be surface subsidence in the project area. Since extraction will not be 100 % (pillars will be left intact below surface features and solid coal barriers between depillared panels will be left intact), subsidence will not be uniform, and a lot of area is likely to remain unaffected by subsidence. Maximum subsidence is likely to occur at the center of the panels and is not expected to

be of substantial magnitude. Cases of subsidence shall be dealt concurrently under progressive mine closure plan. Nevertheless, at the time of final closure of the mine, the entire land under the influence of subsidence will again be surveyed and any lacking aspect towards reclamation of the subsided land would be replenished in such a manner as to match with the natural topography of the Area as far as possible. It would also be ensured that the entire subsided land is afforested by selecting appropriate species in consultation with State Authorities. Efforts shall also be made to convert the reclaimed land into cultivable land, if possible.

Once the reserve is exhausted, the entries into the mine would be securely sealed for safety purposes. Hence, there will not be any discharge from the Mine. It would also be ensured, before closing the entries, that UG workings are in safe condition and would not pose any safety problem in future to other UG workings in the vicinity and also to the surface features.

The vertical shafts shall be filled up with inert debris, which shall be adequately stabilized before final sealing. The sealing cover of suitable thickness shall be laid on the hard rock strata below the top loose cover of earth and unconsolidated strata. Thereafter, the balance part of the shaft above the concrete cover shall be filled up to the surface. Finally the entire freed area including the surrounding area shall be planted with suitable species of plants in consultation with State Government agency suitable for the purpose.

The redundant inclines shall be sealed in such a manner as to ensure stability of overlying surface and to prevent future access of the illegal miners to the UG workings. The entire are shall be biologically reclaimed

Barring roads left for use of local people, all other temporary/permanent roads and any other disturbed areas shall be loosened and topped with at least 100 mm of top soil, where needed, followed by plantation of suitable species of plants.

All the coal stocks shall be cleared of carbonaceous debris. The areas freed from coal stocks shall be loosened and topped with at least 100 mm of top soil, where needed. Finally the entire freed area including the surrounding area shall be planted with suitable species of plants in consultation with State Government agency suitable for the purpose.

The usable infrastructures would be left for local/State agencies for use. Balance freed area after de-commissioning of redundant infrastructures shall be reclaimed and brought under green cover.

Post closure Mine water discharge

Once the reserve is exhausted, the entries into the mine would be securely sealed for safety purposes. Hence, there will not be any discharge from the Mine.

Although there would not be any discharge from the mine, but it is likely that the surface run-off may carry high proportion of suspended solids during first 2-3 years after mine closure. Hence, the surface-run-off shall be routed through the existing settling tanks, which shall be appropriately maintained till the entire area attains a state similar to its neighborhood.

Finally, the drains/settling tanks and other such areas shall be filled with inert material, appropriately graded and topped by at 1 m of sub soil overlain by at least 100 mm of top soil. Thereafter, the freed area including the surrounding area shall be planted with suitable species of plants in consultation with State Government agency suitable for the purpose.

Water Quality Monitoring

Monitoring of water quality would be continued for a period of 3 years after the final mine closure. If any deviation from the prescribed water quality standard is detected, the appropriate remedial actions shall immediately be enforced and frequency of sampling shall be increased till the water quality becomes normal.

The Project area has many surface water bodies. The quality of water contained in these water bodies shall be checked at regular intervals. If the test results show any deterioration in the quality beyond the prescribed limits, appropriate remedial action shall immediately be taken. The source of contamination shall be identified and removed. The contaminated water bodies shall be suitably treated.

The monitoring of water quality and other related aspects vis-a-vis remedial actions shall be continued, if required, for a period in excess of 3 years till an acceptable level of water quality is attained in and around the mine area.

Restoration of Ground water level

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

After cessation of mining, the UG workings would get filled up with water, which will help in recharging the ground water. Thus, in post-mining condition, the recharge and source potential in core zone will be much higher than the existing.

The ground water level shall be monitored at regular intervals to check the rate of recharge. If needed, various options of ground water recharge shall be adopted to recharge the ground water level. Some of the ground water recharge techniques, which may be adopted, are roof top rain water harvesting, ground water recharge through village tanks by de-silting them, proper use of existing de-coaled voids, constructing percolation tanks etc.

Air quality management

As the sources of dust and fume generation would no longer be present, the present practice of arresting the air pollution, as enumerated earlier would no longer be required after the closure of the mine. However, water sprinkling would be done on the roads, which remain in use after the mine closure.

Quality of air would be monitored for a period of 3 years after cessation of mining activity. The test results would be compared with the standards prescribed by the MOEF and if any deviation is detected, remedial actions would be immediately taken to bring the AAQ standard within the prescribed limits.

Disposal of Buildings, Plants & Machineries

Disposal or reuse of Winding system, ventilation, belts, haulages etc.

At the time of closure of the mine, the surveyed off equipment would be auctioned. However, the equipment, which would not have covered their rated life, would be diverted to the neighboring projects for gainful utilization.

As regards the common Railway Siding, it would be linked to some other collieries, if found economical after conducting transportation route analysis in respect of various available sources. If the said Siding is not found economical to be used, it will be dismantled and the usable items/spares would be dispatched to needy Areas/Projects. The freed area shall be cleared of debris/carbonaceous material/contaminants, appropriately loosened and topped with at least 100 mm of top soil, where needed. Finally the entire freed area including the surrounding area shall be planted with suitable species of plants in consultation with State Government agency suitable for the purpose.

Any other industrial structure, which becomes redundant for current or future use of the Company/local body, shall be demolished. The useable materials shall be re-used, the recyclable materials shall be sent for recycling and the balance debris shall be appropriately disposed off. The freed area shall be cleared of contamination, if any, before going for biological reclamation.

Disposal or reuse of transmission lines and sub-station

As per the electricity demand of the existing neighboring Projects, an analysis would be made as to whether the existing sub-station and transmission lines could be gainfully used or not. If the scope of gainful utilization is not found, they will be dismantled and the usable items/spares/conductors etc. would be dispatched to needy Areas/Projects.

The freed area shall be cleared of debris/contaminants, appropriately loosened and topped with at least 100 mm of top soil , where needed. Finally the entire freed area including the surrounding area shall be planted with suitable species of plants in consultation with State Government agency suitable for the purpose.

