

# MAHAGIRI MINES (CHROMITE)

(Over an area of 73.777 Ha in village Kaliapani, Jajpur District)

## INDIAN CHARGE CHROME LTD

(Merged with Indian Metals & Ferro Alloys Limited, dtd: 17.10.2005)  
IMFA Building, Bomikhal, Bhubaneswar - 751 001 (Orissa)



Lease Area: 73.777 Hacts	Forest Area: 66.38 Hacts (Diverted) Non Forest Area: 7.397 Hacts
Date of execution of the ML area	20.09.2005
Date of Expiry of the ML area	19.09.2035
Lease Period	30 Years
Category of Mine	Fully Mechanized category - 'A'

## Scheme of Mining

(Under Rule 12 of MCDR 1988)

and

## Progressive Mine Closure Plan

(Under Rule 23B of MCDR 1988)

### TEXT

( For the period from 2015-16 to 2019-20 )

Prepared by (RQPs)

Sri M. J. Raju

Sri P. Behera

**imfa**

**INDIAN METALS & FERRO ALLOYS LIMITED**

IMFA Building, Rasulgarh, Bhubaneswar - 751 010

NOVEMBER, 2014


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Scheme of Mining & Progressive Mine Closure Plan in respect of Mahagiri Mines (Chromite) of Indian Metals & Ferro Alloys Limited situated in village Kaliapani under Sukinda Tahasil of Jajpur District, Odisha for the period from 2015-16 to 2019-20 under Rule 12 and 23(B) OF MCDR 1988.



## Introduction

M/s Indian Charge Chrome Limited, now merged with M/s Indian Metals & Ferro Alloys Limited have been executed with a mining lease for exploitation of chromite ore over 73.777 Ha area in Kaliapani village of Jajpur District in Odisha since 20.09.2005, which is known as Mahagiri Mines (Chromite) and is situated at about 57 km from Jajpur Road in Jajpur District of Odisha. The leasehold area is well connected by a fair weather road and is located at about 23 Km from the Express Highway at Tomka.

The mining lease was executed in favour of the lessee M/s ICCL for a period of 30 years and the mining operations in the area has commenced from 16.01.2006. The mine is under continued operation since then by opencast mining under Fully Mechanized category - 'A' & underground development has been under progress since January' 2009.

The Chrome ore production level of Mahagiri Mines (Chromite) during the Scheme period (2015-16 to 2019-20) is proposed to be maximum of 6.0 LTPA.

The existing modified Scheme of Mining for the period from 2011-12 to 2014-15 was approved by the Indian Bureau of Mines vide letter no.314(3)/2011-MCCM(CZ)/MP/MS/PMCP-28, dated 11/11/2011 under Rule 10(1) of MCDR 1988 along with progressive Mine Closure Plan under Rule 23(B) of MCDR 1988.

अनुमोदित

**APPROVED**

*[Signature]*  
6/4/15

REGIONAL CONTROLLER OF MINES  
भारतीय खान ब्यूरो  
INDIAN BUREAU OF MINES  
भुवनेश्वर/BHUBANESHWAR

*[Signature]*

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*[Signature]*  
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**1.0 GENERAL****a) Name of applicant /lessee/Rule 45 registration no:**

M/s Indian Charge Chrome Limited (now merged with M/s Indian Metals & Ferro Alloys Ltd), Rule 45 Registration no: IBM/4200/2011

**Address:**

M/s Indian Metals & Ferro Alloys Limited

IMFA Building, Rasulgarh, Bhubaneswar

District: Khurda, State: Odisha, Pin code: 751010

Phone: (0674) 2580100/125, Fax: (0674) 2580020

Email id: crray@imfa.in

**b) Status of applicant/lessee: Public Limited Company.**

List & Address of all Directors

Full Name	Address	Designation
PARAMITA MAHAPATRA	IMFA BUILDING, BOMIKHAL, BHUBANESWAR, 751010, ORISSA, INDIA	DIRECTOR
DEBABRATA BANDYOPADHAYAY	GD-89 SECTOR-III, SALT LAKE, CALCUTTA, 700106, WEST BENGAL, INDIA	DIRECTOR
RABI NARAYAN MISHRA	G-4, EVERARD NAGAR,, EASTERN EXPRESS HIGHWAY, STON, MUMBAI, 400022, MAHARASHTRA, INDIA	DIRECTOR
SATYANANDA ACHARYA	155, VIP COLONY, NAYAPALLI, BHUBANESWAR, 751015, ORISSA, INDIA	DIRECTOR
JAYANT KUMAR MISRA	A-27, NANDA DEVI APPARTMENT, CHANDRASHEKHARPUR, BHUBANESWAR, 751016, ORISSA, INDIA	WHOLE-TIME DIRECTOR
BANSHIDHAR PANDA	IMFA BUILDING, BOMIKHAL, BHUBANESWAR, 751010, ORISSA, INDIA	WHOLE-TIME DIRECTOR
SUBHRAKANT PANDA	'MADHUBAN' 30, GREEN AVENUE, VASANT KUNJ, NEW DELHI, 110070, DELHI, INDIA	MANAGING DIRECTOR
SUDHIR PRAKASH MATHUR	PLOT NO-305, RAJMAHAL APARTMENT, D-253 DEVI MARG BANI PARK, CHINKARA CANTEEN, JAIPUR, 302016, RAJASTHAN, INDIA	DIRECTOR
NALINI RANJAN MOHANTY	FLAT NO 302, SCION COURT, 1ST CROSS, KAGGADASPURA, C.V. RAMAN NAGAR P.O, BANGALORE, 560093, KARNATAKA, INDIA	DIRECTOR
CHITTA RANJAN RAY	MANORAMA APARTMENT, RASULGARH, BHUBANESWAR, 751010, ORISSA, INDIA	WHOLE-TIME DIRECTOR
BAIJAYANT PANDA	PLOT NO 08, BHDI NAGAR, UNIT 08, BHUBANESWAR, 751012, ORISSA, INDIA	WHOLE-TIME DIRECTOR
ALEXIUS MARKUS AMREIN	IN DER CHALEN I, CH-8123 EBMATINGEN, EBMATINGEN, 8123, SWITZERLAND	DIRECTOR
SANTOSH NAUTIYAL	1454, A T S GREEN VILLAGE, SECTOR 93 A,, NOIDA, 201301, UTTAR PRADESH, INDIA	ADDITIONAL DIRECTOR
SHANKAR ROYCHOWDHURY	FE 238, SALT LAKE CITY, SECTOR - 3, KOLKATA, 700091, WEST BENGAL, INDIA	DIRECTOR

  
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- c) **Mineral(s) which is / are included in the prospecting license (or Fresh grant):** Not Applicable
- d) **Mineral(s) which is / are included in the letter of Intent / Lease deed:** Chromite
- e) **Mineral(s) which is the applicant/lessee intends to mine:**  
Chromite
- f) **Name of Recognised Person under rule 22C of MCR,1960 or a Person employed under clause (c) of Sub rule (1) of rule 42 of MCDR, 1988 (Applicable for Scheme of Mining only) preparing Mining Plan:**

<p>Sri M.J.Raju Address: C/o: Sri N K Mishra, Dy. General Manager(Mines) Indian Metals &amp; Ferro Alloys Limited, IMFA Building, Bomikhal, Rasulgarh, Bhubaneswar - 751018, Odisha Phone:09777575711,Fax:0674-2580020, Email: mjraju@imfa.in Mobile No: 09777575711 Registration No. RQP/CAL/199/94/A Date of Grant/Renewal: 02.07.2010 Valid upto: 06.07.2020</p>	<p>Sri P. Behera Address: C/o: Sri N K Mishra, Dy. General Manager(Mines) Indian Metals &amp; Ferro Alloys Limited, IMFA Building, Bomikhal, Rasulgarh, Bhubaneswar - 751018, Odisha Phone:09937058102,Fax:0674-2580020, Email: pbehera@imfa.in Mobile No: 09937058102 Registration No. RQP/BBS/013/99/A Date of Grant/Renewal: 03.05.2011 Valid upto: 19.04.2021</p>
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## 2.0 LOCATION AND ACCESSIBILITY

### a) Lease Details (Existing Mine)

Name of mine : Mahagiri Mines (Chromite),  
 Lat/Long of any boundary point : Boundary Pillar No: E  
 (Latitude 21°01' 45.5" and  
 Longitude 85° 46' 24.94")  
 Date of grant of lease : 20.09.2005  
 Period/Expiry Date : 30 years  
 Name of leaseholder : M/s Indian Charge Chrome Limited  
 (now merged with M/s Indian Metals &  
 Ferro Alloys Ltd)  
 Postal Address : M/s Indian Metals & Ferro Alloys Limited  
 IMFA Building, Rasulgarh, Bhubaneswar  
 District: Khurda, State: Odisha,  
 Pin code: 751010  
 Phone: (0674) 2580100/125,  
 Fax: (0674) 2580020  
 Email id : mail@imfa.in

### b) Details of applied/lease area with location map (fresh area /mine)

Forest		Non Forest	
Forest Land	66.380 Hacts	Waste land	7.397 Hacts

Total lease area /applied area : 73.777 Hacts

District & State : Jajpur, Odisha

Taluka : Sukinda,

Village : Kaliapani

Whether the area falls under Coastal Regulation Zone(CRZ): No.

Existence of public road/railway line, if any nearby and approximate distance:

The mine is situated at about 57 km from Jajpur Keonjhar railway station, 23 Km from the Express Highway at Tomka. The Tomka & Mangalpur road is situated about 1 km towards northern side of the mine.

  
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Toposheet No : 73 G/16

Latitude &amp; longitude of all corner boundary point/pillar:

Sl No	Boundary Pillar	Longitude	Latitude
1	E	85°46'24.94"	21°01'45.51"
2	E1	85°46'29.95"	21°01'37.96"
3	E2	85°46'35.52"	21°01'29.61"
4	F	85°46'44.13"	21°01'16.66"
5	G	85°47'13.58"	21°01'35.03"
6	H	85°47'08.93"	21°01'41.89"
7	I	85°46'57.02"	21°01'34.78"
8	I1	85°46'53.25"	21°01'40.32"
9	I2	85°46'47.66"	21°01'48.59"
10	J	85°46'42.03"	21°01'56.83"
11	K	85°46'41.05"	21°01'54.82"
12	L	85°46'32.33"	21°01'51.63"

c) General location map : Refer Plate No MMC/01.

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### 3.0 DETAILS OF APPROVED MINING PLAN / SCHEME OF MINING

#### 3.1 Date and reference of earlier approved MP/SOM

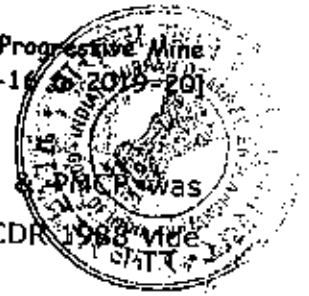
Mining Plan / Scheme	Period		Approval Reference
	From	To	
1 <sup>st</sup> MP (Grant of Lease)	1999-00	2004-05	Approved by Indian Bureau of Mines, Nagpur under Rule 22 of MCR 1960 vide letter No 314 (3)/99/MCCM (C)/MP-4 dated 17.12.1999
Re-submission of MP	2005-06	2009-10	Mining plan was resubmitted, which was approved by Indian Bureau of Mines under Rule 22 of MCR 1960 vide letter No 314 (3)/2002-MCCM(C)/MP-19 dated 11.02.2003
1 <sup>st</sup> Modification to the Approved Mining Plan	2007-08	2009-10	Modifications to the approved mining plan was approved by Indian Bureau of Mines under Rule 10 (1) of MCDR 1988 along with the progressive mine closure plan under Rule 23 B of MCDR 1988 vide letter No 314 (3)/2007/MCCM (C)/MS/PMCP -21 dated 29.11.2007.
1 <sup>st</sup> Scheme of Mining along with PMCP	2010-11	2014-15	The Scheme of Mining & PMCP was approved by Indian Bureau of Mines, Nagpur under Rule 12 of MCDR 1988 vide letter No. 314(3)/2009-MCCM(CZ)/MS/40 dated 22.03.2010.
1 <sup>st</sup> Modification to the Approved Scheme of Mining along with PMCP	2011-12	2014-15	The approved Scheme of Mining was modified under Rule10(1) of MCDR 1988 along with progressive Mine Closure Plan under Rule 23(B) of MCDR 1988, which was approved by the Indian Bureau of Mines vide letter 314(3)/2011-MCCM(CZ)/MP/MS/PMCP-28, dated 11/11/2011.

#### 3.2 Details of last modifications:

Mining Plan / Scheme	Period		Approval Reference
	From	To	
1 <sup>st</sup> Scheme of Mining along with PMCP	2010-11	2014-15	The Scheme of Mining & PMCP was approved by Indian Bureau of Mines, Nagpur under Rule 12 of MCDR 1988 vide letter No. 314(3)/2009-MCCM(CZ)/MS/40 dated 22.03.2010.
1 <sup>st</sup> Modification to the Approved Scheme of Mining along with PMCP	2011-12	2014-15	The approved Scheme of Mining was modified under Rule10(1) of MCDR 1988 along with progressive Mine Closure Plan under Rule 23(B) of MCDR 1988, which was approved by the Indian Bureau of Mines vide letter 314(3)/2011-MCCM(CZ)/MP/MS/PMCP-28, dated 11/11/2011.

  
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The 1<sup>st</sup> Scheme of Mining for the period 2010-11 to 2014-15 & PMCP was approved by Indian Bureau of Mines, Nagpur under Rule 12 of MCDR 1988 letter No. 314(3)/2009-MCCM(CZ)/MS/40 dated 22.03.2010.

*Reason for Modification:*

While mining during the period 2010-11 in the eastern part of the quarry, it was found that the average width of ore body has increased from 11 mtrs to 27 mtrs. Also in the western part of the quarry, the top RL of ore body was found at 204mRL instead of 201mRL, after detailed exploration was completed. The bulk density of chromite ore has also increased from 3 tonne/m<sup>3</sup> to 3.85 tonne/m<sup>3</sup>, after analysis of ore samples at Institute of Mineral & Materials Technology (IMMT), Bhubaneswar. Based on these changed parameters of the ore body, the reserve in the opencast mine was recalculated and found that the opencast mining shall continue beyond the scheme period, i.e. 2014-15, whereas it was earlier proposed that opencast mining shall continue for the period of 3 years i.e. from 2010-11 to 2012-13 in the approved Scheme of Mining & PMCP for the year 2010-11 to 2014-15. Since the bulk density increased, the reserves of underground working projected in the approved scheme of mining was also revised.

In order to protect the hanging wall benches as well as the foothill at hanging wall side, backfilling has been commenced from the eastern end after extending the quarry up to the opencast pit limit (185 mRL). It has also been decided that the quarry shall be advanced towards western end and backfilling shall also be continued in such a way that exposure of hanging wall benches is restricted to 150 m.

Accordingly, with all these proposals, the approved Scheme of Mining was modified under Rule 10(1) of MCDR 1988 along with the Progressive Mine Closure Plan under Rule 23(B) of MCDR 1988, which was approved by the Indian Bureau of Mines vide letter 314 (3)/2011-MCCM(CZ)/MP/MS/PMCP-28, dated: 11.11.2011.

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### 3.3 Review of approved Scheme of Mining for the period 2010-11 to 2014-15 in respect of exploration, excavation, reclamation etc.

#### (A) Exploration:

Exploration during the 1<sup>st</sup> Scheme period (2010-11 to 2014-15)

Commitment - The boreholes proposed during the year 2010-11 and achievement are as under.

Sl. No.	Proposed BH No	Co-ordinate	Collar RL	Angle	Intersection Level(mRL)	Total Mtrs.
1	PBH/MMC/20	807N/3936E	206	90°	185	21
2	PBH/MMC/21	782N/3952E	214	90°	185	29
3	PBH/MMC/22	782N/3893E	206	90°	185	21
4	PBH/MMC/23	756N/3908E	213	90°	185	28
5	PBH/MMC/24	757N/3850E	206	90°	185	21
6	PBH/MMC/25	731N/3865E	215	90°	185	30
7	PBH/MMC/26	731N/3806E	208	90°	185	23
8	PBH/MMC/27	706N/3822E	216	90°	185	31
<b>Total:</b>						<b>204</b>

#### Achievement -

Sl. No.	Proposed BH No	Co-ordinate	Collar RL	Angle	Intersection Level(mRL)	Total Mtrs.
1	BH/MMC/20	807N/3936E	201	90°	185	16
2	BH/MMC/21	782N/3952E	212	90°	185	27
3	BH/MMC/22	782N/3893E	206	90°	185	21
4	BH/MMC/23	756N/3908E	213	90°	185	28
5	BH/MMC/24	757N/3850E	206	90°	185	21
6	BH/MMC/25	731N/3865E	220	90°	185	35
7	BH/MMC/26	731N/3806E	211	90°	185	26
8	BH/MMC/27	706N/3822E	221	90°	185	36
<b>Total:</b>						<b>210</b>

Reason for deviations, if any : Against a proposal of 204 mtrs, the lessee has drilled 210 mtrs during the year 2010-11, so there is no deviation.

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Exploration during the 1<sup>st</sup> Modification to the Scheme of Mining (2011-12 to 2014-15)

Commitment - There was no proposal of boreholes during the period 2011-12 to 2014-15.

## Achievement -

## Surface Bore Holes

Sl No	Drill Hole No.	Co-ordinate	Cross Section	Collar RL(m)	Bearing (degree)	Incline (degree)	Drilling length (m)	True Width (m)
1	MMC/28	4102E/1022N	GG'	173.00	150°	63°	674.50	3.70
2	MMC/29	4102E/1022N	GG'	173.00	150°	57°	270.00	6.00
3	MMC/31	3903E/955N	EE'	183.45	150°	57°	485.00	12.00
4	MMC/32	3882E/990N	EE'	175.00	150°	60°	724.00	6.70
5	MMC/33	3748E/827N	BB'	196.96	150°	50°	325.00	9.85
6	MMC/34	3748E/827N	BB'	196.96	150°	60°	550.00	7.00
7	MMC/35	3680E/927N	BB'	170.83	150°	57°	BH is Running . (Not considered)	
8	MMC/36	3848E/880N	CC'	196.06	150°	62°	471.00	13.50
9	MMC/37	3792E/962N	CC'	167.00	150°	57°	687.00	7.92
10	MMC/38	4012E/1000N	FF'	178.48	150°	57°	569.00	11.00
11	MMC/39	4012E/1000N	FF'	178.48	150°	62	951.00	10.50
12	MMC/40	3822E/718N	-	215.00	150°	74°	81.00	15.20
13	MMC/41	3880E/700N	-	222.00	150°	50°	83.00	14.90
Grand Total							5870.50 mtr.	

## Underground Bore holes

Sl No	Drill Hole No.	Co-ordinate	Drilled RL (m)	Bearing (degree)	Incline (degree)	Drilling length (m)	Level of intersection (mRL)		True Width (m)
							FW	HW	
1	DD-1	3829E/794N	127RL Decline x-cut	150°	2° up	95.00	129RL	129RL	7.50
2	DD-1A	3829E/794N	127RL Decline x-cut	150°	25° down	128.00	84RL	84RL	12.40
3	DD-3	4024E/886N	98RL Decline x-cut	150°	23° up	102.50	126RL	134RL	3.30
4	DD-3A	4024E/886N	98RL Decline x-cut	150°	10° down	106.00	85RL	83RL	13.00
5	DD-4	3998E/870N	94RL Decline x-cut	150°	30° up	90.50	126RL	129RL	5.10
6	DD-4A	3998E/870N	94RL Decline x-cut	150°	8° down	98.00	83RL	82RL	7.50
7	DD-5	3936E/831N	85RL Decline x-cut	150°	1° down	79.00	85RL	85RL	11.00
8	DD-5A	3936E/831N	85RL Decline x-cut	150°	38° down	120.00	35 RL	20RL	15.00
Total						819.00			



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**Reasons for deviations, if any:**

Against NIL proposal, the lessee has drilled 5870.5 mtrs of core drilling by 12 bore holes from surface & 819 meters by 8 boreholes from underground during the period 2011-12 to 2014-15 (till Date 31st January 2015).

Mahagiri Mines (Chromite) is one of the captive mines for M/s Indian Metals & Ferro Alloys Limited. In order to support the enhanced ore requirement for the proposed capacity addition of ferro chrome furnaces, the lessee has decided to enhance the chrome ore production from underground workings at Mahagiri Mines (Chromite) from the existing 3 lakh tonnes per annum to 6 lakh tones per annum.

In order to have a production level of 6 lakh tonnes per annum from underground workings in a consistent basis, the lessee intended to establish reserve upto -400mRL, for which core drilling were done during 2013-14 to 2014-15 so as to convert probable mineral reserve and mineral resources to proved category.

**(B) Mine Development****Mine Development during the 1<sup>st</sup> Scheme period (2010-11 to 2014-15)****Open cast Working**

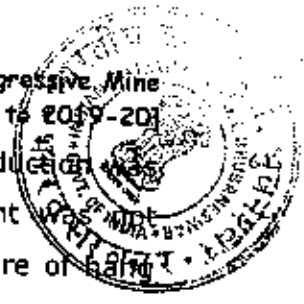
The target and achievement of development in opencast working during the year 2010-11 are as under.

Year	Development (CuM)	
	Proposal	Achievement
2010-11	2,00,900	11,632

**Reason for deviations, if any :** In the scheme period, it was shown that the average width of ore body is 11 m and the top RL is 201m. Accordingly development plan was made. During mining, it was found that the average width of ore body is increased up to 27 m and top RL of the ore body is also extended up to 204m. Since the width of ore body is increased and the top RL of the orebody is extended up to 204 mRL, the reserve has been increased by 2 to 2.5 times in the same portion. In the scheme of period of 2009-10, it was

  
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projected to produce 0.78 lakh tonne of ore and accordingly the production was restricted to the permissible quantity. Hence, further development was required during the year 2010-11. Moreover, in order to avoid failure of wall benches, it has been decided to restrict the exposed benches up to a maximum length of 150 m and extension of the quarry as well as back filling shall be continued simultaneously depending upon the required quantity of ore raising.

### Below Ground Working

During the 1<sup>st</sup> approved scheme of mining, the actual achievement of Below ground total development (in meter) for the year 2010-11 was as follows:

Year	Total Development in Meters	
	Proposal	Achievement
2010-11	768.51	102

Year	Waste Generation in CuM	
	Proposal	Achievement
2010-11	9451.23	2040

**Reason for deviations, if any :** During the scheme period of 2010-11, below ground development was proposed for 768.51m including decline progress of 415.51m. Less development was achieved due to soft rock formation, hence, only 102 mtr of decline was progressed during 2010-11. Hence, in total development lagged behind.

### Mine Development during the 1<sup>st</sup> Modification to the Scheme of Mining (2011-12 to 2014-15)

#### Opencast Working

The target and achievement of development in opencast working during the year 2011-12 to 2014-15 are as under.

Year	Development (CuM)	
	Proposal	Achievement
2011-12	70750	63928
2012-13	84700	76034.39
2013-14	118275	103745.24
2014-15	179025	110668.49 (as on 31.10.2014)
<b>Total</b>	<b>452750</b>	<b>354376.12</b>

  
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**Reason for deviations, if any :** During 2011-12 to 2014-15, there was proposed for excavation of 452750 CuM of overburden, against which a total of 34376.16 CuM of overburden has been excavated as on 31.10.2014. There is practically no deviation. Due to marginal less ore exploitation, the overburden excavation has reduced marginally. It is evident that the mine was operated during this period with a stripping ratio of 1.62, which is more than the proposed stripping ratio of 1.46.

### Below Ground Working

The target and actual achievement of below ground development (in meter) as well as waste generation quantities (in CuM) for the year 2011-12 to 2014-15 are as follows:

Year	Total Development in Meters	
	Proposal	Achievement
2011-12	733	228.1
2012-13	2059	161.58
2013-14	2000	506.12
2014-15	1971	673.6 (as on 31.10.2014)
<b>Total</b>	<b>6763</b>	<b>1569.4</b>

Year	Waste Generation in CuM	
	Proposal	Achievement
2011-12	11848	3932
2012-13	16636	2475
2013-14	16475	7265
2014-15	14381	9531 (As on 31.10.2014)
<b>Total</b>	<b>59340</b>	<b>23203</b>

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**Reason for deviations, if any :****During the period 2011-12**

The specific Condition no: (iv) of the Environment Clearance issued by MoEF, Govt. of India, Vide Letter No. J-11015/345/2007-IA.II (M) dated 10<sup>th</sup> Dec'2008, states that " The mine working and the Underground development work shall be restricted to the above water table. For working below the water table, a detailed hydro-geological study shall be carried out and prior permission of the Central Ground Water Authority as well as this Ministry shall be obtained". The ground water table was reported at 135 mRL (Annexure 3). In compliance to the above condition, development of the decline was restricted above 135mRL, resulting in lesser development as proposed.

**During the period 2012-13**

MoEF, Govt. of India, accorded Environmental Clearance for working below 135mRL and commencement of production from the Underground mine vide Letter No. J-11015/345/2007-IA.II(M) dated 29<sup>th</sup> October'2012 (Annexure 3). Commencement of decline development was made thereafter. Due to delay in receiving above mentioned environment clearance, the development of decline could not be progressed up to 116mRL and sinking of vertical shaft could not be commenced beyond 145mRL.

Also, as per 'Consent to Establish' from State Pollution Control Board, Odisha, Vide letter no. 502/Ind-II-NOC-4891, dated 12.01.2009 (Annexure 5), the underground development in ore was restricted because of the restriction imposed in the Consent to Operate order, which states that, "The production of chromite ore of quantity up to 73883 Tonne/Annum through opencast mining with crusher and screening capacity 60TPH and development of underground mining up to production stage". In compliance to the above conditions, the development was restricted to waste drive only, so there was no development in Ore in the financial year 2011-12 & 2012-13, which ultimately affected the total underground development.

  
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**During the period 2013-14**

As per the specific Condition no: (iii) of the Environment Clearance issued by MoEF, Govt. of India, Vide Letter No. J-11015/345/2007-IA.II (M) dated 29<sup>th</sup> October'2012 (Annexure 3), which states that "Forest Clearance for 2.47 ha of safety zone has not been obtained by the proponent. This Environmental Clearance is subject to grant of forestry clearance for diversion of 2.47 ha of safety zone within one year. The project proponent shall deposit the NPV value for the entire mining lease area". Due to this specific condition, the mining

activity was suspended for the period from 29.10.2013 to 03.01.2014, which affected the overall targeted underground development.

Also, the Consent to Establish & Consent to Operate was obtained from State Pollution Control Board, Odisha, Vide letter no. 15636/Ind-II-NOC-5682, dated 24.08.2013 & Letter No.3823/IND-I-CON-5331 dated 14.03.2014 respectively (Annexure 5 & 6). Due to delay in receiving above clearances, the development in ore couldn't be commenced, which also affected the overall targeted underground development.

**(C) Exploitation****Mine Development during the 1<sup>st</sup> Scheme period (2010-11 to 2014-15)****Open cast Working**

The Ore production programme for the year 2010-11 and the actual achievement was as follows.

Production (MT)	Proposal	Achievement
2010-11	73,800	73,673

**Reason for deviations, if any :** The target and achievement of Ore Production from opencast mine is more or less in accordance with the proposal.

  
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**Below Ground Working**

The Ore production programme for the year 2010-11 and the actual achievement of was as follows:

Year	Production in Tonnes	
	Proposal	Achievement
2010-11	1323	Nil

**Reason for deviations, if any :** During the scheme period of 2010-11, Below ground development was proposed for 768.51m including Decline progress of 415.5 m. Less development was achieved due to soft rock formation, hence, only 102 m of Decline was progressed during 2010-11. Hence, in total development is lagging behind. In this scheme period no ore development have done so there is no production.

**Exploitation during the 1<sup>st</sup> Modification to the Scheme of Mining (2011-12 to 2014-15)****Opencast Working**

The Ore production programme for the period 2011-12 to 2014-15 and the actual achievement was as follows.

Year	Production (Tonnes)	
	Proposal	Achievement
2011-12	76,377	73630.670
2012-13	78,136	73327.760
2013-14	77,850	71544.530
2014-15	77,866	29525.37(As on 31.10.2014)
<b>Total</b>	<b>310229</b>	<b>248028.33</b>

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**Reason for deviations, if any :** It is specified in the 'Consent to Establish' letter no. 502/Ind-II-NOC-4891, dated 12.01.2009, from State Pollution Control Board, Odisha, (Annexure 5) which states that, "The production of chromite ore of quantity up to 73883 Tonne/Annum through opencast mining with crusher and screening capacity 60TPH and development of underground mining up to production stage". In compliance to the above conditions, the production of ore from opencast working was restricted up to 73883 tonnes per annum upto 14.03.2014.

### Below Ground Working

The Ore production programme for the period 2011-12 to 2014-15 and the actual achievement is as follows:

Year	Production (Tonnes)	
	Proposal	Achievement
2011-12	2218	Nil
2012-13	28309	Nil
2013-14	114668	748
2014-15	300000	13630.46 (As on 31.10.2014)
<b>Total</b>	<b>445195</b>	<b>14378.46</b>

**Reason for deviations, if any :**

As per 'Consent to Establish' from State Pollution Control Board, Odisha, Vide letter no.502/Ind-II-NOC-4891, dated 12.01.2009, the underground development in ore was restricted because of the restriction imposed in the Consent to Operate order, which states that, " The production of chromite ore of quantity up to 73883 Tonne/Annum through opencast mining with crusher and screening capacity 60TPH and development of underground mining up to production stage". In compliance to the above conditions, the development was restricted to waste drive only, so there was no development in Ore for the period up to 14.03.2014. The Consent to Operate order for production from underground workings including opencast has been obtained on 14.03.2014, vide letter no. 3823/ IND-I-CON-5331 dated 14.03.2014. (Annexure 6).

  
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**(D) Afforestation Programme****Afforestation Programme during the 1<sup>st</sup> Scheme period (2010-11)**

The year wise afforestation programme was proposed during the year 2010-11 and achievement made is indicated below.



Year	Afforestation on Dump				Afforestation (Green Belt Building)				Total Afforestation			
	Area (Ha.)		Quantity (Nos)		Area (Ha.)		Quantity (Nos)		Area (Ha.)		Quantity (Nos)	
	Prop.	Achv.	Prop.	Achv.	Prop.	Achv.	Prop.	Achv.	Prop.	Achv.	Prop.	Achv.
2010-11	1	0.8	2500	2180	0.5	0.2	1250	410	1.5	1	3750	2590

**Reason for deviations, if any :** The target and achievement of afforestation programme is less in accordance with the proposal due to non-availability of dead end.

**Afforestation Programme during the 1st Modification to the Scheme of Mining (2011-12 to 2014-15)**

The target and achievement of year wise afforestation programme proposed during the period 2011-12 to 2014-15 are as under:

Year	Afforestation on Dump				Afforestation (Green Belt Building)				Others				Total Afforestation			
	Area (Ha.)		Quantity (Nos)		Area (Ha.)		Quantity (Nos)		Area (Ha.)		Quantity (Nos)		Area (Ha.)		Quantity (Nos)	
	Prop.	Achv.	Prop.	Achv.	Prop.	Achv.	Prop.	Achv.	Prop.	Achv.	Prop.	Achv.	Prop.	Achv.	Prop.	Achv.
2011-12	--	--	--	180	0.4	0.38	1000	925	Nil	0.42	Nil	1020	0.4	0.8	1000	2125
2012-13	--	--	--	--	0.2	Nil	500	450	Nil	0.6	Nil	2059	0.2	0.6	500	2509
2013-14	--	--	--	464	0.2	0.23	500	485	Nil	--	Nil	651	0.2	0.23	500	1600
2014-15 As on 31.10.2014	0.2	Nil	500	Nil	--	--	--	--	Nil	0.1	Nil	700	0.2	0.1	500	700
Total	0.2	Nil	500	644	0.8	0.61	2000	1860	Nil	1.12	Nil	4430	1	1.73	2500	6934

**Reason for deviations, if any :** The target and achievement of afforestation programme is more or less in accordance with the proposal.

  
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**(E) Reclamation & Rehabilitation**

**Reclamation & Rehabilitation during the 1<sup>st</sup> Scheme of mining period (2010-11 to 2014-15)**

The reclamation & rehabilitation was proposed during the year 2010-11 and achievement made are as under:

Year	Reclamation				Rehabilitation			
	Area in Ha.		Quantity in L CuM		Area in Ha.		Quantity in Nos	
	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved
2010-11	2.87	0.1	1.0	0.13	Nil	Nil	Nil	Nil

**Reason for deviations, if any :** During the development of the mine, top of the orebody was found at +201mRL against the projection at +194mRL and same additional ore pockets were encountered resulting in increase of reserve as estimated earlier. Due to production limit as specified in the mining scheme, Environmental Clearance from MoEF & Consent to Operate from SPCB, higher quantity could not be produced resulting in lesser development of the mine & in turn lesser generation of overburden.

**Reclamation & Rehabilitation during the 1<sup>st</sup> Modification to the Scheme of Mining (2011-12 to 2014-15)**

The target and achievement of reclamation & rehabilitation as proposed during the period 2011-12 to 2014-15 are as under:

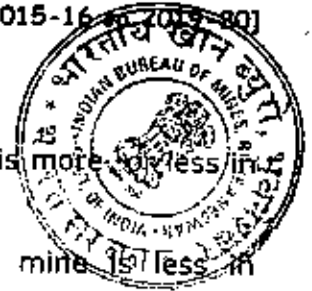
Year	Reclamation				Rehabilitation			
	Area in Ha.		Quantity In L CuM		Area in Ha.		Quantity in Nos	
	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved
2011-12	0.99	0.8	0.82	0.67	Nil	Nil	Nil	Nil
2012-13	0.4	0.4	1.01	0.78	1.1	0.11	2750	300
2013-14	1.15	1.11	1.34	1.11	0.25	0.02	625	70
2014-15 (up to 31.10.2014)	1.12	1.97	1.93	1.15	0.3	0.2	750	925
Total	3.66	4.28	5.1	3.71	1.65	0.33	4125	1295

  
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**Reason for deviations, if any :**

The target and achievement of reclamation in opencast mine is more or less in accordance with the proposal.

The target and achievement of rehabilitation in opencast mine is less in comparison to the proposal due to non-availability of dead end.

**(F) Stabilization of Dump**

Year	Construction of Parapet Walls/ Retaining wall at toe of dumps (meters)	
	Target	Achieved
2011-12	350	207
2012-13	436	421
2013-14	NII	NII
2014-15	NII	NII
Total	786	628

**Reason for deviations, if any :**

The target and achievement of Construction of Parapet Walls/ Retaining wall at toe of dumps is more or less in accordance with the proposal.

