MINING SCHEME
AND
PROGRESSIVE MINE CLOSURE PLAN
OF
SARUABIL CHROMITE MINE
(DISTRICT - JAJPUR, ODISHA STATE)

MINING LEASE AREA - 610 ACRES OR 246.858Ha
DATE OF EXPIRY - 14.05.2014
3rd RML applied on - 10.05.2012
3rd RML applied period - 20 years w.e.f. 15.05.2014
3rd RML applied area - 246.858 ha
CATEGORY OF MINE - Group -A (fully Mechanized)
TYPE OF LAND - Forest & NON-FOREST Area.
SUBMITTED UNDER - Rule 12 of MCDR,1988

LAND PATTERN OF THE LEASE AREA (HA)

DETAILS	FOREST (HA)	NON FOREST (HA)	TOTAL AREA (HA)
M. L. AREA	224.633	22.225	246.858

(PERIOD OF MINING SCHEME – 15/05/2014 TO 31/03/2019)

LESSEE

M/S MISRILALL MINES PRIVATE LIMITED

MINERAL HOUSE

KOLKATA, West B[illegible]

[illegible]

E-mail ID- sjain@misrilall[illegible].com

VOL - I (TEXT)

Prepared by:

DR GURUPINDER SINGH JAISWAL
M.Sc, Ph.D (Geo), PGDip (Eco & Enviro), FAE(QCI)NABET
Regn. No. RQP/CAL/151/90/A, Validity - 14.02.2021
011, Vidyapati Tower, Road No. - 7, Ramnagar, Sonari - 831011, Jamshedpur,
Telefax: 0657 - 2309730, Mob- 9431161972, e-mail: gurpinder_mining@sify.com

APPROVED VIDE LETTER NO
MP/FM/OG-ORI/BHU/2014-15, dtd- 15/04/15

भारत सरकार
खान मंत्रालय
भारतीय खान ब्यूरो
क्षेत्रीय खान नियंत्रक का कार्यालय

No. MP/FM/06-ORI/BHU/2014-15 /191

महानदी कोलफील्ड, दूसरी मंजिल
[illegible]
[illegible]
दिनांक / Date: 15.04.2015

To

M/s Misrillal Mines Pvt ltd,
Mineral house, Camac street,
Kolkata-700016
West Bengal.

Sub: Approval of Mining Scheme along with progressive mine closure plan of Saruabil Chromite Mine over 246.858 ha under Rule 12 & 23B of MCDR 1988 of M/s Mirrilal Mines Pvt Ltd in Jajpur district of Odisha.

Ref: (1) Your letter No. Nil, dated Nil.
(2) This office letter of even no dated 20.05.2014.
(3) Your letter No. Nil, dated 09.09.2014.
(4) Your letter No. SCM/MMPL/IBM/2014, dated 26.09.2014.
(5) This office letter of even no dated 18.11.2014.
(6) This office letter of even no dated 10.12.2014.
(7) Your letter No. Nil, dated 19.12.2014.
(8) Your letter No. MMPL(MMPL)/IBM/Mining Plan/15, dated 09.02.2015.
(9) Your letter No. Nil, dated 10.03.2015.

Sir,

In exercise of the power conferred by Sub-rule (4) of Rule-12 of Mineral Conservation & Development Rules, 1988, I hereby APPROVE the Scheme of Mining including Progressive Mine Closure Plan of Saruabil Chromite Mine over 246.858 ha of M/s Misrilal Mines Pvt Ltd in Jajpur district of Odisha State submitted under rule12 of MCDR, 1988. This approval is subject to the following conditions:

i. The Scheme of mining is approved without prejudice to any other law applicable to the mine area from time to time whether made by the Central Government, State Government or any other authority and without prejudice to any order or direction from any court of competent jurisdiction.

ii. The proposals shown on the plates and/or given in the document is based on the lease map /sketch submitted by the applicant/ lessee and is applicable from the date of approval.

iii. It is clarified that the approval of aforesaid Scheme of Mining does not in any way imply the approval of the Government in terms of any other provision of Mines & Minerals (Development & Regulation) Act, 1957, or the Mineral Concession Rules, 1960 and any other laws including Forest (Conservation) Act, 1980, Environment (Protection) Act, 1986 or the rules made there under, Mines Act, 1952 and Rule & Regulations made there under.

iv. Indian Bureau of mines has not undertaken verification of the mining lease boundary on the ground and does not undertake any responsibility regarding correctness of the boundaries of the leasehold shown on the ground with reference to lease map & other plans furnished by the applicant / lessee.

v. At any stage, if it is observed that the information furnished, data incorporated in the document are incorrect or misrepresent facts, the approval of the document shall be revoked with immediate effect.

vi. If this approval conflicts with any other law or court order/ Direction under any statute, it shall be revoked immediately.

vii. Validity of this document shall expire on the day, as per the provision of MMDR Amendment Act 2015, dated-26.03.2015.

viii. Next Financial Assurance shall be due for submission on 31.03.2019.

Encl: - One copy of the approved document.

(M BISWAS)
क्षेत्रीय खान नियंत्रक / Regional controller of Mines

Copy for kind information to:

1. Dr Gurpinder Singh Jaiswal, RQP,044, Vidyapati Tower, Road No-7, Ramnagar,P.O-Sonari-831011, Jamshedpur, Dist- Singhbhum(East)
2. The Director of Mines, Directorate of Mines, Government of Odisha, Heads of the Department Building, New Capital, Bhubaneswar- 751 001 Odisha along with one copy of approved document **by REGISTERED PARCEL.**

(M BISWAS)
क्षेत्रीय खान नियंत्रक / Regional controller of Mines

N.O.O.
Copy for kind information to:

4. The Controller of Mines (CZ), IBM, Nagpur – 440 102.
5. Concerned MCDR file.

(M BISWAS)
क्षेत्रीय खान नियंत्रक / Regional controller of Mines

SUBMITTED

TO

THE REGIONAL CONTROLLER OF MINES

INDIAN BUREAU OF MINES
MAHANI COMPLEX, 2ND FLOOR,
308 DISTRICT CENTRE A,
CHANDRASHEKHARPUR,
BHUBANESHWAR - 751016

(Dr. G. S. Jaiswal)
IQP /CAL /151 /99 /A.

MISRILALL MINES PRIVATE LIMITED

MINE OWNERS & EXPORTERS

CONSENT LETTER FROM APPLICANT

The Scheme of Mining and Progressive Mine Closure Plan in respect of Saruabil Chromite Mine of M/s Misrilall Mines Pvt. Ltd., over an area of 246.856 hectares, Dist. Jajpur, State Odisha, Mineral Chromite has been prepared by Dr. Gurupinder Singh Jaiswal, Registration No. RQP/CAL/151/90/A.

We request Regional Controller of Mines, Bhubaneswar, to make further correspondence regarding modification of the Scheme of Mining with the said recognized person on his following address:

Dr. GURUPINDER SINGH JAISWAL
011, Vidyapati Tower,
Road No. – 7, Ramnagar,
P.O. – Sonari - 831011
JAMSHEDPUR
DIST:- SINGHBHUM (EAST)

We hereby undertake that all the information so made in the Scheme of Mining and Progressive Mine Closure Plan by the recognized person be deemed to have been made with my knowledge and consent and shall be acceptable to me and binding on me in all respect.

Signature of the applicant in full : **For M/s. Misrilall Mines Pvt. Ltd.**

Name in full in block letters : SHIV KUMAR JAIN, Director

Address : Misrilall Mines Pvt. Ltd.
Mineral House,
27A, Camac Street,
Kolkata – 700016.

Phone No : 033 – 22877880 (Office)

Date :
Place : Kolkata.

(Dr. G. S. Jaiswal)
RQP /CAL /151 /90 /A.

MISRILALL MINES PRIVATE LIMITED

MINE OWNERS & EXPORTERS

Telephone : [illegible]

[illegible]
27A, [illegible]
KOLKATA-700 016

DECLARATION

The Scheme of Mining and Progressive Mine Closure Plan in respect of Saruabil Chromite Mine of M/s Misrilall Mines Pvt. Ltd., over an area of 246.858 hectares, Dist: Jajpur, State: Odisha, Mineral: Chromite has been prepared on my / our consent and approval and that I / we will abide by all the commitments made there under. In case of default, the approval of Scheme of Mining would be withdrawn.

For M/s. Misrilall Mines Pvt. Ltd.

(SHIV KUMAR JAIN)
DIRECTOR

Date :
Place : Kolkata

(Dr. G. S. Jaiswal)
RQP/CAL/151/90/A.

MISRILALL MINES PRIVATE LIMITED

MINE OWNERS & EXPORTERS

CERTIFICATE

"The Provision of Mines Act, Rule and regulations made there under have been observed in the Scheme of Mining and Progressive Mine Closure Plan in respect of Sanuabil Chromite Mines belonging to M/s Misrilall Mines Pvt. Ltd. over an area of 246.858 hectares, Dist: Jajpur, State: Odisha 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 miner's health will be strictly implemented".

For M/s. Misrilall Mines Pvt. Ltd.

(SHIV KUMAR JAIN)
DIRECTOR

Date :
Place : Kolkata

(Dr. G. S. Jaiswal)
WQP /CAL /151 /90 /A

MISRILALL MINES PRIVATE LIMITED

MINE OWNERS & EXPORTERS

CERTIFICATE

"The Progressive Mine Closure Plan in respect of Sarubil Chromite Mines belonging to M/s Misrilall Mines Pvt. Ltd. over an area of 246.858 hectares, Dist. Jajpur, State: Odisha, complies all statutory rules, regulations, orders made by the Central or State Government, Statutory Organizations, Court etc. has been taken into consideration and wherever specific permission is required the concerned authorities will be approached.

We also give an undertaking to the effect that all measures proposed in this Progressive Mine closure plan will be implemented in a time bound manner"

For M/s. Misrilall Mines Pvt. Ltd.