Disposal or reuse of residential and non-residential buildings

At the time of final closure, a list of surface buildings would be prepared in detail. Thereafter following steps would be taken in chorological order in respect of the available buildings:

- An assessment would be made to find that whether the available buildings can be used by the existing neighboring projects or any new project that might have come up in the vicinity.

- In case the listed assets cannot be utilized by the nearby project, efforts would be made to sale these assets after making the list available to potential purchasers and asking the interested purchasers to submit sealed bids.

- Thereafter the state agencies/local agencies may be asked to take possession of the buildings, if they required few of them.

- When there would be no takers, the buildings would be demolished and usable items would be recovered for future use. The debris shall be suitably disposed off. The freed area shall be cleared of debris/contaminants, appropriately loosened and topped with at least 100 mm of soil, where needed. Finally the entire freed area including the surrounding area shall be planted with suitable species of plants in consultation with State Government agency suitable for the purpose.

Safety and security arrangement

Once the reserve is exhausted, the entries into the mine would be securely sealed for safety purposes. In case the mine entries remain unused for some time, they would be properly fenced to avoid any inadvertent entry of animals or human beings. Flags/Boards with warning signals shall be posted at vulnerable places to avoid chances of accidents. Prior to handing over the project area to the State/Local authorities, it shall also be ensured that unstable areas, if any, are appropriately dealt with to render it safe and stable.

Survey records of workings

All the mine workings including subsidence areas, roads, ponds, tanks etc. shall be resurveyed and records shall be updated. Copy of such records shall also be submitted to the appropriate competent authorities, such as DGMS and State Authorities. One copy of these records shall be kept with Environment Department of ECL (HQ).

Disposal management of hazardous material

At the time of closure, assessment would be made as to find whether there are any hazardous material that could cause problem. Such hazardous material e.g. explosives, chemicals, oil etc. shall be appropriately disposed off. Cases of spillage of such material shall also be checked in and around the

susceptible areas. In case of detection, such spillage shall be adequately dealt with by removal and disposal of affected soil followed with biological reclamation.

Re-deployment of work force

At the time of final closure after exhaustion of entire mineable reserve, some of the available manpower shall be engaged for the execution of post closure activities. Thereafter, following steps would be taken for effective management of balance available manpower:

a. First, option of VRS would be given to the age group of + 50 years. Some may accept and some may not.

b. After exhausting the above option, the middle aged group workforce (between 40-50 years) would be transferred to the similar projects.

c. If vacancy in similar nature projects gets exhausted, the relatively young workforce would be re-trained and re-deployed in other projects.

After the completion of all post closure activities, the engaged manpower on these activities would be re-deployed in some other mines of the Company.

Emancipation from the community facilities

The local communities are being provided many civic facilities, such as educational facilities, health facilities, and drinking water by the mine management. One of the objectives of the present closure plan is to ensure that such facilities do not get discontinued after the mine closure.

Few years prior to intended closure, the local body, in consultation with State Government agencies, would be trained and given hands on experience in management of the above mentioned basic facilities so that they could efficiently manage the affairs in the post closure period.

At the time of final mine closure, the above mentioned facilities will be entrusted upon the local bodies/Trust of local people/State bodies. For the first 3 years, the mine management would help the entrusted body in the management of such facilities. Thereafter final transition shall be made. If needed, a lump sum amount would also be paid to the local bodies/Trust of local people/State bodies for proper upkeep and maintenance of various community facilities.

In course of mining, several local people of the vicinity get indirectly engaged with the mining and other allied activities and thereby obtain financial benefits for livelihood of their families. One of the primary aims of this closure plan is to ensure that these people keep getting sustainable incomes for their livelihood even after the closure of the mine.

In view of the above, some skill development programs under guidance of dedicated NGOs would be conducted at regular intervals as part of progressive mine closure plan activities. Such skill development programs may be in the areas of apparel designing, auto repair, tailoring, candle making, food processing, phenyl and liquid soap making etc. The trained persons would be given appropriate financial and other aids for starting their own small scale business for self-sustenance.

Some of the local youth would be hired by contractual agencies working in the mines. While working for the contractors, they would acquire some vital skills, which would help them in acquiring future employments.

With the help of State Forest Department, the reclaimed and afforested land may also be utilized by local people in the form of fruits and fodders for obtaining financial benefits.

In past, it has also been seen that in the event of closure of a mine, the local people indirectly dependent on the mine switch over their economic/ professional activities in the existing/new or expansion mines located in the nearby area. Local Management, if needed, extends some basic helps to them in such type of switching over. Hence, it is expected that in the instant case also the transition of the local people from one area to the other area for their sustenance would not be any problem.

20.2.4 Schedule for Mine Closure Activities

Various progressive mine closure activities have been identified and deliberated in Chapter-III of this report. Towards the end of every year, mine management shall make an assessment and identify the Progressive Mine Closure activities, which become due for execution in the next year.

After observing necessary administrative/financial formalities, the identified progressive mine closure activities shall be executed by the mine as soon as the activity becomes due for execution or the concerned area becomes free for carrying out such activities.

At present, it is bit difficult to conclusively predict the likely mine closure activities that would be taken up towards the end of mine life and during the post closure period. However, a tentative schedule covering the anticipated final mine closure activities to be carried out in the last phase of mine life and during the post-closure period have been prepared.

This tentative schedule shall be firmed up at the time of preparing detailed final mine closure, which shall be prepared at least 5 years before the intended final closure of the mine and be approved by the MOC. This detailed Mine Closure Plan would reflect item-wise activities to be executed towards the last phase of mine life and in the post closure period, various milestones and the schedule of execution of the identified closure activities.

In view of the above deliberation in the preceding paragraphs, a schedule of progressive and final mine closure activities have been prepared.

20.2.5 Abandonment cost

The execution of various mine closure activities (progressive and final) will entail certain expenditures, which will have to be borne by the mine operator. The abandonment cost is to be estimated based on the activities such as barbed wire fencing all around the working area, permanent fencing of dangerous areas, dismantling of structures/demolition and cleaning of sites, filling and grading of subsided areas, rehabilitation of mining machinery, plantation, physical/biological reclamation of other disturbed areas, landscaping, post closure environmental monitoring for 3 years, manpower cost for supervision, vocational/skill development training for sustainable income of affected people, miscellaneous charges etc.