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**(G) Control of Dust, Noise, ground vibration and any other significant features:****(a) Target and achievement**

	Target	Achievements
Scheme of Mining approved on dated 11.11.2011.	<p><b>Control of Dust:</b> The present method of water sprinkling, dry fog system &amp; plantation etc for dust suppression shall be continued.</p>	<p>To control the fugitive dust generated, water sprinkling is done by water tankers. Dry Fog system has been provided in the Screening plants &amp; crusher. Besides, the following steps have been taken for control of Air Pollution:</p> <p>a) Green belt development in the surrounding of the mine lease hold area.</p> <p>b) Green belt development at the over burden dump area.</p> <p>c) Avenue plantation inside mining lease hold area.</p>
	<p><b>Control of Noise:</b> Implementation of all the precautionary measures for control of noise shall be continued.</p> <p><b>Control of Vibration:</b> All the precautionary measures for control of Vibration shall be continued.</p>	<p>Due care has been taken for the control of ground vibration and sound pollution. Mining equipments &amp; plants are regularly checked &amp; properly maintained to minimise sound pollution. Since the strata is softer, frequency of blasting is very less. One Rock breaker is used to break the big boulders for minimising the requirement of blasting. In addition, the use of delay detonators and controlled blasting techniques are being practised, which help in keeping the noise as well as vibration level within the prescribed limits.</p> <p>Regular monitoring of the environmental parameters are being conducted through a reputed Environmental consultant. The parameters are found to be within prescribed limits.</p>
	<p><b>Water quality of surface, ground water around the site and drinking water:</b> During rainy season, the surface runoff water around the quarry shall be directed to a sump and discharged to outside the ML after treatment through ETPs.</p> <p>Seepage water shall be continued to be treated in ETPs before discharging outside the ML.</p>	<p>There is no mine pit water discharged, outside during this period. The surface runoff is allowed to settle so as to reduce TSS, and if found to contain Hexavalent Chromium, then it is treated through ETP before final discharge. The seepage water from dump and other areas are also being treated in the same procedure.</p> <p>Regular environmental monitoring is being conducted in every season through a reputed Environmental consultant. The parameters are found to be within prescribed limits.</p>



  
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**(H) Review of the compliance position of condition and stipulations imposed**

The modification to the Scheme of Mining for the period 2010-11 to 2014-15 was approved by IBM, vide their letter No.314(3)/2011-MCCM(CZ)/MS-28 dated 11.11.2011, certain conditions. The major suggestions /stipulations imposed while approving the Scheme of Mining are as below.

**Condition No. (xiii) :** Yearly report as required under Rule 23E(2) of MCDR'88 setting forth the extent of protection and rehabilitation works carried out as envisaged in the approved Progressive Mine Closure Plan and if there is any deviations, reasons thereof shall be submitted before 1st July of every year.

**Compliance :** Yearly report on protection & rehabilitation works carried out as envisaged in the approved progressive mine closure plan is being submitted regularly. A copy of the same for the year 2013-14 has been submitted vide our letter No. IMFA/MMC/14/474 (Refer Annexure-22)

**Condition No.(xv) :** A copy of the Environment Impact Assessment, Environment Management Plan (EIA-EMP) as approved by MoEF (Ministry of Environment & Forest) shall be submitted to IBM immediately after approval of MoEF.

**Compliance :** EIA - EMP report alongwith copy of environmental clearance of Mahagiri Mines (Chromite) has been submitted to the Controller of Mines, IBM on dated 24.12.2008. (Refer Annexure -23).

**Condition No. (xvi) :** The Environmental Monitoring Cell established by the company shall continue monitoring ambient air quality, dust-fall rate, water quality, soil sample analysis and noise level measurements at various stations established for the purpose both in the core zone and buffer zone as per requirement of Environment Guidelines and keeping in view IBM's circular No.3/92 & 2/93 season wise every year or by engaging the services of an Environmental Laboratory approved by MoEF/CPCB. The data so generated shall be maintained in a bound paged register kept for the purpose and the same shall be made available to the inspecting officer, on demand.

  
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**Compliance :** The lessee has adopted Corporate Environment Responsibility. The Environmental Monitoring Cell has been established under this organisation structure and is headed by Chief of Mining. The Cell monitors the environmental data regularly. The Lessee has entrusted the job of regular environmental monitoring to a reputed laboratory established at Bhubaneswar and approved by NABL & State Pollution Control Board (SPCB), Odisha. The data so generated have been properly maintained by the lessee to be shown to any authority / inspecting officer. Results are being sent regularly to IBM (Regional office), MoEF (Regional office), IBM, Nagpur, MoEF (New Delhi) and SPCB, Odisha.

**3.4 Give status of compliance of violations pointed out by IBM**

The violations pointed out by inspecting officials of IBM under MCDR, 1988 and yearly review of the Scheme of Mining have been duly attended. The violation letter received from IBM and respective compliance are given in Annexure - 7, for the period from 2010-11 to 2014-15.

**3.5 Indicate and give details of any suspension / closure/ prohibitory order issued by any Government agency under any rule or Court of law:**

No such order issued.

**3.6 In case the MP/SOM is submitted under rules 9 and 10 of the MCDR'88 or under rule 22(6) of the MCR'1960 for approval of modification, specify reason and justification for modification under these rules.**

Not applicable.

**Other points requiring attention in the interest of proper mine design, development & conservation and environment & ecology of the area.**

**Mining Machinery**

For enhancement of ore production to 6 Lakh tonnes per annum, underground equipment of bigger capacity have been deployed. Diesel operated LHD of 10 T capacity and LPDT of 25 T capacity have already been introduced, in addition to currently used 6 T capacity LHD and 15 T capacity LPDT, for loading and hauling

  
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of Ore as well as Waste generated from the Underground workings up to the surface.

#### **Scientific study for Back filling Material**

Scientific study is being carried out through CIMFR for feasibility of use of opencast overburden waste material available in abundance at Sukinda Mines (Chromite) and Mahagiri Mines (Chromite), which can be suitably mixed with cement and used as backfill material for hydraulic filling of the blast hole stopes of Mahagiri Mines (Chromite). Based on the mix ratio of overburden waste material and cement as per the study report of CIMFR, filling plant to be constructed at the surface along with pipeline network for supply of filling material to underground stopes.

#### **Ground Monitoring of Stopping Parameters by Instrumentation**

It is proposed to monitor any potential ground movement during the stoping operation by installing the requisite instruments and for this purpose lessee has engaged CIMFR to carry out the scientific studies. The main objectives of the stope monitoring programme is to maintain safe operating conditions to protect personnel and equipment by providing advance notice of any ground movements as well as to optimize the stope dimensions for maximization of ore recovery with minimum dilution. The monitoring programme will utilize several instruments, viz. Extensometer, Stress Cells, Convergence meters, load cells & Backfill Pressure Meter etc.

#### **Increased Production Level from Below Ground Working**

Mahagiri Mines (Chromite) is one of the captive mines for lessee M/s Indian Metals & Ferro Alloys Limited. The present installed capacity of captive ferro chrome plants of M/s IMFA is 187MVA, thereby producing 2.65 Lakh tonnes of ferro chrome per annum. The chrome ore requirement for the above installed plants is thus  $(2.7 \times 2.7 = 7.29 \text{ LTPA})$  around 7.2 LTPA, which is being planned to produce from company's present Sukinda Mines(Chromite) for 3.50LTPA, Mahagiri Mines (Chromite) for 3.0LTPA and Nuasahi Chromite Mines for 1.2 LTPA. Now Company is planning to install 2 Nos of additional 48MVA furnaces each, at Choudwar. It is planned to produce production from the first additional plant by FY 2017-18 and the second additional plant by FY 2019-20. To meet the Chrome ore requirement of the proposed additional plants of M/s IMFA, it is planned to produce chrome ore from Mahagiri Mines(Chromite) 4.0LTPA during 2018-19 & 6.0 LTPA during 2019-20.

  
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## PART A

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## **1.0 GEOLOGY AND EXPLORATION:**

- a) **Brief description on the topography, drainage pattern, vegetation, climate, rainfall data of the mining lease area.**

### **Topography of MMC**

Mining operation at Mahagiri mines (Chromite) having a lease area of 73.777 ha. has started on 16.01.2006. The lease area is surrounded by Kaliapani chromite mines of BAL in the West, Sukinda Mines (Chromite) of M/s IMFA Ltd in the North, area held by Govt of Odisha in the East and Mahagiri Demarcated Protected Forest in the South. The mining lease area, lying in the foot of Mahagiri hill is covered by quartzite in the southern extreme part, laterite associated with quartzite in the central part and pyroxenite in the northern extreme part. Patches of serpentinite are noticed in the central part. The highest & lowest contour of the area is 330mRL & 147mRL respectively. Regional chromite band No VI of Sukinda Chromite belt is lying in the lease area have a general trend of ENE-WSW dipping 75 to 80 degree toward SSE. The southern side of the lease area is very steep where as it becomes gentle slope towards the northern side.

### **Drainage Pattern**

The area comprises of hilly and undulating terrain. The Daitari hill range is located in the north and the Mahagiri range occupies the southern portions. The central valley portions of the area is drained by Damsal Nala flowing in westerly direction. It forms the main watershed of the study area. The entire drainage originating from Daitari hills in north and Mahagiri in the south join Damsal Nala. The drainage network present over the major portions of the study area is sub-parallel except for the drainage emanating from Daitari hills over the northern portion which is radial and dendritic in nature. The maximum elevation of the study area is 600 m above mean sea level in the northern portions (Daitari Hill) while the lowest is less than 100m above sea level in the west central parts of valley. The only surface water source in this area is perennial Damsal Nala which is situated at 2.3 km distance from mining lease area due north. The water flowing through this nala ultimately joins into the Brahmani

  
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river. The lease area, represents undulating and hilly topography marked by linearly disposed mounds of moderate relief. The maximum elevation is 173.30 m RL on the southern side while the minimum elevation is 147 m RL on the northern portion of the lease area.



### Vegetation

Out of 73.777ha lease hold area 66.380 ha. area comes under Forest block -27 of Sukinda Tahasil . In forest area natural trees like Sal ,Kendu, Bahada ,Harida ,Karanja, Bela are grown. In addition we have planted Chankunda, Amba, Jamu, Neem, Karanja ,Sisu, Krushnachuda, Radhachuda etc in the reclaimed o/c quarry benches, dead end slope of the O/B dump & also in safety Zone.

Total plantation done by the lessee in the lease area from 2006 to 31<sup>st</sup>.Oct.2014 is given below in the table.

Year/ Location	Area (Ha)					No. of Plants
	Quarry	Dump	Safety Zone	Other	Total	
<b>Already done (as on 31.10.2014)</b>	0.33	1.8	1.2	4.13	7.46	20212

### Climate

Tropical climate is prevailed in the lease area . During June to October rainy season is influenced getting maximum rain fall in the area .In the last year maximum precipitation is recorded in the month of August (i.e 533.69mm) in the lease area. Winter is influenced from October to February . Severe cold is prevailed during night. Hot summer is influenced from march to may. During hot summer maximum temperature ranges from 38 to 46degree Celsius.

### Rainfall data:

In this area rain falls during the period July to October. The average rain fall in this region varies from 1300mm to 1600mm per annum. Th rain fall data measured by the lessee for the year 2014 given below.

For the Year 2014

Month	Rain fall in mm
January	0
February	20.83
March	36.74

  
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April	47.06
May	79.98
June	165.89
July	442.60
August	533.69
September	174.83
October	173.91
November	0
December	0
<b>Total</b>	<b>1675.53</b>



**b) Brief description of Regional geology with reference to location of lease.**

The Mahagiri Mines (Chromite) deposit (forming the Eastern Central part of the old TISCO lease hold of Sukinda Valley) forms a part of famous chromite bearing Sukinda ultramafic complex. The Sukinda ultramafics belong to the metamorphosed rocks of Pre-Cambrian age. The rocks of the area are associated with six sedimentary sequences separated by unconformities. The Sukinda ultramafics belong to the second sequence of the succession forms a major intrusive into the older rocks and occur as intrusive. The stratigraphic succession of the region is given in Table below.

**STRATIGRAPHIC SUCCESSION THE REGION**

Sixth Sequence	Granite Intrusive Contact Shales Carbonatites Shale lava and tuffs conglomerates
-----Unconformity-----	
Fifth Sequence	Gabbros, Ultrabasals and dyke Swarms Quartzites Conglomerates
-----Unconformity-----	
Fourth Sequence	Basal Granite Intrusive Contact Manganese bearing Shales
"Iron Ore stage of Dunn"	Banded Hematite Jasper Shale
-----Unconformity-----	
Third Sequence	Gabbro and Ultrabasals (intrusive) Lavas and interbedded grits Conglomerates, arils. Sandstone

  
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-----Unconformity-----	
Second Sequence	Granite and granite gneiss (Intrusive) Granophyre (Intrusive) Gabbro and Ultrabasic with chromite lodes (Intrusive) Banded Hematite quartzite Banded Hematite Jasper Conglomerate, ferruginous shale and phyllites
-----Unconformity-----	
First sequence	Metavolcanics chlorite schist Quartzite, BHQ, Banded ferruginous Quartzite, Mica Schist, Fuchsite

The ultrabasics are distributed with two different types of metamorphic facies:  
(a) Green Schist facies: Quartzite or Biotite hornblende-Granite in the northern part. (b) Granulites facies : Assemblages in the southern part of the region.

The ultramafic suite of rocks of Sukinda area is a layered complex of alternate bands of Chromite, Dunite, Peridotite and Orthopyroxinite. The dunite-peridotites are completely serpentinised. The presence of numerous chert bands in association with Chromite bands is the characteristic feature of the area. The lower sequence of Iron Ore Super Group of the region has been folded into syncline with gentle plunge to the WSW direction. The ultrabasics are intrusive into older sequence and subsequently co-folded. The area has been faulted along the northern margins of ultrabasic body.

The chrome ore mineralization is mainly restricted to the ultrabasics and occurs at six different stratigraphic levels. Band-I is the most important chromite bearing unit/member of the region. It extends for a longer distance and is the thickest among all the bands. Band - VI occurs in Mahagiri leasehold area, which contains hard lump chrome ore.

- c) **Detailed description of geology of the lease area such as shape and size of the mineral/ore deposit, disposition various litho units indicating structural features if any etc.**

Not applicable for scheme of mining ,(Only applicable for MP)



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**d) Prospecting / Exploration Agency:**

- (i) Name of prospecting / exploitation agency: Maheshwari Mines Private Limited
- (ii) Address: 21, CML Lane, Raniganj-713347, Dist Burdwan, West Bengal
- (iii) E mail address: rajiv.ganeriwala@maheswaree.com  
and phone no. 913412445446

**e) Details of prospecting / exploration already carried out :**

Year of Exploration	No of boreholes drilled	Location	Depth of bore hole in mtr.	Total meterage	No. of pits, dimensions and location	No. of Trenches, dimensions and location
2005-2006	04	From Surface	MMC/1= 181.75 MMC/3=135.83 MMC/3A= 152.17 MMC/5= 99.55	569.30	Nil	Nil
2006-2007	10	From Surface	MMC/2=120.00 MMC/3B=301.05 MMC/4= 187.30 MMC/7=377.65 MMC/9= 51.70 MMC/10=182.70 MMC/11= 249.50 MMC/12=301.15 MMC/14=315.45 MMC/15= 22.00	2108.50	Nil	Nil
2007-2008	07	From Surface	MMC/6= 124.16 MMC/8=33.00 MMC/13 =89.00 MMC/16=90.00 MMC/17=20.00 MMC/18=20.00 MMC/19=20.00	396.16	Nil	Nil
2008-2009	0		0	0	Nil	Nil
2009-2010	0		0	0	Nil	Nil
2010-2011	8	From Surface	MMC/20=16.00 MMC/21= 27.00 MMC/22=21.00 MMC/23=28.00 MMC/24=21.00 MMC/25=35.00 MMC/26=26.00 MMC/27=36.00	210	Nil	Nil
2013-2014	3	From Surface & U/G	MMC/28=674.50 UBH DD-1 =95.00 DD-1A= 128.00	897.50	Nil	Nil
2014-2015* (Up to 31* Jan 2015)	17	From Surface & U/G	MMC/29=270.00 MMC/31=485.00 MMC/32=724.00 MMC/33=325.00 MMC34=550.00 MMC36=471.00 MMC/37=687.00 MMC/38=569.00 MMC-39=951.00 MMC/40=81.00	5792.00	Nil	Nil

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			MMC/41=83.00 UBH DD-3 =102.50 DD-3A=106.00 DD-4=90.50 DD-4A=98.00 DD-5=79.00 DD-5A=120.00		
Total	49			9973.46	



\* In the FY 2014-15, we have not considered the bore hole no. MMC/35 of 633m, as the hole is continuing.

- f) **The surface plan of the lease area on a scale of 1:1000 or 1:2000 with contour interval of maximum of 10m depending upon the topography and size of the area duly marked by grid lines showing all features indicated under rule 28(1)(a) of MCDR 1988).**

The surface plan of the lease area has been prepared on a scale of 1:2000 with contour interval of 10m duly marked by grid lines showing all features indicated under rule 28(1)(a) of MCDR 1988) the same is shown as Plate No 04.

- g) **The geological plan showing details of exploration already carried out along with supporting data for existence of mineral, locations proposed exploration, various litho units along with structural features, mineralized/ ore zone .**

Geological plan has been prepared taking the surface plan prepared on a scale of 1:2000 specified under para 1.0m(f) of part A of the format as the base plan. The details of exploration already carried out along with supporting data for existence of mineral, locations proposed exploration, various litho units along with structural features, mineralized / ore zone with grade variation have been marked on the geological plan along with other features indicated under Rule 28n (1) (b) of MCDR 1988. Refer plate no 03.

- h) **Geological sections on natural scale of geological plan at suitable interval across the lease area from boundary to boundary.**

Geological sections has been prepared on 1:1000 scale of geological plan at suitable interval across the lease area. Refer plate no MMC/05.

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- i) **Future programme of exploration with due justification (duly marked on Geological plan year wise location in different colours) taking into consideration the future tentative excavation programme planned in next five years.**

In the total mining lease area of 73.777 ha, G1 category of exploration has been done over an area of 27.730ha and the balance area un-explored is 46.047 ha. Regionally this area has been explored by GSI and established that only one ore band (Band VI) is existing within the ML area. As per UNFC classification entire strike length of the Band VI ore body existing within the lease boundaries has been established by way of core drilling as per the exploration proposed in the approved Mining Plan and Scheme of mining.

To comply the Ministry letter 23<sup>rd</sup> Dec 2010 it is proposed to do the geophysical prospecting by Gravity method & Geochemical prospecting to cover the balance unexplored area of 46.047 ha, to know the existence of any chrome ore bodies during the year 2017-18. Depending on the anomaly zones if any found in the geophysical & geochemical prospecting, core drilling shall be done.

Future programme of exploration by core drilling in the Scheme Period (2015-16 to 2019-20) is given below.

Year	No of boreholes (Core/RC/DTH)	Grid interval	Total meterage	No. of pits, dimensions and volume	No. of Trenches, dimensions, and volume	Justification
2015-16	4nos	As per availability of site	280	-	-	To know the precise location, geometry in G1 level.
2016-17	-	-	-	-	-	
2017-18	1nos	As per availability of site	105	-	-	To convert the G2 category to G1 category.
2018-19	2nos	As per availability of site	220	-	-	To convert the G2 category to G1 category.
2019-20	3nos	As per availability of site	505	-	-	- do -
Total	10nos		1110mtr			




**Details of proposed exploration programme**

Year	No of boreholes (Core/RC/DTH)	Sec.	Collar RL	Angle	Hole length (mtr)	
2015-16	PBH -1	AA'	85mRLdrive	0°	30	85mRL ore body
	PBH- 2	GG'	85mRLdrive	0°	30	85mRL ore body
	PBH- 3	B1B1'	75mRL decline	32° down	120	25 mRL ore body
	PBH -4	FF'	85mRL drive	64° down	100	12mRL ore body
2016-17	-	-	-	-	-	-
2017-18	PBH - 5	EE'	-28mRL decline	29°	105	-75mRL ore body
2018-19	PBH-6	CC'	-39 RL Decline	8° down	100	-50mRL ore body
	PBH-7	GG'	25mRL drive	64°	120	-50mRL ore body
2019-20	PBH-8	BB'	-35mRL drive	67°	170	-155mRL ore body
	PBH-9	FF'	-35mRL drive	68°	170	- 155mRL ore body
	PBH - 10	CC'	-159mRL decline	36°	165	-250mRL ore body
Total 10 nos					1110mtr	

- j) **Reserve and resources as per UNFC with respect to the threshold value notified by IBM. Area explored under different level of exploration marked on the geological plan and UNFC code for area considered for different categories of reserve/ resources estimation.**

**Lease area explored as per UNFC norms is given below in the table**

The threshold grade has been kept as 10% Cr<sub>2</sub>O<sub>3</sub> as per IBM guidelines and based on the usability of ore at captive plants, the cut off grade has been fixed at 30% Cr<sub>2</sub>O<sub>3</sub>.

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Name of the mineral : Chromite							
Sl. No	Name of the Lease & owner	Total lease area (in Ha)	Lease area explored as per UNFC norms (in Ha)				Remarks / Comments including reasons for not carrying out the exploration as per UNFC norms
			C= D+E+F+G				
			G1 level	G2 level	G3 level	Other lease area/unexplored area	
A	B	C	D	E	F	G	H
1	Mahagiri Mines (Chromite) Owner- M/s IMFA LTD	73.777	27.730	0	0	46.047	Exploration has been carried out as per the proposed exploration in the approved scheme of mining. The balance unexplored area shall be explored by geophysical & Geochemical prospecting during 2017-18, based on the result of anomalies for chrome zone the bore holes shall be proposed.

Summary of reserve and resources as per UNFC with respect to the threshold value notified by IBM furnished in the tabular form.

**(A) Total Measured Mineral Resources (331)**

Category	mRL considered	Measured Mineral Resources (331) in Tonnes	Proved Mineral Reserve(111) inTonnes	Feasibility Mineral Resources (211) in Tonnes
Opencast	Surface to 185 RL	160911	129129	31782
<b>Under ground</b>				
Sill Pillar	185 to 135 RL	2102557	17713	2084844
Block 1	135 to 85 RL	1693806	1651937	41869
Sill Pillar	85 to 75 RL	270077		270077
Block 2	75 to 25 RL	1232194	1201876	30318
	<b>Total =</b>	<b>5459545</b>	<b>3000655</b>	<b>2458890</b>

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**(B) Total Indicated Mineral Resources (332)**

Category	mRL considered	Indicated Mineral Resources (332) In Tonnes	Probable Mineral Reserve(122) inTonnes	Feasibility Mineral Resources (222) In Tonnes
Opencast	Nil	-	-	-
<b>Underground</b>				
Crown Pillar	25 to 15 RL	211365		211365
Block 3	15 to -35 RL	880139	858483	21656
Crown Pillar	-35 to -45 RL	176137		176137
Block 4	-45 to -95 RL	880139	858483	21656
Crown Pillar	-95 to -105 RL	176137		176137
Block 5	- 105 to -155 RL	880139	858483	21656
Crown Pillar	- 155 to -165 RL	176137		176137
Block 6	-165 to -215 RL	821463	801250	20213
Crown Pillar	-215 to -225 RL	164395		164395
Block 7	-225 to -275 RL	821463	801250	20213
Crown Pillar	-275 to -285RL	152652		152652
Block 8	- 285 to -335 RL	762787	744018	18769
Crown Pillar	-335 to -345RL	140910		140910
Block 9	-345 to -395 RL	704111	686786	17325
	<b>Total</b>	<b>6947974</b>	<b>5608753</b>	<b>1339221</b>

A feasibility study report along with financial analysis for economic viability of the deposit as specified under the UNFC field guideline is given as Annexure -2.

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## k) Detailed calculation of reserves/ resources

By Longitudinal section method

Avg. Width considered for estimation of reserve

Category	MRL considered	T-Section considered	Avg. width
O/C Mine			
G1	Surface to 185 RL	AA' & BB'	13.0 m
Below O/C			
G1	185 to 135 RL	AA' to GG'	18.0 m
G1	135 to 85 RL	AA' to GG'	14.5 m

Category	MRL considered	T-Section considered	Avg. width
G2	85 to 75 RL	AA' to GG'	11.5 m
G2	75 to 25 RL	AA' to GG'	10.5 m
G2	25 to 15 RL	AA' to GG'	9.0 m
G2	15 to -35 RL	AA' to GG'	7.5 m
G2	-35 to -45 RL	AA' to GG'	7.5 m
G2	-45 to -95 RL	AA' to GG'	7.5 m
G2	-95 to -105 RL	BB' to GG'	7.5 m
G2	-105 to -155 RL	BB' to GG'	7.5 m
G2	-155 to -165 RL	BB' to GG'	7.5 m
G2	-165 to -215 RL	BB' to GG'	7.0 m
G2	-215 to -225 RL	BB' to GG'	7.0 m
G2	-225 to -275 RL	BB' to GG'	7.0 m
G2	-275 to -285 RL	BB' to GG'	6.5 m
G2	-285 to -335 RL	BB' to GG'	6.5 m
G2	-335 to -345 RL	BB' to GG'	6.0 m
G2	-345 to -395 RL	BB' to GG'	6.0 m

Note - 1) Width of ore body along T. section AA' is not considered below -95mRL.

2) Width of ore body along T. section DD' is not considered below 25mRL

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T.F. 3.85 is considered for reserve & resource estimation as per the analysis report of core samples analyzed in Institute Of Minerals & Materials Technology, Bhubaneswar on dated 12<sup>th</sup>, May 2011. The average value considered is 3.85 ( Refer Annexure - 28)

The average width of the ore body for Band-VI is taken as per the drilled boreholes intersecting the ore body, in seven different sections viz. AA',B-B',CC',DD',EE',FF',GG' HH'. The strike influence of the ore body is considered as 610 m. For estimation of geological reserve, calculation has been done by taking into consideration the longitudinal sectional area. The longitudinal sectional area is multiplied with the avg. width of ore body to obtain the ore volume. Tonnage Factor of 3.85 is multiplied with the ore volume to get the geological reserve. The parameters considered for calculation of reserve for both Opencast and below opencast are described below in Table no. 3.3.

**Table No. 3.3: Parameters considered for Reserve Estimation**

Category	Parameters considered	Band-VI	
		Opencast	Below Opencast
G1	Level	205 mRL to 185 mRL	185 mRL to 25 mRL
	Surface & U/G Bore Holes considered.	2,25,27,40,41	1,2,3,3A,3B,4,5,7,10,12,25,29,DD-1&1A, DD-3&3A,DD-4 &4-A, DD-5,
	Influence in strike direction	The strike influence has been considered 50 - 100m for total strike length of 222m based on the BH intersection, exposed ore bench of O/C working, referring L-section along XYZ	The strike influence has been considered 100 - 200m for total strike length of 610m based on the BH intersection, referring L-section along XYZ.
	Influence in Dip direction	25-50m upto UPL of +185 mRL	100m from +185 mRL i.e upto 25mRL
	Dip of the Ore body	78° to 80° towards S-W	75° to 84°
	Avg.Width of Ore body	13m	11.5 to 18m
	Grade of the deposit	+30%	+30%
	Tonnage Factor	3.85	3.85

  
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Category	Parameters considered	Band-VI	
		Opencast	Below Opencast
G2	Level	-	25 mRL to -395 mRL
	Bore Holes considered	-	7,14,12,28,29,31,32,33,34,36,37,38,39,
	Strike length considered		610 mtr.
	Influence in Dip direction	-	100m to 200 mtr(from 25 mRL to -395 mRL)
	Dip of the Ore body	-	75° to 84°
	Avg.Width of Ore body	-	11.5 to 6 mtr
	Grade of the deposit	-	+30%
	Tonnage Factor	-	3.85

**Details of Opencast Reserve (331)**

[a] Measured Mineral Resources (331) of Band -VI between surface to 185 mRL

Bore Hole Considered	BH No - 2, 25,27,40,41
Strike Length of the ore body	222 m
Lon. Sectional area	3215 sq.m
Average width of the ore body	13m
Tonnage Factor	3.85
Total Reserve in Tonnes	160911, Grade- +30% Cr2O3

[b] Proved Mineral Reserve (111) of Band -VI between surface to 185 mRL (O/C UPL)

Bore Hole Considered	BH No - 2, 25,27,40,41
Strike Length of the ore body	214
Lon. Sectional area	2580 sq. mtr.
Average width of the ore body	13m
Tonnage Factor	3.85
Total Reserve in Tonnes	129129 , Grade- +30% Cr2O3

(c). Feasibility Mineral Resources(221) of Band-VI between surface to 185mRL (safety zone area and left out bench) =31782 Tonnes



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**Details of Reserve below opencast (331)**

**[d] Measured Mineral Resources (331) of Band -VI between 185 mRL (opencast UPL) to 135 mRL (Sill Pillar)**

T. Section Considered	AA',BB',CC', DD',EE',FF',GG'
Strike Length of the ore body in m	610
Longitudinal sect .area	30481 sq.mtr
Average width of the ore body in m	18m
Tonnage Factor	3.85
Total Reserve in Tonnes	2112333
Mined out during 2014-15	9776 Tonnes
Balance Mineral Resource	<b>2102557 Tonnes , Grade- +30% Cr2O3</b>

**(d1) Proved Mineral Reserve (111) at 145mRL monitoring drive ( between 185 to 135 mRL) = 17713 MT**

(595x4x3x3.85=27489 Tonnes - 9776 MT mined out during 2014-15 till Oct.2014 =17713 MT)

**(d2) Feasible Mineral Resources between 185 to 135 RL (221) = 2102557 Tonnes.**

**[e] Measured Mineral Resources (331) of Band -VI between 135 mRL to 85 mRL (1<sup>st</sup> Stope Block)**

T. Section Considered	AA',BB',CC', DD',EE',FF',GG'
Strike Length of the ore body in m	610
Lon. Sect. area	30481 sq.mtr
Average width of the ore body in m	14.5
Tonnage Factor	3.85
Total Reserve in Tonnes	1701602
Mined out during 2014-15 in Tonnes	7795.81
Balance Measured Mineral Resource in Tonnes	1693806.19, Grade- +30% Cr2O3

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**[f] Proved Mineral Reserve (111) of Band -VI between 135 mRL  
(1<sup>st</sup> Stope Block)**

T. Section Considered	AA',BB',CC'DD' EE',FF',GG'
Strike Length of the ore body	595m
Longitudinal sect. area	29731sq.m
Average width of the ore body in m	14.50
Tonnage Factor	3.85
Total Reserve in Tonnes	1659733
Mined out reserve due to development at 132mRL during 214-15	7795.81 Tonnes.
Balance Mineral Reserves in Tonnes	1651937.19 , Grade- +30% Cr2O3

**[g] Feasibility Mineral Resource (221) of Band -VI between 135 mRL to 85mRL  
(Safety zone area ) = 41869 Tonnes**

**(h) Measured Mineral Resource (331) of Band -VI between 85 mRL to 75 mRL  
(Safty zone area & crown pillar )**

T. Section Considered	AA',BB',CC'DD' EE',FF',GG'
Strike Length of the ore body	610m
Longitudinal sect. area	6100 sq.mtr
Average width of the ore body in m	11.50
Tonnage Factor	3.85
Total Reserve in Tonnes	270077 , Grade- +30% Cr2O3

**h') Feasibility Mineral Resource (221) of Band -VI between 85 mRL to 75 mRL  
(Safty zone area & crown pillar ) = 270077 Tonnes.**

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**[i] Measured Mineral Resources (331) of Band -VI between 75 mRL to 25 mRL  
(2<sup>nd</sup> Stope Block)**

T. Section Considered	AA',BB',CC'DD' EE',FF',GG'
Strike Length of the ore body in m	610
Lon. Sect. area	30481 sq.mtr
Average width of the ore body in m	10.5
Tonnage Factor	3.85
Total Reserve in Tonnes	1232194 , Grade- +30% Cr2O3

**[j] Proved Mineral Reserve (111) of Band -VI between 75 mRL to 25 mRL  
(2<sup>nd</sup>. Stope Block)**

T. Section Considered	AA',BB',CC'DD' EE',FF',GG'
Strike Length of the ore body	595m
Longitudinal sect. area	29731
Average width of the ore body in m	10.5
Tonnage Factor	3.85
Total Reserve in Tonnes	1201876 , Grade- +30% Cr2O3

**[k] Feasibility Mineral Resource (221) of Band -VI between 75 mRL to 25 mRL  
(Safety zone area ) = 30318 Tonnes****( l ) Prefeasibility Mineral Resource (222) of Band -VI between 25 mRL to 15  
mRL****(Safety zone area & crown pillar )**

T. Section Considered	AA',BB',CC', EE',FF',GG'
Strike Length of the ore body	610m
Longitudinal sect. area	6100 sq.mtr
Average width of the ore body in m	9
Tonnage Factor	3.85
Total Reserve in Tonnes	211365 , Grade- +30% Cr2O3



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**[m] Indicated Mineral Resources (332) of Band-VI between 15mRL to -35 mRL  
(3<sup>rd</sup> Stope Block)**

T. Section Considered	AA',BB',CC', EE',FF',GG'
Strike Length of the ore body in m	610
Lon. Sect. area	30481
Average width of the ore body in m	7.5
Tonnage Factor	3.85
Total Reserve in Tonnes	880139 , Grade- +30% Cr2O3

**[n] Probable Mineral Reserve (122) of Band -VI between 15 mRL to -35 mRL  
(3<sup>rd</sup> Stope Block)**

T. Section Considered	AA',BB',CC', EE',FF',GG'
Strike Length of the ore body	595m
Longitudinal sect. area	29731 sq.mtr
Average width of the ore body in m	7.5
Tonnage Factor	3.85
Total Reserve in Tonnes	858483, Grade- +30% Cr2O3

**[o] Prefeasibility Mineral Resources (222) of Band -VI between 15 mRL to -35  
mRL (Safety zone area ) = 21656 Tonnes****(p) Prefeasibility Mineral Resource(222) of Band-VI between -35 mRL to -45  
mRL (Safty zone area & crown pillar )**

T. Section Considered	AA',BB',CC', EE',FF',GG'
Strike Length of the ore body	610m
Longitudinal sect. area	6100 sq.mtr
Average width of the ore body in m	7.5
Tonnage Factor	3.85
Total Reserve in Tonnes	176137 Grade- +30% Cr2O3

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**[q] Indicated Mineral Resources (332) of Band -VI between -45 mRL to -95 mRL (4<sup>th</sup> Stope Block)**

T. Section Considered	AA',BB',CC', EE',FF',GG'
Strike Length of the ore body In m	610
Lon. Sect. area	30481 sq.mtr
Average width of the ore body in m	7.5
Tonnage Factor	3.85
Total Reserve in Tonnes	880139 , Grade- +30% Cr2O3

**[r] Probable Mineral Reserve (122) of Band -VI between -45 mRL to -95 mRL (4<sup>th</sup> Stope Block)**

T. Section Considered	AA',BB',CC' EE',FF',GG'
Strike Length of the ore body	595m
Longitudinal sect. area	29731 sq.mtr
Average width of the ore body in m	7.50
Tonnage Factor	3.85
Total Reserve in Tonnes	858483 , Grade- +30% Cr2O3