(SHIV KUMAR JAIN)
DIRECTOR

Date :
Place : Kolkata.

(Dr. G. S. Jaiswal)
IQP/ COAL /151 /90 (A

MISRILALL MINES PRIVATE LIMITED

MINE OWNERS & EXPORTERS

UNDERTAKING

Regarding approval of Scheme of Mining of Saruabil Chromite Mines over an area of 246.858 hectares, Dist: Jajpur, State: Odisha, of M/s Misrilall Mines Pvt. Ltd.

We do hereby undertake that

a) If there is any change in the name/address/partnership in respect to the above said mine, during the pendency of approval, the same shall be informed promptly to the IBM authority with immediate effect.

b) The boundary Pillar is being maintained in the Mining lease hold area and in future it will be maintained properly.

c) The exploration proposed shall be completed in a time bound manner.

d) We are not working with in other firms/company/organization.

For M/s. Misrilall Mines Pvt. Ltd.

Date :

Place : Kolkata.

(SHIV KUMAR JAIN)
DIRECTOR

Original

(Dr. G. S. Jaiswal)
RQP /CAL /151 /90 /A.

CERTIFICATE

"The Provision of Mines Act, Rule and regulations made there under have been observed in the Mining Plan of Saruabil Chromite Mine of M/s Misrilall Mines Pvt. Ltd., over an area of 246.858 hectares, Village – Saruabil, Dist: Jajpur, State: Odisha and where ever specific permissions are required, the applicant will approach to the Director General of Mines Safety".

"This to certify that there is no serious violation of Mines Safety Rules in this mine which may jeopardize human health and safety".

I, Dr Gurupinder Singh Jaiswal, a recognized qualified person of I.B.M., certify that all the information furnished in the Mining Plan and Progressive Mine Closure Plan are true and correct to the best of my knowledge.

Dr Gurupinder Singh Jaiswal
Regn. No. RQP/ CAL/ 151/ 90/ A.

Place : Jamshedpur.
Date : 10.01.2015

Verified
G. S. Jaiswal
RQP/CAL/151/90/A.

CERTIFICATE

This is to certify that the provisions of Mineral Conservations and Development Rules, 1988 have been observed in the Mining Plan & Progressive Mine Closure Plan of Saruabil Chromite Mine of M/s Misrilall Mines Pvt. Ltd., over an area of 246.858 hectares, Village – Saruabil, Dist: Jajpur, State: Odisha and wherever specific permission is required, the applicant/ Mine Owner will approach the concerned authorities of Indian Bureau of Mines for granting the permission.

The information furnished in the mining plan is true and correct to the best of my knowledge.

Dr Gurupinder Singh Jaiswal
Regn. No. RQP/ CAL/ 151/ 90/ A.

Place : Jamshedpur.
Date : 10.01.2015

G. S. Jaiswal
/CAL/151/90/A.

CERTIFICATE

This is to certify that the plan and section prepared for the mining plan of Saruabil Chromite Mine of M/s Misrilall Mines Pvt. Ltd., over an area of 246.858 hectares, Village – Saruabil, Dist: Jajpur, State: Odisha are on the basis of Lease Map authenticated by the state Government.

Dr. Gurupinder Singh Jaiswal
Regn. No. RQP/ CAL/ 151/ 90/ A.

Place : Jamshedpur
Date : 10.01.2015

G. S. Jaiswal
RQAL/151/90/A.

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L.D.T. Jaiswal
...CAL/161/90/A

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(R. K. Jaiswal)
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(. K. Jaiswal)
AL /151 /90 /A.

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(S. S. Jaiswal)
RQP/CAL/151/88/A

INTRODUCTION

Saruabil Chromite Mines of M/s Misrilall Mines (P) Ltd. is situated in villages Saruabil, Kamarda and Talangi in Sukinda Tahsil under Jajpur district of Odisha. The Area falls in survey of India Topo-sheet No. 73G/16 within Latitude 21°02'42.64" to 21°03'49.65" and Longitude 85°48'35.38" to 85°49'49.92" **(Refer: Plate No. 4)**.

The Mining lease was first granted to Mr Misrilall Jain on 15.05.1954 for a period of twenty years which was executed on 20.08.1959. For smooth operation of the mines, Mr. Misrilall Jain decided to form a company and a company in the name of M/s Misrilall Mines Pvt. Ltd. was incorporated on 15th June'1972. The company, which is a well reputed in the mining field for the last many years and is now managed by the Director named below:

Shri Shiv Kumar Jain - Director
MINERAL HOUSE
27A, Camac Street
Kolkata – 700 016
Tel. No.: (033) 22877880
FAX. No. (033) 22878563

अनुमोदित
APPROVED
15/9/15

History & Status of the Company:

a) M/s Misrilall Mines Pvt. Ltd. is a Private Limited Company.

b) There was Two Directors namely Shiv Kumar Jain & Ashok Kumar Jain. Copy of Memorandum & Articles of Associations of the Company is enclosed as **Annexure – 1.**

c) Late Ashok Kumar Jain who was one of the Directors of the Company and was authorized on behalf of the company to act in respect of RML application. He expired in the year 2013. Form No. 32 which has been submitted with Registrar of Company, Ministry of Corporate Affairs alongwith copy of Death Certificate in respect to the intimation in regard to death/ceasation of late A.K.Jain is enclosed as **Annexure – 2.**

d) A copy of lessee detail downloaded from Dept. of Steel & Mines, Government of Odisha showing the details and name of the nominated Owner and the contact person i.e. Shiv Kumar Jain in respect to the lease of Saruabil Chromite Mine is enclosed as **Annexure – 2.**

e) Copy of Extract of the Resolution passed in the meeting of the Board of Directors of the company on 25.04.2013, resolving that Shri Shiv Kumar Jain is nominated to act as an Occupier on behalf of the company is enclosed as **Annexure – 1.**

R. S. Jaiswal
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f) Further, Copy of Extract of the Resolution passed in the meeting of the Board of Directors of the company on 16.08.2014 authorizing Mr Shiv Kumar Jain to act and comply with the provisions of MMDR Act, 1957 and that there is no legal dispute in respect to Shri Shiv Kumar Jain is enclosed as **Annexure – 1.**

g) A copy of list of present Board of Directors of the company alongwith Form No. 32 is enclosed as **Annexure – 2**.

h) A copy of Form No MGT- 14 duly filed with Registrar of Company, Ministry of Corporate Affairs giving details of each Board of Directors in respect to their interest of their working in different Firms/Companies/Organization is enclosed as **Annexure – 2a.**

Statutory clearance:

a) Grant of Mining Lease, its Renewal and status as on date:

Grant of Mining Lease : The mining lease was granted in favour of Misrilall Jain for a period of twenty years from 15.05.1954, which was executed on 20.08.1959. For smooth operation of the mines, Mr. Misrilall Jain decided to form a company and a company in the name of M/s Misrilall Mines Pvt. Ltd. was incorporated on 15th June'1972. The lease period expired on 14.05.1974.

Grant of 1st RML : The first renewal was granted on 14.03.1974 over an area of 259 hectares for a period of 20 years wef 15.05.1974. The deed was executed on 20.08.1974. (Ref. Annexure – 3).

Grant of 2nd RML : The second renewal of mining lease for chromite over an area of 246.860 ha was granted by Joint secretary to Government, Government of Orissa vide order no.III(G)/SM-4/96-2296/SM, Bhubaneswar dated 13.07.1997 for a period of 20 years from 15.05.1994. A copy of grant order is enclosed as **Annexure – 3**. The deed was executed on 28.07.1997 over an area of 246.858 ha. Copy of the lease deed is enclosed as **Annexure – 4**.

Lessee has submitted application for 3rd RML on 10.05.2012. A copy of application for 3rd renewal in Form – J and its receipt in Form – D is annexed as **Annexure – 5.**

h) Mining Plan/Scheme of Mining:

The details of mining plan/ SoM/ Modification prepared for Saruabil Chromite Mines and approved from the IBM authority is given below:

Details of Mining Plan/Modification/ Scheme	Prepared under Rule	Period	Approved on	Approving Authority
Mining Plan	Rule 22 of MCR 1960 (Amended)	1994-95 to 1998-99.	08th May, 1995 vide letter No. 314(3)/94-MCCM(C)/MP-5	The Controller of Mines, Nagpur.
Modification in the mining plan	Rule 10 of MCDR 1988		27.01.2000 vide letter no. 314 (3)/99-MCCM (C)/MP/5	The Controller of Mines, Nagpur.
Scheme of Mining	Rule 12 of MCDR 1988	2000-01 to 2004-05.	22.10.2001 vide letter no. 314(3)2000-MCCM (C)/MP/S-6	The Controller of Mines, Nagpur.
Scheme of Mining	Rule 12 of MCDR 1988	2005-06 to 2009-10.	21.09.2005 vide letter No. 314 (3)/2004 MCCM(CZ)/S-18	The Controller of Mines, Nagpur.
Scheme of Mining	Rule 12 of MCDR 1988	2010-11 to 2014-15.	31.05.2010 vide letter no. 314(3)/2009-MCCM(CZ)/MS-50	The Controller of Mines, Nagpur.

Copy of approval letter of the last approved scheme of mining is enclosed as **Annexure – 7**.

i) Forest Clearance:

Lessee has obtained forest clearance for the entire forest area over 224.63 ha from the Ministry of Environment & Forests, Government of India vide order no. 8-100/95 FC dated 18.01.1997 from Sr. Asst. Inspector general of Environment and Forest, Paryavaran Bhavan, C.G.O. Complex, Lodi Road, New Delhi. Copy of letter of Forest Clearance is enclosed as **Annexure – 14.**

j) Environment Clearance:

MOEF has accorded Environment Clearance on 19.02.2009 vide letter no. J-11015/7/2007-IA.II (M). The Environmental Clearance has been accorded for the production capacity of 0.136 million TPA. A copy of the Environmental Clearance is enclosed as **Annexure – 15.** Since the lessee wants to enhance the production capacity from 0.136 millionTPA to 0.350 million TPA, EIA/EMP has been prepared and submitted to MOEF, New Delhi. The final presentation on the above was held and EC for production capacity of 0.350 million TPA is expected soon.