MOC's guidelines on Mine Closure stipulates a method to estimate the total mine closure cost by multiplying a mine closure rate with the Project area of the mine /project. The mine closure rate as on Aug-09 was specified as Rs. 1 lakh/ha for UG mines and ₹ 6 lakh/ha for OC mines. The rate of mine closure is to be revised as per the changed WPI in comparison to the base WPI of August-2009.

As required by the MOC guidelines, the details of the updated cost estimates for various mine closure activities shall be incorporated in the detailed final mine closure plan that shall be submitted to the MOC for approval at least 5 years prior to the intended final closure of the mine.

Estimation of Mine Closure Cost and its tentative allocation

a. Total estimated mine closure cost as on February' 2018:

Particulars	Relevant Figures
WPI Month	February' 2018
Total Project area considered (ha)	869
Rate of mine closure cost (₹/ha)	139478.24
Total estimated mine closure cost (In Lakh Rupees)	1212.07

b. Annual Mine closure cost (AMCC)

Particulars	Relevant Data
Estimated life of Mine (Years)	>50
Considered life for present MCP (years)	50
AMCC for 1st Year (Lakh Rupees)	24.24
Nth year AMCC (Lakh Rupees)	24.24 [1+0.05]^(N-1)
Total mine closure cost for 25 years (lakh Rupees)	1156.97

20.2.6 Financial Assurance

For financial assurance, the AMCC, as calculated above, shall be deposited in the Escrow Account every year up to the cessation of mining activities in the project.

The above calculated amount may vary if the project would adopt some new technology in future thereby causing changes in project area and other related parameters. At the time of preparing such new schemes/PR, the mine closure plan shall be modified accordingly.

The mine closure fund, so generated, are towards the security to cover the cost of closure in case ECL fails to complete the relevant closure activities. At the time of preparing detailed mine closure plan 5 years prior to intended mine closure, in case the available funds in the Escrow Account are found insufficient to cover the cost of final mine closure, ECL shall provide the additional fund equivalent to the gap between the estimated final mine closure cost and the available Escrow fund.

20.2.7 Tentative allocation of mine closure on various mine closure activities

The above estimated total mine closure cost in respect of Tilaboni UG may be tentatively allocated on following MC activities (CMPDI norms):

Sl.	Item	Cost involved (Lakh Rupees)
1.	**Dismantling of Structures:**	
1.1	Service Buildings	40.00
1.2	Residential Buildings	121.00
1.3	Industrial Structures.	72.00
2.	**Permanent Sealing of mine entries**	**61.00**
3.	**Subsidence Management**	**58.00**
4.	**Landscaping of the cleared land for improving its aesthetic**	**104.00**
5	**Plantation over the cleared area obtained after dismantling and on other barren spaces**	**150.00**
6.	**Monitoring of Environment:**	
6.1	Air Quality	75.00
6.2	Water Quality	69.00
7.	**Entrepreneurship Development (Vocational/ skill development training for sustainable income of affected people**	**87.00**
8.	**Miscellaneous and other mitigative measures**	**174.97**
9.	**Manpower Cost for Supervision**	**145.00**
	TOTAL	**1156.97**

It may be noted that the above division of total cost has been made on the basis of a generalized norms for a typical UG mine and several projections made in respect of Tilaboni UG mine. Hence, these costs may vary at the time of execution of various mine closure activities and even some new activities may also be included depending on existing geo-mining & environmental conditions in the Colliery.

20.2.8 Withdrawal of Mine Closure Fund from the Escrow Account

The mine closure fund deposited in the Escrow account may be withdrawn in the following two ways:

5 yearly withdrawal:

Up to 80 % of the total deposited amount including interest accrued in the Escrow Account may be got released after every five years subject to examination and monitoring of progress in execution of progressive mine closure activities by a third party (ISM/CMPDI/NEERI etc.). The amount released shall be equal to expenditure incurred on the progressive mine closure activities in past 5 years or 80 %, whichever is less.

As mentioned earlier, Plans and record of executed progressive mine closure activities along with expenditures incurred shall be maintained at Colliery level. The expenditures on the progressive mine closure activities shall include the manpower cost of supervision, power cost and other attributable costs.

The above records shall form the base for 5 yearly monitoring of progressive mine closure plan and subsequent release of admissible mine closure fund.

Final release of Escrow fund:

After release of all admissible 5 yearly refunds, the balance fund (inclusive of additional deposit, if any, as mentioned above) shall remain in the Escrow account till all the post closure activities are completed as per the present mine closure plan and the mining area is restored to a level acceptable to the Coal controller.

Subsequent to compliance of all provisions of Closure Plan, ECL shall certify that the said closure of the mine has complied all statutory rules, regulations, orders made by the Central or State Government, Statutory organizations, Court etc. This compliance report shall be certified by the Coal Controller for final release of the balance Escrow fund.

20.2.9 Responsibility of the Mine Owners

Mine owner will ensure that the protective measures contained in the mine closure plan including reclamation and rehabilitation works are carried out in accordance with the approved mine closure plan and final mine closure plan.

A yearly report before 1st July of every year would be submitted to the Coal Controller setting forth the extent of protective and rehabilitative works carried out as envisaged in the approved mine closure plans (Progressive and Final Closure Plans).

20.2.10 Applicability of the present Mine Closure

As mentioned earlier, Tilaboni UG is an existing mine, which has an approved Mine Closure Plan. The annual mine closure costs are being deposited in the Escrow account w.e.f. 2013-14.

The above mentioned MCP of existing mine (436 ha) will remain in effect till the start of mining activities under the present PR.

Subsequent to competent approval of the present PR and completion of various administrative & legal formalities, as soon as the activities as per the present PR commences, the present Mine Closure Plan shall become operative and the AMCC shall be deposited as per the present Mine Closure Plan.

However, at that point of time, the following actions shall be taken in respect of the approved Mine closure plan of the existing Tilaboni UG:

In respect of approved MCP of Existing mine

- No AMCC shall be deposited.
- Final Mine closure activities, if any, to be carried out as per the approved MCP of existing mine shall be identified along with the mine Closure Funds needed for carrying out the identified mine closure activities.
- A Final closure plan for carrying out the identified final mine closure activities for the existing mine along with estimated cost shall be prepared and got approved.
- Thereafter all the identified final mine closure activities shall be carried out.
- Finally, the escrow fund generated for the existing mine may be got released after observing the various formalities as required by the MOC guidelines of Mine Closure.