**[s] Prefeasibility Mineral Resources (222) of Band-VI between -45 mRL to -95 mRL (Safety zone area ) =21656 Tonnes**

**(t) Prefeasibility Mineral Resources (222) of Band-VI between -95 mRL to -105mRL (Safety zone and sill pillar area )**

T. Section Considered	BB',CC', EE',FF',GG'
Strike Length of the ore body	610m
Longitudinal sect. area	6100 sq.mtr
Average width of the ore body in m	7.50
Tonnage Factor	3.85
Total Reserve in Tonnes	176137 , Grade- +30% Cr2O3

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**[u] Indicated Mineral Resources (332) of Band -VI between -105 mRL to -155 mRL (5<sup>th</sup> Stope Block)**

T. Section Considered	BB',CC', EE',FF',GG'
Strike Length of the ore body in m	610
Lon. Sect. area	30481 sq. mtr
Average width of the ore body in m	7.5
Tonnage Factor	3.85
Total Reserve in Tonnes	880139 , Grade- +30% Cr2O3

**[v] Probable Mineral Reserve (122) of Band -VI between -105 mRL to -155 mRL (5<sup>th</sup> Stope Block)**

T. Section Considered	AA',BB',CC', EE',FF',GG'
Strike Length of the ore body	595m
Longitudinal sect. area	29731 sq. mtr
Average width of the ore body in m	7.50
Tonnage Factor	3.85
Total Reserve in Tonnes	858483 , Grade- +30% Cr2O3

**[w] Prefeasibility Mineral Resources (222) of Band -VI between -105 mRL to -155 mRL(Safety zone area ) =21656 Tonnes**

**(x) Prefeasibility Mineral Resources (222) of Band -VI between -155 mRL to -165 mRL(Safety zone and sill pillar area )**

T. Section Considered	BB',CC', EE',FF',GG'
Strike Length of the ore body	610m
Longitudinal sect. area	6100 sq.mtr
Average width of the ore body in m	7.50
Tonnage Factor	3.85
Total Reserve in Tonnes	176137, Grade- +30% Cr2O3

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**(y) Indicated Mineral Resource (332) of Band -VI between -165 mRL to -215 mRL.**

T. Section Considered	BB',CC', EE',FF',GG'
Strike Length of the ore body	610m
Longitudinal sect. area	30481 sq.mtr
Average width of the ore body in m	7.00
Tonnage Factor	3.85
Total Reserve In Tonnes	821463 , Grade- +30% Cr2O3

**(z) Probable Mineral Reserve (122) of Band -VI between - 165 mRL to -215 mRL.**

T. Section Considered	BB',CC', EE',FF',GG'
Strike Length of the ore body	595m
Longitudinal sect. area	29731 sq. mtr
Average width of the ore body in m	7.00
Tonnage Factor	3.85
Total Reserve In Tonnes	801250 , Grade- +30% Cr2O3

**(z1) Prefeasibility Mineral Resource (222) of Band -VI between - 165 mRL to -215 mRL (safety zone) = 20213 Tonnes****(z2) Prefeasibility Mineral Resource (222) of Band -VI between - 215 mRL to -225 mRL (safety zone and sill pillar)**

T. Section Considered	BB',CC', EE',FF',GG'
Strike Length of the ore body	610m
Longitudinal sect. area	6100 sq. mtr
Average width of the ore body in m	7.0
Tonnage Factor	3.85
Total Reserve In Tonnes	164395 , Grade- +30% Cr2O3

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**(z3) Indicated Mineral Resource (332) of Band -VI between - 225 mRL to -275 mRL.**

T. Section Considered	BB',CC', EE',FF',GG'
Strike Length of the ore body	610m
Longitudinal sect. area	30481 sq.mtr
Average width of the ore body in m	7
Tonnage Factor	3.85
Total Reserve in Tonnes	821463 , Grade- +30% Cr2O3

**(z4) Probable Mineral Reserve(122) of Band -VI between -225 mRL to -275 mRL.**

T. Section Considered	BB',CC', EE',FF',GG'
Strike Length of the ore body	595m
Longitudinal sect. area	29731 sq.mtr
Average width of the ore body in m	7
Tonnage Factor	3.85
Total Reserve in Tonnes	801250 , Grade- +30% Cr2O3

**(z5) Prefeasibility Mineral Resource (222) of Band -VI between - 225 mRL to -275 mRL (safety zone) = 20213 Tonnes****(z6) Prefeasibility Mineral Resource (222) of Band -VI between - 275 mRL to -285 mRL (safety zone and sill pillar)**

T. Section Considered	BB',CC', EE',FF',GG'
Strike Length of the ore body	610m
Longitudinal sect. area	6100 sq.mtr
Average width of the ore body in m	6.5
Tonnage Factor	3.85
Total Reserve in Tonnes	152652 , Grade- +30% Cr2O3

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**(z7) Indicated Mineral Resource (332) of Band -VI between - 285 mRL to mRL.**

T. Section Considered	BB',CC,' EE',FF',GG'
Strike Length of the ore body	610m
Longitudinal sect. area	30481 sq.mtr
Average width of the ore body in m	6.5
Tonnage Factor	3.85
Total Reserve in Tonnes	762787 , Grade- +30% Cr2O3

**(z8) Probable Mineral Reserve(122) of Band-VI between -285 mRL to -335 mRL.**

T. Section Considered	BB',CC,' EE',FF',GG'
Strike Length of the ore body	595m
Longitudinal sect. area	29731 sq.mtr
Average width of the ore body in m	6.5
Tonnage Factor	3.85
Total Reserve in Tonnes	744018 , Grade- +30% Cr2O3

**(z9) Prefeasibility Mineral Resource (222) of Band -VI between - 285 mRL to -335 mRL (safety zone) = 18769 Tonnes.**

**(z10) Prefeasibility Mineral Resource (222) of Band -VI between - 335 mRL to -345 mRL (safety zone and sill pillar)**

T. Section Considered	BB',CC,' EE',FF',GG'
Strike Length of the ore body	610m
Longitudinal sect. area	6100 sq.mtr
Average width of the ore body in m	6
Tonnage Factor	3.85
Total Reserve in Tonnes	140910 , Grade- +30% Cr2O3

  
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**(z11) Indicated Mineral Resource (332) of Band -VI between - 345 mRL to -395 mRL.**

T. Section Considered	BB',CC,' EE',FF',GG'
Strike Length of the ore body	610m
Longitudinal sect. area	30481 sq.mtr
Average width of the ore body in m	6
Tonnage Factor	3.85
Total Reserve in Tonnes	704111 ,Grade- +30% Cr2O3

**(z12) Probable Mineral Reserve (122) of Band -VI between - 345 mRL to -395 mRL.**

T. Section Considered	BB',CC,' EE',FF',GG'
Strike Length of the ore body	595m
Longitudinal sect. area	29731 sq.mtr
Average width of the ore body in m	6
Tonnage Factor	3.85
Total Reserve in Tonnes	686786 , Grade- +30% Cr2O3

**(z13) Prefeasibility Mineral Resource (222) of Band -VI between - 345 mRL to -395 mRL (safety zone) = 17325 Tonnes.**

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**Reserve estimation by cross section method****(Surface to 185mRL)**

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	LH data at 132 RL	60	48	2880	3.85		
	-do-	60	58	3480	3.85	13398	221
	do-	60	34	2040	3.85	7854	111
	do-	60	22	1320	3.85	5082	111
BB'	BH- 1, 27	272	75	20400	3.85	78540	111
CC'	Exposed ore width, BH-3	150	65	9750	3.85	37537	111
						<b>153499</b>	

Proved mineral reserve ( 111) between surface to 185 RL =153499 - 24486 = 129013 tonnes

Feasible mineral resources (221) between surface to 185 RL(Blocked ore in o/c benches& safety zone)=11088+13398 = 24486 tons

**LEVEL (185mRL to 135mRL)**

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	LH data at 132 RL	504	7.5	3780	3.85	14553	331
	-do-	504	74.5	37548	3.85	144559.8	331
BB'	BH-1,27	742	46	34132	3.85	131408.8	331
B1B1'	BH-25, DD-1	518	56	29008	3.85	111680.2	331
CC'	BH-2, exposed ore in o/c quarry	740	60	44400	3.85	170940	331
DD'	BH-10, exposed ore in o/c quarry	1470	48	70560	3.85	271656	331
EE'	BH-3,3A, exposed ore in o/c quarry	1259	34	42806	3.85	164803.1	331
E1E1'	DD-4, exposed ore in o/c quarry	900	32	28800	3.85	110880	331
E2E2'	DD-3, exposed ore in o/c quarry	800	40	32000	3.85	123200	331
FF'	BH-4, exposed ore in o/c quarry	1170	68	79560	3.85	306306	331
GG'	BH-5, exposed ore in o/c quarry	1098	68	74664	3.85	287456.4	331
HH'	BH-5, exposed ore in o/c quarry	1098	68.5	75213	3.85	289570.05	331
			7.5	8235	3.85	31704.75	331
			<b>610</b>	<b>560706</b>		<b>2158718.1</b>	
	Mined out reserve at 145 RL					<b>(-)9776</b>	
	Balance resources upto Oct 2014					<b>2148942</b>	<b>331</b>



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Total Mineral reserve (111) bet. 185 to 135 RL =  $595 \times 4 \times 3 \times 3.85 = 27489.9776$  tons

Reserve mined out during development upto Oct at -145 mRL = 9776 tons

**Balance mineral reserve (111) between 185 to 135 mRL (145drive) = 27489-9776 = 17713 tons**

**Feasible mineral resources (221) bet. 185RL to 145 RL = 2131229 tonnes**

**LEVEL (135mRL to 85mRL)**

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	LH data at 132 RL, BH-12	180	7.5	1350	3.85	5197.5	221
	-do-	180	74.5	13410	3.85	51628.5	111
BB'	BH-1,34	500	46	23000	3.85	88550	111
B1B1'	DD-1&1A	485	56	27160	3.85	104566	111
CC'	BH-2,36	754	60	45240	3.85	174174	111
DD'	BH-10, DD-5	841	48	40368	3.85	155416.8	111
EE'	BH-3,3A,3B	864	34	29376	3.85	113097.6	111
E1E1'	DD-4,84A	320	32	10240	3.85	39424	111
E2E2'	DD-3& 3A	384	40	15360	3.85	59136	111
FF'	BH-4,14	657	68	44676	3.85	172002.6	111
GG'	BH-5,29	969	68	65892	3.85	253684.2	111
HH'	BH-5,29	969	68.5	66376.5	3.85	255549.53	111
	BH-5,29	969	7.5	7276.5	3.85	27979.88	221
			<b>610</b>	<b>389716</b>		<b>1500406</b>	

**Proved mineral reserve ( 111) between 135 RL to 85 RL = 1467228 tonnes**

**Feasible mineral resources (221) between 135 RL to 85 RL(Blocked ore in safety zone)=1500406-1467228=33178 tons**



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**LEVEL (85mRL to 75mRL)**

Cross section	Parameters considered	Area sq.mtr	Strike influence In mtr.	Volume	Bulk density	UNFC Code
AA	BH-12	73	7.5	547.5	3.85	221
	-do-	73	74.5	5438.5	3.85	221
BB'	BH-1,34	101	46	4646	3.85	221
B1B1'	DD-1&1A	126	56	7056	3.85	221
CC'	BH-2,36	147	60	8820	3.85	221
DD'	BH-10, DD-5	119	48	5712	3.85	221
EE'	BH-3,3A,3B	127	34	4318	3.85	221
E1E1'	DD-4,&4A	70	32	2240	3.85	221
E2E2'	DD-3& 3A	144	40	5760	3.85	221
FF'	BH-4,14	86	68	5848	3.85	221
GG'	BH-5,29	15	68	10472	3.85	221
HH'	BH-5,29	15	68.5	10549	3.85	221
	-do-	15	7.5	1155	3.85	221
			<b>610</b>	<b>72562</b>		<b>279363.7</b>

**Feasible mineral resources (221) between 85mRL to 75mRL (Blocked ore in safety zone and sill pillar) =279363.7 Tons**

**LEVEL (75mRL to 25mRL)**

Cross section	Parameters considered	Area sq.mtr	Strike influence In mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	367	7.5	2752.5	3.85	10597.13	221
	-do-	367	74.5	27341.5	3.85	105264.78	111
BB'	BH-1,34	506	46	23276	3.85	89612.6	111
B1B1'	DD-1&1A	630	56	35280	3.85	135828	111
CC'	BH-2,36	731	60	43860	3.85	168861	111
DD'	BH-10, DD-5	713	48	34224	3.85	131762.4	111
EE'	BH-3,3A,3B	456	34	15504	3.85	59690.4	111
E1E1'	DD-4,&4A	385	32	12320	3.85	47432	111
E2E2'	DD-3& 3A	650	40	26000	3.85	100100	111
FF'	BH-4,14	432	68	29376	3.85	113097.6	111
GG'	BH-5,29	568	68	38624	3.85	148702.4	111
HH'	BH-5,29	568	68.5	38908	3.85	149795.8	111
		568	7.5	4260	3.85	16401	221
			<b>610</b>	<b>331726</b>		<b>1277145.1</b>	



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Proved mineral reserve ( 111) between 75 RL to 25 RL = 1250147 tonnes

Feasible mineral resources (221) between 75 RL to 25 RL (Blocked ore in safety zone)=1277145-1250147=26998 tonnes

**LEVEL (25mRL to 15mRL)**

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	73	7.5	547.5	3.85	2107.88	222
	-do-	73	74.5	5438.5	3.85	20938.23	222
BB'	BH-1,34	101	85	8585	3.85	33052.25	222
CC'	BH-2,36	145	87	12615	3.85	48567.75	222
DD'	BH-10, DD-5&5A	165	48	7920	3.85	30492	222
EE'	BH-3,3A,3B	56	74	4144	3.85	15954.4	222
FF'	BH-4,14	88	90	7920	3.85	30492	222
GG'	BH-5,29	70	68	4760	3.85	18326	222
HH'	BH-5,29	70	68.5	4795	3.85	18460.75	222
		70	7.5	525	3.85	2021.25	222
			<b>610</b>	<b>57250</b>		<b>220412.5</b>	

Prefeasible mineral resources (222) between 25 RL to 15 RL (Blocked ore in safety zone & sill)=220412.5 tonnes

**LEVEL (15mRL to -35mRL)**

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	367	7.5	2752.5	3.85	10597.13	222
	-do-	367	74.5	27341.5	3.85	105264.78	122
BB'	BH-133,,34	504	85	42840	3.85	164934	122
CC'	BH-2,36	718	87	62466	3.85	240494.1	122
DD'	DD-5 & 5A	832	48	39936	3.85	153753.6	122
EE'	BH-3,3A,3B	209	74	15466	3.85	59544.1	122
FF'	BH-4,14,38	451	90	40590	3.85	156271.5	122
GG'	BH-5,29	232	68	15776	3.85	60737.6	122
HH'	BH-5,29	232	68.5	15892	3.85	61184.2	122
		232	7.5	1740	3.85	6699	222
			<b>610</b>	<b>264800</b>		<b>1019480</b>	

Probable mineral reserve ( 122) between 15 RL to -35 RL =1019480- 17296 = 1002184 tonnes

Prefeasible mineral resources (222) between 75 RL to 25 RL (Blocked ore in safety zone)=17296 tonnes

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## LEVEL (-35mRL to -45mRL)

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	73	7.5	547.5	3.85	2107.88	222
	-do-	73	74.5	5438.5	3.85	20938.23	222
BB'	BH-33,34	92	85	7820	3.85	30107	222
CC'	BH-2,36	142	87	12354	3.85	47562.9	222
DD'	DD-5 & 5A	166	48	7968	3.85	30676.8	222
EE'	BH-3,3A,3B	55	74	4070	3.85	15669.5	222
FF'	BH-14,38	92	90	8280	3.85	31878	222
GG'	BH-5,29	45	68	3060	3.85	11781	222
HH'	BH-5,29	45	68.5	3082.5	3.85	11867.63	222
		45	7.5	337.5	3.85	1299.38	222
			610	52958		203888.3	

Prefeasible mineral resources (222) between -35 RL to -45 RL (Blocked ore in safety zone & sill) = 203888 tonnes

## LEVEL (-45mRL to -95mRL)

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	367	7.5	2752.5	3.85	10597.13	222
	-do-	367	74.5	27341.5	3.85	105264.78	122
BB'	BH-33,34	421	85	35785	3.85	137772.25	122
CC'	BH-2,36	705	87	61335	3.85	236139.75	122
DD'	DD-5 & 5A	800	48	38400	3.85	147840	122
EE'	BH-3B,31	348	74	25752	3.85	99145.2	122
FF'	BH-14,38	473	90	42750	3.85	163894.5	122
GG'	BH-7,29	215	68	14620	3.85	56287	122
HH'	BH-7,29	215	68.5	14727.5	3.85	56700.88	122
		215	7.5	1612.5	3.85	6208.13	222
			610	264896		1019849.6	

Probable mineral reserve (122) between -45 RL to -95 RL = 1019849.6-16805- = 1003044 tonnes

Prefeasible mineral resources (222) between -45 RL to -95 RL (Blocked ore in safety zone) = 16805 tonnes



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**LEVEL (-95mRL to -105mRL)**

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	50	7.5	375	3.85	1443.75	222
	-do-	50	74.5	3725	3.85	14341.25	222
BB'	BH-33,34	78	85	6630	3.85	25525.5	222
CC'	BH-2,36	140	87	12180	3.85	46893	222
DD'	DD-5 & 5A	110	48	5280	3.85	20328	222
EE'	BH-38,31	85	74	6290	3.85	24216.5	222
FF'	BH-14, 38	97	90	8730	3.85	33610.5	222
GG'	BH-7,,28,29	41	68	2788	3.85	10733.8	222
HH'	BH-7,28 ,29	41	68.5	2808.5	3.85	10812.73	222
		41	7.5	307.5	3.85	1183.88	222
			<b>610</b>	<b>49114</b>		<b>189088.9</b>	

**Prefeasible mineral resources (222) between -95 RL to -105 RL (Blocked ore in safety zone)=189088.9 tonnes**

**LEVEL (-105mRL to -155mRL)**

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	200	7.5	1500	3.85	5775	222
	-do-	200	74.5	14900	3.85	57365	122
BB'	BH-33,34	361	85	30685	3.85	118137.25	122
CC'	BH-36,37	527	87	45849	3.85	176518.65	122
DD'	DD-5 & 5A	525	48	25200	3.85	97020	122
EE'	BH-38,31	501	74	37074	3.85	142734.9	122
FF'	BH-14,38	495	90	44550	3.85	171517.5	122
GG'	BH-28,29	278	68	18904	3.85	72780.4	122
HH'	BH-28,29	278	68.5	19043	3.85	73315.55	122
		278	7.5	2085	3.85	8027.25	222
			<b>610</b>	<b>239790</b>		<b>923191.5</b>	

**Probable mineral reserve ( 122) between -105 RL to -155 RL =923191.5-13802 =909389 tonnes**

**Prefeasible mineral resources (222) between -105 RL to -155 RL (Blocked ore in safety zone and sill)=13802 tonnes**

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## LEVEL(-155mRL to -165mRL)

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	35	7.5	262.5	3.85	1019.63	222
	-do-	70	74.5	5215	3.85	20077.75	122
BB'	BH-33,34	66	85	5610	3.85	21598.5	222
CC'	BH-36,37	79	87	6873	3.85	26461.05	222
DD'	DD-5&5A	80	48	3840	3.85	14784	222
EE'	BH-31,32	117	74	8658	3.85	33333.3	222
FF'	BH-14,38,39	101	90	9090	3.85	34996.5	222
GG'	BH-28,29	59	68	4012	3.85	15446.2	222
HH'	BH-28,29	59	68.5	4041.5	3.85	15559.78	222
		59	7.5	442.5	3.85	1703.63	222
			610	48044.5		184971.33	

**Prefeasible mineral resources (222) between -155 RL to -165 RL (Blocked ore in safety zone)=184971 ton**

## LEVEL (-165mRL to -215mRL)

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	175	7.5	1312.5	3.85	5053.13	222
	-do-	70	74.5	5215	3.85	20077.75	122
BB'	BH-33,34	301	85	25585	3.85	98502.25	122
CC'	BH-36,37	407	87	35409	3.85	136324.65	122
DD'	DD-5&5A	400	48	19200	3.85	73920	122
EE'	BH-31,32	626	74	46324	3.85	178347.4	122
FF'	BH-14,38,39	517	90	46530	3.85	179140.5	122
GG'	BH-28,29	277	68	18836	3.85	72518.6	122
HH'	BH-28,29	277	68.5	18974.5	3.85	73051.83	122
		277	7.5	2077.5	3.85	7998.38	222
			610	219463.5		844934.48	

**Probable mineral reserve (122) between -165 RL to -215 RL =844934.48-13051 = 831883 tonnes**

**Prefeasible mineral resources (222) between -165 RL to -215 RL (Blocked ore in safety zone and sill)=13051 ton**



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**LEVEL (-215mRL to -225mRL)**

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	30	7.5	225	3.85	866.25	222
	-do-	70	74.5	5215	3.85	20077.75	222
BB'	BH-33,34	54	85	4590	3.85	17671.5	222
CC'	BH-36,37	84	87	7308	3.85	28135.8	222
DD'	DD-5&5A	90	48	4320	3.85	16632	222
EE'	BH-31,32	118	74	8732	3.85	33618.2	222
FF'	BH-14,38,39	106	90	9540	3.85	36729	222
GG'	BH-28,29	52	68	3536	3.85	13613.6	222
HH'	BH-28,29	52	68.5	3562	3.85	13713.7	222
		52	7.5	390	3.85	1501.5	222
			<b>610</b>	<b>47418</b>		<b>182559.3</b>	

**Prefeasible mineral resources (222) between -215 RL to-225 RL (Blocked ore in safety zone and sill)=182559.3 ton**

**LEVEL (-225mRL to -275mRL)**

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	150	7.5	1125	3.85	4331.25	222
	-do-	70	74.5	5215	3.85	20077.75	122
BB'	BH-33,34	251	85	21335	3.85	82139.75	122
CC'	BH-36,37	429	87	37323	3.85	143693.55	122
DD'	DD-5&5A	450	48	21600	3.85	83160	122
EE'	BH-31,32	537	74	39738	3.85	152991.3	122
FF'	BH-14,38	539	90	48510	3.85	186763.5	122
GG'	BH-28,29	245	68	16660	3.85	64141.63	122
HH'	BH-28,29	245	68.5	16782.5	3.85	64612.63	122
		245	7.5	1837.5	3.85	7074.38	222
			<b>610</b>	<b>210126</b>		<b>808985.1</b>	

**Probable mineral reserve ( 122) between -225mRL to -275RL =808985 - 11405=797580**

**Prefeasible mineral resources (222) between -225 RL to-275 RL (Blocked ore in safety zone )=11405 ton**


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## LEVEL (-275mRL to -285mRL)



Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	30	7.5	225	3.85	866.25	222
	-do-	70	74.5	5215	3.85	20077.75	222
BB'	BH-33,34	50	85	4250	3.85	16362.5	222
CC'	BH-36,37	88	87	7656	3.85	29475.6	222
DD'	DD-5&5A	90	48	4320	3.85	16632	222
EE'	BH-31,32	97	74	7178	3.85	27635.3	222
FF'	BH-14,38,39	75	90	6750	3.85	25987.5	222
GG'	BH-28,29	46	68	3128	3.85	12042.8	222
HH'	BH-28,29	46	68.5	3151	3.85	12131.35	222
		46	7.5	345	3.85	1328.25	222
			<b>610</b>	<b>42218</b>		<b>162539.3</b>	

**Prefeasible mineral resources (222) between -275 RL to -285 RL (Blocked ore in safety zone & sill)=162539 ton**

## LEVEL (-285mRL to -335mRL)

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	150	7.5	1125	3.85	4331.25	222
	-do-	70	74.5	5215	3.85	20077.75	122
BB'	BH-33,34	249	85	21165	3.85	81485.25	122
CC'	BH-36,37	451	87	39237	3.85	151062.45	122
DD'	DD-5&5A	430	48	20640	3.85	79464	122
EE'	BH-31,32	434	74	32116	3.85	123646.6	122
FF'	BH-14,38,39	538	90	48420	3.85	186417	122
GG'	BH-28,29	213	68	14484	3.85	55763.4	122
HH'	BH-28,29	213	68.5	14590.5	3.85	56173.43	122
		213	7.5	1597.5	3.85	6150.38	222
			<b>610</b>	<b>198590</b>		<b>764571.5</b>	

**Probable mineral reserve ( 122) between -285mRL to -335RL =764571-10481 =754090 tonnes**

**Prefeasible mineral resources (222) between -285 RL to -335 RL (Blocked ore in safety zone )=10481 tonnes**



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**LEVEL (-335mRL to -345mRL)**

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	30	7.5	225	3.85	866.25	222
	-do-	70	74.5	5215	3.85	20077.75	222
BB'	BH-33,34	50	85	4250	3.85	16362.5	222
CC'	BH-36,37	92	87	8004	3.85	30815.4	222
DD'	DD-5&5A	80	48	3840	3.85	14784	222
EE'	BH-31,32	77	74	5698	3.85	21937.3	222
FF'	BH-14,38,39	111	90	9990	3.85	38461.5	222
GG'	BH-28,29	39	68	2652	3.85	10210.2	222
HH'	BH-28,29	39	68.5	2671.5	3.85	10285.28	222
		39	7.5	292.5	3.85	1126.13	222
			<b>610</b>	<b>42838</b>		<b>164926.3</b>	

**Prefeasible mineral resources (222) between -335 RL to -345 RL (Blocked ore in safety zone )=164926 tonnes**

**LEVEL (-345mRL to -395mRL)**

Cross section	Parameters considered	Area sq.mtr	Strike influence in mtr.	Volume	Bulk density	Total Tonnage	UNFC Code
AA'	BH-12	150	7.5	1125	3.85	4331.25	222
	-do-	70	74.5	5215	3.85	20077.75	122
BB'	BH-33,34	249	85	21165	3.85	81485.25	122
CC'	BH-36,37	472	87	41064	3.85	158096.4	122
DD'	DD-5&5A	400	48	19200	3.85	73920	122
EE'	BH-31,32	368	74	27232	3.85	104843.2	122
FF'	BH-14,38,39	555	90	49950	3.85	192307.5	122
GG'	BH-28,29	181	68	12308	3.85	47385.8	122
HH'	BH-28,29	181	68.5	12398.5	3.85	47734.23	122
	-do-	181	7.5	1357.5	3.85	5226.38	222
			<b>610</b>	<b>191015</b>		<b>735407.75</b>	

**Probable mineral reserve ( 122) between -345mRL to -395RL =735408 -9557 = 725851 tonnes**

**Prefeasible mineral resources (222) between -285 RL to -335 RL (Blocked ore in safety zone )=9557 tonnes**



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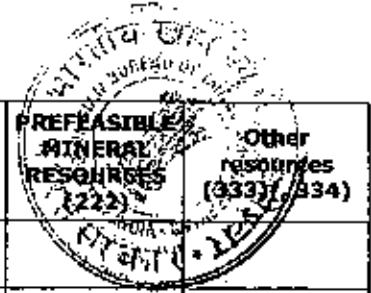


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**TOTAL SUMMARY**

LEVEL	TOTAL RESERVE	PROVED MINERAL RESERVE (111)	PROBABLE MINERAL RESERVE (122)	FEASIBLE MINERAL RESOURCES (221)	PREFEASIBLE MINERAL RESOURCES (222)	Other resources (333) (334)
SURFACE TO 185mRL	153499	129013		24486		
185mRL to 135mRL	2158718.1	27489		2131229		
135mRL to 85mRL	1500406.6	1467228		33178		
85mRL to 75mRL	279363			279363.7		
75mRL to 25mRL	1277145	1250147		26996		
25mRL to 15mRL	220412				220412.5	
15mRL to -35mRL	1019480		1002184		17296	
-35mRL to -45mRL	203888				203888	
-45mRL to -95mRL	1019849		1003044		16805	
-95mRL to -105mRL	189088				189088.9	
-105mRL to -155mRL	923191		909389		13802	
-155mRL to -165mRL	184971				184971	
-165mRL to -215mRL	844934		831883		13051	
-215mRL to -225mRL	182559				182559.3	
-225mRL to -275mRL	808985		797580		11405	
-275mRL to -285mRL	162539				162539	
-285mRL to -335mRL	764571		754090		10481	
-335mRL to -345mRL	164926				164926	
-345mRL to -395mRL	735407		725851		9557	
<b>TOTAL</b>	<b>12793938</b>	<b>2873877</b>	<b>6024021</b>	<b>2495255</b>	<b>1400782</b>	



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## (a) Proved Mineral Reserves - 111

Economic Axis	Feasibility Axis	Geological Axis
<p>1. Exploration carried out by the lessee by way of core drilling since 2005, opening up of the opencast quarry since 2006 and conducting exploration in the area by drilling (as on 1.2.2015) 41 nos of bore holes from surface covering 9154.46mtrs &amp; 8nos from underground covering 819mtrs of drilling.</p> <p>2. Mining report/ mining plan has been prepared time to time and approved by the authorities of Indian Bureau of Mines.</p> <p>3. Proved mineral reserve is 3.00 million tons with grade of +30% Cr2O3.</p> <p>4. Knowledge of forest &amp; non forest &amp; other land use data are available. Diversion of forest land has been obtained from Department of Forests, MoEF New Delhi</p>	<p>1. <b>Geology</b> : Exploration carried out by geological mapping and study of working quarries and exploratory holes sunk in the area during the mining lease period.</p> <p>2. <b>Mining</b>: Open cast mechanized method of mining with formation of 6m height benches is being followed. Tentative production plan prepared. Development of under ground mining and ore production has been started .</p> <p>3. <b>Environmental</b>: Base line data on environment has been collected. Environmental clearance for open cast mining and underground development has been obtained.</p> <p>4. <b>Processing</b> : Detail screen tests on the ore from the mine has been done which has indicated its amenability to segregate the mineral in different sizes. A crushing &amp; screening of 60 tph plant &amp; 40tph plants have been installed in the leasehold area.</p> <p>5. <b>Infrastructure and Services and construction activities</b>: Infrastructural facilities are available since the mine operations in the area and surrounding areas are continuing since last around 45 years.</p> <p>6. <b>Costing</b>: The cost of mining shall be economical as being done since last 9 years.</p> <p>7. <b>Economic viability</b>: The mining project shall be economically viable since the ore will be supplied for charge chrome/ ferro chrome plants of the company. .</p> <p>8. <b>Mining</b> : Mining is being carried out under Mines Act-1952, MCDR-1988. The mining method is continuing by opencast mechanized method. Underground development started since 2009-10. Production from Underground in ore development, started from 2014-15.</p>	<p>1. <b>Geological Survey</b> : Mapping has been done on 1.2.2015.</p> <p>2. <b>Geotechnical Survey</b> : Samples collected from two drill holes and quarry workings have been analyzed for different constituents.</p> <p>3. <b>Geophysical Survey</b>: Geophysical survey was done by ISM, Dhanbad in the year 2004, Not required, now since drilling points have been fixed basing on the exposed ore body and it's proved continuity.</p> <p>4. <b>Technological</b>: i) Pitting/Trenching- 4 nos of trial pitting which are presently merged to open cast quarry were done. ii) Drilling- A total of 41 no of bore holes from surface covering 9154.46 mtrs and 8nos from underground covering 819 mtrs of drilling (as on 1.2.2015) to establish the chromite ore zone. iii) Sampling- Sampling of ROM ore, screened ores and drill hole cuttings are being done.</p> <p>5. <b>Petrography</b> : Not done as not necessary.</p> <p>6. Reserve under proved category has been calculated upto 25mRL by considering the borehole intersection influence of all sides of the borehole where ore is intercepted and code 1 geological axis under UNFC is assigned.</p>

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## b) Probable Mineral Reserve (122)

Economic Axis	Feasibility Axis	Geological Axis
<p>1. Exploration carried out by the lessee by way of core drilling since 2005, opening up of the opencast quarry since 2006 and conducting exploration in the area by drilling (as on 1.2.2015) 41 nos of bore holes from surface covering 9154.46mtrs &amp; 8nos from underground covering 819mtrs of drilling.</p> <p>2. Mining report/ mining plan has been prepared time to time and approved by the authorities of Indian Bureau of Mines.</p> <p>3. Probable mineral reserve is 5.61 million tons with grade of +30% Cr2O3.</p> <p>4. Knowledge of forest &amp; non forest &amp; other land use data are available. Diversion of forest land has been obtained from Department of Forests, MoEF New Delhi</p>	<p>1. <b>Geology</b> : Exploration carried out by geological mapping and study of working quarries and exploratory holes sunk in the area during the mining lease period.</p> <p>2. <b>Mining</b>: Open cast mechanized method of mining with formation of 6m height benches is being followed. Tentative production plan prepared. Development of under ground mining and ore production has been started .</p> <p>3. <b>Environmental</b>: Base line data on environment has been collected. Environmental clearance for open cast mining and underground development has been obtained.</p> <p>4. <b>Processing</b> : Detail screen tests on the ore from the mine has been done which has indicated its amenability to segregate the mineral in different sizes. A crushing &amp; screening of 60 tph plant &amp; 40tph plants have been installed in the leasehold area.</p> <p>5. <b>Infrastructure and Services and construction activities</b>: Infrastructural facilities are available since the mine operations in the area and surrounding areas are continuing since last around 45 years.</p> <p>6. <b>Costing</b>: The cost of mining shall be economical as being done since last 9 years.</p> <p>7. <b>Economic viability</b>: The mining project shall be economically viable since the ore will be supplied for charge chrome/ ferro chrome plants of the company. .</p> <p>8. <b>Mining</b> : Mining is being carried out under Mines Act-1952, MCDR-1988. The mining method is continuing by opencast mechanized method. Underground development started since 2009-10. Production from Underground in ore development, started from 2014-15.</p>	<p>1. <b>Geological Survey</b> Mapping has been done on 1:2000 scale.</p> <p>2. <b>Geochemical Survey</b> : Samples collected from two drill holes and quarry workings have been analyzed for different constituents.</p> <p>3. <b>Geophysical Survey</b>: Geophysical survey was done by ISM, Dhanbad in the year 2004, Not required, now since drilling points have been fixed basing on the exposed ore body and it's proved continuity.</p> <p>4. <b>Technological</b>: i) Pitting/Trenching- 4 nos of trial pitting which are presently merged to open cast quarry were done. ii) Drilling-A total of 41 no of bore holes from surface covering 9154.46 mtrs and 8nos from underground covering 819 mtrs of drilling (as on 1.2.2015) to establish the chromite ore zone. iii) Sampling- Sampling of ROM ore, screened ores and drill hole cuttings are being done.</p> <p>5. <b>Petrography</b> : Not done as not necessary.</p> <p>6. Reserve under probable category has been calculated from 25 mRL to -395 mRL considering the borehole intersection &amp; code 2 geological axis under UNFC is assigned.</p>



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## (c) Feasibility Mineral Resources (221)