K. Jaiswal
AE (191/92) A.

e) Consent to Operate from Pollution Control Board:

Consent order for operating the mines for discharge of sewage/effluent under Section 26 of the Water (Prevention & control pollution) Act, 1974 (Central Act-6 of 1974 and under section 21 of the Air (Preservation and control of pollution) Act, 1981 (Central Act 14 of 181) is obtained from State Pollution Control Board vide letter No. 6327/IND-I-CON-220 valid up to 31.03.2014.

Table Showing the last approved Documents

Sl No	Documents	Rule No.	Letter No.	Validity
1	2nd Renewal letter of Mining Lease.	Section 8(3) of the Mines and Minerals (Regulation &Development) Act, 1957.	III(C)SM 4/96, Bhubaneswar dated 24.05.1996.	14.05.2014.
2	Last approved Mining Scheme letter	Section(12) of MCDR, 1988	314(3)/2009-MCCM(CZ)/MS-50 dated 31.05.2010	01.03.2015
3	Forest clearance letter from MOEF, Delhi	Section 2 of forest right Act, 1960	8-100/95 FC dated 16.01.1997	14.05.2014
4	Environment Clearance		J-11015/7/2007-IA.II (M) dated 19.02.2009.	14.05.2014
5	Consent to operate from OSPCB.	Section 25 of the Water (Prevention & control pollution) Act, 1974 (Central Act-6 of 1974 and under section 21 of the Air (Preservation and control of pollution) Act, 1981 (Central Act 14 of 181)	6327/IND-I-CON-220 valid up to 31.03.2014.	31.03.2014.
6	NOC from Central Ground water Board.	------	21-4(73)/SER/CGWA/2008 1300 dated 24.09.2008.	25.09.2013.

Present status of mine:

The mining operation in Saruabil Chromite mine is temporary discontinued from 05.10.2013 under the direction of Deputy Director of Mines, Jajpur, Odisha but there is no such violation under MCR, MMRD, MCDR or any other rules/Act.

Review of salient points of previous approved SoM, conditions imposed in the last approved SoM and compliance of violation pointed out:

The last scheme of mining was approved vide letter no. 314(3)/2009-MCCM(CZ)/MS-50 dated 31.05.2010 for the period from 2010-11 to 2014-15 (upto 14.05.2014). The proposal given and its achievement is given below:

(a) Exploration:

The exploration in the area was carried out by putting 23 boreholes prior to 1970. Later, in the year 1990, the lessee again drilled 5 numbers of boreholes in and around quarry 1&2 and 7. Some of these boreholes were positive showing presence of Chrome ore. During, 1961-62, an inspection was carried out by IBM officials and presence of Nickeliferous Limonite was noticed by them. It occurs on the hang-wall and foot-wall of the Chromite zone. On the basis of this detailed exploration, the presence of Nickeliferous Limonite was ascertained during 1962–1966. During this exploration, the depth of Chromite was ascertained to be up to 114m depth, on the basis of data of the boreholes. In all, total 63 numbers of boreholes were drilled by GSI. The detail of the location of these boreholes has been shown on the surface Geological Plan (Plate – 6).

The Saruabil Chromite Mine is well known for its production of high grade Chrome ore in Baitarani valley. The mine is being worked for more than 50 years and has high grade ore.

Proposal as per approved scheme of mining:

Total nine numbers of boreholes were proposed during the approved SoM to prove the continuity of along strike length & as well as down dip. The details is given below:

Year	Qty No.	location	Depth in mts.	Inclination (In degree)	No. of borehole (Core drilling)	Remark
2011-12	7	HW side along strike length.	60 65 70 60 70 65	55 60 65 70 65 70	PBH-1 PBH-2 PBH-3 PBH-4 PBH-5 PBH-6	To prove the continuity of along strike length & down dip continuity
2013-14	1/2	HW side along strike	40 to 50	60° to 75°	PBH-7 PBH-8	To prove the continuity of along

		length.			PBH-9	strike length & depth dip continuity 1...

Achievement during the scheme period

During the last approved scheme of mining 12 no. of bore hole were drilled around the quarry-7 to know the lateral extension and depth of the chromite lode. All the bore holes are inclined borehole. Five bore holes give negative result means this bore hole didn't encountered any chrome ore lode. The detail of the bore hole is given in the table- 3.1 of chapter – 3.

(b) Mine Development:

Proposal as per approved scheme of mining:

In the approved SoM, quarry nos.1/2, 4, 5, 5A&6 were proposed to be worked for the production of chrome ore. Considering the past production, present & future marketability and side by side for consumption of ore in own Ferro Chrome Plant the target of production of chrome ore during the next five years have been chalked out. Planning had been made to extent these quarries both laterally and at depth. The working RL as proposed in the scheme of mining was from 116m RL to 98m RL in quarry no. 1&2; 118 to 82 mRL in quarry no.4; 127 to 92 mRL in quarry no. 5A&6 and 156 to 140 mRL in quarry no.7.

Achievement during the scheme period

During the approved scheme period, work could not be carried out as proposed because the EC for enhanced quantity (for 3.5 million tons) could not be obtained. There was no work in quarry 1&2 and quarry – 7 during the approved Scheme period. Further, the mining operation in Saruabil Chromite mine is temporary discontinued from 05.10.2013 under the direction of Deputy Director of Mines, Jajpur, Odisha. The quarry depth as reached at the end of scheme period is given below.

Dimensions of existing Pits

Name of quarry	Length (m)	Width (m)	Depth (m)	Existing R.L. (m)	
				Top	Bottom
Q 1 & 2	320.00	178.00	29.45	143.08	113.63
Q 4	650.00	245.00	43.08	161.94	118.86
Q 5 & 5A, 6	690.00	312.00	63.42	182.22	118.80
Q 7	263.00	132.00	34.25	187.25	153.00

v) Exploitation:

Proposal as per approved scheme of mining:

The year-wise production target as proposed in the approved SoM is given in table below:

Year	Saleable Ore (M.T.)	Low grade ore from contact zone (M.T)	Low grade ore from 2nd vein (M.T.) & Qry No.7	Total production (MT)
2010-11	2,00,104.00	50,026.00	96,005.00	3,46,135.00
2011-12	2,06,556.00	51,639.00	91,700.00	3,49,895.00
2012-13	1,97,300.00	49,350.00	1,01,437.00	3,48,186.00
2013-14	2,08,561.00	51,391.00	1,00,904.00	3,57,856.00
2014-15	2,06,234.00	51,558.00	92,508.00	3,50,300.00
Total	**10,15,854.00**	**2,53,964.00**	**4,82,554.00**	**1,7,52,372.00**

Achievement during the scheme period

As stated above, during the approved scheme period, work could not be carried out as proposed because the EC for enhanced quantity (for 3.5 million tons) could not be obtained and production target was restricted within the granted EC. There was no work in quarry No.2,3 and quarry – 7 during the approved Scheme period. The year-wise production achieved during the approved scheme period is given below:

Year	Total production (MT)
2010-11	104000.00
2011-12	101850.00
2012-13	78927.81
2013-14	23150.00
2014-15	-
Total	**307927.81**

vi) Waste Management:

Proposal as per approved scheme of mining:

Waste dump:

It was proposed that the waste generated during the next five year scheme period will be dumped over dump no.2/3,6,10 and11. Keeping the lead factor within control, dumping pattern had been chalked out. Further, it was mentioned that any spoil bank, which will

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exceed 25m in height, shall be benched so that no bench exceeds 25m height and the individual slope does not exceed 37° from the horizontal. A terrace of 25m will be left along the dump to start the 2nd phase. The year-wise generation of waste proposed in the approved scheme of mining is given below:

Year	Overburden waste (cum) (Insitu)	Nickeliferous Limonite overburden (cum) (Insitu)
2010-11	934264.80	306243.20
2011-12	1162542.00	221350.00
2012-13	1228992.40	216489.80
2013-14	1854701.97	411320.00
2014-15	1932486.40	166688.00
Total	**7132987.57**	**1322091.00**

The year-wise spread and height of proposed dumping for the scheme period is given below:

O/B Dump No.	Year	Waste to be accommodated (Cum)(Loose)	Area of Spread (Hectare)	Proposed Height (m)
Dump -2/3	2010-11	3,34,178.00	1.29	25.0
	2011- 12	5,18,811.00	2.07	25.0
	2012-13	1,72,024	0.68	25.0
Dump - 6	2010-11	95359	9535.90	10
	2011-12	156098	6243.92	25
Dump - 10	2010-11	85219	8521.9	10
	2011-12	187636	6305.44	29
	2012-13	127236	5654.93	22.5
	2013-14	172123	7649.91	22.5
	2014-15	137513	6111.68	22.5
Dump -11	2010-11	8,88,019.00	35520.76	25.00
	2011-12	495000 262697	19800.60 15452.76	25.0 17.0
	2012-13	619500 719845	29500 28790.8	21 25
	2013-14	2388392	95535.68	25.0
	2014-15	2258135	90325	25.0

Nickeliferous dump

During the next five years, generation of nickeliferous limonite has been estimated as 18,19,725 cum (loose), out of this; a quantity of 1, 45,894 cum (loose) comes under the category of having nickel percentage more than 0.5. This material will be dumped over dump no. C & D. The capacity of this dump is sufficient to accommodate the above material and the dump height will be attain 10m and an additional area required for dumping nickel is 1.45ha.