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Chapter-21

LAND REQUIREMENT, R&R PACKAGE & PROJECT IMPLEMENTATION SCHEDULE

21.1 Land Requirement

The total area of Tilaboni UG Project is 869 ha. The break-up of land is as per details provided by colliery for Mine No.1 and the field survey conducted during the exploration in the block done by MECL for Mine No.2 is given below: -

Sl. No.	Particulars	Tilaboni Block/ Mine No. 1			Tilaboni Extn. Block/ Mine No.2	Total
		Within ECL Leasehold*	Outside ECL Leasehold	Total Tilaboni Block	Outside ECL Leasehold	
1	Road	3.16		3.16	1.05	4.21
2	Built-up Area	27.20		27.20	36.26	63.46
3	Nala/tank	8.18		8.18	21.35	29.53
4	Forest Land	36.14		36.14	2.30	38.44
5	Danga/Waste land	121.37		121.37	34.15	155.52
6	Agricultural land	239.95	30.00	269.95	308.94	578.89
	Total	**436.00**	**30.00**	**466.00**	**403.00**	**869.00**

Figures of ECL Leasehold as per colliery record.

The land is mostly agricultural in nature as obvious from the table above. The actual figure may vary, which has to be ascertained after actual field survey. Breakup of land to be acquired under surface right, mining right and all right is as under:

Requirement of Land under Surface right (in ha):

Particulars	**Mine-1** (Option-I & II)	**Mine-2** (Option-I & II)	**Outside mine boundary**		**Total**	
			Option-I	Option-II	Option-I	Option-II
Land for mine infrastructure, approach road, Railway siding, Rehabilitation & colony	1.00	-	21.50	19.50	22.50	20.50
Land for caving :						
Tenancy Land	301.56	-	-	-	301.56	301.56
Govt. land	2.00	-	-	-	2.00	2.00
Forest Land	36.14	-	-	-	36.14	36.14
Land to be acquired under surface right	***340.70***	***-***	***21.50***	***19.50***	***362.20***	***360.20***

Requirement of Land under only Mining right (in ha):

Particulars	**Mine-1**	**Mine-2**	**Outside mine boundary**	**Total**
Land to be acquired under Mining right (below Tilaboni / Jhanjra village)	2.90	18.60	-	21.50

Requirement of Land under All right (Surface right and Mining right):

Particulars	Mine-1	Mine-2	Outside mine boundary	Total
Land for mine infrastructure, approach road, Railway siding, Rehabilitation & colony	-	2.00	-	2.00
Land for caving :				
Tenancy Land	27.10	374.10	-	401.20
Govt. land	-	6.00	-	6.00
Forest Land	-	2.30	-	2.30
Land to be acquired under All right	**27.10**	**384.40**	**-**	**411.50**

About 30 ha area for Mine No.1 and 403 ha for Mine No.2 lies outside the ECL leasehold. Thus about 433 ha (21.50 ha + 411.50 ha) has to be acquired under mining right prior to mining operation. Additional requirement of land works out to be 773.70 ha (362.20 ha + 411.50 ha) for Risk-Gain Sharing option and 771.70 ha (360.20 ha + 411.50 ha) for Equipment Hiring option.

21.2 Land Acquisition

The total land requirement (in ha) for this project is as tabulated below:

Sl. No.	Description	Option-I	Option-II
1	Mining Area	869.00	869.00
2	Outside Mining Area	21.50	19.50
3	Sub Total	890.50	888.50
4	Less:		
	Area under possession of ECL	72.60	72.60
	Built up area	44.20	44.20
5	Additional land requirement:	773.70	771.70
	Forest Land	38.44	38.44
	Govt. Land	21.34	21.34
	Tenancy Land	713.92	711.92

Out of the additional land requirement, 749.20 ha land will be required for caving operation which includes 38.44 ha of forest land and 21.34 ha of Govt. land. About 3 ha land (within mine boundary) is required for development of infrastructures. Breakup of land requirement is shown in Appendix A1.

Requirement of the tenancy land and the employment under CIL R&R policy for the two options considered under this report are as tabulated below:

Particulars	Risk-Gain Sharing option	Equipment Hiring option
Tenancy land (in ha)	713.92	711.92
Employment (in nos.)	883	880

Employment would have to be provided @ 1 employment for every 2 acre of land acquired under direct purchase mode. For outside of ECL leasehold area land would be acquired under RTTFCLARR Act' 2013. Action for land

acquisition is required to be initiated as soon as the project report is sanctioned for developing mine infrastructure and caving operation thereafter.

21.3 R&R Package

Four villages' viz. Shyamsundarpur, Majhi bustee, Jhanjra and Tilaboni along with number of ECL colonies fall within the area considered for mining. One Nabaghanapur village, fall partially within the project area. As depillaring has not been envisaged below Shyamsundarpur, Jhanjra, Tilaboni and Nabaghanapur villages, rehabilitation of those villages are not required.

Majhi bustee has been proposed for the rehabilitation under this report. This bustee contains around 58 nos. of houses and family as informed by the project authorities. This has to be resettled. However proper demographic survey is required for ascertaining the exact number of the homestead and family which require rehabilitation. Compensation for homestead, lump sum payment and subsistence allowance has to be given to the person whose homestead is acquired as per the R&R Policy of CIL-2012.

Adequate capital provision has been made in this report for the rehabilitation and resettlement. Beside this 730 nos. of different type of ECL quarters fall within the area considered for mining, out of which 439 nos. are allotted to ECL employee, which has to be relocated for carrying out underground mining with caving.

21.4 Project Implementation Schedule

The major activities leading to the achievement of capacity after the approval of the report by competent authority are:

i. Applying for mining lease and land acquisition.
ii. Land acquisition for infrastructure, road diversion, nala diversion, caving and colony.
iii. Construction of approach road.
iv. Preparation and finalization of NIT and award of work for Incline drivage and shaft sinking.
v. Arrangement for power supply.
vi. Construction of mine infrastructure viz. service buildings, railway siding etc.
vii. Construction of residential buildings.
viii. To undertake the physico-mechanical properties of rocks for designing the support system & caving characteristics of the roof strata.
ix. Procurement of equipment including low height and standard height CM Packages (2 sets each), remote controlled LHDs, belt conveyors and other P&M.
x. Construction of strata bunker (2 nos. of 500 t each) between R-VIIIB1 and R-VII seams and between R-VII and R-VIIA seams.