Economic Axis	Feasibility Axis	Geological Axis
<p>1. Exploration carried out by the lessee by way of core drilling since 2005, opening up of the opencast quarry since 2006 and conducting exploration in the area by drilling (as on 1.2.2015) 41 nos of bore holes from surface covering 9154.46mtrs &amp; 8nos from underground covering 819mtrs of drilling..</p> <p>2. Mining report/ mining plan has been prepared time to time and approved by the authorities of Indian Bureau of Mines.</p> <p>3. Feasibility mineral resources is 2.45 million tons with grade of +30% Cr2O3.</p> <p>4. Knowledge of forest &amp; non forest &amp; other land use data are available. Diversion of forest land has been obtained from Department of Forests, MoEF New Delhi. As the feasibility of mining is not established as on date for mining of blocked ore in O/c &amp; U/g it is considered economic axis code as 2 under UNFC.</p>	<p>1. <b>Geology</b> : Exploration carried out by geological mapping and study of working quarries and exploratory holes sunk in the area during the mining lease period.</p> <p>2. <b>Mining</b>: Open cast mechanized method of mining with formation of 6m height benches is being followed. Tentative production plan prepared. Development of under ground mining &amp; ore production from development has been started.</p> <p>3. <b>Environmental</b>: Base line data on environment has been collected. Environmental clearance for open cast mining and underground development has been obtained.</p> <p>4. <b>Processing</b> : Detail screen tests on the ores from the mine has been done which has indicated its amenability to segregate the mineral in different sizes. A crushing &amp; screening of 60 tph plant &amp; 40 tph plant have been installed in the leasehold area.</p> <p>5. <b>Infrastructure and Services and construction activities</b>: Infrastructural facilities are available since the mine operations in the area and surrounding areas are continuing since last around 45 years.</p> <p>6. <b>Costing</b>: The cost of mining shall be economical as being done since last 9 years.</p> <p>7. <b>Economic viability</b>: The mining project shall be economically viable since the ore will be supplied for charge chrome/ ferro chrome plants of the company.</p> <p>8. <b>Mining</b> : Mining is being carried out under Mines Act-1952, MCDR-1988. The mining method for blocked ore on the common lease boundary by O/C method and in U/g mining of crown / sill pillar is not established as on date code 2 feasible axis under UNFC is assigned.</p>	<p>1. Geological Survey Mapping has been done on 1:2000 scale.</p> <p>2. Geochemical Survey : Samples collected from two drill holes and quarry workings have been analyzed for different constituents.</p> <p>3. Geophysical Survey: Geophysical survey was done by ISM, Dhanbad in the year 2004, Not required now, since drilling points have been fixed basing on the exposed ore body and it's proved continuity.</p> <p>4. Technological: i)Pitting/Trenching- 4 nos of trial pitting which are presently merged to open cast quarry were done. ii) Drilling-A total of 41 no of bore holes from surface covering 9154.46 mtrs and 8nos from underground covering 819 mtrs of drilling (as on 1.2.2015) to establish the chromite ore zone. iii) Sampling- Sampling of ROM ore, screened ores and drill hole cuttings are being done.</p> <p>5. Petrography : Not done as not necessary.</p> <p>6. Reserve under 221 category has been calculated upto 25mRL by considering the G1 level of exploration intercepted and code 1 geological axis under UNFC is assigned.</p>



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## (c) Prefeasibility Mineral Resources (222)

Economic Axis	Feasibility Axis	Geological Axis
<p>1. Exploration carried out by the lessee by way of core drilling since 2005, opening up of the opencast quarry since 2006 and conducting exploration in the area by drilling (as on 1.2.2015) 41 nos of bore holes from surface covering 9154.46mtrs &amp; 8nos from underground covering 819mtrs of drilling.</p> <p>2. Mining report/ mining plan has been prepared time to time and approved by the authorities of Indian Bureau of Mines.</p> <p>3. Prefeasibility mineral resources is 1.34 million tons with grade of +30% Cr2O3.</p> <p>4. Knowledge of forest &amp; non forest &amp; other land use data are available. Diversion of forest land has been obtained from Department of Forests, MoEF New Delhi. As the feasibility code is considered as 2 under UNFC, even though the mining is economical the code for economic axis is considered as code 2.</p>	<p>1. <b>Geology</b> : Exploration carried out by geological mapping and study of working quarries and exploratory holes sunk in the area during the mining lease period.</p> <p>2. <b>Mining</b>: Open cast mechanized method of mining with formation of 6m height benches is being followed. Tentative production plan prepared. Development of under ground mining &amp; ore production from development has been started.</p> <p>3. <b>Environmental</b>: Base line data on environment has been collected. Environmental clearance for open cast mining and underground development has been obtained.</p> <p>4. <b>Processing</b> : Detail screen tests on the ores from the mine has been done which has indicated its amenability to segregate the mineral in different sizes. A crushing &amp; screening of 60 tph plant &amp; 40 tph plant have been installed in the leasehold area.</p> <p>5. <b>Infrastructure and Services and construction activities</b>: Infrastructural facilities are available since the mine operations in the area and surrounding areas are continuing since last around 45 years.</p> <p>6. <b>Costing</b>: The cost of mining shall be economical as being done since last 9 years.</p> <p>7. <b>Economic viability</b>: The mining project shall be economically viable since the ore will be supplied for charge chrome/ ferro chrome plants of the company.</p> <p>8. <b>Mining</b> : Mining is being carried out under Mines Act-1952, MCDR-1988. Mining is feasible by U/g method upto -395mRL but as on date code 2 feasible axis under UNFC is assigned as the reserves are under G2 category.</p>	 <p>1. Geological Mapping has been done on 1:2000 Scale.</p> <p>2. Geochemical Survey : Samples collected from two drill holes and quarry workings have been analyzed for different constituents.</p> <p>3. Geophysical Survey: Geophysical survey was done by ISM, Dhanbad in the year 2004, Not required now, since drilling points have been fixed basing on the exposed ore body and it's proved continuity.</p> <p>4. Technological: i) Pitting/Trenching- 4 nos of trial pitting which are presently merged to open cast quarry were done. ii) Drilling- A total of 41 no of bore holes from surface covering 9154.46 mtrs and 8nos from underground covering 819 mtrs of drilling (as on 1.2.2015) to establish the chromite ore zone. iii) Sampling- Sampling of ROM ore, screened ores and drill hole cuttings are being done.</p> <p>5. Petrography : Not done as not necessary.</p> <p>6. Resources under 222 category has been calculated from 25mRL to -395 mRL by considering the G2 level of exploration intercepted and code 2 geological axis under UNFC is assigned.</p>

  
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I) **Mineral Reserve/Resources :**

Mineral Resources has been estimated purely based on level of exploration with reference to the threshold value of minerals declared by IBM.

Level of Exploration	Resources in million tons	Grade
G1- Detailed exploration	5.46	+30% Cr <sub>2</sub> O <sub>3</sub>
G2- General exploration	6.95	+30% Cr <sub>2</sub> O <sub>3</sub>
G3- Prospecting	Nil	
G4- Reconnaissance	Nil	

**Reserve/ Resources as on 01.11.2014**

As per UNFC classification .

(By Longitudinal Section Method)

Classification	UNFC Code	Quantity in million tons	Grade (Cr <sub>2</sub> O <sub>3</sub> %)
<b>Total Mineral Resources (A+B)</b>		12.41	+30%
<b>A. Mineral Reserves</b>			
(1) Proved Mineral Reserves	111	3.00	+30%
(2) Probable Mineral Reserve	121 122	- 5.61	- +30%
<b>B. Remaining Resources</b>			
(1) Feasibility Mineral Resources	211	-	-
(2) Prefeasibility Mineral Resources	221 222	2.46 1.34	+30% +30%
(3) Measured Mineral Resources	331	-	-
(4) Indicated Mineral Resources	332	-	-
(5) Inferred Mineral Resource	333	-	-
(6) Reconnaissance Mineral Resource	334	-	-

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**Reserve/ Resources as on 01.11.2014  
As per UNFC classification.  
(By Cross Section Method)**



Classification	UNFC Code	Quantity in million tons	
<b>Total Mineral Resources (A+B)</b>		12.78	+30%
<b>A. Mineral Reserves</b>			
(1) Proved Mineral Reserves	111	2.87	+30%
(2) Probable Mineral Reserve	121 122	6.02	- +30%
<b>B. Remaining Resources</b>			
(1) Feasibility Mineral Resources	211	-	-
(2) Prefeasibility Mineral Resources	221 222	2.49 1.40	+30% +30%
(3) Measured Mineral Resources	331	-	-
(4) Indicated Mineral Resources	332	-	-
(5) Inferred Mineral Resource	333	-	-
(6) Reconnaissance Mineral Resource	334	-	-

The reserves estimation has been done both by X-sectional method and L-sectional method. The total mineral resource estimated is 12.78 Million tonne & 12.41 Million tonne respectively. The variation is 0.37 Million tonne, i.e. 2.98%. The estimation of resources by L sectional method has been done since exploitation of ore deposit will be done by underground mining in level plan basis. The area considered for volume calculation in L-section method is more uniform than the area considered for cross sectional method, because in cross sections method the area considered for volume calculation in a particular level will be the projected area in between bore hole intersections.

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**2.0 MINING:****A. OPENCAST MINING:**

- a) **Description on the existing as well as proposed method of excavation with all design parameters.**

**Present mining methods:** At present the mine is fully mechanized mine where both opencast and underground mining has been adopted. In opencast mine the ore and overburden is being extracted by opencast method using HEMM in conjunction with Deep hole drilling and blasting where ever required. Till date the overall slope of the mines is being maintained at less than 30° with, individual bench adequately sloped. The ultimate opencast pit limit is at 185mRL. Backfilling in the mined out areas where the UPL has reached 185mRL is being concurrently done. Leaving a parting of 50 m below 185 mRL (opencast pit limit), underground mining has started. Trackless mining using LHD & LPDT has being adopted at underground mines. Blast hole stoping with filling has been proposed as method of stoping as per Geo - technical study conducted by CIMFR, Dhanbad.

**Design Parameters:**

Top RL of opencast mine: 233mRL

UPL of opencast mine: 185mRL

Bench Height: 6 mtrs

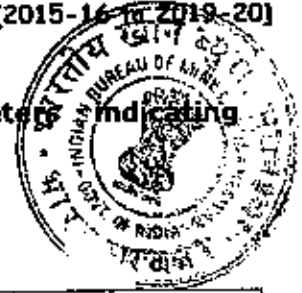
Bench Width: 10 mtrs

Overall Pit Slope angle: 30 degree

**Proposed mining methods:** The present method of opencast mining will continue for the whole opencast life of the mine. There is no change proposed in the method of opencast mining.

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- b) Year-wise tentative Excavation in Cubic Metres indicating development, ROM, pit wise.

**I. In situ Tentative Excavation**

Year	Pit No	Total tentative Excavation (CuM)	Top Soil (CuM)	OB/SB/IB (CuM)	ROM (CuM)		Mineral reject	ROM/Waste Ratio (Tonne/CuM)
					Ore Ratio (CuM)	Mineral reject (CuM)		
1	2	3	4	5	6	7	8	9
2015-16	1	133584	Nil	118000	15584	Nil	Nil	0.51
2016-17	1	119312	Nil	111000	8312	Nil	Nil	0.29
2017-18	1	67007	Nil	61000	6007	Nil	Nil	0.38
2018-19	1	Nil	Nil	Nil	Nil	Nil	Nil	NA
2019-20	1	Nil	Nil	Nil	Nil	Nil	Nil	NA

**II. Dump rehandling (for the purpose of recovery of mineral):**

As the existing dump consists of waste overburden material, so there is no proposal for dump re handling for the purpose of recovery of mineral.

However, overburden from the dump yard shall be utilised for filling of underground voids after being suitably mixed with cement as per study report of CIMFR.

- c) Individual year wise development plans and sections showing pit layouts, dumps, stacks of mineral reject.

Individual year wise development plans and sections showing pit layouts, dumps, stacks of mineral reject is shown in plate nos: MMC/08, MMC/09 & MMC/10.



## Proposed mining in quarry during 2015-16

RL of working	233 mRL to 185 mRL
Average height of bench	6 m
Slope of individual bench	Adequately Sloped
Individual bench floor width	10 m
Width of the floor	27 m
Overall direction of excavation	E - W
RL of floor	185
Sections considered for excavation	BB', B1B1'
Number of benches proposed	8
ROM in tonnes	60000
Recovery % from ROM	100.00%
Mining Losses & Dilution	Nil
Sub grade ore (10 to 30% Cr <sub>2</sub> O <sub>3</sub> ) in tonnes	Nil
Mineral Rejects in tonnes	Nil
Ore in tonnes (30% Cr <sub>2</sub> O <sub>3</sub> & above)	60000
Overburden removed in CuM	118000
Overburden (CuM) : Ore (t)	01:01.96

## Section-wise development and production in quarry during 2015-16

Section Line	CS Area (Sq.m)	Ore (Sq.m)	OB (Sq.m)	Influence (m)	Ore In CuM	OB In CuM	CF	Ore in MT
BB'	850	0	850	46	0	39100	3.85	0
B1B1'	1630	269	1361	58	15602	78900	3.85	60000
<b>TOTAL</b>	<b>2480</b>	<b>269</b>	<b>2211</b>		<b>15602</b>	<b>118000</b>		<b>60000</b>


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## Proposed mining in quarry during 2016-17



RL of working	233 mRL to 185 mRL
Average height of bench	6 m
Slope of individual bench	Adequately Sloped
Individual bench floor width	10 m
Width of the floor	27 m
Overall direction of excavation	E- W
RL of floor	185
Sections considered for excavation	AA' & BB'
Number of benches proposed	8
ROM in tonnes	32000
Recovery % from ROM	100.00%
Mining Losses & Dilution	Nil
Sub grade ore (10 to 30% Cr <sub>2</sub> O <sub>3</sub> ) in tonnes	Nil
Mineral Rejects in tonnes	Nil
Ore in tonnes (30% Cr <sub>2</sub> O <sub>3</sub> & above)	32000
Overburden removed in CuM	111000
Overburden (CuM) : Ore (t)	3.46

## Section-wise development and production in quarry during 2016-17

Section Line	CS Area (Sq.m)	Ore (Sq.m)	OB (Sq.m)	Influence (m)	Ore in CuM	OB in CuM	CF	Ore in MT
AA'	1022	0	1022	46	0	47000	3.85	0
BB'	1572	181	1391	46	8312	64000	3.85	32000
<b>TOTAL</b>	<b>2594</b>	<b>181</b>	<b>2413</b>		<b>8312</b>	<b>111000</b>		<b>32000</b>



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## Proposed mining in quarry during 2017-18



RL of working	233 mRL to 185 mRL
Average height of bench	6 m
Slope of individual bench	Adequately Sloped
Individual bench floor width	10 m
Width of the floor	27 m
Overall direction of excavation	E - W
RL of floor	185
Sections considered for excavation	AA'
Number of benches proposed	8
ROM in tonnes	23129
Recovery % from ROM	100.00%
Mining Losses & Dilution	Nil
Sub grade ore (10 to 30% Cr <sub>2</sub> O <sub>3</sub> ) in tonnes	Nil
Mineral Rejects in tonnes	Nil
Ore in tonnes (30% Cr <sub>2</sub> O <sub>3</sub> & above)	23129
Overburden removed in CuM	61000
Overburden (CuM) : Ore (t)	2.63

## Section-wise development and production in quarry during 2017-18

Section Line	CS Area (Sq.m)	Ore (Sq.m)	OB (Sq.m)	Influence (m)	Ore in CuM	OB in CuM	CF	Ore in MT
AA'	1456	130	1326	46	6007	61000	3.85	23129
<b>TOTAL</b>	<b>1456</b>	<b>130</b>	<b>1326</b>		<b>6007</b>	<b>61000</b>		<b>23129</b>

## Abstract of Opencast Working

Products	2015-16	2016-17	2017-18
OB (CuM)	118000	111000	61000
Usable grade ore (tonnes)	60000	32000	23129
OB (CuM) / Ore (t)	1.96	3.46	2.63

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- d) **Brief Description on salient features of the proposed method of working indicating Category of mine.**

#### **Mining**

Since 16.01.2006 (2005-06) opencast mining operation is being continued with deployment of shovel and tippers and will continue up to the year 2017-18, when the quarry floor reaches 185 mRL (UPL). At present the mine is fully mechanized mine where both opencast and underground mining has been adopted. In opencast mine the ore and overburden is being extracted by opencast method using HEMM in conjunction with Deep hole drilling and blasting where ever required. Drilling and blasting requirement is only 10% of the total excavation. Till date the overall slope of the mines is being maintained at less than 30° with, individual bench adequately sloped. The ultimate opencast pit limit is at 185mRL. Crushing & screening plants have been installed. Chrome ore recovered from the mines are being transported to the crushing and screening plant, where these are subjected to screening after crushing to (-) 75mm in the following sizes. (-) 75mm to (+) 25mm, (-) 25mm to (+) 10 mm and (-) 10 mm. The screened ore are transported by tippers to their respective stack yards as earmarked for the purpose.

The proved mineable reserve under UNFC 111 category as on 01.11.2014 is 129129 tonnes up to 185 mRL. During the period 01.11.2014 to 31.03.2015, it is proposed to exploit 14000 tonnes of ore. So, after 2014-15 the mineable reserve under UNFC 111 category shall be 115279 tonnes. During the scheme period it is proposed to exploit 115279 tonnes of ore from opencast mine during the first three years, i.e. from 2015-16 to 2017-18.

#### **Blasting**

Hard materials shall be dislodged by drilling and blasting prior to excavation and loading. Drilling & blasting requirement is only for 10% of the total excavated quantity. The blasting parameters are as below.

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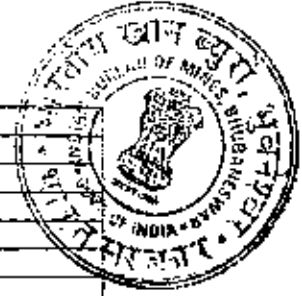
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**Broad Drilling & Blasting Parameters**

Max. Height of bench	6 m
Sub-grade drilling	0.5 m
Depth of Blast hole	6.5 m
Burden	2.5 to 4.5 m
Spacing	3 to 5 m
Hole diameter	115 mm
Maximum no of holes per round	20
Max charge per delay	120 Kgs

**Measures to minimize vibrations due to blasting**

Staggered pattern of drilling shall be done. Maximum charge per delay, maximum no of holes per round and maximum charge per blast shall be kept within norm, so as to minimise vibrations due to blasting.

**Type of explosives to be used**

Booster explosives along with non cap sensitive emulsion/ slurry explosives are to be used for blasting.

**Powder Factor**

Generally blasting is carried out for medium hard to hard rock formations, where excavator can't be engaged directly. The average powder factor experienced is 3 to 5 CuM/kg of explosive.

**Annual explosive consumption**

Total volume to be excavated - maximum in a year .	133500 CuM
Blasting volume is estimated to be 10% of the total excavated volume.	13350 CuM
Powder factor (CuM/Kg)	3 to 5
Annual Explosive consumption	4.5 to 2.6 tonnes

**Type and storage of explosives**

A 5 tonne capacity magazine is available at adjacent mines of same lessee, i.e. Sukinda Mines (Chromite). This magazine shall meet the storage requirement of explosives needed for Mahagiri Mines (Chromite). An explosive van of 2.39 tonne capacity is being used for transportation of Explosives and accessories to site and back to magazine.

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**Extent of mechanization in opencast mine:****Present deployment of machinery**

Presently the following machinery for construction, leveling, compaction, drilling & blasting, loading and transporting operations are deployed in the mines.

Machinery Category	Name of the machine	Specification Capacity	Capacity unit	No. of Machine
Bull Dozer	BEML-D65 E8	-	-	01
Front end loader	HM-2021	1.7	CuM	02
Front end loader with backhoe	TATA JD-315	1.0 & 0.3	CuM	01
Hyd. Excavator/Rockbreaker	L&T PC-200	0.9	CuM	01
Tipper	Ashok Leyland	6.4	CuM	04
Water tanker	Ashok Leyland	8.0	kL	01
Screening plant -1	-	40	tph	01
Screening plant -2	-	60	tph	01
Jaw crusher	-	60	tph	01
Air cooled compressor	IR	674	CFM	01
Generator	Cummins	200	KVA	01
Generator	Cummins	750	KVA	01

**Requirement of machinery during the scheme period****Wagon drill (Composite - Compressor mounted Crawler Wagon Drill)**

Specification of wagon drill	
Diameter of wagon drill	: 115 mm
Air consumption	: 7.5 CuM/min
Pressure supplied upto	: 10.5 kg / sq.cm.
Drilling parameters	
Dia of blast hole (D)	: 115 mm
Height of the bench	: 6 m
Additional drilling required (sub grade)	: 0.5 m
Length of the hole (H)	: 6.5 m
Burden (B)	: 3 m
Spacing (S)	: 3.5 m
Volume of rock to be broken / loosen per hole	: $B \times S \times H = 3.0 \times 3.5 \times 6 = 63 \text{ CuM}$
Total volume of material to be excavated (max. In a year) of scheme period	: 133500 CuM
Blasted volume (10% of excavation)	: 13350 CuM
No of Holes	: $13350 / 63 = 212 \text{ nos}$
Requirement of Drill	: 1 no

  
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## Requirement of Shovel / Excavator :

Specification of Excavators	
Bucket capacity(C)	: 0.9 CuM
Bucket fill factor (F)	: 0.8
Time cycle pass at 90° swing (T)	: 30 sec.
Swell factor (S)	: 0.7
Production efficiency factor (e)	: 0.85
Job management factor (f)	: 0.9
Time Scheduling	
Working days per year	: 300
Number of working shifts per day	: 2
Working hours per shift	: 8
Effective working hours per shift	: 6
Effective working hours per 2 shifts	: 12
Seconds per hour	: 3600
Output of 0.9 CuM shovel per annum	: $[C \times F \times S \times e \times f \times 3600 \times 12 \times 300] / T = 1,66,562 \text{ CuM in 2 shifts}$
Number of shovel / excavators required	
Maximum excavation in a year during the scheme period	: 1,33,500 CuM
Requirement of shovel	: 2 Nos ( including 1 as standby)



## Transportation

Overburden & ore shall be generated during the scheme period. Calculation of tippers for transportation of ore and overburden to their respective sites are based on 1.5 km hauling distance from the quarry.

Loading time	
Capacity of the tipper (16 tonnes)	: 16 T or 6 CuM
Rate of production of 0.9 CuM shovel per day	: 556 CuM
Number of passes required for one tipper attached to 0.9 CuM shovel	: Say 7 passes
Hauling time for waste dump yard and ore stack yard	: Avg lead 3 Km / 9 min.
Return time	: 6 min.
Tipper cycle time = Loading time + hauling time + unloading time + return time + Spotting time + waiting time	: $2.5 + 9 + 2 + 6 + 5 = 24.5 \text{ min.}$
Working time per tipper per day	: 12 hrs
Number of trips per tipper per day	: $(12 \times 60) / 24.5 = 29 \text{ trips}$
Volume per day per tipper	: $29 \times 6 = 174 \text{ CuM}$
Tipper requirement (attached to 0.9 CuM shovel)	: 06 Nos. (including 2 as standby)

  
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Dozer	:	1 no.
Water Tanker	:	1 no
Explosive Van	:	1 no
Jeep	:	1 no

**List of machinery proposed in scheme period :**

Sl. No.	Equipment	Size / Capacity	Numbers
1	Bull Dozer	--	01
2	Compressor mounted crawler Wagon drill	115 mm	02
3	Front end loader	1.7 CuM	02
4	Front end loader with backhoe	1.0 & 0.3 CuM	01
5	Hyd. Excavator/Rockbreaker	0.9 CuM	02
6	Tipper	6.4 CuM	08
7	Water tanker	8.0 KL	01
8	Screening plant -1	40 TPH	01
9	Screening plant -2	60 TPH	01
10	Jaw crusher	60 TPH	01
11	Air cooled compressor	674 CFM	01
12	Screening plant -3	50 TPH	01
13	Generator	200 KVA	01
14	Generator	750 KVA	01

**Backfilling in the mine:**

In order to protect the hanging wall benches as well as the foothill at hanging wall side, backfilling has been commenced from the eastern end after extending the quarry up to the opencast pit limit (185 mRL). It has also been decided that the quarry shall advance towards western end and backfilling shall also be continued in such a way that exposure of hanging wall benches is restricted to approximately 150 m.

**e) Brief description of the layout of mine workings, pit road layout, the layout of faces and sites for disposal of overburden/waste.**

The opencast working extends in east & west direction along the strike of the ore body. The pit road is having a gradient of maximum 1 in 16. The overburden being excavated is utilised for back filling the mined out areas where the ultimate pit limit has reached 185mRL. There is a waste dump yard towards northern side of the leasehold area.

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Size of existing quarry : Length: 594 mtrs, width: 140 mtrs.

Size of dump yard : Length: 505 mtrs, width: 100 mtrs

Leaving a parting of 50 meters from ultimate opencast quarry limit (185 mRL) underground working has started from 135 mRL.



**f) Conceptual Mine planning up to the end of lease period:**


**Reserves and anticipated life of opencast working:**

The proved mineable reserve under UNFC 111 category as on 01.11.2014 is 129129 tonnes up to 185 mRL. During the period 01.11.2014 to 31.03.2015, it is proposed to exploit 14000 tonnes of ore. So, after 2014-15 the mineable reserve under UNFC 111 category shall be 115129 tonnes. During the scheme period it is proposed to exploit 115129 tonnes of ore from opencast mine during the first three years, i.e. from 2015-16 to 2017-18. Opencast mining has been proposed upto 185 mRL. Beyond this level though opencast mining is feasible, but it will be uneconomical to continue mining operation by opencast method because of the steep rise of the hill towards south of the hangwall, which will require high excavation of overburden in order to go deeper than 185 mRL for recovering ore. The ratio of ore and overburden will increase substantially, thereby making the opencast mining totally uneconomical. Therefore, anticipated life of opencast working is 3 years, i.e. upto 2017-18. So there shall be no generation of ore & overburden beyond 2017-18 from opencast mines. However, backfilling activities will be carried out in the opencast mined out areas.

**Ultimate Pit Size & Dump size:**

The ultimate size of opencast working and dump yard is mentioned below. However, during the conceptual period the opencast working will be backfilled. The waste from dump yard will be utilised for filling underground mined out stopes after suitably mixed with cement.

	Opencast Working	Dump Yard
Length, mtrs	594 mtrs	505 mtrs
Width, mtrs	140 mtrs	100 mtrs
Top mRL	233 mRL	170 mRL
Bottom mRL	185 mRL	148 mRL
No of Benches/Stages	8 nos	2 nos

  
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**Waste and sub grade material management:**

By end of conceptual period, it has been calculated to excavate about 6.5 Lakh CuM of overburden from opencast and 5.205 Lakh CuM of waste from underground, which shall be utilized for reclamation by back filling of opencast quarry, after reaching the ultimate opencast pit limit (185mRL).

Year	From O/C (in LCuM)	From U/G (In LCuM)	Total
2015-16	1.180	0.245	1.425
2016-17	1.110	0.255	1.365
2017-18	0.610	0.321	0.931
2018-19	0.000	0.272	0.272
2019-20	0.000	0.257	0.257
Conceptual	0.000	3.855*	3.855
<b>Total :</b>	<b>2.900</b>	<b>5.205</b>	<b>8.105</b>

\* During the year 2019-20, there will a production of 6 Lakh tonnes of ROM from underground mine and generation of waste from underground will be approximately 0.257 Lakh CuM. Thereafter, the underground mine will give a production of 6 Lakh tonnes of ROM per annum. Assuming, the level of production from underground to be constant throughout the remaining life of underground mine, the rate of generation of waste will be approximately 0.257 Lakh CuM per annum. Therefore, total generation of waste from underground from 2020-21 to end of conceptual period (15 years) will be  $0.257 \times 15 = 3.855$  Lakh CuM.

The capacity of the present waste dump in non forest area is to accommodate 10.50 LCuM. As on 01.04.2014 the waste dump is containing 4.15 LCuM, leaving a balance for 6.35 LCuM waste that can be accommodated.

There shall be no generation of sub grade material during the conceptual period.



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**Land degradation:**

By the end of opencast mining, an area over 9.600 Ha within the lease hold shall be degraded. Land use at present, by the end of proposed scheme period & end of conceptual period is as follows.

Land use	At present In Ha (as on 01.10.2014)			By the end of scheme period 2019-20 (in Ha)			By the end of conceptual period (in Ha)		
	Non forest	Forest	Total	Non forest	Forest	Total	Non forest	Forest	Total
Area under mining /quarrying	0.000	8.810	8.810	0.000	9.600	9.600	0.000	0.000	0.000
Waste dump	4.700	0.000	4.700	4.700	0.000	4.700	0.000	0.000	0.000
Mineral storage	0.000	4.600	4.600	0.000	13.480	13.480	0.000	0.000	0.000
Infrastructure	0.000	3.990	3.990	0.000	8.550	8.550	0.000	8.550	8.550
Roads	0.240	2.500	2.740	1.140	1.720	2.860	1.140	1.720	2.860
Subsidence Pillar	0.000	0.610	0.610	0.000	0.610	0.610	0.000	0.610	0.610
Storage of Top Soil	0.000	0.250	0.250	0.000	0.250	0.250	0.000	0.000	0.000
Safety zone	0.610	2.470	3.080	0.610	2.470	3.080	0.610	2.470	3.080
Others undisturbed	1.847	43.150	44.997	0.947	29.700	30.647	5.647	53.030	58.677
<b>Total</b>	<b>7.397</b>	<b>66.380</b>	<b>73.777</b>	<b>7.397</b>	<b>66.380</b>	<b>73.777</b>	<b>7.397</b>	<b>66.380</b>	<b>73.777</b>

**Post Mining Land Use Details**

Sl No	Particulars of Land	Area in Hacts	Remark
1	Quarry & Subsidence Pillar	9.600 + 0.610	Quarry area shall be reclaimed by backfilling & rehabilitated by plantation.
2	Waste Dump	4.700	The present OB dump dead ends have been rehabilitated by plantation. It is planned to utilise the OB dump material for backfilling in stoped out areas, if it is found suitable. Thereafter, plantation shall be done over this area.
3	Mineral Storage	13.480	The area shall be utilised for plantation after cessation of the mining activities.
4	Infrastructure	8.550	This area shall be left as it is for future utilisation by concerned authority.
5	Roads	2.860	- do -
6	Storage of topsoil	0.250	The area shall be utilised for plantation purpose.
7	Safety Zone	3.080	Plantation has been done over this area and the same status shall be maintained.
8	Other undisturbed	30.647	The area shall be maintained as it is.

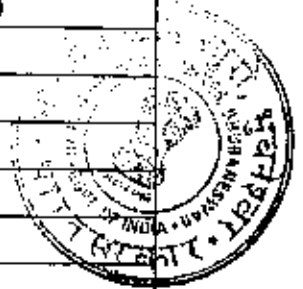
**Reclamation and Rehabilitation**

Reclamation of mined out quarry areas shall be done concurrently with mining activities. Generation of overburden from opencast mine shall cease after 2017-18. There shall be generation of waste from underground workings only. This waste shall be utilised for backfilling of the mined out areas of opencast quarry. Mined out stopes in underground shall be backfilled with suitable filling material along with cement.

  
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Year	Backfilling in O/C Mines (in LCuM)	Dumping at waste dump yard (in LCuM)
2015-16	1.425	Nil
2016-17	1.365	Nil
2017-18	0.931	Nil
2018-19	0.272	Nil
2019-20	0.257	Nil
<b>Total :</b>	<b>4.25</b>	<b>Nil</b>



Afforestation shall be carried out in backfilled areas over mined out areas of opencast quarry in a phased manner. Necessary precautions shall be taken for good survival rate and protection of plantations. Coll matting shall be tried to stabilize the waste dump slopes. Good quality grasses shall be planted on the dump slopes with small growing local trees, shrubs etc. Terraces at a height of 20 m shall be constructed with inward slope for absorption of water avoiding creation of gullies on dump slopes.

#### B. UNDERGROUND WORKING

Based on the computer modeling done by CIMFR, Geo-technical parameters has been determined for underground development at Mahagiri Mines (Chromite). As per the computer model developed by CIMFR, stope length of 54 m has been considered for the initial stopes, and each stope block will be further sub divided into three panels as Primary, Secondary and Tertiary in the first mining horizon of 50 m vertical block between 132 mRL and 85 mRL. (Refer Annexure -24)

Lessee has given a work order (IMFA/JKR/14/2661) to CIMFR for carrying out monitoring of the first stope namely P5 with instrumentation & establishing the parameters, i.e. length of primary panel of 18m. This monitoring study with instrumentation will also help in increasing the exposure of the exposed hanging wall and foot wall towards the adjacent panel 'S5' and thereby increasing/ decreasing the length of the initial stope panel to 36m/54m by continuously measuring the stress & strain changes in the exposed hanging wall & foot wall. Once the parameters of the stopes are finalised, the stoping sequence will be determined as per the final recommendation from CIMFR. However, present mining scheme has been done, considering 18m stope panel length as per the recommendation of CIMFR based on computer modeling alone. (Refer Annexure -25)

  
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### i) A. Mode of entry (Shaft & Decline).

#### Decline & it's purpose

Location	
Latitude	3836.85E
Longitude	975.02N
Cross Section of Opening	Width- 4.5m, Height – 3.5 m
Inclination	1 in 8
Starting Level	167 mRL
Ending Level	-165 mRL (Upto the year 2019-20)
Present Satus	85 mRL

The decline will also provide flexible access for equipment, men and services to all levels. The decline is used as fresh air intake for ventilating underground working areas.

#### Main Vertical Shaft & it's purpose

Location	
Latitude	3906.07E
Longitude	846.21N
Cross Section of Opening	Finished Diameter – 4.5 m Excavated Diameter – 5.1 m
Inclination	Vertical
Starting Level	200 mRL
Ending Level	-155 mRL (Upto the year 2019-20)
Present Satus	116 mRL
Method of Sinking	Drop Raising
Capacity of Handling	3.5 LakhTonne/ Year

The Main Shaft will be equipped with double drum winder for hoisting of ore as well as men and material. The shaft is being sunk by Drop Raising Method.

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**Production Shaft & it's purpose**

Location	
Latitude	4051.6E
Longitude	938.26N
Cross Section of Opening	Finished Diameter - 6 m Excavated Diameter - 7.2 m
Inclination	Vertical
Starting Level	193 mRL
Ending Level	-400 mRL (Upto the year 2019-20)
Present Satus	Starting from 2015-16
Method of sinking	Conventional method
Capacity of Handling	9 LakhTonne/ Year

This shaft will be used for hoisting of 9 LTPA ore & waste from underground to surface initially from -400 mRL and later on from the -600 mRL. The Shaft will be equipped with a friction winder for hoisting of ore. The shaft shall be sunk by Conventional Method.