Dump No. C & D

Year	Nickeliferous limonite having nickel percentage more than 0.5to be accommodated (Cum)(Loose)	Area of Spread (Hectare)	Proposed Height (m)
2010 to 2015	145894.00	14589.40	10

Justification and precautionary steps as proposed in the approved SoM

(a) The rolled down material shall be taken care of by the existing boulder wall all along the bottom periphery of the Dump No.2/3 with a catchments drain already dug in between the boulder wall and the bottom of dump to prevent any wash-off dump. Pits have also been provided along the catchments drain to arrest the solid material during the rainy season.

(b) Plantation with suitable species shall be taken up in a phased manner over slopes and foot of the dump. Shrubs and grasses shall also be planted which act as a good binding agent.

(c) In future any part of the dumps will get saturated to a height of totally e.i 50m. or partly, the topsoil shall be spread in slope and top surface of the dump for plantation. By this process, the whole dump area shall be covered with plants as a rehabilitating measure.

(d) For the survival of the plants all precautionary steps such as watering, weeding, fertilizing etc. shall be taken. In this fashion, a green area will be developed in the long run in place of a barren waste dump.

Achievement during the scheme period

Due to restriction of production target, within granted EC and temporary discontinuation of mining operation from 05.10.2013, development and production could not be achieved as proposed in approved SOM. As such, generation of waste as well as nickeliferous limonite (having more than 0.5% nickel %) was also not upto the target. The generation of waste

and nickeliferous limonite (more than 0.5% nickel %) generated during the [illegible] scheme period and present position of existing dump is given below:

Year	Overburden waste (cum) (In-situ)
2010-11	423000.00
2011-12	379000.00
2012-13	450544.00
2013-14	141113.68
2014-15	-
Total	**1393657.68**

The dimension of existing dump (waste and Nickeliferous limonite) at the end of scheme period is given below:

Dump No.	Location	Spread (m^2)	Dimension (LxB)	Height (m)
		Waste Dump		
1	Northern western part of Quarry-A	10920	168x65	12.20
2/3	South Western part of lease area	128241	493x260	45.00 (party)
A		**Amalgamated with Dump 2/3**		
B	Nothern part of Qry-B	21320	290x73	7.22
8 &9	SE part of Qry-C	26074	205x127	7.90
10	Northern part of Qry-D	17801	175x102	19.00
11	Centre of lease area	205137	620x328	36.00
		Scattered Dump		
[illegible]	East side of Qry-A	3673	100x36	1.45
[illegible]	East side of Qry-A	4661	75x64	4.27
[illegible]	North east of Qry-C	7288	134x54	2.83
[illegible]	North east of Qry-C	5790	85x68	5.02
[illegible]	South of reservoir	16707	160x104	0.72
[illegible]	SE of Qry-C	28526	600x47	0.5
[illegible]	SE of Qry-C	5558	100X55	6.06
[illegible]	SE of Qry-C	1214	55X22	2.05
[illegible]	East of reservoir	7641	100x76	1.59

Nickel Dump				
ND-A	SE of Qry-C	2423	68x35	
ND-B	SE of Qry-C	1891	43x40	
ND-C & D	Near reservoir	21629	170x127	10.0
ND-E	Western part of Qry-A	2244	65x34	7.10
SUB GRADE DUMP				
SG-1	Northern part of lease area	3939	90x44	8.0

(e) Afforestation:

Proposal as per approved scheme of mining:

In the coming five years scheme period it is proposed to grow 50,000 saplings over an area of 13.4 Ha inside the lease hold, 2.5ha outside the lease hold and over old plantation area. It is proposed to plant different local species for better ecological balance. The details of plantation proposed during the next five years is given

Year	Location	Plant Species	No. of Plants	Area covered Ha.
1st year 2010 - 11	• Dump No.2/3 slope (Eastern side slope). • Eastern side Green belt • Over old plantation area. • Village area within 5Km radious of lease boundary	Chhatiana, Neem, Karanja, Simarua, Bamboo, Teak, Kaju, Bara, Radhachuda,Amala, Jhaun, Jammun, Asan, Harida, Bahara, Mango.	• 2500 • 3250 • 2000 • 1250	1.00 1.70 — 0.50
2nd year 2011-12	• Main road side vacant area. • Northern and western side of 1st year dumping slope of dump No.11. • Over old plantation area. • Village area.	Chhatiana, Neem, Karanja, Simarua, Bamboo, Teak, Kaju, Bara, Radhachuda,Amala, Jhaun, Jammun, Asan, Harida, Bahara.	• 2500 • 4250 • 2000 • 1250	1.00 1.60 — 0.50
3rd year 2012 - 13	• Western & Northern side of 1st year & 2nd year dumping slope of dump No.2/3. • Northern side of Hurtting No.2. • Northern side Green belt • Over old plantation area. • Village area within	Chhatiana, Neem, Karanja, Simarua, Bamboo, Teak, Kaju, Bara, Radhachuda,Amala, Jhaun, Jammun, Asan, Harida, Bahara.	• 3000 • 1200 • 2550 • 2000 • 1250	1.20 0.48 1.02 0.50

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	5Km radius of lease boundary.			
4th year 2013-14	• Eastern side of 3rd year dumping slope of dump No11. • Total plantation over dump No.6. • Over old plantation area. • Village area within 5Km radius of lease boundary.	Chhatiana, Neem, Karanja, Simarua, Bamboo, Teak, Kaju, Bara, Radhachuda,Amala, Jhaun, Jammun, Asan, Harida, Bahara.	• 3250 • 3500 • 2000 • 1250	1.30 1.40 — 0.50
5th year 2014 - 15	• Slope plantation of dump No. 10. • Over old plantation area • Village area within 5Km radious of lease boundary.	Chhatiana, Neem, Karanja, Simarua, Bamboo, Teak, Kaju, Bara, Radhachuda,Amala, Jhaun, Jammun, Asan, Harida, Bahara.	• 6750 • 2000 • 1250	2.70 — 0.5
TOTAL			**50,000**	**15.9**

Achievement during the scheme period

During the approved scheme period, plantation was carried out as proposed, the detail of which is given below:

Year	No. of Plants	Survival Rate (%)
1st year (2010–11)	12010	65
2nd year (2011-12)	20018	72
3rd year (2012–13)	10115	72
4th year (2013 - 14)	10230	70
5th year (2014 – 15)	-	-
Total	**52373**	

(f) Mine Reclamation:

Proposal as per approved scheme of mining:

It was mentioned in the approved scheme of mining that during the next five years scheme period, about 13.40 hectares area (covering dead dumps, Green belt, camp, roadside) shall be rehabilitated by means of plantation. Further, as per clause 5 of part III of model form of Mining Lease Deed in Form K, under regulation 109(1) of MMR, 1961, no work shall be carried out within 50m of public road. Due to this restriction of public road near quarry 1&2, no further extension is possible on the hang wall side. Also there is no scope of development of this quarry after 5 years with the present situation. In that case, this quarry

shall be reclaimed by means of backfilling after putting a concrete mat in the floor of the quarry. On the other side, lessee shall approach to the State Government to divert the public road outside the lease area so that quarry no. 1&2 and part of qry. 4 may not be affected at ultimate depth of 80m/100m subjected to the approval by the State Government. Otherwise, efforts will be made to divert the road over the filled up area of quarry no. 1&2 with necessary permission from the appropriate authority

Achievement during the scheme period

Reclamation by backfilling of mined out area has not done because the ore body in any or part of any quarry is not exhausted. However, plantation was carried out as proposed in the approved scheme of mining.

(g) Land use pattern:

Proposal as per approved scheme of mining:

The existing and proposed land use pattern for the scheme period was given in the approved SoM which is given below:

Categories	Description of land use of mining lease area (in Ha)	
	Existing land use Pattern	At the end of five years scheme
1.Area of excavation due to quarries	40.22	47.64
2. Dump :- O/B. Dump Nickel Dump Topsoil Dump	62.02 0.20	98.31 0.20
3. Colony/ Township	21.63	21.63
4. Workshop, COB Adm. Building etc.	2.56	2.56
5. Magazine	1.13	1.13
6. Mineral storage	7.77	7.77
7. Road	6.68	6.68
8. Green belt	0.46	2.72
9. Tailing pond	-	Proposed inside the Serial no.4
10. E. T. P.	**Existing ETP area is included in item No.1**	
11. Mineral separation plant	Proposed COB plant will be inside the Sl.no.4	7.43
12.Exploration	-	1.65
13.Plantation	5.90	5.90
TOTAL	**148.57**	**196.19**

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Achievement during the scheme period

Due to restriction of production target, within granted EC and temporary discontinuation of mining operation from 05.10.2013, development and production could not be achieved as proposed in approved SOM. As such, land use pattern as proposed in the approved SoM could not be achieved. The land use pattern at the end of scheme period is given below:

Sl. No.	Category	Existing land use in Ha		
		Forest	Non-forest	Total
1	Quarry and roads	51.43	0.16	51.59
2	Dump - OB Dump Nickel Dump	59.88	7.01	66.89
3	Colony/ Township	19.61	2.73	22.34
4	COB	1.85	--Nil--	1.85
5	Magazine	1.13	--Nil--	1.13
6	Mineral storage	3.98	0.32	4.30
7	E. T. P.	Included in Quarry area		
8	Plantation area			
	a) Safety Zone	3.30	0.27	3.57
	b) Nala Barrier	2.31	0.23	2.54
	c) Road Barrier	2.78	0.54	3.32
	d) Over Dump (Already included in Dump area)	24.21	0.30	24.51
	e) Township area (Already included in township area)	0.59	Nil	0.59
Total		146.27	11.26	157.53

Specific Conditions in the Last approved Scheme of Mining:

i. This Scheme of Mining is approved without prejudice to any other laws applicable to the mine/area from time to time whether made by the Central Government, State Government or any other authority.

ii. It is clarified that this approval of the Scheme of Mining does not in any way imply the approval of the Government in terms of any other provisions of the Mines and Minerals (Development & Regulation) Act, 1957 or the Mineral Concession Rule, 1960 and any other laws including the Forest (Conservation) Act, 1980, Environment (protection) Act 1986 and the rules made there under.