Time frame of the major activities leading to achievement of targeted production is shown in the Harmonogram (Figure-21.1). The preparation and approval of PR has to be completed before any major construction activity is initiated.

21.5 Critical Activities

Critical Activities for the proposed project are as follows:

i. Approval of Project Report.
ii. Acquisition and possession of land required for infrastructure, road diversion, nala diversion and caving.
iii. Diversion of Ukhra-Laudoha D.B. Road.
v. Diversion of seasonal nala in Mine-2.

21.5 Year of commencement of Production

It is envisaged that production would commence from the second year from roof heightening and from CM panel from fourth year. Zero date being the date of approval of PR, land acquisition for mine entries and other infrastructure whichever is later. Target production is expected to be achieved in the seventh year.

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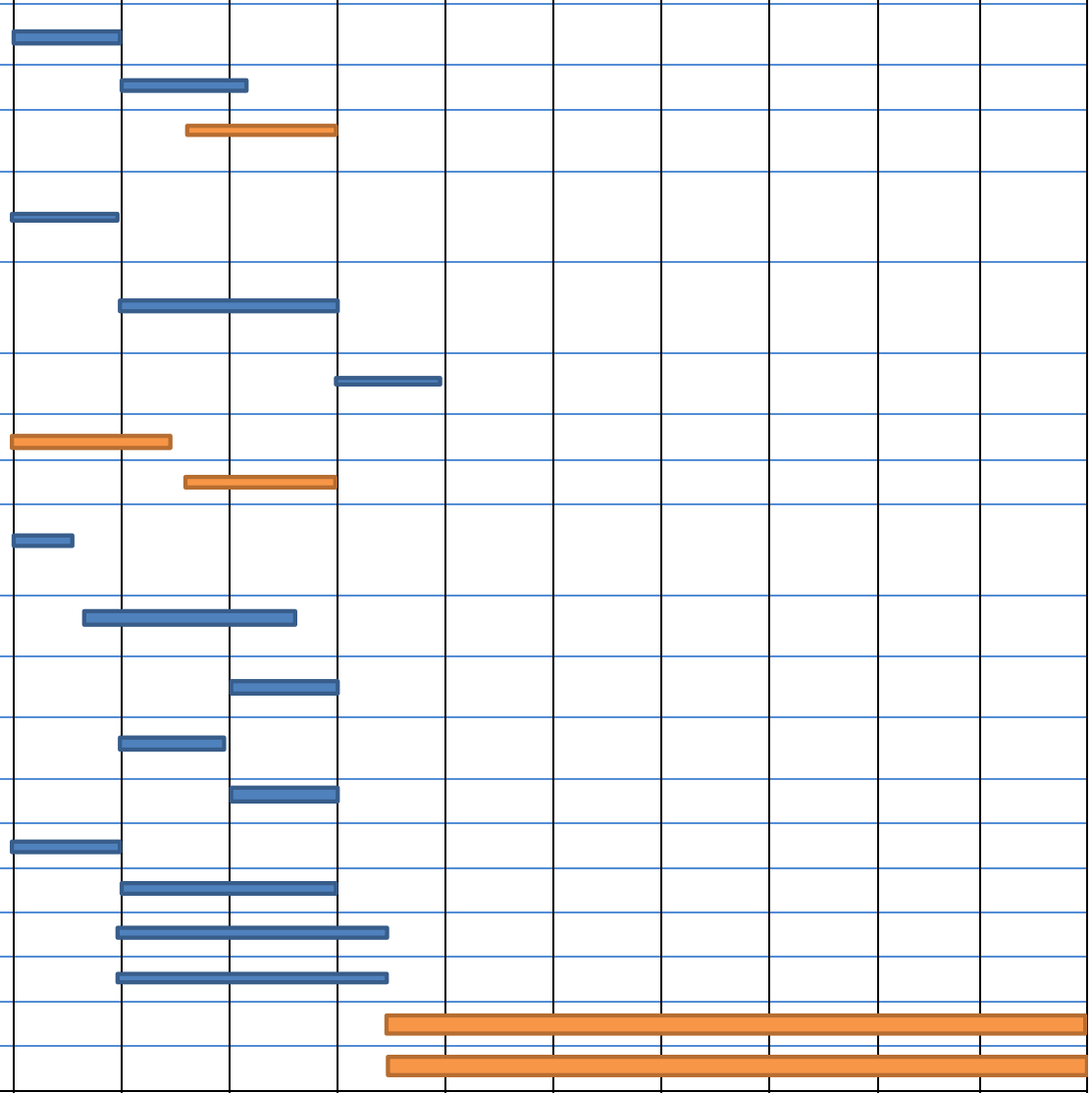
Sl. No.	Activity	Duration (Month)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
A	**MINE NO. 1 (TILABONI BLOCK)**											
1	Tender preperation, finalisation of tender & issue of work order for drivage of Incline	12										
2	Incline drivage (828m upto R-VIIB, 1145m upto R-VI Seam)	15										
3	Tendering, Procurement & installation of Belt Conveyor and Haulage in the incline	18										
4	Design, estimate, tendering & award of work order for Widening & Deepening of Tilaboni unit Pit No.2 (345m upto R-II Seam) & SSP unit Pit No.2 (365m upto R-II Seam)	12										
5	Widening (94.7m upto R-VII seam) & Deepening of Tilaboni unit Pit No.2 (from 94.7m to 155 m upto R-VII B seam); 345m upto R-II Seam	24										
6	Design, estimate, tendering , award of work order for fan drift & evasee and its construction and commissioning of fan	18										
7	Preparation of NIT, tender & award of work for two set of CMs	18										
8	Supply of CM packages & its commissioning	18										
9	Design, estimate, tendering & award of work order for Construction of service buildings (sub-station, workshop, store etc.)	6										
10	Construction of service buildings (sub-station, workshop, store etc.)	24										
11	Tendering, procurement & commissioning of equipments for sub-station, workshop	12										
12	Design, estimate, tendering & award of work order for fabrication of CHP	12										
13	Fabrication of CHP	12										
14	Land acquisition for railway siding	12										
15	Construction of railway siding	24										
16	Rehabilitation and Resettlement of Majhi Basti (Tribal Village)	30										
17	Diversion of Ukhra-Loudoha DB Road	30										
18	Production from 1st CM (CM-1)											
19	Production from 2nd CM (CM-2)											
20	**TOTAL PRODUCTION (Mty)**		**0.138**	**0.198**	**0.258**	**0.73**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**