**Ventilation Raise & it's purpose**

Location	
Latitude	3826.86E
Longitude	709.45N
Inclination	Vertical
Starting Level	185 mRL (from opencast pit)
Ending Level	145 mRL
Present Status	Starting from 2016-17

It is proposed that the ventilation shaft will be developed at 185mRL (from opencast pit). This ventilation raise shall act as return air way.

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**i) B. Brief description on Development and stoping method.**

Conventional solid blasting using single/double boom jumbo explosives is being practiced for development in waste and ore development faces Burn cut drilling pattern is being followed. Blast hole stoping with post filling has been proposed as method of stoping as per Geo - technical study conducted by CIMFR, Dhanbad. Trackless mining using LHD & LPDT is being adopted at underground mines.

**ii) Underground layout**

Underground mining has been accessed by a Decline from the surface. The rocks appear to be competent enough below +160 mRL as established during exploration drilling. The surface elevation of the Decline is 167 mRL & has already been developed up to 85 mRL with a gradient of 1 in 8 . Dimensions of the Decline are 4.5 m width & 3.5 m height. During progress of Decline, it was found that the passage is going through moderately hard strata up to +145 mRL, hard & fractured strata started from +145 mRL. From the Decline, three levels at 145 mRL, 132 mRL & 85 mRL have been driven. To establish the second entry to the underground workings & to facilitate better ventilation of the development headings, one Vertical Shaft has been sunk from 200 mRL & has been connected with the Decline at 145 mRL & 116 mRL. The Vertical Shaft is circular with a finished diameter of 4.5 m.

  
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**Proposed yearwise / levelwise extent of development for five years  
alongwith the support system:**



The underground development & production from 2015-16 to 2019-20 are tabulated as under.

**(I) Underground Mine Working (2015-16).**

		Length in 'm'
DECLINE	Starting RL of Decline	74.5
	Ending RL of Decline	49.5
	Total length of Decline	207
SHAFT (4.5m dia.)	Top RL of Shaft	85
	Bottom RL of Shaft	52
	Meters of Shaft	33
SHAFT (6m dia.)	Top RL of Shaft	200
	Bottom RL of Shaft	80
	Vertical development in waste	120
145 mRL	Linear development In waste	40
	Linear development In Ore	230
132 mRL	Linear development in waste	287
	Linear development in Ore	260
	Ventilation Raise Development	20
85 mRL	Linear development in waste	573
	Linear development in Ore	240
	Slot Raise development	220
	Linear Development in waste to connect Ore Pass	50
72mRL	Linear development in waste	227
	Linear development In waste for X-Cut to FW drive	50
52mRL	Horizontal Platform in decline	10
	X-Cut to connect shaft	30
	Conveyor drive	50
STOPE	Stope to be developed (132mRL to 85mRL)	P6,S5,P4,P7,P3
	Stope Under Production(132mRL to 85mRL)	P5,S5,P6

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## Underground Development &amp; production (2015-16)

Development (W - Waste, O - Ore)	Total length (in 'm')	Proposed target (m')	Waste in 'CuM'	Ore in 'CuM'	Ore in 'CuM'
<b>Decline Developments</b>					
Decline 74.5mRL to 72 mRL	20 (W)	20	315		
Curve (1 in 10) 72mRL to 69 mRL	31 (W)	31	488		
Decline 69mRL to 52 mRL	136 (W)	136	2142	--	--
Horizontal Platform at 52 mRL	10 (W)	10	158	--	--
Decline 52mRL to 49.5 mRL	20 (W)	20	315	--	--
<b>Vertical Shaft (4.5 m Diameter)</b>					
Shaft sinking 85mRL to 52 mRL	33 (W)	33	674	--	--
<b>Vertical Shaft (6 m Diameter)</b>					
Shaft sinking 200mRL to 80 mRL	120 (W)	120	4883	--	--
<b>52 mRL Developments</b>					
Shaft x-cut at 52mRL	30(W)	30	360	--	--
Conveyor drive at 52 mRL	50(W)	50	600	--	--
<b>145 mRL Developments</b>					
Ore drive in East & West	225(O)	225		2700	10395
X - cut to West Ventilation raise	20(W)	20	240	--	--
X - cut to East Ventilation raise	20(W)	20	240	--	--
X-cut to Surface Ventilation Raise	5(O)	5	--	60	231
<b>132 mRL Developments</b>					
F/W Waste Drive (East & West)	197(W)	197	2364	--	--
X - cut to East Ventilation raise	5(W)	5	60	--	--
East Ventilation Raise (132mRL to 145mRL)	10(W)	10	90	--	--
X - cut to West Ventilation raise	5(W)	5	60	--	--
West Ventilation Raise (132mRL to 145mRL)	10(W)	10	90	--	--
X-Cut from WD to OD at 132mRL (P3,S5,P8,P1,P2,P9 Stopes)	80(W)	80	960	--	--
OD & Ore x-cut at 132 mRL (P3,S5,P8,P1,P2,P9 stopes)	260(O)	260	--	3120	12012
<b>85 mRL Developments</b>					
F/W Extraction Drive East & West	383(W)	383	4596	--	--
X - cut to East Ventilation raise	10(W)	10	120	--	--
Development of X-cut to Ore Pass at 85mRL	50(W)	50	600	--	--
X-Cut from ED(W) to OD at 85mRL (P6,S5,P4,P7,P3,P2)stopes	180(W)	180	1890	--	--
OD & Ore x-cut at 85 mRL (P6,S5,P4,P7,P3,P2)stopes	240(O)	240	--	2700	10395
Slot raise from 85mRL to 132mRL ( P6,S5,P4,P7,P3) stopes	220(O)	220	--	1980	7623

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Development (W - Waste, O - Ore)	Total length (in 'm')	Proposed target (m)	Waste in 'CuM'	Ore in 'CuM'	Ore in 'Tonne'
<b>72 mRL Developments</b>					
Linear development in waste for X-Cut to F/W Drive	50(W)	50	600		
F/W Waste Drive East & West	227(W)	227	2724	--	--
<b>Installation Work</b>					
Construction of Waste Bin at 85 mRL	1 month	0			
<b>Total:</b>		<b>2647</b>	<b>24569</b>	<b>10560</b>	<b>40656</b>

## (ii) Underground Mine Working (2016-17)

		Length in 'm'
DECLINE	Starting RL of Decline	49.5
	Ending RL of Decline	-1
	Total length of Decline	418
SHAFT (4.5m dia.)	Top RL of Shaft	52
	Bottom RL of Shaft	25
	Meters of Shaft	27
SHAFT (6m dia.)	Top RL of Shaft	80
	Bottom RL of Shaft	-40
	Vertical development in waste	120
145 mRL	Ventilation Raise development to surface	52
132 mRL	Linear development in waste	75
	Linear development in Ore	359
85 mRL	Linear development in waste	272
	Linear development in Ore	240
	Ventilation Raise development	88
	Slot Raise development	308
72mRL	Linear development in waste	295
	Linear development in Ore	250
	Ventilation Raise development	20
52mRL	Conveyor Drive	10
	Ore Pass Raise development (52mRL to 85 mRL)	30
25mRL	Linear development in waste	175
	Horizontal Platform in Decline	18
	X-Cut to connect shaft	35
	Ore Bin Raise development (25mRL to 52mRL)	27
12 mRL	Linear development in waste	130
STOPE	Stope to be developed (132mRL to 85mRL)	P2,S6,S4,T5,P8,P9,P10
	Stope Under Production(132mRL to 85mRL)	P4,S4,T5,S6,P3

  
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## Underground Development &amp; production (2016-17)

Development (W - Waste O - Ore)	Total length (in 'm')	Proposed target ( 'm')	Waste in 'CuM'	Ore in 'CuM'	Ore in 'Tonne'
<b>Decline Development</b>					
Decline 49.5 to 40 mRL	76 (W)	76	1197		
Curve (1 in 10) 40 to 37 mRL	31 (W)	31	488		
Decline (37 to 25mRL)	96 (W)	96	1512		
Horizontal Platform at 25 mRL	18 (W)	18	284	--	--
Decline 25 to 12 mRL	104 (W)	104	1638	--	--
Curve (1 in 10) 12 to 9 mRL	31 (W)	31	488	--	--
Decline 9 to -1 mRL	80 (W)	80	1260	--	--
<b>Vertical Shaft Development</b>					
Shaft sinking 52mRL to 25 mRL	27 (W)	27	551	--	--
<b>Vertical Shaft (6 m Diameter)</b>					
Shaft sinking 80mRL to -40 mRL	120 (W)	120	4883	--	--
<b>145 mRL Developments</b>					
Ventilation Raise from (Surface to 145 mRL)	52(O)	52	--	637	2452
<b>132mRL Development</b>					
X-Cut from WD to OD at 132mRL (P9,S4,S6,T5,P10,P11 Stopes)	75 (W)	75	900	--	--
OD & Ore x-cut at 132 mRL (P9,S4,S6,T5,P10,P11 stopes)	359 (O)	359	--	4308	16586
<b>85 mRL Development</b>					
F/W Extraction Drive in East	62 (W)	62	744	--	--
X - cut to West Ventilation raise	10 (W)	10	120	--	--
West Ventilation Raise (85 mRL to 132mRL)	44 (W)	44	396	--	--
X cut to East ventilation raise	10 (W)	10	120	--	--
East Ventilation Raise (85mRL to 132mRL)	44 (W)	44	396	--	--
X cut to East ventilation raise	10 (W)	10	120	--	--
X-Cut from ED(W) to OD at 85mRL (S6,S4,T5,P8,P9,P10)stopes	180 (W)	180	1890	--	--
OD & Ore x-cut at 85 mRL (S6,S4,T5,P8,P9,P10)stopes	240 (O)	240	--	2520	9702
Slot raise from 85mRL to 132mRL(P2,S6,S4,T5,P8,P9,P10) stopes	308 (O)	308	--	1925	7411



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Development (W - Waste O - Ore)	Total length (in 'm')	Proposed target ( 'm')	Waste in 'CuM'	Ore in 'CuM'	Ore in 'Tonne'
<b>72 mRL Development</b>					
F/W Extraction Drive in East	225(W)	225	2700		
X - cut to East Ventilation raise	10 (W)	10	120		
East Ventilation Raise (72 mRL to 85mRL)	10 (W)	10	90		
X cut to East ventilation raise	10 (W)	10	120	--	--
East Ventilation Raise (72mRL to 85mRL)	10 (W)	10	90	--	--
X-Cut from WD to OD at 72mRL ( AP5,AP4,AP6,AP3,AP7 Stopes)	50 (W)	50	600	--	--
OD & Ore x-cut at 72 mRL (AP5,AP4,AP6,AP3,AP7 stopes)	250 (O)	250	--	2250	8662
<b>52 mRL Development</b>					
Conveyor drive at 52 mRL	10 (W)	10	120	--	--
Ore Pass Raise development (52mRL to 85 mRL) & crusher chamber	30 (W)	30	480	--	--
<b>25 mRL Development</b>					
X-Cut to connect shaft	35 (W)	35	420	--	--
Ore Bin & Measuring pocket Raise development (25mRL to 52mRL)	27 (W)	27	675	--	--
Linear development in waste for X- Cut to F/W Drive	55 (W)	55	743	--	--
F/W Extraction Drive in East & West	120 (W)	120	1440	--	--
<b>12 mRL Development</b>					
Linear development in waste for X- Cut to F/W Drive	50 (W)	50	675	--	--
F/W Extraction Drive in East & West	80 (W)	80	960	--	--
<b>Installation Work</b>					
Grizzle, rock-Breaker Installation & Ore pass lining work at 85mRL	2 Months	0	-	-	-
Crusher installation at 52 mRL sub level	2 Month	0	-	-	-
<b>Total</b>	<b>2949</b>	<b>2949</b>	<b>26220</b>	<b>11640</b>	<b>44813</b>

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## (iii) Underground Mine Working (2017-18)

		Length in m
DECLINE	Starting RL of Decline	
	Ending RL of Decline	
	Total length of Decline	
SHAFT (4.5m dia.)	Top RL of Shaft	
	Bottom RL of Shaft	-35
	Vertical development in waste	60
SHAFT (6m dia.)	Top RL of Shaft	-40
	Bottom RL of Shaft	-160
	Vertical development in waste	120
132 mRL	Linear development in waste	80
	Linear development in Ore	292
85 mRL	Linear development in waste	220
	Linear development in Ore	296
	Slot Raise development	352
72mRL	Linear development in waste	208
	Linear development in Ore	100
	Ventilation Raise development	20
25mRL	Linear development in waste	503
	Linear development in Ore	192
	Slot Raise development	132
12 mRL	Linear development in waste	60
-4 mRL	Horizontal Platform in Decline	9
	X-Cut to connect shaft	20
-35mRL	Horizontal Platform in Decline	18
	X-Cut to connect shaft	35
	Linear development in waste for X-Cut to Extraction drive	55
	X-cut to connect between two vertical shaft	260
STOPE	Stope to be developed (132mRL to 85mRL)	T4,S3,T6,P11,P1,S7,T2
	Stope to be developed (72mRL to 25mRL)	AP5,AP4,AP6
	Stope Under Production(132mRL to 85mRL)	S3,T4,T6,P7,P8,P9



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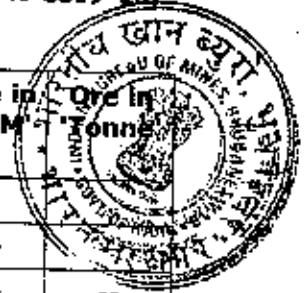
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## Underground Development &amp; production (2017-18)

Development (W - Waste O - Ore)	Total length (in 'm')	Proposed target (m')	Waste in 'CuM'	Ore in 'CuM'	Ore in 'Tonnes'
<b>Decline Development</b>					
Decline -1 to -4 mRL	24(W)	24	378	--	--
Horizontal Platform at -4 mRL	9(W)	9	142	--	--
Decline -4 to -18 mRL	112(W)	112	1764	--	--
Curve (1 in 10) -18 to -21 mRL	31(W)	31	488	--	--
Decline -21 to -35mRL	112(W)	112	1764	--	--
Horizontal Platform at -35 mRL	18(W)	18	284	--	--
Decline -35 to -48 mRL	104(W)	104	1638	--	--
Curve (1 in 10) -48 to -51 mRL	31(W)	31	488	--	--
Decline -51 to -61 mRL	80(W)	80	1260	--	--
<b>Vertical Shaft Development</b>					
Shaft sinking 25 to -4 mRL (Waste)	29(W)	29	592	--	--
Shaft sinking -4 to -35 mRL (Waste)	31(W)	31	633	--	--
<b>Vertical Shaft (6 m Diameter)</b>					
Shaft sinking -40mRL to -160 mRL	120 (W)	120	4883	--	--
<b>132mRL Development</b>					
X-Cut from WD to OD at 132mRL (T4,S3,T6,S7,T2 Stopes)	80(W)	80	960	--	--
OD & Ore x-cut at 132 mRL (T4,S3,T6,S7,T2 stopes)	292(O)	292	--	3504	13490
<b>85 mRL Development</b>					
X-Cut from ED(W) to OD at 85mRL (T4,S3,T6,P11,P1,S7,T2) stopes	220(W)	220	2310	--	--
OD & Ore x-cut at 85 mRL (T4,S3,T6,P11,P1,S7,T2) stopes	296(O)	296	--	3108	11966
Slot raise from 85mRL to 132mRL( T4,S3,T6,P11,P1,S7,T2)sto pes	352(O)	352	--	3168	12197
<b>72 mRL Development</b>					
F/W Extraction Drive in East & West	143(W)	143	1716	--	--
X-Cut from WD to OD at 72mRL (AP2,AP1 Stopes)	20(W)	20	240	--	--
OD & Ore x-cut at 72 mRL (AP2,AP1 stopes)	100(O)	100	--	1050	4043
X - cut to West Ventilation raise	25(W)	25	300	--	--



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Development (W - Waste O - Ore)	Total length (in 'm')	Proposed target (m)	Waste in 'CuM'	Ore in 'CuM'	Ore in 'Tonne'
West Ventilation Raise (72 mRL to 85mRL)	10(W)	10	90		
X cut to East ventilation raise	20(W)	20	120		
East Ventilation Raise (72mRL to 85mRL)	10(W)	10	90		
<b>25 mRL Development</b>					
F/W Extraction Drive in East & West	373(W)	373	4476	--	--
X-Cut from ED(W) to OD at 25mRL (AP5,AP4,AP6,AP7,AP3) stopes	130(W)	130	1365	--	--
OD & Ore x-cut at 25 mRL (AP5,AP4,AP6,AP7,AP3) stopes	192(O)	192	--	2016	7762
Slot raise from 25mRL to 72mRL ( AP5,AP4,AP6 ) stopes	132(O)	132	--	1188	4574
<b>12 mRL Development</b>					
F/W Drive In East & West	60(W)	60	720	--	--
<b>-4 mRL Development</b>					
Shaft X-Cut at -4mRL	20(W)	20	240	--	--
<b>-35 mRL Development</b>					
Shaft X-Cut at -35mRL	35(W)	35	420	--	--
Linear development In waste for X-Cut to Extraction drive	55(W)	55	660	--	--
X-cut to connect between two vertical shaft at -35mRL	260(W)	260	4095		
<b>Installation Work</b>					
Construction of loading arrangement at +25mRL, Ore Bin & measuring pocket etc.	2 months	-			
<b>Total</b>	<b>3526</b>	<b>3526</b>	<b>32116</b>	<b>14034</b>	<b>54032</b>



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## (iv) Underground Mine Working (2018-19)

DECLINE	Starting RL of Decline	
	Ending RL of Decline	-124
	Total length of Decline	534
SHAFT (4.5m dia.)	Top RL of Shaft	-35
	Bottom RL of Shaft	-95
	Vertical development in waste	60
SHAFT (6m dia.)	Top RL of Shaft	-160
	Bottom RL of Shaft	-280
	Vertical development in waste	120
132 mRL	Linear development in waste	100
	Linear development in Ore	343
85 mRL	Linear development in waste	230
	Linear development in Ore	279
	Slot Raise development	308
72mRL	Linear development in waste	40
	Linear development in Ore	200
25mRL	Linear development in waste	342
	Linear development in Ore	248
	Slot Raise development	308
	Ventilation raise development	88
12 mRL	Linear development in waste	125
	Linear development in Ore	40
	Ventilation raise development	10
-48 mRL	Linear development in waste for X-Cut to FW drive	50
-65mRL	Horizontal Platform in Decline	9
	X-Cut to connect shaft	20
-95mRL	Horizontal Platform in Decline	18
	X-Cut to connect shaft	35
	Linear development in waste for X-Cut to Extraction drive	55
-124mRL	Horizontal Platform in Decline	9
STOPE	Stope to be developed (132mRL to 85mRL)	T3,T7,S8,S9,S10,S2,S1,T8
	Stope to be developed (72mRL to 25mRL)	AP7,AP3,AP2,AP1,AP8,AP9, AP10
	Stope Under Production (132mRL to 85mRL)	P1,P2,S2,T2,T3,S7,T7,S8,S9,P10,S10,P11

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## Underground Development &amp; production (2018-19)

Development (W - Waste O - Ore)	Total length (in 'm')	Proposed target 'm')	Waste in 'CuM'	Ore in 'CuM'	Ore in 'Tonne'
<b>Decline Development</b>					
Decline -61 to -65 mRL	32(W)	32	504		
Horizontal Platform at -65 mRL	9(W)	9	142		
Decline -65 to -79mRL	112(W)	112	1764		
Curve (1 in 10) -79 to -81 mRL	31(W)	31	488		
Decline -81 to -95 mRL	112(W)	112	1764		
Horizontal Platform at -95 mRL	18(W)	18	284		
Decline -95 to -108 mRL	104(W)	104	1638		
Curve (1 in 10) -108 to -111 mRL	31(W)	31	488		
Decline -111 to -124 mRL	112(W)	112	1764		
Horizontal Platform at -124 mRL	9(W)	9	142		
<b>Vertical Shaft (4.5 m Diameter)</b>					
Shaft sinking -35 to -65 mRL	30(W)	30	613		
Shaft sinking -65 to -95 mRL (Waste)	30(W)	30	613		
<b>Vertical Shaft (6 m Diameter)</b>					
Shaft sinking -160mRL to -280 mRL	120 (W)	120	4883	--	--
<b>132mRL Development</b>					
X-Cut from WD to OD at 132mRL (T3,T7,S8,S9,S10,S2,S1,T8 Stopes)	100(W)	100	1200		
OD & Ore x-cut at 132 mRL (T3,T7,S8,S9,S10,S2,S1,T8 stopes)	343(O)	343	--	4116	15847
<b>85 mRL Development</b>					
X-Cut from ED(W) to OD at 85mRL (T3,T7,S8,S9,S10,S2,S1,T8) stopes	230(W)	230	2415		
OD & Ore x-cut at 85 mRL (T3,T7,S8,S9,S10,S2,S1,T8) stopes	279(O)	279	--	2930	11281
Slot raise from 85mRL to 132mRL (T7,S8,S9,S10,S2,S1,T8) stopes	308(O)	308	--	2772	10672
<b>72 mRL Development</b>					
X-Cut from FWD to OD at 72mRL (AP8,AP9,AP10,AP11 Stopes)	40(W)	40	480		
OD & Ore x-cut at 72 mRL (AP8,AP9,AP10,AP11 stopes)	200(O)	200	--	2400	9240
<b>25 mRL Development</b>					
F/W Extraction Drive in East	102(W)	102	1224		
X - cut to East Ventilation raise	10(W)	10	120		



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Development (W - Waste O - Ore)	Total length (in 'm')	Proposed target 'm')	Waste in 'CuM'	Ore in 'CuM'	Ore in 'CuM'
X - cut to East ventilation raise	10(W)	10	120		
X cut to West ventilation raise	10(W)	10	120		
West Ventilation Raise (72mRL to 85mRL)	44(W)	44	396		
X cut to East ventilation raise	10(W)	10	120		
East Ventilation Raise (72mRL to 85mRL)	44(W)	44	396		
X-Cut from ED(W) to OD at 25mRL (AP7,AP3,AP2,AP1,AP8,AP9,AP10,A P11) stopes	200(W)	200	2100		
OD & Ore x-cut at 25 mRL (AP7,AP3,AP2,AP1,AP8,AP9,AP10, AP11) stopes	248(O)	248	--	2604	10025
Slot raise from 25mRL to 72mRL (AP7,AP3,AP2,AP1,AP8,AP9,AP10) stopes	308(O)	308	--	2772	10672
<b>12mRL Development</b>					
F/W Extraction Drive In East	110(W)	110	1320		
X - cut to East Ventilation raise	5(W)	5	60		
East Ventilation Raise (12mRL to 25mRL)	10(W)	10	90		
X-Cut from FWD to OD at 12mRL (BP5 Stopes)	10(W)	10	120		
OD & Ore x-cut at 12 mRL (BP5 stopes)	40(O)	40	--	480	1848
<b>-48 mRL Development</b>					
Linear development in waste for X- Cut to FW drive	50(W)	50	600		
<b>-65 mRL Development</b>					
Shaft X-Cut at -65mRL	20(W)	20	240		
<b>-95 mRL Development</b>					
Shaft X-Cut at -95mRL	35(W)	35	420		
Linear development in waste for X- Cut to Extraction drive	55(W)	55	660		
<b>Total</b>	<b>3571</b>	<b>3571</b>	<b>27288</b>	<b>18074</b>	<b>69585</b>



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## (v) Underground Mine Working (2019-20)

		Length in m
DECLINE	Starting RL of Decline	-124
	Ending RL of Decline	
	Total length of Decline	336
SHAFT	Top RL of Shaft	-95
	Bottom RL of Shaft	-155
	Vertical development in waste	60
SHAFT (6m dia.)	Top RL of Shaft	-280
	Bottom RL of Shaft	-400
	Vertical development in waste	120
132 mRL	Linear development in waste	75
	Linear development in Ore	319
85 mRL	Linear development in waste	150
	Linear development in Ore	225
	Slot Raise development	220
72mRL	Linear development in waste	50
	Linear development in Ore	250
25mRL	Linear development in waste	150
	Linear development in Ore	200
	Slot Raise development	264
12 mRL	Linear development in waste	213
	Linear development in Ore	160
	Ventilation raise development	10
-35mRL	Linear development in waste	510
	Linear development in Ore	150
	Slot raise development	176
-108 mRL	Linear development in waste for X-Cut to FW drive	50
-124mRL	X-Cut to connect shaft	30
-155mRL	Horizontal Platform in Decline	18
	X-Cut to connect shaft	35
STOPE	Stope to be developed (132mRL to 85mRL)	T9,S11,T10,T1,T11
	Stope to be developed (72mRL to 25mRL)	AP11,AS5,AS6,AS7,AS4,AT3
	Stope to be developed (12mRL to -35mRL)	BP5,BP4,BP6,BP7
	Stope Under Production (132mRL to 85mRL)	S1,T1,T8,T9,T10,S11,T11
	Stope Under Production (72mRL to 25mRL)	AP5,AP4,AP6,AP7,AP8,AS5,AS7,AS6



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## Underground Development &amp; production (2019-20)

Development (W - Waste O - Ore)	Total length (in 'm')	Proposed target 'm')	Waste 'CuM	Ore in 'CuM	Ore in 'Tonne
<b>Decline Development</b>					
Decline -124 to -138mRL	112(W)	112	1764		
Curve (1 in 10) -138 to -141 mRL	31(W)	31	488		
Decline -141 to -155 mRL	112(W)	112	1764		
Horizontal Platform at -155 mRL	18(W)	18	284		
Decline -155 to -165 mRL	80(W)	80	1260		
<b>Vertical Shaft (4.5 m Diameter)</b>					
Shaft sinking -95 to -124 mRL	29(W)	29	592		
Shaft sinking -124 to -155 mRL (Waste)	31(W)	31	633		
<b>Vertical Shaft (6 m Diameter)</b>					
Shaft sinking -280mRL to -400 mRL	120 (W)	120	4883	--	--
<b>132mRL Development</b>					
X-Cut from WD to OD at 132mRL (T8,T9,S11,T10,T1,T11 Stopes)	75(W)	75	900		
OD & Ore x-cut at 132 mRL (T8,T9,S11,T10,T1,T11 stopes)	319(O)	319		3828	14738
<b>85 mRL Development</b>					
X-Cut from ED(W) to OD at 85mRL (T8,T9,S11,T10,T1,T11) stopes	150(W)	150	1575		
OD & Ore x-cut at 85 mRL (T8,T9,S11,T10,T1,T11) stopes	225(O)	225		2363	9096
Slot raise from 85mRL to 132mRL ( T8,T9,S11,T10,T1,T11) stopes	220(O)	220		1980	7623
<b>72 mRL Development</b>					
X-Cut from FWD to OD at 72mRL (AS5,AS4 ,AS6,AS7 stopes)	50(W)	50	600		
OD & Ore x-cut at 72 mRL (AS5,AS4 ,AS6,AS7 stopes)	250(O)	250		3000	11550
<b>25 mRL Development</b>					
X-Cut from ED(W) to OD at 25mRL (AS5,AS4,AS6,AS7 stopes)	150(W)	150	1575		
OD & Ore x-cut at 25 mRL (AS5,AS4,AS6,AS7 stopes)	200(O)	200		2100	8085
Slot raise from 25mRL to 72mRL ( AP11,AS5,AS4,AS6,AS7 stopes	264(O)	264		2376	9148

  
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Development (W - Waste O - Ore)	Total length (In 'm')	Proposed target 'm')	Waste in 'CuM'	Ore in 'CuM'	Disc In 'CuM'
<b>12mRL Development</b>					
F/W Drive In East & West	163(W)	163	1956		
X - cut to West Ventilation raise	5(W)	5	60		
West Ventilation Raise (12mRL to 25mRL)	10(W)	10	120		
X - cut to East Ventilation raise	5(W)	5	60		
X-Cut from FWD to OD at 12mRL (BP4, BP6, BP7, BP3 Stopes)	40(W)	40	480		
OD & Ore x-cut at 12 mRL ( BP4, BP6, BP7, BP3 stopes)	160(O)	160		1920	7392
<b>-35 mRL Development</b>					
F/W Extraction Drive In East & West	360(W)	360	3780		
X-Cut from ED(W) to OD at -35mRL (BP5, BP4, BP6, BP7, BP3) stopes	150(W)	150	1575		
OD & Ore x-cut at -35 mRL (BP5, BP4, BP6, BP7, BP3) stopes	150(O)	150		1575	6064
Slot raise from -35mRL to 12mRL ( BP5, BP4, BP6, BP7 ) stopes	176(O)	176		1584	6098
<b>-108 mRL Development</b>					
Linear development in waste for X- Cut to FW drive	50(W)	50	600		
<b>-124 mRL Development</b>					
X-Cut to connect shaft	30(W)	30	360		
<b>-155 mRL Development</b>					
X-Cut to connect shaft	35(W)	35	420		
<b>Total</b>	<b>3770</b>	<b>3770</b>	<b>25729</b>	<b>20726</b>	<b>79794</b>



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## U/G Development proposal for the Scheme period 2015-16 to 2019-20

Activities	Development	2015-16	2016-17	2017-18	2018-19	2019-20
		Proposal in 'm'	Proposal in 'm'	Proposal in 'm'	Proposal in 'm'	Proposal in 'm'
Decline	Starting RL of Decline	74.5	49.5	-1	-61	-124
	Ending RL of Decline	49.5	-1	-61.0	-124	-165
	Total length of Decline	207	418	494	534	335
Shaft (dia. 4.5m)	Top RL of Shaft	85	52	25	-35	-95
	Bottom RL of shaft	52	25	-35	-95	-155
	Meters of Shaft	33	27	60	60	60
Shaft (dia. 6m)	Top RL of Shaft	200	80	-40	-160	-280
	Bottom RL of shaft	80	-40	-160	-280	-400
	Meters of Shaft	120	120	120	120	120
145 mRL	Linear development in waste	40	--	--	--	--
	Linear development in Ore	230	--	--	--	--
	Ventilation Raise Development in ore	--	52	--	--	--
132 mRL	Linear development in waste	287	75	80	100	75
	Linear development in Ore	260	359	292	343	319
	Ventilation Raise Development	20	--	--	--	--
85 mRL	Linear development in waste	573	272	220	230	150
	Linear development in Ore	240	240	296	279	225
	Ventilation Raise Development	--	88	--	--	--
	Slot Raise development	220	308	352	308	220
	Linear Development in waste to connect Ore Pass	50	--	--	--	--
72mRL	Linear development in waste	227	295	208	40	50
	Linear development in Ore	--	250	100	200	250
	Linear development in waste for X-Cut to FW drive	50	--	--	--	--
	Ventilation Raise development	--	20	20	--	--

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Activities	Development	2015-16	2016-17	2017-18	2018-19	2019-20
52 mRL	Horizontal Platform in decline	10	--	--	--	--
	X-Cut to connect shaft	30	--	--	--	--
	Conveyor drive	50	10	--	--	--
	Ore Pass Raise development (52mRL to 85 mRL)	--	30	--	--	--
25 mRL	Linear development in waste	--	175	503	342	150
	Linear development in Ore	--	--	192	248	200
	Horizontal Platform in Decline	--	18	--	--	--
	X-Cut to connect shaft	--	35	--	--	--
	Ore Bin Raise development (25mRL to 52mRL)	--	27	--	--	--
	Slot Raise development	--	--	132	308	264
	Ventilation raise development	--	--	--	88	--
12mRL	Linear development in waste	--	130	60	125	213
	Linear development in Ore	--	--	--	40	160
	Ventilation raise development	--	--	--	10	10
-4mRL	Horizontal Platform in Decline	--	--	9	--	--
	X-Cut to connect shaft	--	--	20	--	--
-35mRL	Horizontal Platform in Decline	--	--	18	--	--
	X-Cut to connect shaft	--	--	35	--	--
	Linear development in waste for X-Cut to Extraction drive	--	--	55	--	--
	Linear Development in waste to connect between two Vertical shaft	--	--	260	--	--
	Linear development in waste	--	--	--	--	510
	Linear development in Ore	--	--	--	--	150
	Slot raise development	--	--	--	--	176
-48mRL	Linear development in waste for X-Cut to FW drive	--	--	--	50	--
-65mRL	Horizontal Platform in Decline	--	--	--	9	--
	X-Cut to connect shaft	--	--	--	20	--

  
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Activities	Development	2015-16	2016-17	2017-18	2018-19	2019-20
<b>-95mRL</b>	Horizontal Platform In Decline	--	--	--	--	--
	X-Cut to connect shaft	--	--	--	--	--
	Linear development in waste for X-Cut to Extraction drive	--	--	--	--	--
<b>-108mRL</b>	Linear development in waste for X-Cut to FW drive	--	--	--	--	50
<b>-124mRL</b>	Horizontal Platform In Decline	--	--	--	9	--
	X-Cut to connect shaft	--	--	--	--	30
<b>-155mRL</b>	Horizontal Platform In Decline	--	--	--	--	18
	X-Cut to connect shaft	--	--	--	--	35
<b>STOPE</b>	Stope to be developed					
	Stope under production					
	<b>GRAND TOTAL (in 'm')</b>	<b>2647</b>	<b>2949</b>	<b>3526</b>	<b>3571</b>	<b>3770</b>



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## Abstract of Proposed U/G Development from 2015-16 to 2019-20

Description	2015-16			2016-17			2017-18			2018-19			2019-20			TOTAL		
	Waste (CuM)	Ore (CuM)	Ore (T)	Waste (CuM)	Ore (CuM)	Ore (T)	Waste (CuM)	Ore (CuM)	Ore (T)	Waste (CuM)	Ore (CuM)	Ore (T)	Waste (CuM)	Ore (CuM)	Ore (T)	Waste (CuM)	Ore (CuM)	
Dedline	3418			6867			8206											
Shaft (4.5m dia.)	674			551			1225											
Shaft (6m dia.)	4883			4883			4883											
145	480	2760	10626		637	2452												
132	3624	3120	12012	900	4308	16586	980	3504	13490	1200	4116	15847	900	3828	14738	7584	18876	72673
85	7206	4680	18018	3786	4445	17113	2310	6276	24163	2415	5702	21953	1575	4343	16719	17292	25446	97966
72	3324			3720	2250	8662	2556	1050	4043	480	2400	9240	600	3000	11550	10680	8700	33495
52	960			600														
25				3278			5841	3204	12336	4596	5376	20697	1575	4476	17233	15292	13056	50266
12				1635			720			1590	480	1848	2676	1920	7392	6621	2400	9240
-4							240											
-35							5175											
-48																		
-65																		
-95																		
-108																		
-124																		
-155																		
TOTAL	24569	10560	40656	26220	11640	44813	32116	14034	54032	27288	18074	69585	25729	30726	79794	135924	75034	288880



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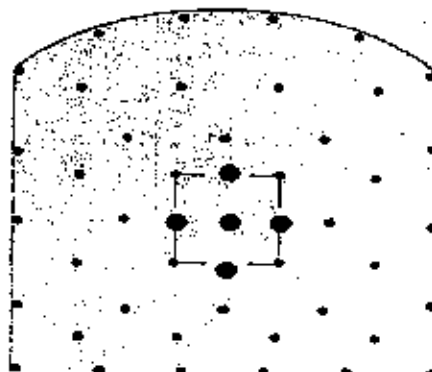


## iii) System of drilling and blasting

Drilling pattern in ore	Burn Cut
Drilling pattern in Rock	Burn Cut
Drilling pattern in Stopes	Ring Drilling
Maximum number of holes blasted in a round.	47 holes - in development
Charge per round (Kg)	80 in Development
Charge per hole (kg)	2.5 in Development
Type of explosive	Emulsion/Slurry explosive in catridged form of 83mm, 40mm & 25mm dia.
Powder Factor (Norms) Rock development- Ore development- Stope -	Rock Development - 0.45 m <sup>3</sup> /Kg Ore Development - 0.5 m <sup>3</sup> /Kg Stope - Presently stopes are in development stage.
Powder Factor (Actual) Rock development- Ore development- Stope -	Rock Development - 0.42 m <sup>3</sup> /Kg Ore Development - 0.48 m <sup>3</sup> /Kg Stope - Presently stopes are in development stage.