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iii. It is further clarified that this approval of the Scheme of Mining is subject to the provision Forest (Conservation) Act 1980. Forest Conservation Rule 1981 and other relevant statutes order and guideline as may be applicable to the lease area from time to time.

iv. It is further clarified that the approval of Scheme of Mining is subject to the provision of the Mines Act 1952 and Rules & Regulations made there under including submission of notice of opening, appointment of manager and other statutory officials as required by the Mines Act 1952.

v. The execution of Scheme of Mining shall be subjected to vacations of prohibitory orders / notice, if any.

vi. This approval for mining operations and associated activities is restricted to the mining lease area only. The mining lease area is as shown on the statutory plans under Rule 28 of Mineral Conservation and Development Rules 1988, by the Lessee/RQP/Applicant, and Indian Bureau of Mines has not undertaken verification of the mining lease boundary on the ground.

vii. If anything is found to be concealed as required by the mines Act in the content of the Scheme of mining and the proposals for rectification has not been made the approval shall be deemed to have been withdrawn with immediate effect.

viii. This approval is given for the received proposals as applicable from this date.

ix. At any stage, if it is observed that the information furnished in the document are incorrect or misleading or wrong, the approval of the document shall be revoked with immediate effect.

x. 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, reason thereof shall be submitted before 1st July of every year to the Regional Office, IBM, Bhubaneswar.

xi. The Scheme of Mining is approved without prejudice to any order or direction from the court of competent jurisdiction.

Compliance:

i. Lessee has obtained forest clearance for the entire forest area over 224.63 ha from the Ministry of Environment & Forests, Government of India vide order no. 8-100/95 FC dated 16.01.1997 from Sr. Asst. Inspector general of Environment and Forest, Paryavaran Bhavan, C.G.O. Complex, Lodi Road, New Delhi. Copy of letter of Forest Clearance is enclosed as **Annexure – 14**. Further, forest diversion proposal has been submitted for renewal case which is under process.

ii MOEF has accorded Environment Clearance on 19.02.2009 vide letter no. J-11015/7/2007-IA.II (M). The Environmental Clearance has been accorded for the

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production capacity of 0.136 million TPA. A copy of the Environmental [illegible] enclosed as **Annexure – 15**. Further, EC for production capacity of 0.350 million TPA is expected soon.

Violation pointed out by IBM and its compliance:

Details of violation letters issued by IBM and its reply are given hereunder and copies of the same are also enclosed as **Annexure – 27.** The date of issue of violation, nature of violation and its compliance is given in tabular form as below:

Date of Issued of Violation	Nature of Violation	Date of Compliance
09.12.2010	Rule 13(1), 24(3), 33(5), 34, 33(3), 47 of MCDR, 1988	06.01.2011
18.07.2012	Rule 13(1), 42 (1)(c)(i), 23(E)(2), 29 of MCDR, 1988	20.08.2012
30.11.2012	Rule 45(7)(i) of MCDR, 1988	22.01.2013
07.02.2013	Violation cum show cause notice Rule 13(1), 42(1)(c)(i), 23(E)(2), 29 of MCDR, 1988	–
02.02.2013	Rule 13(1), 42(1)(c)(i), 23(E)(2), 29 of MCDR, 1988	01.03.2013

As mentioned above, the period of lease is about to expire on 14.05.2014, as such, a renewal application has already been filed for the same. The last approved Scheme of Mining of this mine is about to expire on 14.05.2014. As such, this Mining Plan has been prepared in all chapters including Environmental Management Plan & Progressive Mine Closure Plan and is submitted herewith, under Rule 24(A) from 15.05.2014 to 2018-19.

This Mining Plan & Progressive Mine Closure Plan has been presented in all chapters of the text and covers the guidelines for preparing the Mining Plan. This report is based on the information and data obtained from previous records, data provided by project proponent and by the field study carried out by the consultant. The text is supported by Tables, Calculations, Figures and Drawings as felt necessary. All drawings related this report have been presented in a separate folder. As the Progressive Mine Closure plan is a part of Mining Plan and shall be valid up to the year for which Mining Plan is valid, with this view the said Progressive Mine Closure Plan has been prepared along with this Mining Plan and submitted to Indian Bureau of Mines for its approval.

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1.0 GENERAL

a) Name and Address of the Applicant:

M/s MISRILALL MINES PVT. LTD.
MINERAL HOUSE
CAMAC STREET
KOLKATA - 700 016
WEST BENGAL
E-mail: sjain@misrilalljaingroup.co.in
Tel. No. (033) 22477880
FAX. No. (033) 22478563.

Name and Address of the Director

Shri Shiv Kumar Jain, Director
M/s Misrilall Mines Pvt. Ltd.
Mineral House,
Camac Street,
Kolkata - 700 016.
West Bengal
Tel. No. (033) 22477880.
FAX. No. (033) 22478563.

b) Status of the applicant:

M/s Misrilall Mines Pvt. Ltd. is one of the well-known Mine Owner of the country having Registrar Office at 27A Camac Street, Kolkata- 700016. The company is involved into mining and trading business since last few decades. The applicant Mr. Shiv Kumar Jain is a Director in the company and is successfully managing the operation of this mine. He is well known personality not only in the field of mining but also in the field of social activities. The Photo ID and address proof of the Director is enclosed as **Annexure –6.**

Besides mining and other business, lessee has been continuously engaged in CSR activities. Local People have been given priority for employment. Drinking Water and solar lights is provided in the nearby villages. Village Roads, health services and other facilities, in the surrounding areas of the leasehold have been provided by the lessee as per the Guideline by the local Administration. Games, Sports & Tournaments and cultural activities are being conducted in the surrounding area by the Mines Management in regular manner.

The lessee does not possess any lease in any state of India.

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c) Mineral(s) which are occurring in the area and which the applicant intends to mine:

Chromite.

d) Period for which the mining lease is granted/renewed/proposed to be applied:

The mining lease was granted for a period of twenty years on 15.05.1954, which was executed on 20.08.1959. For smooth operation of the mines, Misrilall Jain decided to form a company and a company in the name of M/s Misrilall Mines Pvt. Ltd. was incorporated on 15th June'1972.

The lease, after expiry of first renewal period of 20 years on 1994, was renewed for another 20 years. The second renewal of mining lease for chromite over an area of 246.860 ha was granted by Joint secretary to Government, Government of Orissa vide order no.III(G)/SM-4/96-2296/SM, Bhubaneswar dated 13.07.1997 for a period of 20 years from 15.05.1994. A copy of grant order is enclosed as **Annexure – 3.** The lease was executed on 26.07.1997 for 20 years with effect from 15.05.1994 and will expire on 14.05.2014. The Lessee has submitted the application for 3rd renewal of the lease within time. A copy of application for 3rd renewal in Form – J and its receipt in Form – D is annexed as **Annexure – 5.**

e) Name of RQP preparing the Mining Plan:

Dr Guruplnder Singh Jaiswal
Address: 011, Vidyapati Tower,
Road No. – 7, Ramnagar,
P.O. – Sonari - 831011
Dist. Singhbhum East, Jamshedpur
Regn. No. RQP/CAL/151/90/A,
Valid up to 14. 02. 2021

A copy of RQP's certificates is enclosed as **Annexure – 9.**

f) Name of prospecting agency:

The area has been prospected by GSI by putting total of 63 numbers of boreholes during 1962 – 66 and 1976 – 1982. On the basis of that it was observed that the depth of Chromite ore is up to 114m. However, during the course of operation, the lessee has also carried out exploration time to time. This exploration also proved presence of high grade Chromite in the lease hold area. The present day quarry is a result of past

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prospecting and recent exploration data. The detail is given in chapter – 3.0. All the boreholes drilled have been duly shown in Surface Plan and Surface Geological Plan.

g) Reference No. & date of consent letter from the State Government:

Grant of Mining Lease : The mining lease was granted in favour of Misrilall Jain for a period of twenty years from 15.05.1954, which was executed on 20.08.1959. For smooth operation of the mines, Mr. Misrilall Jain decided to form a company and a company in the name of M/s Misrilall Mines Pvt. Ltd. was incorporated on 15th June'1972. The lease period expired on 14.05.1974.

Grant of 1st renewal of Mining Lease : The first renewal was granted on 14.03.1974 over an area of 259 hectares for a period of 20 years wef 15.05.1974. The deed was executed on 20.08.1974. (Ref. Annexure – II).

Grant of 2nd renewal of Mining Lease : The second renewal of mining lease for chromite over an area of 246.860 ha was granted by Joint secretary to Government, Government of Orissa vide order no.III(G)/SM-4/96-2296/SM, Bhubaneswar dated 13.07.1997 for a period of 20 years from 15.05.1994. A copy of grant order is enclosed as **Annexure – 3**. The deed was executed on 26.07.1997 over an area of 246.858 ha. Copy of the lease deed is enclosed as **Annexure – 4**.