Sl. No.	Activity	Duration (Month)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
B	**MINE NO. 2 (TILABONI EXTENSION BLOCK)**											
1	Land acquisition for mine infrastructure	24										
2	Tender preperation, finalisation of tender & issue of work order for drivage of Inclines (2 No.)	12										
3	Drivage of Inclines (2 no.) (960m upto R-VII A&B, 1180m each upto R-VI Seam)	15										
4	Tendering, procurement & installation of Belt Conveyor and Haulage in the incline	12										
5	Design, estimate, tendering & award of work order for sinking of airshaft (415m upto R-II Seam)	12										
6	Sinking of air shaft (220 upto R-VII AB seam; 415m upto R-II Seam) including preparatory work	20										
7	Design, estimate, tendering , award of work order for fan drift & evasee and its construction and commissioning of fan	12										
8	Preparation of NIT, tender & award of work for third set of CM	18										
9	Supply of third set of CM packages & its commissioning	18										
10	Preparation of NIT, tender & award of work for fourth set of CM	18										
11	Supply of fourth set of CM packages & its commissioning	18										
12	Design, estimate, tendering & award of work order for Construction of service buildings (sub-station, workshop, store etc.)	12										
13	Construction of service buildings (sub-station, workshop, store etc.)	24										
14	Tendering, procurement & commissioning of equipments for sub-station, workshop	12										
15	Design, estimate, tendering & award of work order for fabrication of CHP	12										
16	Fabrication of CHP	12										
17	Land acquisition for railway siding	12										
18	Construction of railway siding	24										
19	Diversion of Nalla	24										
20	Production from 3rd CM (CM-3)											
21	Production from 4th CM (CM-4)											
22	**TOTAL PRODUCTION (Mty)**		**0**	**0**	**0**	**0.25**	**0.36**	**0.61**	**0.87**	**0.87**	**0.87**	**0.87**
	GRAND TOTAL (MINE NO.1+ MINE NO.2)		**0.138**	**0.198**	**0.258**	**0.98**	**1.35**	**1.60**	**1.86**	**1.86**	**1.86**	**1.86**

Chapter-22

FINANCIAL EVALUATION

22.1 General

PR for Tilaboni UG Mine has been formulated for target capacity of 1.86 Mty from underground workings by deploying four sets of Continuous Miner (two standard height CM and two low height CM) and one heightening district. Production from underground will be achieved by introduction of Continuous Miner Technology with caving operation. It is envisaged that the production from the Continuous Miner district will commence from 4th year in both the mine i.e. Mine-1 and Mine.2. Peak production of 1.86 Mty will be achieved during 7th year.

Economic analysis has been carried out for the introduction of Continuous Miner Technology in underground on Risk-Gain Sharing Basis as well as on Equipment Hiring basis. The modalities of Risk & Gain sharing and Equipment Hiring basis envisaged are as follows:

22.1.1 Modalities of Risk & Gain sharing basis

This Model are in line with the existing agreements between ECL and Continuous Miner Package Suppliers. In the Risk-Gain Sharing model, the Continuous Miner package(s) would be procured by ECL and operated & maintained by the supplier with an annual production guarantee. The entire capital and operating cost of 2nd Continuous Miner Package as per the M/s Bucyrus (caterpillar) contract dated 14.06.12 of Jhanjra UG mine has been adopted after updating the figures as per the Standard Pricelist of Mining Equipment published by CMPDI HQ in June 2015. ECL will pay to the Continuous Miner package supplier or his sub-assignee an Operation & Maintenance cost on per tonne basis which includes the maintenance spares.

The scope of work in Risk-Gain Sharing model also includes Scientific Investigations for support design during development and extraction stage, installation and commissioning of equipment, pre-production planning and site preparation, training etc. For all these services, ECL will pay separately to the equipment supplier. In addition to the above following activities have been proposed to be added in the Risk-Gain Sharing model under this report:

a. The expenditure on revenue items such as roof bolt assembly, drill rods, drill bits, consumables and lubricants for the operation of Continuous Miner Package will be borne by the equipment supplier.

b. ECL would pay to the equipment supplier the cost of consumables on per tonne basis.

c. Additionally, depillaring of existing developed panels in the seam/sections R-VIII B1/ R-VIII B1(Bot), R-VII and R-VII A are envisaged to be under the scope of the Equipment Supplier. Wherever coal is left in the roof of developed galleries, roof heightening will be carried out prior to the depillaring operation. The roof of developed galleries will be heightened upto the full seam thickness or maximum cutting height of Continuous Miner.

d. Risk-Gain Sharing model have been proposed for initial nine years (assuming the life of Continuous Miner package as 9 years) of the Project. After that project would be run on departmental basis with a provision of full service maintenance agreement of Continuous Miner Packages.

22.1.2 Equipment Hiring Basis:

The modalities of Equipment Hiring basis are in line with the various agreement between SECL and Continuous Miner Package Supplier. In this option, ECL will pay to the contractor a single outsourcing cost on per tonne basis. The cost will include the expenditure on revenue items such as roof bolt assembly, drill rods & drill bits, power cost, consumables and lubricants for the Continuous Miner package. The following activities related to production from Continuous Miner Districts have been envisaged for out-sourcing:

a. All brand new and unused equipment and machinery will be provided by the bidder for the operation of Continuous Miner districts.

b. Supply, operation and maintenance of Continuous Miner Package equipment and LHD in the district including supply of spares, consumable and lubricants. The Continuous Miner Package includes one no. Standard/ low height Continuous Miner, two nos. shuttle cars, one no. feeder breaker, two nos. of Roof Bolter, electrical equipment for the same including 6.6/1.1 kV FLP transformer, trailing cables and DAC communication etc. and spare parts. Low height LHD for working upto 1.5m height for Continuous Miner district shall also be out-sourced.