**Drilling Pattern**

(a) **Development Faces** : In development faces Burn cut drilling pattern shall be followed which will be done by single boom/ double Boom of Jumbo. There will be 47nos of holes of 45mm diameter. 5 holes will be reamed to 89mm diameter as shown below



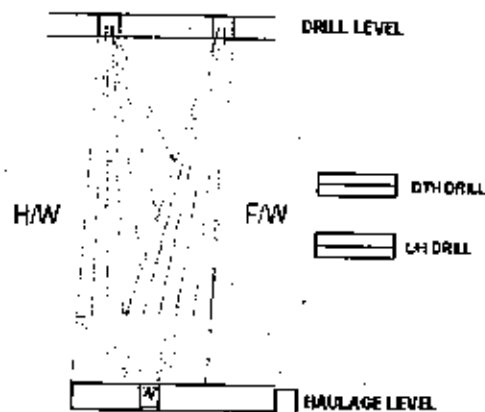
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(b) **Stope** : In Stope drilling, 57mm dia. long hole and 115mm dia. DTH combination shall be used. The holes will be drilled in ring pattern. Large dia. Holes will be drilled from drill level at upper horizon. The 57mm dia. Holes will be drilled mainly in trough level and in drill level for horizontal holes. The patterns are shown below:



#### Type of explosives to be used

(a) **Development Faces** : In development faces slurry explosive of 25 mm & 40mm size of cartridge shall be used for effective blasting.

**Pull per blast**: As per the rock types of Mahagiri Mines(Chromite), Pull per blast shall be 2.9m to 3.0 m and 80 -100 kgs of explosive shall be consumed per blast.

(b) **Stope blasting** : For stope blasting, explosives will be in catridged form of 83mm dia , 40mm & 25mm dia.. Each hole to be primed with primax and connected with delay detonators. For connecting the holes, chord lines with cordex will be used in combination with non electric delay detonators in DTH holes. For long hole drilled upward, small dia cartridge will be used. The chord line is to be detonated at its either ends with electric detonators. However, for large circuits different variations and combinations of trunk line connections will be used for better results.

  
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**Annual explosive consumption**

Maximum development meterage (drivage & shaft) in a year during the scheme period	3770 m
Explosive consumption with pull (3.0 m) per blast	80 Kg
Explosive Consumption in development.	111703 Kg
Maximum no of Stope to be Blasted in a year (15nos x 10000cum.)	150000 CuM
Explosive consumption in stope with output 1.33 cum/Kg.	112782 Kg
Total explosive consumption in development & Stope per year	224485 Kg
Avg. Explosive consumption per month	18.7 Tonnes

The existing magazine at Sukinda Mines (Chromite), which is another captive mines of same lessee will cater the explosive requirement at Mahagiri Mines (Chromite). However, looking at the future explosive requirement at Mahagiri Mines (Chromite), the lessee may enhance the magazine capacity at Sukinda Mines (Chromite) or go for a separate magazine at Mahagiri Mines (Chromite).

**iv) Method and Sequence of Stoping****Blast Hole Stoping with Post Filling & Sequence**

The ore body is vertically divided into blocks of 50 m. It has been planned that there will be vertical parting of 10 m between each block, which will act as Crown Pillar.

The stoping operation will commence at the block between 135mRL and 85 mRL and will be accessed from the foot wall waste drive by crosscuts. The foot wall waste drive of 4 m (w) x 3 m (h) will be driven parallel to the foot wall contact of the ore body. The ore body will be split into Primary, Secondary and Tertiary stope panels of 18 m length. In the drill level of the stope, two drives of 4 m (w) x 3 m (h) will be developed along the wall contacts.

At the extraction level of the stope, cross cuts will be developed from the foot wall extraction drive. The parting between two cross-cut from center to center will be 9m. The dimension of cross-cut will be 3m (w) x 3m (h) & the ore drive will be 3 m (w) x 3 m (h). An ore drive of 3 m (w) x 3 m (h) along the strike in the centre of the ore-body will then be developed as Trough Drive, from where upwards holes will be drilled for formation of 'Trough'. The cross cuts between the foot wall waste drive and the trough drive will be used as 'Draw Points' for mucking by LHD from the stopes.

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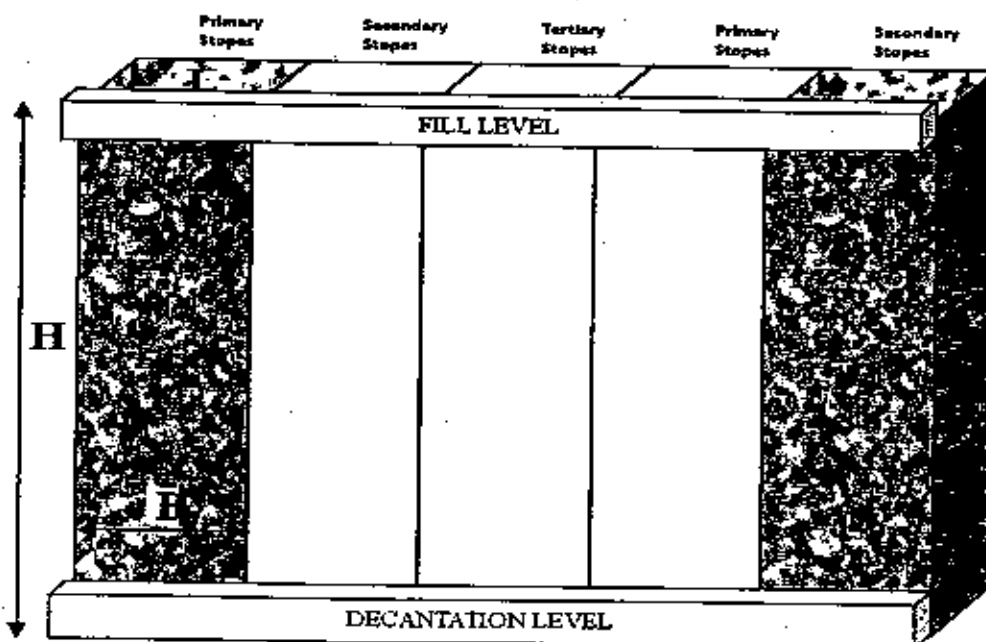


The overall sequence of panel extraction shall be starting from top stope. The method of development and stoping will leave no rib pillars between two stopes blocks.

Initially, a slot will be opened at one end by developing a slot raiser by drop Raising method, for which 115 mm downwards holes will be drilled (with DTH) in 3 m x 3 m diamond pattern and blasted with drop raising method. The slot rings will then be blasted to make the slot between Hanging Wall & Foot Wall. The ring spacing and toe burden of the 115 mm holes rings will initially be kept as 2.7 m and 2.5 m respectively, which will be later optimized for better fragmentation with progressive results and rock type variations.

At the extraction level, the trough drilling will be done with longhole drill for 57 mm holes in rings pattern with toe burden and ring spacing of 1.2 m and 1.4 m respectively. Trough rings will be blasted against the slot.

The ore body will be divided along the strike length into primary, secondary and tertiary stopes. These will be filled with cemented fill sequentially. This process will continue and subsequently all stopes filled. The Figure below depicts a schematic layout of blast hole stopes with cemented backfilling proposed.



Schematic layout of blast hole stopes with consolidated backfilling

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Year-wise / Stope-wise Underground Production Plan for next five years along with grade.

Year	Stope to be developed	Stope Under production	Production from Development in 'Tonne'	Production from Stope in 'Tonne'	Total in 'Tonne'	Grade
2015-16	P6,S5,P4,P7,P3	P5,P6,S5	40656	70000	110656	+30% Cr <sub>2</sub> O <sub>3</sub>
2016-17	P2,S6,S4,T5,P8 P9,P10	P3,P4,S4,T5,S6	44813	155187	200000	+30% Cr <sub>2</sub> O <sub>3</sub>
2017-18	T4,S3,T6,P11,P1 S7,T2,AP5, AP4, AP6	P3,S3,T4,T6,P7, P8, P9	54032	245968	300000	+30% Cr <sub>2</sub> O <sub>3</sub>
2018-19	T3,T7,S8,S9,S10 S2,S1,T8,AP7, AP3,AP2,AP1,AP 8, AP9, AP10	P1,P2,S2,T2,T3, S7,T7,S8,S9,P10, S10, P11,	69585	330415	400000	+30% Cr <sub>2</sub> O <sub>3</sub>
2019-20	T9,S11,T10,T1, T11,AP11,AS5,A S6,AS7,AS4,BP5, BP4,BP6,BP7	S1,T1,T8,T9,T10 S11,T11,AP5,AP4, AP6,AP7,AP3, AP2, AP1, AP8, AS5,AS7,AS6	79794	520206	600000	+30% Cr <sub>2</sub> O <sub>3</sub>

Year-wise Opencast & Underground Production Plan for next five years along with grade.

Year	Opencast Production in 'Tonne'	Underground Production in 'Tonne'	Total in 'Tonne'	Grade
2015-16	60000	110656	170656	+30% Cr <sub>2</sub> O <sub>3</sub>
2016-17	32000	200000	232000	+30% Cr <sub>2</sub> O <sub>3</sub>
2017-18	23129	300000	323129	+30% Cr <sub>2</sub> O <sub>3</sub>
2018-19	Nil	400000	400000	+30% Cr <sub>2</sub> O <sub>3</sub>
2019-20	Nil	600000	600000	+30% Cr <sub>2</sub> O <sub>3</sub>

### Backfill Plant Design

As per design of a backfill technology developed by CIMFR during 2009 (Annexure 26), the backfill plant for Mahagiri Mines (Chromite) would never be operated below 50 m<sup>3</sup>/hr rate so that the velocity would always be above the critical condition. This slurry would deliver sand @ 30 m<sup>3</sup>/hr and water @ 32 m<sup>3</sup>/hr through 100mm dia pipeline.

Keeping this in view, the layout of a typical consolidated fill plant has been designed.

A tentative location of the filling plant is shown in the surface plan (Plate No. 04).

The fill plant would have seven major components as follows:

  
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- Fill storage tank or Sand Bunker
- Mixing tank (agitator)
- Cement mixing system
- Water tank
- Boreholes
- Underground pipe line network
- Instrumentation.



**(a) Fill Storage Tank or Sand Bunker**

Keeping a minimum of 8 hrs storage capacity of the sand, a 300 m<sup>3</sup> capacity ground based bunker would be erected at the site. Arrangement of ramps would be made to access the bunker top having a grizzly fitted over it. The sand would be directly discharged to the bunker by the trucks/tippers. The grizzly would prevent foreign materials and large pebbles/boulders entering into the bunker. In addition to this sufficient storage at the surface nearby the plant would be kept to avoid any interruption in filling operation. A contingency stock before the onset of rainy season would also be maintained as gathering of sand from the rivers would be difficult due to water logging.

For a 300m<sup>3</sup> capacity bunker the dimension of the bin would be 7.5m x 7.5m x 2.0m (L x B x H). The hopper portion would be of 3.35m height and inclined at an angle of 45° to the horizontal to allow free flow of the sand. The bottom part of the hopper would be 0.8m x 0.8m (L x B) dimension. Discharge of the sand would be made through a chute having an opening size of 30cm x 20cm.

The sand would be taken directly from the bunker chute to the mixing tank through a variable feed conveyor with weighing device for controlling the feed rate. A minimum free fall height of 0.6m between the chute and the belt conveyor would be kept to avoid piling up of sand at the discharge point.

**(b) Mixing Tank (Agitator)**

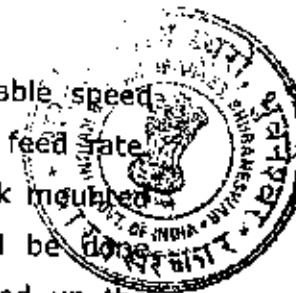
A cylindrical mixing tank of 10 m<sup>3</sup> capacity would be provided below the bunker. The tank would be of 2m diameter upto a height of 3m. A stirrer arrangement would be provided at the centre of the tank to prepare the slurry of sand, cement and water. The stirrer would be driven by a 10 KW motor. A retention time of at least 10 minutes would be allowed to ensure that the sand and cement get homogeneously mixed.

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**(c) Cement Feeding System**

This system would consist of a cement storage silo with a variable speed conveyor and weighing device attached to it, for controlling the feed rate. Cement would be transported to the cement silo by means of truck mounted pressurised tanks. Loading and unloading from this truck would be done pneumatically, in order to reduce the dust formation and to speed up the handling of cement.

**(d) Water Tank**

A water tank of 1000m<sup>3</sup> would be installed at an elevated position (at least 2m to obtain water head) to provide water in making slurry, controlling slurry density and for flushing pipeline. Water flow meter would be fitted in the water line to measure the flow rate.

**(e) Boreholes**

Two vertical boreholes would be driven from the surface up to an intermediate level underground (which would serve as a slurry distribution level). One out of the two boreholes would be operated and the other would act as a standby. The bore hole would be enforced by a double layer casing (with HDPE/cast iron /mild steel pipe) to deal with weathered rock, upper sub soil, excessive wear, scaling and hence collapse and blockage of the holes. The casing would be securely fixed to prevent accidental dislodgement.

**(f) Pipeline Network**

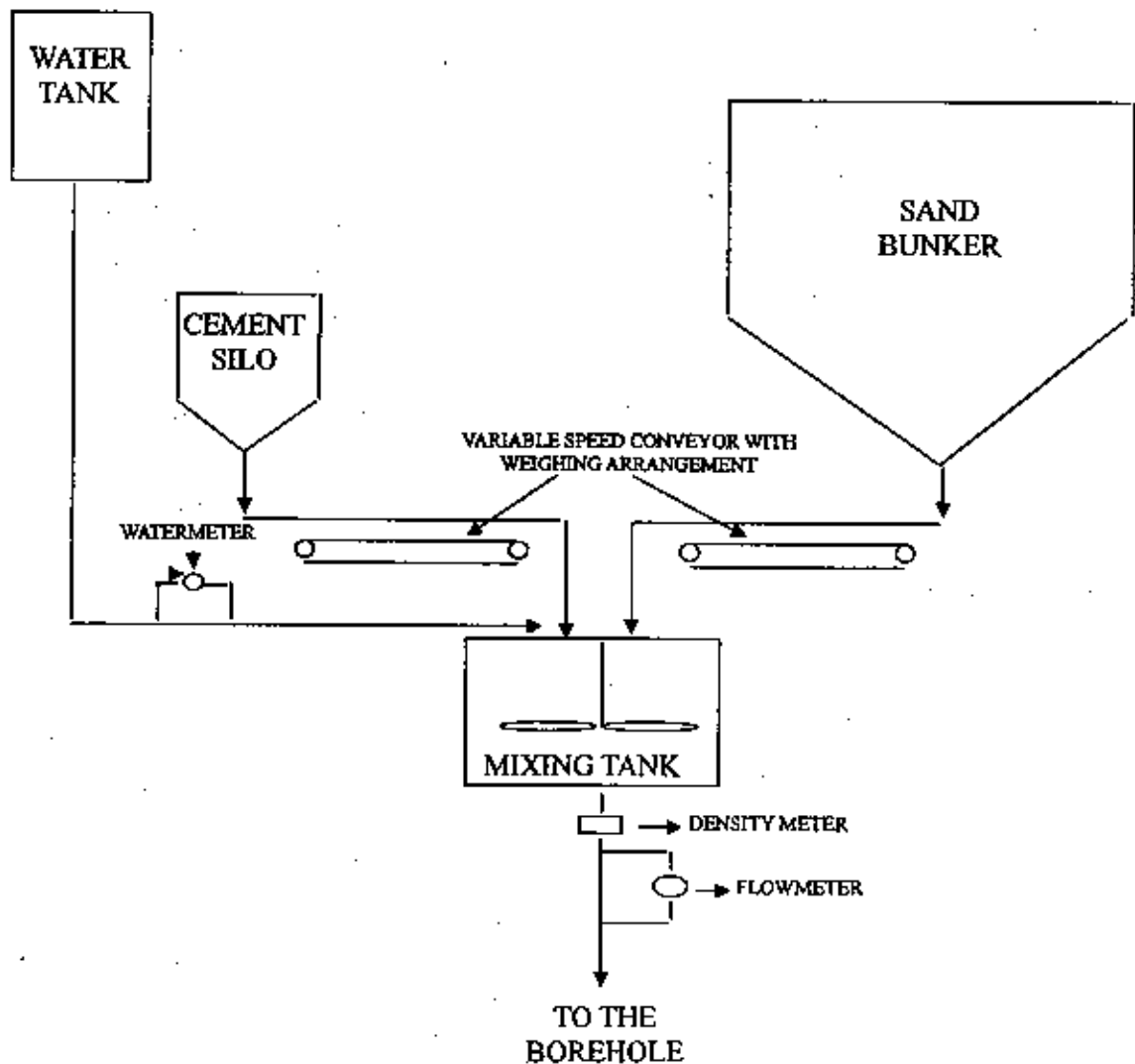
A cross-cut would be driven in the intermediate level (distribution level) to connect the bore hole with underground network of pipes of 100mm diameter. The underground range would be the combination of mild steel and HDPE pipes. The portion of range, which encounters high hydraulic head (i.e. immediately after the vertical fall) would consist of pipe with more wall thickness and flange welded mild steel pipes. In the low pressure area it may consist thinner HDPE pipe with permissible working pressure in the range of 10 Kg/cm<sup>2</sup>.

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**(g) Instrumentation**

The following instrumentation would be installed in the plant for effective control of slurry parameters: -

- Weighment device for sand and cement.
- Density Meter to measure slurry pulp density in the range of 1.3 - 2.0 t/m<sup>3</sup>.
- Slurry Flowmeter to measure slurry flow rate in the range of 50 - 300 m<sup>3</sup>/hr.
- Water Meter to measure water flow rate in the range of 0 - 200 m<sup>3</sup>/hr.
- Portable Telephones with five cores telephone cables for communication.



**Schematic layout of the consolidated Fill Plant**

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**(h) Fill & Cement Consumption**

Stope size	15m x 18m x 50m	=	13500 m <sup>3</sup>
Total fill requirement	13500 x 1.61 x 0.95	=	20648 T
Fill required for Plug	7.5m x 15 x 18 x 1.61	=	3260 T
Fill required for rest of stope	20648 - 3260	=	17388 T
Cement required for plug	3260 x 11%	=	359 T
Cement required for rest of stope	17388 x 6%	=	1043 T
Total cement required for one stope filling is		=	1402 T
Cement consumption rate is mined	1402/(13500x3.9x0.95)	=	28kg/ton ore

However, as per recommendation of CIMFR, additional work order (Letter No.IMFA/JKR/14/1177) has been issued to CIMFR, to explore the possibility of cemented overburden fill into the voids there by replacing the sand (fully or partially) . (Refer Annexure -26 & 27).

<b>Stope parameters:</b>		
1	Number of working stopes	Presently Stopes are in development stage.
2	Size of the panel	18 m each of primary, secondary & tertiary panels
3	Level interval	50 m
4	Thickness of crown pillar	10 m
5	Thickness of Sill pillar	10 m
6	Thickness of Rib pillar	18 m (secondary / tertiary panels at both sides, which will be mined out after backfilling of primary / secondary panels)
7	Size and interval of Stope pillar	Size-18 m (w) x 50 m (h) Interval - Alternate panel, before extraction, will act as pillar
8	Size/shape of man way	Height - 1.8 m (Min.) Width - 0.75m to 1m Length - 1.2 m (Min.)
9	Size/shape of ore pass	3m x 3m, Shape - Square
10	Method of stowing/back filling	Cemented backfilling
11	Method of drainage of stowed water	By Pumping

  
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**v) System of underground transportation:****From face to pit bottom or loading point:**

Load haul dumper (LHD) of 4 CuM & 2 CuM capacity shall be deployed to load ore and waste from stope and development and unloads on to low profile dump truck (LPDT) of 25 & 15 tonne capacity. LPDT shall carry ore & waste from stope & development to unloading point.

**From pit bottom to surface:**

We shall adopt two ways of transportation to surface:

1. LPDT of 25 tonne capacity shall carry the ROM to surface from upper levels.
2. Skip loading system shall be arranged at the vertical shaft for hoisting ore and waste rock from Pit Bottom to Surface. (Annexure: 33)
3. The proposed 6 lakh tonnes of ore along with waste to be generated from underground will be transported from pit bottom to surface through existing shaft & decline.

**From surface to end use plant:**

In surface Front End Loader & Tipper of 18 t capacity shall be deployed to transport the ore to the Plant for processing.

**Safety features provided on conveyor/ haulage track/ roadway:**

Road Way- We are providing Visual signaling system in underground road way & man holes and Lighting arrangements for Traffic system in the turning points of the road way.

**Safety features of LPDT**

- Parking Brake
- Service Brake
- Audio Visual Alarm
- Fire Extinguisher
- Door Interlocking with parking break
- Rear view camera with LCD screen at the operator cabin
- Fume diluter

**vi) System of winding / hoisting :**

The system of winding will be the present main shaft (dia - 4.5mtr) and a proposed production shaft (dia - 6mtr). Skip loading system will be adopted for hoisting ROM & waste. The decline shall serve as a service way.



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**Main Vertical Shaft**

Location	
Latitude	3906.07
Longitude	846.21
Cross Section of Opening	Finished Diameter – 4.5 m
Inclination	Vertical
Starting Level	200 mRL
Ending Level	-155 mRL (Upto the year 2019-20)
Present Satus	116 mRL
Method of Sinking	Drop Raising
Capacity of Handling	3.5 LakhTonne/ Year



The Main Shaft will be equipped with double drum winder for hoisting of ore as well as men and material. The shaft is being sunk by Drop Raising Method.

**Production Shaft**

Location	
Latitude	4051.6E
Longitude	938.26N
Cross Section of Opening	Finished Diameter – 6 m
Inclination	Vertical
Starting Level	193 mRL
Ending Level	-400 mRL (Upto the year 2019-20)
Present Satus	Starting from 2015-16
Method of sinking	Conventional method
Capacity of Handling	9 LakhTonne/ Year

This shaft will be used for hoisting of 9 LTPA ore & waste from underground to surface initially from -400 mRL and later on from the -600 mRL. The Shaft will be equipped with a friction winder for hoisting of ore. The shaft will be sunk by Conventional Method.

**vii) Subsidence management**

The scope of subsidence due to underground mining will not be there, since the stopes will be backfilled by cemented fill material. The stability of void shall be monitored through strata monitoring instruments installed at strategic location. Subsidence survey shall also be carried out at regular interval.

  
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**Under Ground Conceptual Plan:**

**Reserves and anticipated life of underground working:** The mineable reserve category as on 01.11.2014 is 86.10 lakh tonnes up to -395mRL. During the period 01.11.2014 to 31.03.2015, it is proposed to exploit 16500 tonnes of ore. So, after 2014-15 the mineable reserve category shall be 85.935 lakh tonnes. During the next proposed scheme period, i.e. from 2015-16 to 2019-20, it is proposed to exploit 16.10 lakh tonnes of ore from underground mine and from opencast 1.291 Lakh Tonnes. So, the mineable reserve category after 2019-20 shall be 68.545 lakh tonnes. There shall be no generation of sub grade chrome ore (10 to below 30% Cr<sub>2</sub>O<sub>3</sub>). After the proposed scheme period, the mineable reserve estimated till date up to -395mRL shall cater for another 12 years, i.e. upto 2031-32 keeping a maximum production level of 6 lakh tonnes per annum from underground mine. Exploratory drilling shall be proposed during the conceptual period which will add more reserves, there by extending the life of underground mine beyond lease period.

**Exploration beyond the Scheme period**

Exploration proposals during the scheme period 2015-16 to 2019-20 have been discussed in detail in Chapter 3. Beyond scheme period bore holes shall be proposed from underground or opencast to explore ore body at greater depth beyond -395mRL.

**Number of Levels to be developed:**

There will be a total of 19 levels upto -395mRL to be developed.

**Waste and sub grade material management:**

Beyond scheme period up to end of conceptual, it is calculated that approximately 3.855 lakh CuM of waste shall be generated. There shall be no generation of sub grade chrome ore (10 to below 30% Cr<sub>2</sub>O<sub>3</sub>). The waste shall be backfilled in the mined out areas of opencast working and in the stoped out voids of underground working.



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Year	From U/G (in LCuM)
2015-16	0.245
2016-17	0.255
2017-18	0.321
2018-19	0.272
2019-20	0.257
Conceptual	3.855*
<b>Total :</b>	<b>5.205</b>



\* During the year 2019-20, there will a production of 6 Lakh tonnes of ROM from underground mine and generation of waste from underground will be approximately 0.257 Lakh CuM. Thereafter, the underground mine will give a production of 6 Lakh tonnes of ROM per annum. Assuming, the level of production from underground to be constant throughout the remaining life of underground mine, the rate of generation of waste will be approximately 0.257 Lakh CuM per annum. Therefore, total generation of waste from underground from 2020-21 to end of conceptual period (15 years) will be  $0.257 \times 15 = 3.855$  Lakh CuM.

**Ventilation Arrangement:** Based on the future ventilation requirement, the main mechanical ventilator shall be placed either in underground or opencast.

**Backfilling:** All the stopes after being mined out shall be backfilled with consolidated cement fill.

#### viii) Mine Ventilation

During development of decline, the face will be ventilated by 2 x 20 hp auxiliary ventilation fans. Wherever the decline is connected to the main vertical shaft a fan of higher capacity as installed, makes the decline as intake & main vertical shaft as return. The decline face will further extended by the axillary fan of 2 x 20hp till the next connection is made. Thus the development will be carried out till the shaft & decline are completed.

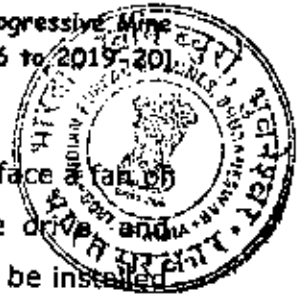
  
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In the final stages when the ventilation raise is connected to the surface adequate capacity will be installed to draw air from 145mRL ore drive and levels below 145mRL will be connected to this drive. Regulators will be installed in the connecting cross cuts, so that the air quantity from the particular level can be regulated.

The Main vertical Shaft & Decline will act as intake & return will be through ventilation raise connecting to the surface from 145mRL.

#### **Mine ventilation calculations:**

As per statute, selection of ventilation norms for different parts of the mine is calculated in accordance with following aspects:

##### **As per Production**

The av. Production per day is 2000 tonnes. For every tonnage of daily ore produced the recommended quantity of air required is 2.5 m<sup>3</sup>/min. So, for 2000 tonnes the requirement of air shall be  $2000 \times 2.5 = 5000$  m<sup>3</sup>/min.

##### **As per Man Power**

The quantity of air required per person employed in largest shift is 6m<sup>3</sup>/min.

Assuming overall O.M.S of 5 Tonnes per man shift, the requirement of manpower shall be 200.

So, quantity of air required for ventilation purpose shall be  $(200) \times 6 = 1200$  m<sup>3</sup>/min

##### **Permissible concentration of noxious gases from Machineries**

For achieving required production and development targets, following machineries shall be deployed in the shift. It has been observed that approx. 4.2cum/min of air per KW is required for good ventilation in underground.

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Total Horse Power of equipments to be deployed are:

Name of Equipment	Capacity	Numbers	Power (in KW)	Total KW	Usage (%)	Total KW	Ventilation (cum/min)
LHD	4 CuM	1	186	186	100	186	781
LHD	2 CuM	1	79	79	100	79	332
LPDT	15 T	1	148	148	1000	148	622
LPDT	25 T	2	261	522	100	522	2192
Drill Jumbo	45 MM dia.	1	65	65	50	33	139
Service Utility Vehicle	--	2	79	158	50	79	332
Total				1158		1047	4398

So, a quantity of approx. 4400 cum / minute is required to dilute the noxious gases. It has planned to install the main mechanical ventilator of 5000 cum / minute capacity to cater the ventilation requirements.

#### ix) Extent of Mechanisation

Calculation to find out performance of UG mining machinery:

##### Drilling

Drilling	47 holes x 3.3 m = 155 m, dia of holes 45 mm
Drilling rate by Jumbo	1.2 m/min.
Total time required	155 m/ 1.2 = 129 min.
Diameter of reaming holes	89 mm (45mm ~ 64mm ~ 89 mm)
Total length of hole to be reamed	3.3 x 5 holes = 16.5m
Reaming rate	0.5 m / min.
Total time required	33 min.
M/C shifting & setting time	30 min.
Total time	129 + 33 + 30 = 192 min. or 3 hr. 12 min.

  
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**MUCKING BY LHD of 4 CuM CAPACITY**

Total excavated volume	$4.5 \times 3.5 \times 3 = 47 \text{ CuM}$
Considering Swelling @ 25%, broken rocks volume	59 CuM
L.H.D. bucket capacity	4 CuM
Considering 80% fill factor	3.2 CuM
Total No. of pass required	19
To complete one pass by LHD distance to be covered	$300 \text{ m} + 300 \text{ m} = 600 \text{ m}$
Average speed	5 Km per hour
Time for hauling	420 sec.
Loading time	60 sec.
Unloading time	60 sec.
Time of changing direction	60 sec.
Total cycle time for one pass	$420+60+60+60 = 600 \text{ sec} = 10 \text{ min.}$
In one hour total no. of passes	$60 \text{ min} / 10 \text{ min} = 6$
For achieving 19 passes, total time required	$19 \times 10 \text{ min.} = 190 \text{ min.}$
Mucking Time	3 hrs 10 mins.

**MUCKING BY LHD of 2 CuM CAPACITY**

Total excavated volume	$4.5 \times 3.5 \times 3 = 47 \text{ CuM}$
Considering Swelling @ 25%, broken rocks volume	59 CuM
L.H.D. bucket capacity	2 CuM
Considering 80% fill factor	1.6 CuM
Total No. of pass required	37
To complete one pass by LHD distance to be covered	$300 \text{ m} + 300 \text{ m} = 600 \text{ m}$
Average speed	5 Km per hour
Time for hauling	420 sec.
Loading time	60 sec.
Unloading time	60 sec.
Time of changing direction	60 sec.
Total cycle time for one pass	$420+60+60+60 = 600 \text{ sec} = 10 \text{ min.}$
In one hour total no. of cycles	$60 \text{ min} / 10 \text{ min} = 6 \text{ cycles}$
For achieving 37 passes, total time required	$37 \times 10 \text{ min.} = 370 \text{ min.}$
Mucking Time	6 hrs 10 mins.



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**HAULING by LPDT of 25 T Capacity**

Speed	9 km/hr = 150 m/min (Loaded) 11 km/hr = 183 m/min (Empty & level)
Total lead distance up & down (from 85mRL to Surface)	1200 x 2 = 2400 m
Total hauling time required	1200 / 150 = 8 min. (Loaded) 1200 / 183 = 6.5 min. (Empty) Total = 14.5 min. (say 15 min.)
Total loading, unloading & spotting time	80+120+120 = 320 Sec. = 5min. 20 sec.
Total time required / load	15min. + 5min. 20 sec. = 20 Min. 20 sec.
For a 25 MT LPDT, effective carrying capacity	20 MT, @ 80% filling
Considering effective working hrs/shift	5 hrs
Total no. of trips/LPDT/Shift	15
Total materials transported to surface/LPDT/Shift	300 MT

**HAULING by LPDT of 15 T Capacity**

Speed	9 km/hr = 150 m/min (Loaded) 11 km/hr = 183 m/min (Empty & level)
Total lead distance up & down (from 85mRL to Surface)	1200 x 2 = 2400 m
Total hauling time required	1200 / 150 = 8 min. (Loaded) 1200 / 183 = 6.5 min. (Empty) Total = 14.5 min. (say 15 min.)
Total loading, unloading & spotting time	80+120+120 = 320 Sec. = 5min. 20 sec.
Total time required / load	15min. + 5min. 20 sec. = 20 Min. 20 sec.
For a 15 T LPDT, effective carrying capacity	12 MT, @ 80% filling
Considering effective working hrs/shift	5 hrs
Total no. of trips/LPDT/Shift	15
Total materials transported to surface/LPDT/Shift	180 MT



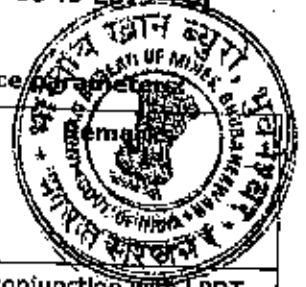
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A list of mining machinery under use &amp; proposed along with performance parameters

Name of Equipments	Capacity	Projected norms of performance / Shift	Present Status	Proposal for additional requirement	
Load-haul-dump	4 CuM	240 T	1	2	In conjunction with LPDT
Load-haul-dump	2 CuM	120 T	2	--	In conjunction with LPDT
Low profile dump truck	15 T	180 T	1	1	
Low profile dump truck	25 MT	300 T	2	2	
Drill jumbo (Double boom)	1.2m /min	250 m	1	--	Considering shifting/ placement
Drill jumbo (Single boom)	1.2m /min	250m	2	1	Considering shifting/ placement
Long hole Drilling Machine (small dia.)	6 m/hr	30	1	3	Considering shifting/ placement
Down-the-hole Drill 115 mm	2 m/hr	10	0	4	Considering shifting/ placement
Dewatering Pumps (120 HP)	72 KL/hr	---	--	2	
Jaw Crusher	120 TPH	--	--	1	
Service Utility Vehicle	--	--	--	2	



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### 3.0 MINE DRAINAGE:

- (a) **Minimum and maximum depth of water table based on observations from nearby wells and water bodies:**

Station No	Location	Maximum Ground water level (mRL)	Minimum Ground water level
GWL-4	Bore well inside Mahagiri Mines (Chromite)	163.34	155
GWL-5	Bore well inside Mines Main Office - SMC	122.27	116
GWL-6	Bore well Village Purunapani	120.2	116.3
GWL-7	Bore well Village Goramian	117.2	112.41
GWL-8	Bore well OMC Labour Colony	99.17	94

The maximum & minimum level of ground water is 163.34mRL & 94mRL respectively as per annual environmental monitoring report for the year 2013-14. (Annexure - 20)


- (b) **Maximum and minimum depth of Workings:**

The maximum and minimum depth of working is 233 mRL & (-)155mRL respectively.