Lessee has submitted application for 3rd RML on 10.05.2012. A copy of application for 3rd renewal in Form – J and its receipt in Form – D is annexed as **Annexure – 5.**

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2.0 LOCATION AND ACCESSIBILITY

(a)	Details of area (with location map)	The mining lease of Saruabil Chromite Mine of M/s Misrilall Mines Pvt. Ltd over 246.858 Ha is located under Jajpur, District of Odisha. The location of the area is shown in Plate – 1& 2. The leasehold area falls in Forest as well as non-forest land. The area can be located on Survey of India Toposheet number - 73G/16 and bounded by latitude 21°02'42.64" to 21°03'49.65" and longitude 85°48'35.38" to 85°49'49.92". (**Ref : Key Plan - Plate No. 2**).
	District & State	Jajpur, Odisha.
	P.S.	Sukinda
	Village Khasra No./Plot No./ Block Range/ Felling Series etc.	The detailed Land Schedule has been annexed as **Annexure – 8**.
	Lease Area (Hectares)	The land pattern of the total mining lease area is as follows: Land Pattern of the Lease area (Ha) Details / Forest (Ha) / Non-Forest (Ha) / Total area (Ha) M. L. area / 224.633 / 22.225 / 246.858 An authenticated lease map is enclosed as **Plate – 3**. Further, DGPS map of the area showing co-ordinates of all points, prepared by ORSAC is enclosed as **Plate – 4**. The map provided by ORSAC showing lease area of 247.6629 ha. So, there is a variation of 0.8049 ha (0.326%) from the granted mining lease area. Lessee has informed the same to Director of Mines, a copy of which is enclosed as **Annexure – 28**.
	Whether the area is Recorded to be in forest	Out of the total lease area of 246.858 hectares, an area

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	(Please specify whether protected, reserve etc.)	of 224.633 Ha falls under Demarcated Protected Forest category which is under Cuttack Forest Division Odisha.
	Ownership/Occupancy	State Forest Department over the Forest area, whereas private owners over the tenant land.
	Existence of public road/ Railway line, if any nearby and approximate distance	The leasehold of Saruabil Chromite Mines of M/S Misrilall Mines Pvt. Ltd. is situated on Jajpur – Keonjhar road at about 55 Kms. It is all weathered road from Dubri-Tomka to Saruabil area. Paradeep port is 155 Kms from the area on Daitari-Paradeep Port Express Highway. The nearest railhead is Jajpur Road.
	Latitude & longitude	Latitude : $21^0 02' 42.64"$ to $21^0 03' 49.65"$ Longitude : $85^0 48' 35.38"$ to $85^0 49' 49.92"$.
	Land use pattern (forest, Agriculture, Grazing etc)	The land use pattern of the area under consideration here consists of Forest as well as Non-Forest land. The land use pattern mainly consists of barren land & agricultural land.
(b)	Attach a general location and vicinity map showing Area boundaries and existing and proposed access routes. It is preferred that the area be marked on a Survey of India Topographical map or a Cadastral map or forest map as the case may be. However if more of these area available, the area should be shown on an Accurate sketch map on a Scale of 1:50000.	The lease area is marked on Survey of India Topo-Sheet No. 73 G/16 on a scale of 1: 50000. (Ref. Plate No. 2).

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Latitude & Longitude of boundary pillars of lease area of Saruabil Chrom[illegible] in table below:

SL NO	PILLAR NO	GEOGRAPHIC COORDINATES	
		LONGITUDE	LATITUDE
1	A	85°49'22.34"	21°03'48.16"
2	B	85°49'18.62"	21°03'49.25"
3	C	85°49'15.57"	21°03'49.65"
4	D	85°49'13.01"	21°03'49.09"
5	E	85°49'09.95"	21°03'48.77"
6	F	85°49'06.49"	21°03'48.79"
7	G	85°49'02.11"	21°03'47.46"
8	H	85°49'02.94"	21°03'45.91"
9	I	85°49'02.34"	21°03'44.45"
10	J	85°49'00.30"	21°03'43.62"
11	K	85°48'58.34"	21°03'43.97"
12	L	85°48'55.03"	21°03'39.56"
13	M	85°48'50.52"	21°03'38.50"
14	N	85°48'47.52"	21°03'38.52"
15	O	85°48'45.59"	21°03'38.62"
16	P	85°48'40.57"	21°03'38.90"
17	Q	85°48'39.94"	21°03'32.31"
18	R	85°48'37.62"	21°03'31.82"
19	S	85°48'35.38"	21°03'30.51"
20	S1	85°48'37.76"	21°03'27.38"
21	S2	85°48'39.31"	21°03'25.35"
22	S3	85°48'42.98"	21°03'20.51"
23	S4	85°48'48.56"	21°03'13.46"
24	S5	85°48'54.10"	21°03'06.17"
25	S6	85°48'55.86"	21°03'03.73"
26	S7	85°48'58.68"	21°03'01.18"
27	S8	85°46'59.35"	21°02'58.93"
28	S9	85°49'01.34"	21°02'56.52"
29	S10	85°49'03.22"	21°02'54.05"
30	S11	85°49'05.24"	21°02'51.53"
31	S12	85°49'06.76"	21°02'49.33"
32	S13	85°49'08.68"	21°02'47.17"
33	S14	85°49'10.44"	21°02'44.73"
34	T	85°49'11.86"	21°02'42.64"
35	U	85°49'22.36"	21°02'44.49"
36	V	85°49'27.02"	21°02'45.30"
37	W	85°49'29.04"	21°02'47.62"
38	X	85°49'30.65"	21°02'49.38"
39	Y	85°49'31.74"	21°02'50.61"
40	Z	85°49'33.35"	21°02'52.41"
41	a	85°49'34.62"	21°02'53.77"
42	b	85°49'44.81"	21°02'55.48"

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43	c	85°49'49.92"	21°02'[illegible]
44	C1	85°49'49.18"	21°02'[illegible]
45	C2	85°49'47.79"	21°03'00.42"
46	C3	85°49'46.38"	21°03'3.37"
47	C4	85°49'44.96"	21°03'05.74"
48	C5	85°49'43.55"	21°03'08.38"
49	C6	85°49'42.19"	21°03'11.26"
50	C7	85°49'40.75"	21°03'13.94"
51	C8	85°49'39.47"	21°03'16.60"
52	C9	85°49'37.91"	21°03'19.22"
53	C10	85°49'36.63"	21°03'21.84"
54	C11	85°49'35.17"	21°03'24.55"
55	C12	85°49'33.77"	21°03'27.14"
56	C13	85°49'32.24"	21°03'29.61"
57	C14	85°49'30.68"	21°03'25.57"
58	C15	85°49'29.45"	21°03'35.19"
59	C16	85°49'27.97"	21°03'37.87"
60	C17	85°49'26.61"	21°03'40.21"
61	C18	85°49'25.19"	21°03'42.86"

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3.0 GEOLOGY AND EXPLORATION

a) Briefly describe the topographical, general geology and local geology of the mineral deposit including drainage pattern:

Physiography:

The mining lease of Saruabil Chromite Mine of M/s Misrilall Mines Pvt. Ltd over 246.858 Ha is located under Jajpur, District of Odisha. Out of the total lease area of 246.858 hectares, an area of 224.633 Ha falls under Demarcated Protected Forest category which is under Cuttack Forest Division, Odisha. The area can be located on Survey of India Toposheet number - 73G/16 and bounded by latitude 21°02'42.64" to 21°03'49.65" and longitude 85°48'35.38" to 85°49'49.92".

The area is situated at about 55 Kms from Jajpur – Keonjhar road. It is all weathered road from Dubri-Tomka to Saruabil area. Paradeep port is 155 Kms from the area on Daitari-Paradeep Port Express Highway. The nearest railhead is Jajpur Road.

Topographically, Saruabil Chromite Mine represents a moderately hilly terrain. Sukinda valley represents a gently rising terrain mostly with plain land. The elevation ranges as observed within the leasehold area is 192mRL on SE side to a lowest of 137mRL on northern side of the lease area. The gradient of the area is 15°. The Saruabil sector is an Eastern part of Sukinda area which lies in a Westerly slopping valley between Quartzite ridges of Mahagiri in the south and Daitari in North. The Damsal nala defines the Northern boundary of the leasehold in which two nalas flowing from SW-NW join the Damsal nala. The area comprises soil covered plains on the East and elongated mounds of Chert and silicified ultramafic rocks with Chromite bands on the West. The rock types exposed in the area are Quartzites, silicified cherty rock, Laterite, Nickeliferous limonite and talc serpentine. The general trend of the formations is due NE-SW with dip towards NW. The Quartzites and Silicified cherty rocks are exposed in the Central and in the Northern part of the area. The Chrome ore occurs in the form of thick Stratified deposit with almost uniform thickness. It is confined within talc serpentine schist, silicified rock and nickeliferous limonite.

Drainage:

There are a number of thin streams in fan shape which are formed due to the topographic and structural feature of the area. These rivulets originate from Daitari and Mahagiri hills in

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north and south of the leasehold respectively. The central portion of the study area is drained by the only perennial water course is a thin stream, the Damsal nala flowing westward with low stream velocity and then south-ward down the slope of the valley. It forms the main watershed of the area. The entire drainage originating from Daitari hills in North and Mahagiri in the south joins Damsal nala. The drainage network present over the major portions of the area is sub-parallel except for the drainage emanating from Daitari hills over the northern portion which is radial and dendritic in nature. The only surface water source in this area is westerly flowing perennial Damsal nala which is situated at 50m distance from the project area due south. The water flowing through this nala ultimately joins the main Brahmani river due South of the area.

Vegetation & Rainfall:

The vegetation is a sub-tropical forest with local savannah-type grassy patches. The dominant species include shorea robusta (Sal), Terminalia tomentosa (Asan) etc. The climate is sub-tropical with abundant seasonal rain fall during the monsoon months of June to September. The average annual rainfall is in the range of 1200–1400mm. The temperature and rainfall data pertaining to the nearest observatory at Cuttack and rainfall data of Sukinda, based on observations over many years, is given in Hydrogeology & Ground Water resource report, annexed as **Annexure- 18**. The human population in the valley mainly includes aboriginals belonging to the Sadar and Munda tribes.