c. Coal preparation by Continuous Cutting, loading and transport of coal upto the gate belt and controlled loading of the same on to the gate belt, fragment size (-) 100 mm. Roof support using resin encapsulated roof bolts as per the approved support system and supply of roof bolting consumables including drill rods, resins and bits for the bolter as per the quality and quantity requirement.

d. Supply, installation, operation and maintenance of auxiliary fans. Extension of ventilation ducting/brattices and cleaning of path of shuttle cars and loading and unloading points. Coordination with the mine Management regarding extension of gate belt, cables, etc. and operation and maintenance of equipment as per the permission granted by DGMS or any other Competent Authority. All operations in the district shall be carried out under the control and supervision of the Mine Management.

e. Supply of clean water from near gate belt tail end to the point of use. Supply of electricity from the 6.6/1.1 kV transformer and 6.6 kV/550V transformer to various equipment operating in the district.

f. Depillaring of existing developed panels in the seam/sections R-VIII B1/ R-VIII B1(Bot) R-VII and R-VII A. Wherever coal is left in the roof of developed galleries, roof heightening will be carried out prior to the depillaring operation. The roof of developed galleries will be heightened upto the full seam thickness or maximum cutting height of the Continuous Miner.

g. Bidder has to obtain DGMS permission for the equipment and method of mining.

h. Construction of temporary ventilation stoppings/devices.

i. Supply, operation and maintenance of face pumps.

j. Supply of material from surface upto the point of usage belowground.

k. For the purpose of calculating economics, the outsourcing cost of Continuous Miner districts on per tonne basis has been taken from low height Continuous Miner project of Jhanjra UG Mine of ECL. This rate may not have any relevance to the proposed project, as the rate is purely for planning purpose and has nothing to do with the tendering processes if any that may follow.

Additionally, where the seam thickness is less than 1.8m, ripping of roof may be done to get a height of 1.8m for ease in movement of work personnel and for ventilation.

22.2 Economic Evaluation

PR for Tilaboni UG Mine has been formulated for following production capacity:

(a) Producing 1.86 Mty, by deploying four sets of Continuous Miner technology and two remote controlled LHD districts for heightening.

(b) Target production (1.86 Mty) from the proposed project will be achieved during 7th year.

22.3 Capital Investment

The break-up of total capital under different heads are presented below:

Major Heads	Risk-Gain Sharing Option			Equipment Hiring Option		
	Amount (₹ Cr)	In %	Specific Investment (₹/te)	Amount (₹ Cr)	In %	Specific Investment (₹/te)
Land	347.15	24.51%	1866.42	346.83	36.82%	1864.70
Civil	114.40	8.08%	615.06	97.03	10.30%	521.65
Plant & Machinery	661.53	46.71%	3556.62	287.06	30.48%	1543.33
Capital Outlay	135.25	9.55%	727.14	135.25	14.36%	727.14
Others	157.92	11.15%	849.00	75.69	8.04%	406.91
Total Capital	**1416.25**	**100%**	**7614.24**	**941.85**	**100%**	**5063.73**

22.3.1 Existing Capital and additional capital with phasing

This is an existing mine and production from the proposed project will commence from the 2nd year. An additional capital investment for both options are as tabulated below:

Particulars		Unit	Risk-Gain Sharing	Equipt. Hiring
Total Capital Requirement		₹ Cr	1416.249	941.853
Existing	Gross Block	₹ Cr	25.236	24.39
	WDV	₹ Cr	5.311	5.44
Additional Capital Requirement		₹ Cr	1391.013	916.617

The phasing of additional capital investment has been shown in Appendix-A.

22.3.2 Basis of price of P&M & Civil works

The estimate for capital investment are based on CPMDIL price list for May'2017 and escalated up to February' 2018 and at a civil cost index of 4159.

22.3.3 Foreign Capital

Foreign capital involved is 69.2504 M US $ (i.e. ₹ 443.407 Cr) in Risk-Gain sharing option and 7.753 M US $ (i.e. ₹ 48.492 Cr) in Equipment hiring option.

22.3.4 Capital upto target year & capital investment beyond target

Capital investment up to the target year and beyond target year are as tabulated below:

Particulars	Unit	Risk-Gain	Equipment Hiring
Total Capital Requirement	₹ Cr	1416.25	941.85
Existing Capital	₹ Cr	25.24	25.24
Capital requirement upto Target Yr	₹ Cr	1314.43	840.03
Capital requirement beyond Target Yr	₹ Cr	76.58	76.58
Specific investment	**₹/te**	**7614.24**	**5063.73**
Specific investment (P&M)	**₹/te**	**3556.62**	**1543.33**

22.4 Opening of Revenue account and Revenue exp. Capitalized

As it is a running mine whose cost statements are prepared regularly no revenue expenditure has been capitalized.

22.5 Replacement capital

Year wise requirement of replacement capital is shown below:-

(Amount in ₹ Lakhs)

Yrs	Risk - Gain Sharing	Equipment Hiring
2	0.50	0.50
4	0.09	0.09
5	5.80	5.80
6	1.05	1.05
7	11.86	11.86
8	12.39	10.30
9	8.84	6.75
10	13.82	12.23
11	13.83	13.68
12	61.48	5.92
13	264.30	44.76
14	37.78	17.40
15	109.87	34.61
16	20.39	18.79
17	19.34	19.34
18	7.48	6.95
19	39.01	39.01
20	33.23	30.98
21	93.53	35.99
22	289.01	67.40
23	52.08	33.22
24	120.23	46.21
25	21.49	21.29
Total Replacement Capital	**1237.40**	**484.15**
Residual Value	**611.78**	**378.53**

P&M with one year life is charged to stores cost as and when replaced.

22.6 Sources of Finance

It has been assumed that funding will be from internal resources and hence no interest on loan capital has been charged.