- (c) **Quantity and quality of water likely to be encountered, the pumping arrangements and places where the mine water is finally proposed to be discharged:**

#### Opencast Working Pumping

As the maximum & minimum depth of opencast working is much above the ground water level, so it is obvious that there will be no mine discharge water form opencast mine.

  
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**Under ground Pumping**

<b>Water Accumulation Per Day</b>		
Water from surface to 85mRL	600 KL/Day	
Water from 85mRL (Decanted water from Filling)	100 KL/Day	
Water below 85mRL (50% of sl no 01)	300 KL/Day	
<b>Total Accumulation Per Day</b>	<b>1000 KL/Day</b>	
The capacity of 120HP pump is 26LPS with a head of 120 mtrs.		94 KL/Hr.
The rating of 60HP pump is 20LPS with a head of 130mtrs.		72 KL/Hr.
The capacity of 40HP pump is 10LPS with a head of 80mtrs.		36 KL/Hr.
<b>PUMP SELECTION:</b>		
Capacity of 100/150 IPB Type-80 pump as per Manufacturer ( $\eta = 70\%$ )	150	KL/Hr.
For 150 mtr head, stages of pumps required	4	Stages
Power Requirement for Pump	87500	Watt
Power Requirement for Pump	117	HP

It has been planned to install two nos. water pump of 120 HP each.

**(d) Regional and local drainage pattern. Annual rainfall, catchments area, and likely quantity of rain water to flow through the lease area, arrangement for arresting solid wash off etc:**

The area comprises of hilly and undulating terrain. The Daitari hill range is located in the north and the Mahagiri range occupies the southern portions. The central portions of the area is drained by Damsal Nala flowing in westerly direction. It forms the main watershed of the study area. The entire drainage originating from Diatari hills in north and Mahagiri in the south join Damsal Nala. The drainage network present over the major portions of the study area is sub-parallel except for the drainage emanating from Diatari hills over the northern portion which is radial and dendritic in nature. The maximum elevation of the area is 600 m above mean sea level in the northern portions (Diatari Hill) while the lowest is less than 100m above sea level in the west central parts of valley. The only surface water source in this area is perennial Damsal Nala which is situated at 2.3 km distance from Mahagiri due north. The water flowing through this nala ultimately joins into the Brahmani river. The lease area, represents undulating and hilly topography marked by linearly disposed mounds

  
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of moderate relief. The maximum elevation of the area is 330m RL on the southern side while the minimum elevation is 147 m RL on the northern portion of the lease area.

Annual rainfall during 2014 was 1675mm. Although the lease area is 73.777 Hacts, but catchment area is approx. 54.3 Hacts due to hilly terrain of the area. The intensity of rainfall depends on duration of the rain. For Indian conditions, the intensity of rainfall varies between 12 mm/h to 20 mm/h as per CPHEEO manual. For Sukinda, as no hourly rainfall data is available, so, 15mm/h has been chosen as design intensity of rainfall. So, likely quantity of rain water to flow through the lease area is approximately 815 CuM/Hr. Sufficient nos of settling ponds, check dams and retaining walls are there to arrest solid wash offs.

The mine water discharge will be pumped to a settling pond at surface for settling. If the sump water contains Cr+6 of higher concentration than permissible limit, the water from this sump will be passed through the treatment plant established in adjoining Sukinda Mines (Chromite) of the lessee. The treated water will be having all parameters within permissible limits and will be re-circulated for industrial use. The excess water after industrial use, if any, will be discharged to the natural surface water channels.

  
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#### 4.0 STACKING OF MINERAL REJECTS / SUB GRADE MATERIAL AND DISPOSAL OF WASTE:



**a) Nature and quantity of top soil, overburden / waste and Mineral Reject to be disposed off:** The area has lateritic soil / laterite / quartzite boulders alongwith ultramafic floats on the top where no working has been commenced within the targeted area for opencast mining. In the opencast mining area where work is in progress ultramafic along with big quartz boulder are encountered those are termed as waste. No top soil is there any where. Chromite ore less than 10% Cr<sub>2</sub>O<sub>3</sub> is also termed as waste which usually comes with the ore zone as intermediate waste. The waste ranges in colour from brown, reddish brown, brownish black to black. The texture is sand to sandy loam. Waste from underground working mainly consists of fresh serpentinite & Dolerite.

Year	Top Soil (CuM)		Mineral Rejects (CuM)			
	Reuse / Spreading	Storage	Back filling	Storage	Blending	Beneficiation
2015-16	As per requirement	Nil	Nil	Nil	Nil	Nil
2016-17	As per requirement	Nil	Nil	Nil	Nil	Nil
2017-18	As per requirement	Nil	Nil	Nil	Nil	Nil
2018-19	As per requirement	Nil	Nil	Nil	Nil	Nil
2019-20	As per requirement	Nil	Nil	Nil	Nil	Nil

#### b) Backfilling & Waste Dump:

**Rate of yearly generation of wastes and proposals for disposal of waste for next five years.**

The rate of yearly generation of wastes and over burden to be excavated in the next five years have been calculated and is given below:

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	Year	Overburden from Opencast working in CuM	Waste from Underground development working in CuM	Total
Proposed during 2015-16 to 2019-20	First Year (2015-16)	1.180	0.245	1.425
	Second Year (2016-17)	1.110	0.255	1.365
	Third Year (2017-18)	0.610	0.321	0.931
	Fourth Year (2018-19)	0.000	0.272	0.272
	Fifth Year (2019-20)	0.000	0.257	0.257
	<b>Grand Total</b>	<b>2.9</b>	<b>1.350</b>	<b>4.25</b>

During 2014-15 ( i.e. between 01.11.2014 to 31.03.2015 ) there will be generation of 0.6 Lakh CuM of overburden. Similarly, it has been calculated that approximately 2.9 Lakh CuM of overburden shall be generated from opencast working during the scheme period, i.e. from 2015-16 to 2019-20. As opencast working is proposed up to 2017-18, so there shall be no generation of overburden beyond 2017-18.

Similarly, it has been calculated that approximately 1.35 Lakh CuM of waste shall be generated from underground working during the scheme period, i.e. from 2015-16 to 2019-20.

The whole 4.85 Lakh CuM overburden (3.5 Lakh CuM from O/C working & 1.35 Lakh CuM from U/G) to be generated during the scheme period, shall be utilised for backfilling of mined out areas of opencast working (within the forest area), where the ultimate pit limit (185mRL) has reached.

The year wise plan for management of overburden/waste is tabulated below:

Year	Backfilling in O/C Mines (in LCuM)	Dumping at waste dump yard (in LCuM)
2015-16	1.425	Nil
2016-17	1.365	Nil
2017-18	0.931	Nil
2018-19	0.272	Nil
2019-20	0.257	Nil
<b>Total :</b>	<b>4.25</b>	<b>Nil</b>

  
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**Designed Capacity, Maximum height and spread of waste dump -**

The capacity of the present waste dump in non forest area is to accommodate 10.50 LCuM. Till end of 2010-11, about 8.12 LCuM waste has been generated and put on the dump from which about 2.61 LCuM waste has been used for making & filling of other infrastructure work, 1.39 Lakh CuM has been used for backfilling of quarried out area of opencast pit and balance 4.12 lakh CuM overburden has been dumped. Waste from underground development during 2009-10 and 2010-11 is about 0.03 LCuM, which also dumped on the same waste dump. Thus as on 01.04.2011 the waste dump is containing 4.15 LCuM, leaving a balance for 6.35 LCuM waste that can be accommodated.

**Rate of yearly generation of sub grade ore with reference to threshold value and proposal for its stacking**

The grade of usable ore is above 30% Cr<sub>2</sub>O<sub>3</sub>. Chrome ore having 10 to below 30% Cr<sub>2</sub>O<sub>3</sub> is termed as sub grade ore. Till date there is no generation of sub grade ore. Generation of sub grade ore shall be nil. However, provisions have been made to stack the sub grade ores separately, in case there is any generation.

**Maximum height, spread of sub grade dump and its management**

The maximum height of the sub grade stack shall be 5 m and material from this shall be used for beneficiation in future along with mineral rejects.

**Quantity and Grade of sub grade material available at the mine as on date**

As on date there is no sub grade material available at the mine.

**c) Manner of disposal of waste, configuration and sequence of year wise build up of dumps along with the proposals for protective measures.****Details of existing dump in the lease area:**

Name of the dump: Waste dump							As on: 31.10.2014	
Sl No	Dump No	Location	Length	Width	No of terraces	Top mRL	Bottom mRL	
1	Waste Dump	Northern side of lease	505 mtrs	100 mtrs	2	170mRL	148mRL	

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Details of Waste/Sub Grade generation and it's disposal during last scheme period  
( 2010-11 to 2014-15 till 31.10.2014):

Discussed in detail in chapter no 03.

**Proposals for protective measures.**

Plantation shall be done over the waste dump and backfilled area. In a phased manner the dead end slopes of the waste dump/backfilled area shall be reclaimed. Good quality grasses shall be planted on the dump slopes with small growing local trees, shrubs etc. Terraces at a maximum height of 20 m shall be constructed with inward slope for absorption of water avoiding creation of gullies on dump slopes. A number of garland drains, settling pond and retaining walls have been done. Details are as follows:

Garland drain: 3597 mtrs

Settling Pond: 6 nos of settling ponds

Retaining wall: 1110 mtrs

**Plantation**

Year/ Location	Area (Ha)					No. of Plants
	Quarry	Dump	Safety Zone	Other	Total	
<b>Already done (as on 31.10.2014)</b>	0.33	1.8	1.2	4.13	7.46	20212
<b>2015-16</b>	0.16	Nil	Nil	Nil	0.16	400
<b>2016-17</b>	0.1	Nil	Nil	Nil	0.1	250
<b>2017-18</b>	0.14	Nil	Nil	Nil	0.14	350
<b>2018-19</b>	0.1	Nil	Nil	Nil	0.1	250
<b>2019-20</b>	0.1	Nil	Nil	Nil	0.1	250
<b>End of Scheme period</b>	<b>0.93</b>	<b>1.8</b>	<b>1.2</b>	<b>4.13</b>	<b>8.06</b>	<b>21712</b>

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## 5.0 USE OF MINERAL AND MINERAL REJECT

### a) Requirement of end-use industry specifically in terms of physical and chemical composition.

Since this is a captive mine, ore being mined out from this mine is being utilised at lessee's ferro chrome plants. The ROM is being screened to different size specifications before being dispatched to captive ferro chrome plants. Chrome ore at 30% Cr<sub>2</sub>O<sub>3</sub> cut off is directly used in company's Ferro Chrome and Charge Chrome plants.

**Physical Specification:** Size of Lumps & Chips is 10-100 mm & size of fines is (-)10mm.

**Chemical Specification:** The cut off grade of ore stipulated by captive ferro chrome plants is 30% Cr<sub>2</sub>O<sub>3</sub>. However, in case of generation of chrome ore between 10% to below 30% Cr<sub>2</sub>O<sub>3</sub>, the same shall be stored & suitably beneficiated before being dispatched to plants.

### b) Requirement of intermediate Industries involved in upgradation of mineral before its end-use.

At present there is no intermediate industry involved in upgradation of mineral before its end use. ROM from mine is screened to different size ranges and is dispatched to lessee's captive plants.

### c) Requirements for captive consumption.

This being a captive mine of the lessee, the ore will be utilised for captive consumption only. Future requirement for captive consumption will be 6 lakh tonnes per annum.

### d) Indicate precise physical and chemical specification stipulated by buyers

As the mined ore is used for captive purpose, the question of physical and chemical specification stipulated by buyers does not arise.

### e) Give details of processes adopted to upgrade the ROM to suit the user requirements.

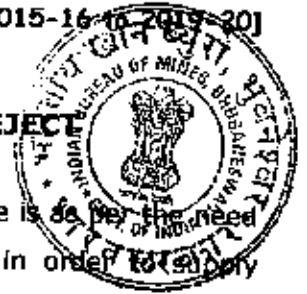
Till date, ROM being generated from the mine is above 30% Cr<sub>2</sub>O<sub>3</sub> which is acceptable to lessee's captive ferro chrome plants. So, upgrading the ROM is not required.

  
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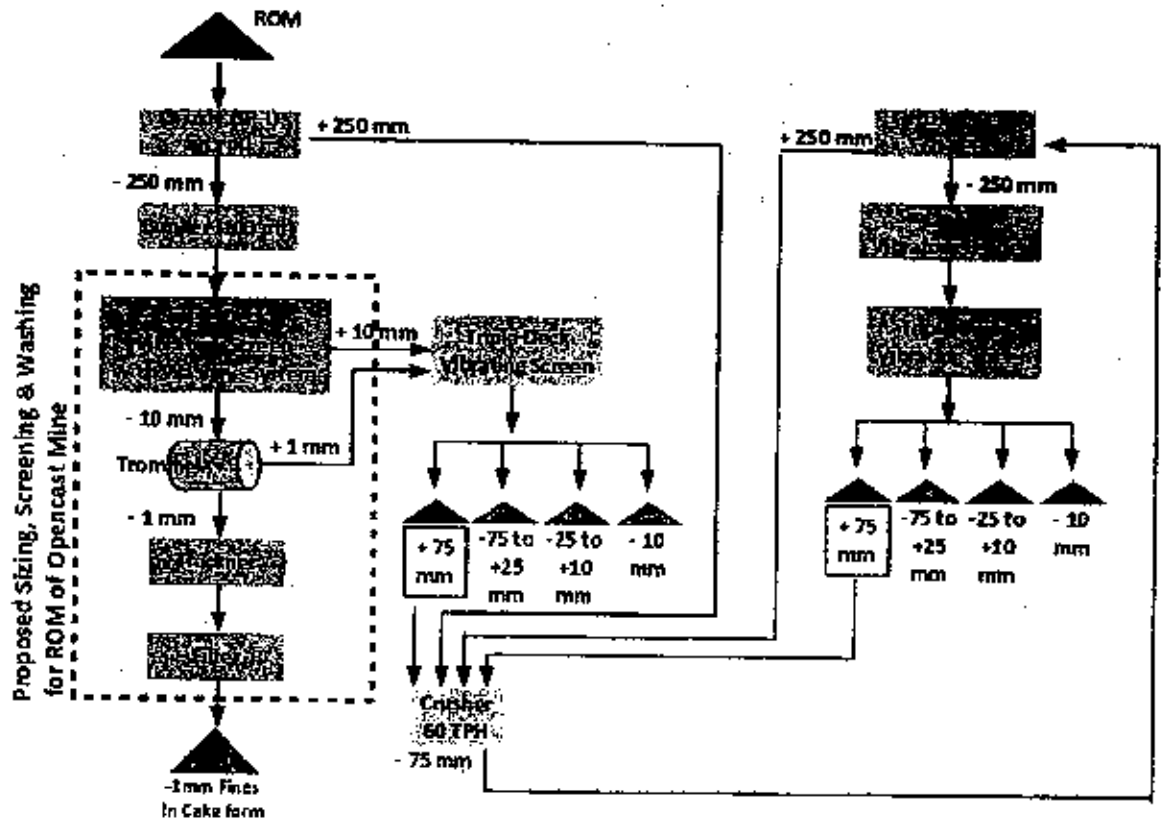
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### 6.0 PROCESSING OF ROM AND MINERAL REJECT

The ore produced from the mine is hard lumpy variety and the grade is as per the need of the company's facilities and needs no beneficiation. However in order to supply chromite ore of required specification to the company's plants, strict quality control measures are being undertaken. There is a crushing and screening plant within the leasehold area. Following procedures are followed to meet the ore specification as required by company's plants.

1. ROM excavated is transported to crushing & screening plant which is situated within the leasehold area and those are subjected to crushing and then screening to different sizes such as (-) 10 mm, (+) 10 mm to (-) 25 mm and 25 to (-)75 mm, 75 to (-) 150mm and +150mm.
2. After proper screening, the materials are again transported to the ore stack yard by tippers engaged for the purpose for future transportation to the captive plants of the company.



Flow Diagram of Screening Plant

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## 7.0 OTHER

### a) Site services :

The infrastructures available within the ML area are office buildings, borewells, rest shelter, first aid center, Diesel Dispensing unit, Sub Station, Contractor Office & Garage, Headgear & Winder etc.

### b) Employment potential :

Highly Skilled: Approx. 130  
Skilled: Approx. 150  
Semi-Skilled: 300

#### Requirement of other

##### Technical Persons:

Graduate Mining Engineer: 15

Diploma Mining Engineer: 20

Geologist: 05

Surveyor: 05

Other competent personnel: 70

#### Qualification & Experience

BE (Mining), 1 to 10 yrs with statutory certificate

Diploma (Mining), 1 to 10 yrs with statutory certificate

M Sc (Geology), 1 to 10 yrs

Surveyor Certificate of Competency, 1-5 yrs

As per statutory requirement

**Grand Total: 695 nos**

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## 8.0 Progressive Mine Closure Plan (Rule 23 of MCDR 1988)

### 8.1 Environment Base line information:

#### Existing land use pattern as on 01.11.2014:

Land use	Forest (Ha)	Non forest (Ha)	Total (Ha)
Area under mining	8.810	0.000	8.810
Storage of top soil	0.250	0.000	0.250
Overburden dump	0	4.700	4.700
Mineral storage/Sub Grade	4.600	0.000	4.600
Infrastructures	3.990	0.000	3.990
Roads	2.500	0.240	2.740
Green Belt	2.470	0.610	3.080
Subsidence Pillar	0.610	0.000	0.610
<b>Total</b>	<b>23.230</b>	<b>5.550</b>	<b>28.780</b>

#### Water regime Ground Water

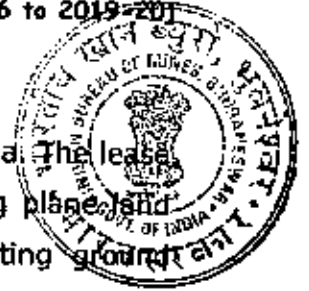
The rock mass is serpentine, pyroxenite and quartzite which are though jointed are very hard, massive and are of negligible porosity. Therefore primary voids in ground rock are almost non existed. Secondary voids in form of joints, fissures, fault and fractures abound in large measure in the rock mass but are not connected for each other to enable water infiltration into the ground and to cause sub surface transmission. However, some amount of percolation to underground mine void area shall take place when hydraulic gradient is very high due to standing water in the sump of neighborhood lease hold area. Some times long fissure/fault plane may cause water to flow from the surface water body into the underground working. But there is no ground water body as such. Regular monitoring of ground water table from nearby open well sources is being carried out. Ground water depth from surface was measured in each of the 4 seasons and it was seen that there is no adverse effect on ground water level in any of the cases. It was seen that the ground water level fluctuates in between 2 m (minimum) to 3 m (maximum) depending on seasonal variance.

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### Surface water

There is no surface water body available in the entire lease hold area. The lease area is mostly covered by hill except 7.397 ha of non ore bearing plain land wherein waste / overburden dumping is going on. In the existing ground configuration scope of formation of surface water body does not arise. However, during rainy season some water may accumulate at the bottom of the pit in a sump which will regularly be pumped out. Similarly for the underground working, lying vertically below opencast working, pumping will be done directly to surface. Besides the quarry sump and underground sump, there will be man-made garland drain, to enable the rain water over the catchment area to flow out smoothly, out of lease area, by stream flow. Since the gradient of lease area is steep, rain water flow out quickly and infiltration into the ground is very little. However this drain is active only in rainy season and the balance period these drains are almost dry.

### Quality of air

Ambient Air Quality Monitoring is being conducted at six selected locations in Core & Buffer Zone. Monitoring is carried out during Summer, Post-monsoon & Winter Season. Monitoring parameters are Particulate Matter-PM10, Particulate Matter-PM2.5, Sulphur Dioxide (SO<sub>2</sub>) and Oxides of Nitrogen (NO<sub>x</sub>) & Carbon Monoxide (CO). In addition, parameters like Ozone (O<sub>3</sub>), Lead (Pb), Arsenic (As) and Nickel (Ni) are also being analyzed in the ambient air as per "National Ambient Air Quality Standards, CPCB notification, New Delhi, the 1st November- 2009."

### Ambient Air Quality Monitoring Stations:

Station No.	Identification	Location
1	AAQ-1	Near Electric Sub- Station (Inside MMC)
3	AAQ-3	Near Canteen
5	AAQ-5	Near Purunapani Village
6	AAQ-6	Near OMC Labour Colony Kallapani
7	AAQ-7	Near Saruabil Village
8	AAQ-8	Near Goramlan Village

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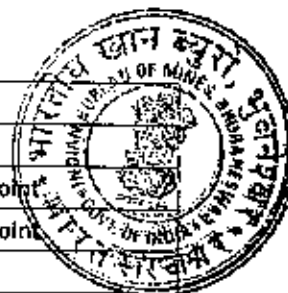
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**Ambient Air Quality - Fugitive Emission Monitoring Stations:**

Station No.	Identification	Location
1	AAQF-2	Near Mines Working Loading Point
2	AAQF-3	Near Over Burden Dump Un-loading Point
3	AAQF-4	Near Stack Yard Loading/Un-loading point
4	AAQF-5	Near Screening Plant

**Ambient Air Quality - Dust Fall Monitoring Stations:**

Station No.	Identification	Location
1	AAQD-1	Near Electric Sub Station (Insides Mines)
2	AAQD-2	Near Screening Plant
3	AAQD-3	Near Canteen
4	AAQD-4	Kaliapani Village (Near Hutting No. 5)

For base line information on ambient air quality, please refer Annual Report on Environmental Parameters monitoring for the year 2013-14. (Annexure: 20)

**Ambient noise level**

The Ambient Noise Monitoring within the Core & Buffer zone area are monitored at fifteen sampling stations covering the mining leasehold and residential areas. Measurements are taken, during daytime and night time at each of the locations during the four seasons.

**Noise Monitoring Stations**

Station No.	Identification	Location
1	N-1	Mines Bench (197 mRL)-MMC
2	N-2	Dump Area-MMC
3	N-3	Site office of Mahagiri Mines
4	N-4	Stack Yard of Mahagiri Mines
5	N-5	Near Kallapani Village
6	N-6	Near Chingudipal Mines Office
7	N-7	Near Goramlan Village
8	N-8	Near OMC Colony
9	N-9	Near Saruabli Village
10	N-10	Near Ostia Village
11	N-11	Near Purunapani Village
12	N-12	Near Kusumundla Village
13	N-13	Near Kampulei Village
14	N-14	In front of Mines office -SMC
15	N-15	Near Mines Main Gate-SMC

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## Flora

On the basis of the land use pattern and vegetation types the buffer zone can be divided under the following categories:

### *Agricultural Land*

The agricultural land in the buffer zone covers 21.96% of the area, out of which 6.02% is irrigated. Paddy is the main crop of the region. Besides pulses, cereals, mustard, ground nut etc. are also cultivated. Seasonal vegetables are grown in the household lands.

### *Waste land*

The waste land (culturable), which does not give economic return, is uncultivated, uninhabited land and barren rocky land lacking in moisture (mainly on steep slopes) covers an area of 5.29% in the buffer zone. In this waste land where soil is not sufficient for development of vegetation.

### *Grass land*

Patches of grass lands are commonly found in forest and non-forest areas in the buffer zone of the valley. These grass lands are dominant at human settlements, foot hills of forest land and road sides. Bushy lands are common in the study area. They are mostly in forests (Mahagiri and Daitary) and their immediate surroundings. Bushes are also at non forest places.

### *Forest Land (Area under rich vegetation cover)*

In general the characteristic nature of the forest of this region is tropical deciduous and covers about 64.54% of the buffer zone. The forest is rich in flora species. The Mahagiri protected forest area continues from South South East (SSE) to South East (SE) of the lease area.

## **Climatic conditions**

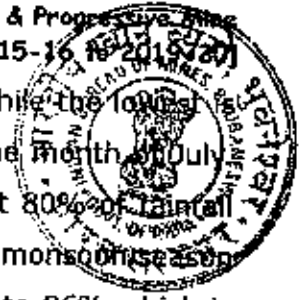
The climate of this region is mainly tropical type and is influenced to some extent by the conditions in the Bay of Bengal. South west monsoon season starts from June and extends upto October with total average annual rainfall of 1600 mm, out of which about 80% of the rainfall can be observed in the monsoon season only. The summer is severe during May-June with temperature as high as ~46°C. A pleasant winter prevails from December to January. The minimum temperature recorded during December is 7.6°C. The relative humidity varies from 56% in January to 86% in August.

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The maximum temperature is recorded in the month of May while the lowest is observed during December. Maximum rainfall is observed in the month of July. November and December are the lowest rainfall months. About 80% of rainfall takes place during a 5 month period of June to October. During monsoon season in the month of August, the average relative humidity goes upto 86% which is highest in comparison with other months. During winter, in the month of January, it comes down to 56%.

#### **Human settlements**

The lease hold area is situated in one of the backward regions of the country where most of the inhabitants are of Scheduled Caste and Scheduled Tribe categories. The major scheduled tribes are Munda, Majhi, etc. However, the Scheduled Caste communities are Pana, Hadi, Dama, etc. These two communities together constitutes approximately 55% of the total population of the Tahasil. The main occupation of this locality is agriculture. Other than this, a large number of people are employed as labourers directly and/or indirectly in various mining companies.

Transport facilities have been improved. Buses are plying up to Bhadrak, Keonjhar, Jajpur, Cuttack and Bhubaneswar from this area. Marketing facilities have been improved as a number of shops have been developed in this locality.

Due to progress of mining activities, the postal and tele-communication links have also been developed. The income of the local has increased due to the employment in mining, contractor-ship, supply of mining materials to the mines, in marketing of locally produced vegetables, fish, poultry, rice etc.

#### **Public buildings, places of worship and monuments**

There are no public building or places of archaeological / tourist / religious importance within the lease area. Among the historical places, Biraja Mandir at Jajpur, Mahabinayak Temple at Chandikhol and Lalitgiri cave are located at distances of 110 km, 70 km and 90 km, respectively.

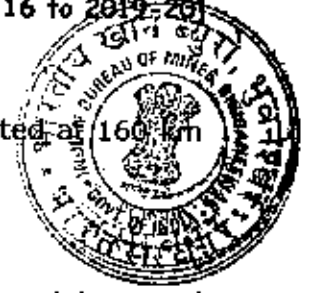
There are a number of amenities in the buffer zone. Some rural Health and Medical facilities, primary schools, middle schools, secondary schools, senior secondary schools and graduate collage along with bust stop, power supply, post office and telephone line are there.

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**Any sanctuary in the vicinity of leasehold**

Nearest zoo is at Bhubaneswar and Birds Sanctuary at Chilika, situated at 160 km and 320km, respectively.

**8.2 Impact Assessment:**

Environmental Impact Assessment describing the impact of mining and beneficiation on environment is described below:

i) Land use pattern indicating the area likely to be degraded due to quarrying, dumping, roads, workshop, processing plant, tailing pond/dam, township etc during the scheme period.

Land use	At present in Ha (as on 01.10.2014)			By the end of scheme period 2019-20 (in Ha)			By the end of conceptual period (in Ha)		
	Non forest	Forest	Total	Non forest	Forest	Total	Non forest	Forest	Total
Area under mining /quarrying	0.000	8.810	8.810	0.000	9.600	8.760	0.000	0.000	0.000
Waste dump	4.700	0.000	4.700	4.700	0.000	4.700	0.000	0.000	0.000
Mineral storage	0.000	4.600	4.600	0.000	13.480	13.480	0.000	0.000	0.000
Infrastructure	0.000	3.990	3.990	0.000	8.550	8.550	0.000	8.550	8.550
Roads	0.240	2.500	2.740	1.140	1.720	2.860	1.140	1.720	2.860
Subsidence Pillar	0.000	0.610	0.610	0.000	0.610	0.610	0.000	0.610	0.610
Storage of Top Soil	0.000	0.250	0.250	0.000	0.250	0.250	0.000	0.000	0.000
Safety zone	0.610	2.470	3.080	0.610	2.470	3.080	0.610	2.470	3.080
Others undisturbed	1.847	43.150	45.000	0.947	29.700	30.650	5.647	53.030	58.680
<b>Total</b>	<b>7.397</b>	<b>66.380</b>	<b>73.777</b>	<b>7.397</b>	<b>66.380</b>	<b>73.777</b>	<b>7.397</b>	<b>66.380</b>	<b>73.777</b>

**ii) Air quality**

All the surface mining projects have negative impact on the ambient air quality if proper precautions are not taken before hand.

The proposed increase in production may increase the generation of pollutants like PM10, PM2.5, SO2 and NOx from the existing levels which are generally below the limits specified for "Residential and Rural use areas". Source of particulate matter in open cast mine is due to excavation, transportation, and operation of HEMM and DG sets also contribute to air pollution. As the scale of opencast working will reduce therefore air pollution due to opencast working will also reduce. No impact on air quality is envisaged due to the underground mining activities. The winding engine will be electrically operated and will not cause any emissions.

  
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Operations that may add to the load of air pollution in the area are:

- Operation of diesel based equipment and the D.G. sets
- Removal of vegetation and soil
- Handling of the mineral and waste material
- Transport of the ore & waste material.
- Material handling at the pit top (shaft mouth)

Following air pollution control measures will be strictly followed to maintain the emissions to the minimum level.

#### **Drilling Operation**

Dust emanated during drilling operation will be reduced by taking the following measures:

Proper maintenance of drill bits.

Sprinkling of water before and after drilling in dry seasons.

Dust generation will also be reduced by using sharp drill bits for drilling holes and drills with water flushing system.

Drill operators will be provided with dust mask, if necessary.

#### **Blasting Operation**

Generation of dust during blasting will be minimised by taking the following measures:

Proper burden and spacing of blast hole

Proper charge per delay.

Blasting will be done during shift change time when minimum number of persons is present around the blast area.

#### **Loading and transportation**

The following measures will be adopted:

Overloading of vehicles will be avoided to avoid spillage

Continuous cleaning of hauls roads by dozer and graders.

Regular maintenance of Heavy Earth Moving Machinery engines to control emission of exhaust fumes.

Water sprinkling during loading and unloading of excavated materials.

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**Dumping**

The volume of dust raised from dump areas, by action of wind will be significantly reduced by planting of grasses and creeper species on the dumps.

**Haul Road**

Haul roads are the major sources of dust in the mine. The following actions will be taken up :

The present practice of construction of haul roads with the layers of hard stones overlaid by laterite fines and subsequently compacted by road rollers will be continued.

Practice of water spraying on haul roads will be continued.

**Ore Stack Yard**

Present practice of water sprinkling daily in ore stack yards to bring down the air borne dust will be continued. Peripheral plantation around the stack yard will also be taken up to arrest the air borne dust, if any.

**iii) Water Regime & Water quality**  
**Ground water**

As the other adjacent mines in the valley are under operation for over many years and the nearest ground water has not been contaminated, It is not anticipated to pollute the groundwater in future. However, it may be mentioned that Mahagiri Pit bottom is farther from any ground water wells than other mines and also the proposed pit bottom (+185 m AMSL) is at considerably higher level from the water table, it is not anticipated to cause any adverse impact on ground water quality.

**Surface water**

The object is to regulate surface water of the mining area so as to cause minimum contamination and alteration in drainage system. The topographical features of the lease area are such that water flows away from the mining area. Development of waste dumps and quarry interfere with the natural course of the streams flowing down the area in rainy season but does not have any impact on the existing drainage system because of provision of drains all around the dump, quarry and mineral stack yard, which will guide the water to accumulate in a settling tank

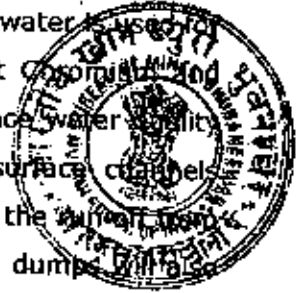
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provided within the lease area. After settlement of sediments the clean water is used for industrial purpose. The water analysis has been done for hexavalent chromium. It is found that the water did not contain Hexavalent chromium. The surface water quality may, however, be deteriorated due to Cr+6 contamination in the surface channels (Damsal nala) if the collected mine sump water during rains as well as the surface water from OB and ore stacks is discharged without treatment. The wash off from dumps contribute suspended particulate and silt to the surrounding natural water drainage channels if appropriate control measures are not adopted.



### **Control measures for water pollution**

The entire area is underlain by chromite ore. Under mining operation, the effluents have been proposed to be treated to reduce hexavalent chromium. Therefore, mining activity will not cause any additional increase in hexavalent chromium concentration in the water. The object is to regulate the surface water of the mining area in such a manner so as to cause minimum contamination and alteration of drainage system. Present topographical feature of the mining area is such that water (mostly precipitated water) flows away from the mining area. Development of existing dumps and quarries in future will interfere with the natural course of the streams flowing down the area but will have no impact on the existing drainage system because of provision of drains all around the dumps and quarries to guide the water down to join the natural water courses again (out-side the lease area).

The rainwater accumulated in the mine pit during monsoon and the run-off from the surface dumps will have to be treated before discharging in to the surface drains.

The mine water discharge will be pumped to a settling pond at surface for settling. As the sump water will contain Cr+6 of higher concentration than permitted under the law, the water from this reservoir will be passed through a treatment plant established in adjoining Sukinda Mine (Chromite) of same lessee. The treated water will be having all parameters within permissible limits and will be re-circulated for industrial use. The excess water after industrial use, if any, will be discharged to the natural surface water channels.

### **System Description of ETP in adjoining Sukinda Mines (Chromite)**

Capacity of ETP : 360 KI/Hr.

Treatment Concept: Clariflocculation followed by polishing treatment.

Effluents from mines is pumped at controlled rate to Flash Mixing Tank where reducing agent (Fe SO<sub>4</sub>) is dosed along with polyelectrolyte through metering type dosers. The content is then allowed into High Rate Reactivator Type Clarifier, which reduces

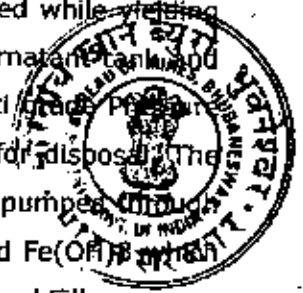
  
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consumption of reagents and can tolerate fluctuation in turbidity of feed while yielding consistent output quality. The clarifier supernatant is collected in supernatant tank. After on-line adjustment of pH using NaOH, it is pumped through Multi-Stage Pressure Sand Filter. The output from the filter is of reusable quality or safe for disposal. The sludge from the clarifier is continuously withdrawn in sludge sump and pumped through Filter Press for dewatering. The dewatered cakes contains  $\text{Cr}(\text{OH})_3$  and  $\text{Fe}(\text{OH})_3$  which could either be reprocessed or disposed off through Hazardous Waste Land Fill.