GEOLOGY:

Regional Geology:

Sukinda Chromite deposit of Orissa region mainly occurs as bands, lenses and pockets in the serpentinised dunite peridotite. The ultrabasic rocks are all of Precambrian age parallel or sub parallel to major tectonic zones of peninsular India and are intrusive into the pre-existing sediments and Volcanics, subsequently regionally metamorphosed and tectonically deformed. The Sukinda ultramafic belt, as well as, igneous complex of Boula-Nuasahi is intrusive into the Precambrian Metamorphites, namely the quartzites and quartz muscovite sericite schists. Out of the 11 major Chromite deposits distributed in 9 states of India, in Orissa, the two major deposits i. e. Sukinda Ultramafic Belt and Boula-Nuasahi Igneous Complex hold around 98% of the total Indian reserve. Boula-Nuasahi Igneous complex consists of three rock units i e. the ultramafic rocks, mafic rocks and the felsic rocks. The

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ultramafic body, which hosts four Chromite lodes, occurs as a dyke like pluton [illegible] and 0.6 km width at the central part. The Chromite bearing ultramafics of [illegible] have intruded into the Precambrian Metamorphites in the form of lopoliths. The intrusive has a width of 2-5 kilometers and extends for about 20 kilometers in an ENE-WNW direction from Kansa in the east to Maruabil and beyond in the west. The ultramafic body consists essentially of magnesite-rich dunite-peridotite with the Chromite bands and subordinate amount of Pyroxenite devoid of Chromite mineralization. There are as many as six Chromite bands, fairly thick and persistent both along strike direction of the intrusive and with depth as observed in the quarry and bore-hole sections from Saruabil in the east to Bhimtanagar in the west. Further west at Kalrangi, Kathpal, Maruabil - the chrome ore bodies do not exhibit any regular alignment, rather these are exposed in disjointed bands and lenses apparently disrupted by the emplacement of younger granite. The granite is exposed at several places around Maruabil and also encountered in the borehole sections at the western part of TISCO's quarry, Kalrangi and Kathpal mines. Small exposures of diorite are found in Kathpal and Bhimtanagar. Besides, several dolerite dykes have intruded into the ultramafics, quartzites as well as the granites. This happens to be the last stage of igneous activity in this Precambrian terrain. Soil, alluvium and laterite of recent origin overlie ultramafics unconformably.

The area around Boula-Nuasahi consists of older quartzites which include massive, ferruginous and micaceous varieties. The intrusive into these Precambrian meta-sediments are suites of dunite-peridotite Pyroxenite rocks with less magnesium and pronounced gabbroic differentiate, younger granite and a still younger swarm of dolerite dykes. The ultramafic body to the west of village Nuasahi extends for about 3 kilometers in a NNW-SSE direction from phuljhora Hull down to the village Jauthabahali. The Sukinda ultramafic body is classified as a layered complex or Stratiform composed of rhythmic layers of orthopyroxinite peridotite-dunite-Chromite sequences with number of Chromite bands. The Chromite bodies occur in the form of discontinuous bands and lenses as well exposed in the mines at the central part and confined to the altered dunite peridotite. These bands have a NW-SE to NNW-SSE strike with moderate easterly dip and an average width of 5 meters.

The chromiferrous ultramafic rocks occupy the cores of folds along the margins of iron ore group rocks having a general East-West trend of foliation in the area. They have been

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emplaced in to the present position along deep marginal fractures within the iron ore and rocks. The lithological constituents are ultramafics intrusives or dunite-Pyroxenite and acid differentiates of granite and granophyre. All these rocks are traversed by swarm dolerite dykes which have not only cut across the rocks but also have displaced the ore bands at many places. In Sukinda mainly three ultramafic rocks are prominent:

- Partially/ wholly serpentinised peridotite
- Partially/ wholly serpentinised dunite
- Partially altered orthopyroxinite

The Regional stratigraphic sequence of the region is as follows:

GENERALIZED STRATIGRAPHIC SEQUENCE

Recent to Sub-Recent	Alluvium and soil Laterite Limestone
	Unconformity
Kolhan	Talc schist, Talc-chlorite schist and serpentinite formed during Iron Ore Orogen, Grit and conglomerate.
	Unconformity
Igneous rocks	Granite and Granophyres Anorthosite, Vanadiferrous Magnetite Gabbro (basalt) Pyroxenite (Enstatite) and Enstatite, Harzburgite saxonite, plagioclase pegmatite, Lherzolite etc.-Chromiferrous Chromite, chromiferous dunite and peridotite, Kyanite (as lodes), phyllite, ash bed, basalt, shale quartzite, micaceous quartzite fuchsite- quartzite, chert, banded hematite Jasper, banded hematite quartzite, banded chert, quartzite chlorite rock and andalusite quartzite.
	Unconformity
Basement gneiss	Hornblende-Chlorite gneiss (part of the Singhbhum granite)

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e) Cavernous Laterite: It is found only beneath or laterally grading into type b) and is characterized by large (up to diameter) tabular voids, interconnected by tortuous passages. Parts of these voids are filled up with granular soil.

An interesting feature of the process of lateralization is the conversion of the grey, friable Chromite down to a depth of about 3m from the surface in to a lumpy, brownish ore, poorer in chrome content and richer in iron oxides.

2. Talc-Schist and Serpentine talc schist:

This rock is exposed in the south-western and south-eastern part of the area. It is pale apple green to milky white colour, schistose and soft. The fine flakes of talc with antigorite were also observed.

3. Limonitised rocks:

They are mainly of lateritic type resulting from intense weathering and limonitisation of the silicified ultramafic rocks. The limonitic rocks composed essentially of hydrous ferric oxides i.e. goethite and hematite. They are ochre yellow to orange colored, extremely porous, soft rocks with average bulk specific gravity of 1.5. Because of their soft and porous nature they hardly outcrop at the surface. They are well exposed in quarry number 4 and 5 both on the hang-wall and footwall of the Chrome ore body.

There are several variants differentiated on the basis of colour and mineralogical or chemical differences which are as follows:

Yellow limonite is rich in silica.

Brown limonite is rich in nickel.

Dark brown limonite is very rich in nickel.

Coffee brown limonite is rich in Chromiferrous dissemination with more iron.

White limonite is rich in talc.

Green limonite is rich in serpentine and chlorite.

They are found as parallel bands, their contacts being parallel to foliations and to the margin of the associated Chromite. Residual concentration of Nickel occurs in two distinct zones namely (1) the upper nickeliferous limonite, characterized by high iron and low silica magnesia and (2) The lower serpentinites are marked by medium iron and magnesia and

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high silica. The nickel ore is generally associated with the Chromite lodes and are best developed on the hang wall side of the friable type of Chromite lodes.

The following features indicate that the limonitised rocks are derivations from an ultramafic parent.

1. Abnormally high Cr_2O_3 content.
2. High Ni content.
3. Structural concordance with the Chrome ore Bodies.
4. Preservation of relict rhythmic mineral layering defined by variable concentration of Chromite.
5. Absence of this rock type outside the ultramafic field.

The limonitised rocks are associated with a mantle of Laterite and appear at first glance to be downward continuation of the later. On close examination of age separation from Laterite is revealed in the following features:

i) Slickenside surface is fairly common in the limonitised rock. This slickenside is not confined to any linear tract, but is ubiquitous. Therefore, the limonitised rocks are pre-slicken siding in age.

ii) Angular fragments of partly assimilated limonitised rocks lie swamped with silicified rocks. Therefore, the limonitised rocks are formed before silicification (Kamarda area).

iii) Limonitised rocks and the associated goethite calcinite rocks cut across Chromite bodies (No. 5A quarry-Saruabil).

iv) The limonitised rocks are not confined to shallow depths and their thickness does not vary sympathetically with the thickness of overlying Laterite. Downward continuation of this rock type to 70m has been proved in No X deposit of M/s TISCO area.

Thus the limonitised rocks are of earlier phase of transformation and are not correlative with the Laterite. This transformation is of the ultramafic suite.

4. Silicified rocks:

These are milky white to dirty brown in colour, hard and compact. They are massive and structure less and appear to be traversed by lode lets of amorphous silica or quartz. They are uniform except where they engulf with serpentinites and limonitised rocks. These rocks are exposed in the Southern part of the leasehold. These are also exposed in quarries within the limonitised rocks in the form of thin lenticular lenses and termed as cherty silicified rocks.

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5. Quartzite:

These are exposed in the lower flanks of Mahagiri range which falls in the Southern part of leasehold. They are fine to medium grained highly jointed crushed ferruginous belonging to the iron ore group.

Regional Structure:

The past exploration carried out by GSI and lessee shows that the thickness of ore body and its behavior is more or less uniform within the leasehold. The hang wall and footwall contact dip is quite steep in depth.

In Daitari-Mahagiri Area, the lower sequence of Iron ore super group has been folded into a broad syncline plunging low 10^0 - 15^0 towards WSW. The ultra-mafic rocks have intruded into this sequence as a laccolith and then subsequently co-folded with them. A period of quittance followed and in the shallower basin the younger sequence of the rocks was deposited towards the center of the syncline. The whole group of rocks was then affected by two parallel faults coinciding with the southern and northern margins of the ultra-mafic body. The ultra-mafic body along with the sedimentary apron was uplifted, while both the side blocks were down-thrown. This horst with continued denudation over millions of years has given rise to the present configuration of the Dhamsala Valley.

These two faults are located at the northern base of Mahagiri range and southern base of Daitari range which trend in ENE-WSW direction. In the proximity of the faults, the sedimentary beds are almost vertical and extremely sheared mylonitized and silicified.

The Ultramafic rocks near these faults also show extensive shearing and are almost Schistose at places, and the Chromite bands are stretched and separated as bounding.

The northern limb of the fold extends in a linear fashion in WNW-ESE direction from the Daitari hill whereas the Southern limb is cross-folded in a NW-SE axis. The beds of northern limb dips towards south, the amount of dip varying from 50^0 to almost vertical. Due to cross-folding the amount and direction of dips of the southern limb varies but the general dip is towards north.

Local geology:

The rock type exposed in the area is quartzite, silicified cherty rocks, laterite, nickeliferous limonite and talc serpentine. The general trend of the formation is due NE-SW with dip due

NW. The quartzites and silicified cherty rocks are exposed on the Southern part of the lease hold. The laterites and thin bands of serpentine are exposed in the central and in the northern part of the area.