22.7 Cost of Production at different level of production

Incremental cost of production are as under:

Option	Cost of Production (₹/te)	
	at 100% Capacity Utilisation	at 85% Capacity Utilisation
Risk-Gain Sharing	2539.29	2328.87
Equipment Hiring	2807.21	2519.93

The details of cost heads are detailed below:-

a. Salary & wages: Average Salary & wages has been calculated taking category/grade wise wages & Benefits circulated by CMPDI, HQ in March'2018 (with NCWA-X impact). Comparative wages are shown below:-

Particulars	Unit	Risk - Gain Sharing		Equipment Hiring	
		at 100% Capacity Utilisation	at 85% Capacity Utilisation	at 100% Capacity Utilisation	at 85% Capacity Utilisation
Salary & Wages	₹/te	594.85	699.82	427.85	503.35
% of total Cost of Production	%	23.43%	24.93%	18.37%	19.97%

b. Stores cost: - Option-wise Stores cost (in ₹/t) are shown below:

Store Cost (₹/te)		
Option	Capacity Utilisation	
	at 100%	at 85%
Risk-Gain Sharing	652.34	660.98
Equipment Hiring	62.83	71.24

c. Power: - The average power cost (in ₹/t) at 100% and 85% Capacity utilization are shown below:-

Power Cost (₹/te)		
Option	Capacity Utilisation	
	at 100%	at 85%
Risk-Gain Sharing	165.26	187.13
Equipment Hiring	120.87	136.87

d. Misc. Exp.: - Under this head TA/DA, printing stationery, telephone, postage, civil repair and repair & maintenance of assets other than P&M, workshop debit raised by company workshops, Hired Vehicle, insurance & taxes of vehicles and a provision of Contingency @ ₹1.0 per ton is considered. Provision of five nos. of Hired vehicle (LMV) has been considered under this report. However the number of hired vehicle may vary depending upon the actual requirement. Option-wise misc. cost (in ₹/t) are shown below:

Misc. Cost (₹/te)		
Option	Capacity Utilisation	
	at 100%	at 85%
Risk-Gain Sharing	367.69	379.12
Equipment Hiring	56.87	66.04

e. Administrative cost: - 10% of Administrative cost has been considered for calculating Financial IRR. However the existing methodology has been followed while calculating the Cost of Coal Production.

f. Interest on Working Capital: Four months cash revenue expenditure is considered as working capital and interest @ 14.5% charged as per guideline received from the Department of Economic affairs GOI dated 18th Sept, 2006.

g. Depreciation: - Straight line method has been adopted. Plant & Machinery has been depreciated over their standard life. Land has not been depreciated. And for other investment amortization has been made over the life of the project.

h. Interest on loan capital: - No interest is charged as the funding is proposed from internal resources and no opportunity cost of using own money is considered.

i. Mine closure cost: - The Mine Closure related cost works out to ₹ 2.97 per te and ₹ 3.49 per te at 100% and 85% capacity utilization respectively. Year-wise Mine Closure cost has been shown in Appendix –C.

Particulars	at 100% Capacity Utilisation	at 85% Capacity Utilisation
Mine closure cost (₹Cr)	11.57	11.57
Mine closure cost (₹/te)	2.97	3.49

22.8 Selling price:

Grade wise notified selling price is as tabulated below:

Particulars	Unit	Existing Mine	Mine - 1			Mine - 2		
Grade	GCV	G - 4	G - 4	G - 4	G - 5	G - 4	G - 5	G - 6
Reserve	Mte	0.414	0.180	18.070*	2.590*	8.080	0.870	8.800
Notified Selling Price	₹/te	3000.00	3000.00	3000.00	2737.00	3000.00	2737.00	2317.00
98.5% of Notified Selling Price	₹/te	2955.00	2955.00	2955.00	2695.95	2955.00	2695.95	2282.25
Sizing (-)100 mm	₹/te	87.00						
Transportation	₹/te	57.00	57.00			57.00		
Evacuation Facility Charges	₹/te	50.00						
Selling Price	₹/te	3149.00	3149.00	3092.00	2832.95	3149.00	2889.95	2476.25
Average Selling Price	₹/te	**2944.04**						

* Transportation through Belt conveyor upto Siding.

22.9 Profitability, Cash Flow and IRR:

The financial indices are tabulated below:-

Financial Indices	Unit	Risk - Gain Sharing		Equipment Hiring	
		At 100%	At 85%	At 100%	At 85%
Cost of Production	₹/te	2,539.29	2,807.21	2,328.87	2,519.93
Selling Price	₹/te	2944.04			
Profit/Loss	₹/te	404.75	136.83	615.17	424.11
Financial IRR	%	11.07%	5.85%	19.88%	14.03%
Desired Selling Price for 12% Fin IRR	₹/te	2997.47	3346.96		

22.10 Break-even point:

Particulars	Unit	Risk - Gain Sharing	Equipment Hiring
Break-Even Point	Mt	1.47	1.19
Production Level	%	78.95%	63.77%

22.11 Manpower & OMS:

Requirement of manpower, EMS and OMS of target year are as under :-

Particulars	Unit	Risk - Gain Sharing	Equipment Hiring
Manpower	Nos.	1203	799
EMS	₹	3149.50	3205.73
OMS	te	5.90	8.88

22.12 Sensitivity Analysis

In case of Risk-Gain Sharing option, Financial IRR is below 12% both at 100% & 85% capacity utilization, so sensitivity analysis has been done only in case of Equipment Hiring option considering the following parameters:

a) Capital investment

b) Operating cost

c) Capacity utilisation

d) Selling price of coal

The above parameters have been increased / decreased in steps of 5% to a maximum of 25% over the base case and the IRR have been computed. The following table summarises the results of sensitivity analysis:

EQUIPMENT HIRING (MINE - I & II Combined)			
Particulars	**Increase / Decrease by**	**Fin IRR**	**NPV at 12% discount**
Base Case	**0%**	**19.88%**	**33955.38**
Cost - Over- Run	5%	18.95%	30817.53
	10%	18.07%	27679.67
	15%	17.23%	24541.82
	20%	16.44%	21403.97
	25%	15.70%	18266.12
Increase in Operating Cost	5%	17.62%	24279.11
	10%	15.39%	14602.85
	15%	13.15%	4926.58
	20%	10.88%	-4749.68
Decrease in Capacity	5%	17.95%	25491.30
	10%	16.01%	17027.23
	15%	14.03%	8563.16
	20%	12.02%	99.08
	25%	9.96%	-8364.99
Decrease in Selling Price of Coal	5%	16.65%	19679.88
	10%	13.31%	5404.38
	15%	9.79%	-8871.12
Increase in CM Hiring Rate	5%	18.69%	28534.89
	10%	17.48%	23114.39
	15%	16.25%	17693.90
	20%	14.98%	12273.41
	25%	13.69%	6852.91

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