The following measures for prevention of water pollution as being practiced presently will be continued:

- Storage of oil/grease in leak proof containers
- Underground impervious drains for sewage waste.
- Periodical Water quality monitoring.
- Proper garland drains around excavation and toe drains around the dumps.
- Regular de-siltation of drains
- Provision of peripheral bunds and check dams to arrest silt from washing off.
- Treatment Process for Hexavalent Chromium

As the opencast mining activities will remain above the water table, the ground water will not be contaminated due to this mine. The underground mining will cut the water table and there are chances of ground water contamination due to underground mining activities. Water from the underground mine will be collected in a sump constructed underground in a dip location for settling and the water will be pumped to a surface reservoir for treatment to avoid groundwater contamination.

#### iv) Noise levels

The ambient noise levels are much below the limits specified for adverse impacts even with 8 hour exposure under occupational health and safety. With implementation of the project, ambient noise level is likely to increase slightly. Impact on the workforce can affect the hearing of those deployed close to the machines which generate high level of noise. Machines like drills, jack hammers, dumpers, LHD, LPDT, blasting etc. generate high noise levels upto 100 dB(A). Exposure to such high level of noise can create health problems. The activities, in case no environmental management measures are taken, can cause severe impacts on the health of the workforce. No adverse impact on surrounding population is anticipated as there is no habitation within 500m distance beyond which any noise level attenuates to background levels.

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The following measures are being practiced at the mine site and will continue to keep the noise levels within the permissible limits.

- Provision and maintenance of thick tree belts to screen noise.
- Proper maintenance of noise generating machinery including transportation vehicles.
- Ear muffs for operators of high noise generating equipment like drills.
- Provision of air silencers to modulate the noise generated by the machines.
- Provision of protective devices like ear muffs/ear plugs to those workers who can not be isolated from the source noise.
- Reducing the exposure time of workers to high noise levels.

#### v) Vibration levels (due to blasting)

Ground vibration study was conducted by the Indian School of Mines in the month of December 2002 in adjacent Sukinda Chromite Mine. The vibration due to blasting can cause damage to nearby structures if appropriate control measures are not adopted. No

adverse impacts are anticipated if recommendations mentioned in management plan are adopted. Therefore, the recommendations given shall be strictly adhered to at Mahagiri Mines (Chromite) also.

#### vi) Water regime

Described in detail earlier.

#### vii) Acid mine drainage

Opencast mines will be at (+) 185 mRL. General ground level in the area is at (+) 110 mRL and ground water exists 6-7 m below the general ground level. The possible source of contamination of ground water exists in the lease hold area is mineral stack yard. Chromite ore is hard, tough, weather resistant. The quality of affluent water, ground water, mine pumped out water indicates that the ore can not be leached. The pH of water is about 6. The water is free of sulphuric acid. There is no other element in the ore, which can be contaminated in water. Hence, the scope of contamination of ground water does not arise. The analysis of ground water samples indicate that all the parameters are within the prescribed limit and hence taking up of corrective measures for maintaining ground water quality is not warranted.

  
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For surface runoff or discharge water, there is an ETP in the Sukinda Mines (Chromite) of same lessee adjacent to this mine. In case discharged water is found to contain Hexavalent Chromium, the same shall be treated in this ETP before final discharge outside lease. Contamination of ground water due to infiltration of leached water from dumps, if any, will be checked by developing a good drainage system over the overburden dumps and green cover.

#### viii) Surface subsidence

The scope of subsidence due to underground mining will not be there since void due to open stopping remain stable due to post filling. When void is stable the question of subsidence does not arise. The stability of void shall be monitored through instrumental monitoring like load cell, tape extensometer, bore hole extensometer. Subsidence survey shall be done at regular interval.

#### vii) Socio-economics

No habitation falls within ML area, hence rehabilitation of population is not involved.

The mine is already working. There will be only increase in production from the mine. This will cause an increase in material handling and the transportation activities. The service sector will raise employment of local people in ancillary activities. The mining activities have already benefited the local people in the following ways :

Better economic status of the community.

Faster industrial development of the area.

Higher inputs in the area towards infrastructural facilities provided for better access to markets, health care, education, communication etc.

Apart from introducing systematic, scientific and environment friendly mining and generating employment, CSR activities in following areas will be taken up for upliftment of socio-economic conditions of the nearby villagers:-

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- Health
- Education
- Roads Development
- Drinking Water Facility
- Cultural and Recreational Activities
- Afforestation and Environment
- Vocational training
- Employment
- Sanitation system survey and improvement

#### viii) Historical monuments etc.

There is no historical monuments within the buffer zone of the lease hold area. However, the mining lease hold area of Mahagiri Mines (Chromite Mines) is falling within the seismic zone II, adverse impact is not anticipated.

#### 8.3 Progressive reclamation Plan :

To mitigate the impacts and ameliorate the condition, year wise proposals for following items are described separately for 5 years period.

##### 8.3.1. Mined-Out Land:

Year	Mined out area at start of year (Ha)	Additional area proposed during the year (Ha)	Total area (Ha)	Area to be Reclaimed during the year (Ha)	Area to be Rehabilitated by plantation during the year (Ha)
2015-16	8.81	0.26	9.07	0.470	8.6
2016-17	8.6	0.25	8.85	0.100	8.75
2017-18	8.75	0.28	9.03	0.140	8.89
2018-19	8.89	-	8.89	0.100	8.79
2019-20	8.79	-	8.79	0.1	8.69

##### 8.3.2 Topsoil Management:

Since no topsoil is available within the ML area, those are being procured from outside source for plantation and this system will be continued through out the life of the mine.

##### 8.3.3 Tailings Dam Management:

There is no mineral beneficiation plant inside the lease. So no tail dam is proposed.

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**8.3.4 Acid mine drainage:**

Contamination of ground water due to infiltration of leached water from dumps, if any, will be checked by developing a good drainage system over the overburden dumps, mineral stack yard and green cover.

**8.3.5 Surface subsidence mitigation measures through backfilling of mine voids or by any other means and its monitoring mechanism.**

The scope of subsidence due to underground mining will not be there since void due to open stopping remain stable due to post filling. When void is stable the question of subsidence does not arise. The stability of void shall be monitored through instrumental monitoring like load cell, tape extensometer, bore hole extensometer. Subsidence survey shall be done at regular interval.

**Backfilling in underground mined out stopes:**

Year	Stopes to be backfilled	Backfilling volume in Lakh CuM.
2015-16		Nil
2016-17	P5, S5, P6, P4, S6 & S4	0.8
2017-18	T5, P3, P7, T4, S3, P8, P9 & T6	0.9
2018-19	T3, S7, P10, S3, P2, T2, T7, S8, S9, P11 & P1	1
2019-20	S1, S2, S10, S11, T1, T8, T9, T10, T11, AB5, AB4, AP6, AP7, AP8, AS5, AS7 & AS6	1.9

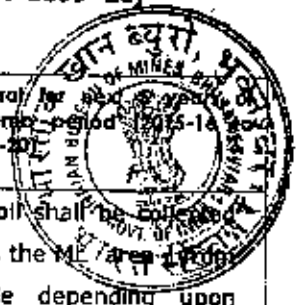
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**ENVIRONMENT MANAGEMENT PLAN**



	Proposal as per modified Scheme of Mining approved on 11.11.2011	Position at the end of four years of Mining Scheme period. 2011-12 to 2014-15 (P# 31.10.2014)	Proposal for Scheme period 2015-16 to 2019-20																																																																																						
<p><b>Topsoll storage, preservation and utilization.</b></p>	<p>Top soil shall be collected within the ML area / from outside depending upon the requirement and shall be utilised for plantation purpose.</p>	<p>No top soil generated in the plan period.</p>	<p>Top soil shall be collected within the ML area / from outside depending upon the requirement and shall be utilised for plantation purpose.</p>																																																																																						
<p><b>Land reclamation &amp; rehabilitation</b></p>	<p><b>Dump -</b> Dead end slope of the OB dump for an area of 0.20 Ha shall be reclaimed &amp; plantation to be done with about 500 saplings. Besides the above, the available spaces within the ML area shall be planted.</p> <p><b>O/C-</b> The backfilled area of 1.65 Ha of O/C shall be planted with 4125 Indigenous species to match the nearby forest line .</p> <p><b>U/G -</b> During the scheme period 0.28 LCuM void created due to U/g mining shall be suitably backfilled by cement and sand mixture.</p>	<p><b>O/C Reclamation Achievement</b></p> <table border="1"> <thead> <tr> <th>Year</th> <th>Area</th> <th>Quantity(LCuM)</th> </tr> </thead> <tbody> <tr> <td>2011-12</td> <td>0.8</td> <td>0.67</td> </tr> <tr> <td>2012-13</td> <td>0.4</td> <td>0.78</td> </tr> <tr> <td>2013-14</td> <td>1.11</td> <td>1.11</td> </tr> <tr> <td>2014-15</td> <td>1.97</td> <td>1.15</td> </tr> </tbody> </table> <p><b>O/C Rehabilitation Achievement</b></p> <table border="1"> <thead> <tr> <th>Year</th> <th>Area</th> <th>Sapling</th> </tr> </thead> <tbody> <tr> <td>2011-12</td> <td>Nil</td> <td>Nil</td> </tr> <tr> <td>2012-13</td> <td>0.11</td> <td>300</td> </tr> <tr> <td>2013-14</td> <td>0.02</td> <td>70</td> </tr> <tr> <td>2014-15</td> <td>0.2</td> <td>925</td> </tr> </tbody> </table> <p><b>Filling of Underground Stopes Achievement</b></p> <table border="1"> <thead> <tr> <th>Year</th> <th>Quantity(Lm3)</th> </tr> </thead> <tbody> <tr> <td>2011-12</td> <td>Nil</td> </tr> <tr> <td>2012-13</td> <td>Nil</td> </tr> <tr> <td>2013-14</td> <td>Nil</td> </tr> <tr> <td>2014-15</td> <td>Nil</td> </tr> </tbody> </table>	Year	Area	Quantity(LCuM)	2011-12	0.8	0.67	2012-13	0.4	0.78	2013-14	1.11	1.11	2014-15	1.97	1.15	Year	Area	Sapling	2011-12	Nil	Nil	2012-13	0.11	300	2013-14	0.02	70	2014-15	0.2	925	Year	Quantity(Lm3)	2011-12	Nil	2012-13	Nil	2013-14	Nil	2014-15	Nil	<p><b>Reclamation:</b></p> <p><b>Mined out area of Opencast Working:</b></p> <table border="1"> <thead> <tr> <th>Year</th> <th>Area (Hact)</th> <th>Qty (LCuM)</th> </tr> </thead> <tbody> <tr> <td>2015-16</td> <td>1.05</td> <td>1.425</td> </tr> <tr> <td>2016-17</td> <td>0.08</td> <td>1.365</td> </tr> <tr> <td>2017-18</td> <td>0.23</td> <td>0.931</td> </tr> <tr> <td>2018-19</td> <td>0.11</td> <td>0.272</td> </tr> <tr> <td>2019-20</td> <td>0.23</td> <td>0.257</td> </tr> </tbody> </table> <p><b>Filling of Underground Stopes Qty (LCuM)</b></p> <table border="1"> <tbody> <tr> <td>2015-16</td> <td>Nil</td> </tr> <tr> <td>2016-17</td> <td>0.8</td> </tr> <tr> <td>2017-18</td> <td>0.9</td> </tr> <tr> <td>2018-19</td> <td>1.0</td> </tr> <tr> <td>2019-20</td> <td>1.9</td> </tr> </tbody> </table> <p><b>Rehabilitation:</b></p> <p><b>Mined out area of Opencast Working:</b></p> <table border="1"> <thead> <tr> <th>Year</th> <th>Area (Hact)</th> <th>Nos</th> </tr> </thead> <tbody> <tr> <td>2015-16</td> <td>0.16</td> <td>400</td> </tr> <tr> <td>2016-17</td> <td>0.10</td> <td>250</td> </tr> <tr> <td>2017-18</td> <td>0.14</td> <td>350</td> </tr> <tr> <td>2018-19</td> <td>0.10</td> <td>250</td> </tr> <tr> <td>2019-20</td> <td>0.10</td> <td>250</td> </tr> </tbody> </table>	Year	Area (Hact)	Qty (LCuM)	2015-16	1.05	1.425	2016-17	0.08	1.365	2017-18	0.23	0.931	2018-19	0.11	0.272	2019-20	0.23	0.257	2015-16	Nil	2016-17	0.8	2017-18	0.9	2018-19	1.0	2019-20	1.9	Year	Area (Hact)	Nos	2015-16	0.16	400	2016-17	0.10	250	2017-18	0.14	350	2018-19	0.10	250	2019-20	0.10	250
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Salient items to be covered.	Proposal as per modified Scheme of Mining approved on 11.11.2011	Position of the end of four years of Mining Scheme period. 2011-12 to 2014-15 ( till 31.10.2014)	Proposal for next years of Scheme period 2015-16 to 2018-19																														
<b>Waste dump management</b>	Afforestation over dead end slope of OB dump shall be completed. Regular cleaning of garland drain shall be done. Out of balance 786 m retaining wall, it is proposed to construct during 2011-12 and 2012-13.	<b>Afforestation on dump -</b> <b>Achievement</b> 2011-12 - 207 2012-13 - 421 2013-14 - Nil 2014-15 - Nil.  Justification for any deviation is given in Chapter No-2	There will be no dumping of overburden on existing dump yard during the scheme period. Plantation over dead ends have completed. So, there is no proposal for plantation over waste dump.																														
<b>Afforestation programme with precaution proposed for survival and protection of plantation</b>	<b>Dump-</b> It is proposed to plant 500 saplings on the dead end of dump slopes. <b>O/C-</b> On the back filled area it was proposed to plant 4125 nos of plant over an area of 1.65 Ha.	<b>Afforestation on dump -</b> <b>Achievement</b> 2011-12 : 207 2012-13 : 421 2013-14 : Nil 2014-15 : Nil  <b>Afforestation (Green Belt Building) -</b> <b>Achievement</b> <table border="1" data-bbox="815 1189 1070 1346"> <thead> <tr> <th>Year</th> <th>Area</th> <th>Sapling</th> </tr> </thead> <tbody> <tr> <td>2011-12:</td> <td>0.38</td> <td>925</td> </tr> <tr> <td>2012-13:</td> <td>Nil</td> <td>450</td> </tr> <tr> <td>2013-14:</td> <td>0.23</td> <td>485</td> </tr> <tr> <td>2014-15:</td> <td>Nil</td> <td>Nil</td> </tr> </tbody> </table> <b>Afforestation (Others) -</b> <b>Achievement</b> <table border="1" data-bbox="815 1447 1070 1603"> <thead> <tr> <th>Year</th> <th>Area</th> <th>Sapling</th> </tr> </thead> <tbody> <tr> <td>2011-12:</td> <td>0.42</td> <td>1020</td> </tr> <tr> <td>2012-13:</td> <td>0.6</td> <td>2059</td> </tr> <tr> <td>2013-14:</td> <td>-</td> <td>651</td> </tr> <tr> <td>2014-15:</td> <td>0.1</td> <td>700</td> </tr> </tbody> </table>	Year	Area	Sapling	2011-12:	0.38	925	2012-13:	Nil	450	2013-14:	0.23	485	2014-15:	Nil	Nil	Year	Area	Sapling	2011-12:	0.42	1020	2012-13:	0.6	2059	2013-14:	-	651	2014-15:	0.1	700	<b>Afforestation on dump -</b> No Proposal.  <b>Afforestation (Green Belt Building) -</b> No proposal  <b>Afforestation (Others) -</b> No proposal.
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Salient items to be covered.	Proposal as per modified Scheme of Mining approved on 11.11.2013	Position at the end of four years of Mining Scheme period. 2011-12 to 2014-15 (till 31.10.2014)	Proposal Scheme period 2019-20).
Quality of Air	Regular monitoring of environment shall be done for air, water, noise etc. Wherever, the prescribed norm shall increase, preventive measures shall be undertaken.	Regular environmental monitoring in every season is being done for air, water, noise etc. For suppression of dust, mobile water tanker on roads & dry fog system in screening plants are used. Control measures to keep the environmental parameters within prescribed limit is being taken on a regular basis.	Regular monitoring of environment shall be done for air, water, noise etc. Wherever, the prescribed norm shall increase, preventive measures shall be undertaken.
Quality of make up water including surface and ground water		All the runoff water during rainy season around the quarry is being directed to a sump. Water from sump is treated in ETP-4 (situated in Sukinda Mines Chromite of same lessee) and is finally discharged outside after treatment. Regular monitoring is being done.	All the runoff water during rainy season around the quarry & underground water shall be directed to a sump. Water from sump shall be treated in ETP-4 (situated in Sukinda Mines Chromite of same lessee) and shall be discharged outside after treatment. Regular monitoring as being practiced shall be followed.
Noise level		Control measures to keep the noise level within prescribed limit is being taken and is regularly monitored.	Regular monitoring of environment shall be done for noise. Wherever, the prescribed norm shall increase, preventive measures shall be undertaken.

  
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Salient items to be covered.	Proposal as per modified Scheme of Mining approved on 11.11.2011	Position at the end of four years of Mining Scheme period. 2011-12 to 2014-15 (till 31.10.2014)	Proposal for next 4 years of Scheme period (2015-16 to 2019-20)
Vibration	In U/G, delay detonator shall used to minimise vibration & recommendations of the Blast Vibration Study is to be implemented.	Use of delay detonators and recommendations of blast vibration study are being implemented.	Use of delay detonators and recommendations of blast vibration study shall be followed.
Treatment of mine water & effluent/toxic before discharge.	There is no mine water. Surface runoff & underground water are only source of water. If at any time Hexavalent Chromium is found more than permissible limit, the water shall be treated before discharge. The Same procedure shall be followed for U/G discharge also.	There is no water from the quarry. However seepage water from underground workings & rainwater that is accumulated on surface is passing through gariand drain to a settling tank. Water is treated in ETP-4 before discharge, if Hexavalent Chromium is found in it.	There is no mine water. Surface runoff & underground water are only source of water. If at any time Hexavalent Chromium is found more than permissible limit, the water shall be treated before discharge. The Same procedure shall be followed for U/G discharge also.
Recirculation of treated water	Recirculation of treated water shall be utilized for industrial use, plantation etc.	The quantum of treated water was very small. However, the said treated water was utilized in the form of water sprinkling on haul roads, plantation etc.	Recirculation of treated water shall be utilized for industrial use, plantation etc.



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**PROPOSED YEARWISE PLANTATION PROGRAMME**

Year/ Location	Area (Ha)					Plants
	Quarry	Dump	Safety Zone	Other	Total	
<b>Already done (as on 31.10.2014)</b>	0.33	1.8	1.2	4.13	7.46	20212
<b>2015-16</b>	0.16	Nil	Nil	Nil	0.16	400
<b>2016-17</b>	0.1	Nil	Nil	Nil	0.1	250
<b>2017-18</b>	0.14	Nil	Nil	Nil	0.14	350
<b>2018-19</b>	0.1	Nil	Nil	Nil	0.1	250
<b>2019-20</b>	0.1	Nil	Nil	Nil	0.1	250
<b>End of Scheme period</b>	<b>0.93</b>	<b>1.8</b>	<b>1.2</b>	<b>4.13</b>	<b>8.06</b>	<b>21712</b>

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**SUMMARY OF YEARWISE PROPOSAL FOR ITEM NO. 8.3**

ITEMS	YEAR		AREA (HECT.) Prop										QUAN. Prop.					EXPENDITURE (LAKH) Prop					REMARKS
	2015-16	2016-17	2015-16	2016-17	2017-18	2018-19	2019-20	2015-16	2016-17	2017-18	2018-19	2019-20	2015-16	2016-17	2017-18	2018-19	2019-20						
(A) RECLAMATION & REHABILITATION OF MINED OUT : LAND/AREA	(i) Backfilling, L Cum	1.05	0.08	0.23	0.11	0.11	0.11	1.43	1.37	0.93	0.27	0.26	286	274	186	54	52						
	(ii) Afforestation on the backfilled area,	0.16	0.1	0.14	0.1	0.1	0.1	400	250	330	250	250	0.8	0.5	0.7	0.5	0.5						
	(iii) Others (please specify) eg. filling of underground stopes, L Cum	NA	NA	NA	NA	NA	NA	NA	NA	0.8	0.9	1	1.9	NA	40	45	50	95					
	(iv) Pisciculture	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil				
	(v) Converting into water reservoir	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil				
	(vi) Picnic Spot	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil				
(B) STABILIZATION & REHABILITATION OF DUMPS (with lease)	(i) Terracing	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil				
	(ii) Pitching	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil				
	(iii) Construction of Parapet Walls/ Retaining wall at toe of dumps (in mbr)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil				
	(iv) Construction of Check Dams along slope of valleys etc.	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil				
	(v) Construction of Settling Ponds (Garland drain etc.)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil				
(C) REHABILITATION OF BARREN AREA WITHIN LEASE	(vi) Desilting of settling ponds, channels	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil				
	(vii) Afforestation on dumps	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil				
	(viii) Others (please specify)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil				
	(i) Afforestation (Green belt building)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil				
	(ii) Others (please specify)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil				
	(i) Ambient Air Quality	--	--	--	--	--	--	--	--	--	--	--	--	0.8	0.8	0.8	0.8	0.8	0.8				
	(ii) Water Quality	--	--	--	--	--	--	--	--	--	--	--	--	0.8	0.8	0.8	0.8	0.8	0.8				
	(iii) Noise Level Survey	--	--	--	--	--	--	--	--	--	--	--	--	0.8	0.8	0.8	0.8	0.8	0.8				
	(iv) Ground vibration	--	--	--	--	--	--	--	--	--	--	--	--	0.8	0.8	0.8	0.8	0.8	0.8				
	(v) Others (Please specify)	--	--	--	--	--	--	--	--	--	--	--	--	0.8	0.8	0.8	0.8	0.8	0.8				
<b>Total</b>																	290.8	318.5	235.7	108.5	198.5		



*M. J. Raju*  
M. J. Raju  
RQP/CAL/199/94/A

*P. Behera*  
P. Behera  
RQP/BBS/D13/99/A



#### 8.4 Disaster Management and Risk Assessment:

**Landslide:** There is no chance of slope failure in opencast mining. Slope will be maintained at less than  $30^\circ$  and the foot wall slope at less than  $30^\circ$  over the entire strike length of 600 m. Factor of safety computed by CMRI in early 2006 after carrying out strength test for cohesion, friction angle and uniaxial compressive strength is 1.21. So, there is no risk of collapse of any wall.

**Subsidence:** The scope of subsidence due to underground mining will not be there since void due to open stopping remain stable due to post filling. When void is stable the question of subsidence does not arise. The stability of void shall be monitored through instrumental monitoring like load cell, tape extensometer, bore hole extensometer. Subsidence survey shall be done at regular interval.

**Flood and Inundation:** There is no natural nala or river course or lake within the lease hold area which may create danger of inundation and flooding of mines. Damsal nala which is 3 km away towards the north east of the mines is having highest flood level of 90 mRL. So, this will not cause any danger to the mine working both for opencast and underground.

**Fire:** Sources of mine fire are likely to be from oil depot, power line, machinery, belt conveyor etc. Adequate maintenance of machinery and electrical apparatus prevent any such danger of fire. Fire extinguishers are provided in all places those are prone to fire. The underground mine is a natural wet mine and so risk of fire does not exist.

**Seismic activity:** The mine lease area falls in Seismic Zone-II. There has been any history of earth quack in the area. Resultant peak particle velocity of the ground vibration due to blasting does not exceed 10 mm/sec and therefore no danger exists on that ground.

M. J. Raju

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P. Behara

RQP/BBS/013/99/A



As far as the nature of the deposit and working methods are concerned, there will be no possibility of landslide, subsidence etc. The State of Odisha falls under seismic zone - I, II and III. Minor earthquakes have been felt many times in Odisha but none was severe. The lessee shall depend for help of nearest State fire department for rescue if any high-risk accident occurs.

If any emergency arises in the mines (Blasting, fire, inundation, cyclone etc) one shall inform security in-charge. Immediately after receiving the emergency call security will blow the emergency alarm. The key personnel of the mines will reach the site of emergency and check the area thoroughly, evaluate the situation and action will be taken accordingly.

**Responsibility of the person in case of emergency:**

**Disaster due to blasting:**

Any disaster occurs during blasting, the incharge of blasting i.e Asstant Manager will be the responsible person to intimate the mine official and to take the necessary rescue operations.

**Contact Person:** Sri Jalandhar Patra, Asst Manager, Mob No: 09937297143

**Disaster due to Fire :**

Any disaster occurs due to fire within in the lease area, it is the responsibility of the persons witnessed to inform the fire fighting station, security main gate, Mines Manager. On receipt of the information it is the responsibility of the Administrative officer to call the fire brigade and Inform the Govt authorities like District administration & Police. Security personnel will guide the fire brigade to the site of emergency. Mines Manager will rush to the spot and assess the situation, make necessary arrangements for rescue operations for the affected persons.

**Contact Person:** Sri Manoj Pati, Mines Manager, Mob No: 09937297128

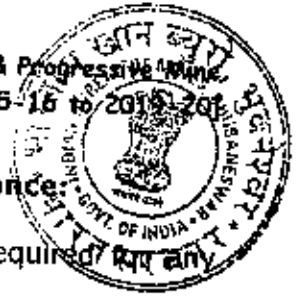
**Security Main Gate: 100 (Intercom)**

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### 8.5 Care and maintenance during temporary discontinuance.

In case, at any time temporary discontinuance of mines is required cause, the following regular monitoring will be there.

- Mining fences, gates, barricade guard, parapet wall etc shall be checked and maintained.
- Mine benches shall be ensured that no collapse or slide is taking place.
- Fire fighting devices shall be kept at sensitive places to control fire in case that occurs.
- Pumps shall be checked and maintained on regular basis so that there will be no failure in discharging water.
- Stationary machinery shall be checked and maintained.
- Electrical circuits shall be checked and maintained on regular basis.
- Vegetative materials in places such as electric sub station, magazine, stores shall be cleared and the premises kept clean.

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### 8.6 Financial assurance

The financial assurance shall be submitted in the form of letter of Credit from any schedule bank / performance or surety bond / trust fund / any other form of security / guarantees, acceptable to authorities after the actual value of guarantee required in our case is assessed and intimated by the Regional Controller of Mines, Indian Bureau of Mines, Bhubaneswar.

Sl No	Head	Area put on use at start of scheme of mining (Ha)	Additional requirement during scheme period (Ha)	Total (Ha)	Area considered as fully reclaimed & rehabilitated (Ha)	Net area considered for calculation (Ha)
1	Area under mining	8.810	0.790	9.600	0.000	9.600
2	Storage of topsoil	0.250	0.000	0.250	0.000	0.250
3	Waste Dump Site	4.700	0.000	4.700	0.000	4.700
4	Mineral storage/Sub grade (including Screening Plant & Crusher)	4.600	8.880	13.480	0.000	13.480
5	Infrastructure (Workshop, Building UG, weighbridge etc)	3.990	4.560	8.550	0.000	8.550
6	Roads	2.740	0.120	2.860	0.000	2.860
7	Railways	0.000	0.000	0.000	0.000	0.000
8	Tailing pond	0.000	0.000	0.000	0.000	0.000
9	ETP	0.000	0.000	0.000	0.000	0.000
10	Mineral Separation Plant	0.000	0.000	0.000	0.000	0.000
11	Township area	0.000	0.000	0.000	0.000	0.000
12	Others to specify					
	i. Subsidence pillar	0.610	0.000	0.610	0.000	0.610
	ii. Green belt/ Safety zone	3.080	0.000	3.080	0.000	3.080
		A	B	C=(A+B)	D	
<b>Grand total</b>		<b>28.780</b>	<b>14.350</b>	<b>43.130</b>	<b>0.000</b>	<b>43.130</b>

This being a Category "A" (Fully Mechanized) Mine, financial assurance for 43.130 Ha is calculated at the rate of Rs 25000.00 per Ha. This amounts to Rs 10,78,250/- (Rupees Ten Lakh Seventy Eight Thousand Two Hundred Fifty) only. The lessee shall submit a financial assurance in shape of Bank Guarantee for Rs. 10,78,250/- to the Regional Controller of Mines of Indian Bureau of Mines, Bhubaneswar, Odisha.

अनुमोदित  
APPROVED

*[Signature]*  
24/15

जे.जी. खान निदेशक  
REGIONAL CONTROLLER OF MINES  
भारतीय खान ब्यूरो  
INDIAN BUREAU OF MINES  
भुवनेश्वर/BHUBANESWAR

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*[Signature]*  
(C R Ray)  
Nominated Owner

*[Signature]*  
M J Redju  
RQP/CAL/199/94/A

*[Signature]*  
P Behara  
RQP/BBS/013/99/A



## PART B

### 9.0 Certificates / Undertakings/ Consents (As detailed below)

M J Raju

RQP/CAL/199/94/A

P Behara

RQP/BBS/013/99/A



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Odisha, India

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## CONSENT LETTER FROM THE APPLICANT

The Scheme of Mining in respect of Mahagiri Mines (Chromite) over an area of 73.777 Hacts in Village: Kaliapani, PO: Kalarangiatta, Dist: Jajpur, Odisha under Rule12 of MCDR 1988 has been prepared by RQPs, Sri M.J. Raju (Registration No. RQP / CAL / 199 / 94/ A, valid upto 06.07.2020) and Sri P. Behera (Registration No.RQP/BBS/013/99/A, valid upto 19.04.2021 )

This is to request the Regional Controller of Mines, Indian Bureau of Mines, Bhubaneswar, to make any further correspondence regarding any correction of the Scheme of Mining with the said recognized person at his address below

<p>Sri M.J.Raju Address: C/o: Sri N K Mishra, Dy. General Manager(Mines) Indian Metals &amp; Ferro Alloys Limited, IMFA Building, Bomikhal, Rasulgarh, Bhubaneswar - 751018, Odisha Phone:09777575711,Fax:0674-2580020, Email: mjraju@imfa.in Mobile No: 09777575711 Registration No. RQP/CAL/199/94/A Date of Grant/Renewal: 02.07.2010 Valid upto: 06.07.2020</p>	<p>Sri P. Behera Address: C/o: Sri N K Mishra, Dy. General Manager(Mines) Indian Metals &amp; Ferro Alloys Limited, IMFA Building, Bomikhal, Rasulgarh, Bhubaneswar - 751018, Odisha Phone:09937058102,Fax:0674-2580020, Email: pbehera@imfa.in Mobile No: 09937058102 Registration No. RQP/BBS/013/99/A Date of Grant/Renewal: 03.05.2011 Valid upto: 19.04.2021</p>
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We hereby undertake that all modifications / updating as made in the said Scheme of Mining by the said recognized person be deemed to have been made with our knowledge and consent and shall be acceptable on us and binding in all respects.

Place: Bhubaneswar  
Date: 19.03.2015

  
M J Raju  
RQP/CAL/199/94/A

  
Chitta Ranjan Ray  
Designation: Nominated Owner  
M/s Indian Metals & Ferro Alloys Ltd

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P Behera  
RQP/BBS/013/99/A

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## UNDERTAKING TO COMPLETE THE EXPLORATION (DRILLING) PROPOSED, IN A TIME BOUND MANNER

We do hereby undertake to complete the drill holes proposed in the scheme of mining in a time bound period.

Place: Bhubaneswar  
Date: 19.03.2015

**Chitta Ranjan Ray**

Designation: Nominated Owner

M/s Indian Metals & Ferro Alloys Ltd

M J Raju  
RQP/CAL/199/94/A

P Behera  
RQP/BBS/013/99/A

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## CERTIFICATE FROM THE APPLICANT

It is certified that the CCOM Circular No-2/2010 will be implemented and complied with when an authorized agency is approved by the State Government.

Place: Bhubaneswar

Date: 19.03.2015

**Chitta Ranjan Ray**

**Designation: Nominated Owner**

**M/s Indian Metals & Ferro Alloys Ltd**

**M J Raju**

**RQP/CAL/199/94/A**

**P Behera**

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## CERTIFICATE FROM THE APPLICANT

It is certified that the Progressive Mine Closure plan of Mahagiri Mines (Chromite) of M/s Indian Charge Chrome Limited (now merged with M/s Indian Metals & Ferro Alloys Ltd) over an area of 73.777 Hacts complies with all statutory rules, Regulations, Orders Made by the Central or State Government, Statutory organization, Court etc which have been taken into consideration and wherever any specific permission is required the lessee will approach the concerned authorities.

The information furnished in the Progressive Mine Closure plan is true and correct to the best of our knowledge and records.

Place: Bhubaneswar

Date: 19.03.2015

**Chitta Ranjan Ray**

**Designation: Nominated Owner**

**M/s Indian Metals & Ferro Alloys Ltd**

**M. J. Raju**

RQP/CAL/199/94/A

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**P Behara**

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## UNDERTAKING FROM THE APPLICANT

The provisions of Mines Act, Rules and Regulations made there under have been observed in the Scheme of Mining over an area of 73.777 hectares in Jajpur district in Odisha state belonging to Mahagiri Mines (Chromite), and where specific permissions are required, the applicant will approach the D.G.M.S. Further, standards prescribed by D.G.M.S. in respect of miners' health will be strictly implemented.

Place: Bhubaneswar  
Date: 19.03.2015

**Chitta Ranjan Ray**  
Designation: Nominated Owner  
M/s Indian Metals & Ferro Alloys Ltd

**M J Raju**  
RQP/CAL/199/94/A

**P Behera**  
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**CERTIFICATE FROM THE APPLICANT**

This is to certify that the progressive mine closure plan of Mahagiri Mines (Chromite) complies all statutory rules, regulations, orders made by the State or Central Government, Statutory organizations, Court etc. Wherever any specific permission is required, the lessee will approach the concerned authorities. The lessee also undertakes to the effect that all the measures proposed in this closure plan will be implemented in a time bound manner.

**Place: Bhubaneswar****Date: 19.03.2015**
**Chitta Ranjan Ray****Designation: Nominated Owner****M/s Indian Metals & Ferro Alloys Ltd**
**M J Raju****RQP/CAL/199/94/A**

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**P Behera****RQP/BBS/013/99/A**



### CERTIFICATE FROM RQP

The provisions of the Mineral Conservation and Development Rules 1988 have been observed in the preparation of the Scheme of Mining for Mahagiri Mines (Chromite) over an area of 73.777 Hacts, of M/s Indian Charge Chrome Limited (now merged with M/s Indian Metals & Ferro Alloys Ltd, in Village: Kaliapani, P.O: Kalaranglatta, District: Jajpur of Odisha State and whenever specific permissions are required, the applicant will approach the concerned authorities of Indian Bureau of Mines.

The information furnished in the Scheme of Mining is true and correct to the best of our knowledge.

Place: Bhubaneswar  
Date: 19.03.2015

**M J Raju**  
Recognised Person  
Regd No: RQP/CAL/199/94/A

Place: Bhubaneswar  
Date: 19.03.2015

**P Behera**  
Recognised Person  
Regd No: RQP/BBS/013/99/A

**M J Raju**  
RQP/CAL/199/94/A

**P Behera**  
RQP/BBS/013/99/A