The Chrome ore occurs in the form of thick stratiform deposit with almost uniform thickness. It is confined within talc serpentine schist, silicified rock and nickeliferous limonites. The trend of the chrome ore zone in quarry No.5, 5A and 6 (Qry-C) is NE-SW with dip of 50^0 to 80^0due NW. The trend of the Chrome ore zone in quarry Nos. B and A is varying from E-W to WNE-ESE with dip due South and SSW respectively. The amount of dip is almost horizontal on the footwall side and subsequently increases to 10^0 to 40^0 and become 45^0 to 50^0 at a depth in quarry No. B and A. From the correlation of the attitude of different ore bands i.e (a) the NE-SW with dip 50^0 to 80^0 due NW (b) EW or WNW-ESE with dip varying from almost horizontal to 50^0. The general structure reveals from these attitudes, an asymmetrical synclinal fold plunging due west of South West. The fold axis shows its closure in between quarry Nos. 4E and 4W. The ore body of quarry No.6 has taken a swing at right angle form NE-SW trend to NW-SE trend near the closure of the fold. The trend of the ore body in quarry No.4E is E-W with dip due South. On the western end serpentine shows slickenside feature, Brecciation was observed on the foot wall of the quarry. The attitude of the ore body and its quality is similar to that of quarry No.B. From these geological considerations it has been inferred that the closure of the fold has been faulted by an oblique fault. South westerly plunging mesoscopic folds are bounded in the Chromite bodies around Saruabil. Fracture cleavage is present in the Chrome ore zone.

Saruabil Chromite mines exposes different litho-units. The local stratigraphic sequence is established as follows:

↑
Soil & Alluvium
Laterite
Pyroxinite
Yellow limonite with Goethite
Limonite with Chromite disseminations
Cherty Limonite
Quartzite

Structural Description of the Quarries:

All the six quarries have been developed on the two limbs of the asymmetrical synclinal fold. The quarry Nos.D and B were developed on the East and South East part of the area.

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Quarry No.1 & 2 (Qry-A)

This quarry is located on the NW part of lease boundary. The chrome ore is associated with Laterite and nickeliferous limonite both on hang wall and footwall, the strike of the ore body is N60°W-S60°E with dip of 50°at S30°W.The formations are folded on footwall side, the dips are 18° to 20° which gradually become steeper to 30° to 35° and then to 45° to 50° which may be due to refolding of the formations.

The ore body is dipping towards south. Ore is friable, black in colour and of high grade. The width of the ore body as exposed in the quarry is around 18m. Nickeliferous limonite is also observed in working face. On the footwall side of this quarry there is low to medium grade ore which has been proved by trial pits in the past. The ore zone extends over a strike length of 200m. The average width is about 20m and depth persistence is 9m.

Quarry No.4 (Qry-B)

This quarry is located adjacent to quarry A towards East. The strike of the formation is due E-W but it swing N 60° E. The amount of dip on footwall side is 18° in contact with nickeliferous limonite while on the hang wall side, it varies from 45° to 50° .The direction of dip is S 30° W. Nickeliferous limonite occurs both on the hang wall and footwall sides below the soil cover. There are silicified cherty bands within the limonite's on the hang wall side of the quarry; on footwall side the dip is very flat. The ore of this quarry is friable and high grade. Average width of ore body is 8.5m. In the eastern section of quarry No - B, Chrome ore is associated with silicified cherty rock and limonite both on the hang wall and foot wall. The general strike is N 80° W-S 80° E with a dip of 35° to 45° at S10°W. This quarry has been developed at the closer of the fold. It is also faulted zone. The width of the ore zone is about 18m.

Quarry No. 5, 5A & 6(Qry-C)

These quarries are located adjacent to the eastern section of quarry No.B on the Southern limb of the fold. The rock type exposed on the hang wall and foot wall are morrum, ferruginous soil, silicified limonite zone, yellowish brown limonite and talc serpentine. The general strike of these formations is N 30° E-S30°W with dip of 50° to 75° at N 60°W.On the Eastern end of this quarry, the ore body has been dragged by an oblique fault and the strike become N 40° W-S 40° E. The width of the ore body in quarry 5 is about 15m and in quarry 5A, it is about 10.8m. One more ore bands having thickness of 0.6m and 3m is exposed in this quarry.

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This quarry is located on the Midwestern part of area and is situated at higher elevation. This is in continuation of quarry C. On the Eastern portion of the quarry, low to medium grade ore is exposed with a band of talc serpentine. The grade of the ore again improves on the Western end of the quarry. The average width of ore body is 6m.

At present, quarry – B and C are merged and became a single large quarry. The ore body exposed in quarry A, B & C is grey in colour, fine crystalline, powdery whereas, the ore exposed in quarry C is brown, coarse crystalline, powdery and the ore exposed in the quarries No. D and 8 (old) is lumpy, friable sheared coarse crystalline type. The ore exposed in the quarry D is of disseminated and banded type. The lodes exposed in quarries A, B & C are mutually parallel and also two lodes observed at a distance, are also parallel to them. Each of the lodes is bounded on either side by silicified or limonitised ultramafic rocks. A band of chart is parallel to them. The thickness of the main grey ore lode is varying from 6m to 18m and is exposed all thought the area in different quarries. The side lode of Chromite occurring south of the main lode in quarry C is also exposed in quarry B and C.

Quarry No.7 (Qry-D)

Quarry No.D is located on the South-Eastern part of the leasehold. Here the chrome ore occurs in the form of thin lodes varying in thickness from 0.82m to 1.80m (from bore hole) and in erratic in behavior but thickness seems to be around 7m as it advances towards SW. The ore is mostly friable and of low to medium grade. With a view of prospecting to know the behavior and extent of the ore body the quarry has been developed towards South West direction i.e.in strike direction. The strike of the ore body is NE-SW and dips towards SE. The ore band in the quarry is mainly brownish black in colour.

Quarry No. 8 (old) is located on the Eastern part of the area. Here the chrome ore occurs in the form of float ore and erratic in behavior. The ore is mainly hard and lumpy.

b) The topographic plan of the lease area prepared on a scale of 1:1000 or 1:2000 with contour interval of 3 to 10 m depending upon the topography of the area should be taken as the base plan for preparation of geological plan. The details of exploration already carried out including evidences of mineral existence should be shown on the geological plan.

The Surface Geological plan has been prepared on a scale of 1:2000 with contour interval of 4m. The detail of exploration already carried out including evidence of mineral existence has been detailed below and shown on the Surface Geological Plan (Plate – 6).

Exploration already carried out in the area:

The Chrome ore body has been proved by putting number of boreholes and trenches by the lessee from time to time in the past. The area was also been explored by G.S.I by putting deep-hole drilling. The chrome ore bands thus explored have been delineated.

a) Exploration carried out by geological Survey of India:

GSI has carried out drilling exploration of nickeliferous limonite ore in this area and the adjoining area by putting bore holes in a grid interval of 100m. During the course of the above work, bore hole Nos.8, 18,26,35,37 and 42 have established the continuity of the ore body of quarry No. A thickness varying from 1.55 to 10.50m. The maximum depth of the ore zone in quarry No.A was proved in borehole No.42 from 53.60 to 64.10m. The borehole No.77 has proved the continuity of the quarry No.C ore body from 89.60m to 114.60m.

Detailed exploration work has been carried out in Orissa by GSI for proving additional reserves of Chrome ore, while doing so 13 bore holes were drilled by them in Saruabil lease hold. In these bore holes, the borehole No.D has proved the Chrome ore thickness of 11.69m while bore hole Nos.10 and 21 have proved the Chrome ore thickness 11.25m to 11.89m respectively. In all GSI drilled 63 boreholes in the leasehold and drilling was completed during 1982. Geological transverse sections were prepared in Quarry Nos. B,C and A at suitable places where litho logical details were observed and bore holes drilled by GSI have proved the continuity of mineralization in depth. It may be seen that the thickness of the ore and its behavior have more or less remained uniform. The hang wall and footwall contact dip is quite steep in depth. Longitudinal vertical sections were prepared on the hang wall of quarry No.B and C. In these sections the top profile of the working the floor of the quarry workings and intersection of chrome ore zone in GSI borehole have been correlated. This clearly brought out that the ore zone continues in depth.

The report of GSI on chrome ore of Odisha which include our Saruabil Chromite Mine is enclosed as **Annexure – 12** wherein, reserve of chrome ore has been estimated to the tune of 8.85 million tons.

b) Exploration carried out by lessee:

The lessee has carried out exploration work by drilling bore holes in the Eastern and the South eastern part of the area. In all 14 boreholes were drilled by the lessee prior to 1970.

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down to a maximum depth of 25m. The borehole Nos.1 and 2 have intersected two lenses of ore at a depth of 6m. On the North and South of the old abandoned quarry No.B, the borehole No. 6 has intersected 1.2m thick ore at quarry No.D at a depth of 13.5m.

The borehole No.8 (located in SE portion of the area) has intersected thin lodes of 10 to 15 cm. thicknesses of Chrome ore to establish the continuity of the ore body of quarry No.D. The borehole No.6, 7, 8, 10, 11 and 12 were drilled and no Chrome ore was intersected in these boreholes. Similarly borehole No.13 and 17 were drilled with an anticipation of intersecting any parallel lodes to that of main ore body but all have proved barren. The borehole No. 18 was drilled on the hang wall of quarry No.C and has proved the Chrome ore body at a depth of 3m. The Borehole No.19 to 23 was put in the region of quarry No.C and of which borehole No.20 has intersected the ore at a depth of 16.5m. The borehole Nos.19, 21, 22 and 23 has not intersected any ore body.

Details of Bore-holes drilled in and around quarry No.1/2 or A and 7 or D during 1990-91:

The Lessee has carried out the exploration work by drilling boreholes during 1989-90 in and around Quarry A and D. Total 5 nos. of boreholes were sunk down to a maximum depth of 31m. The borehole No.1/90 has intersected the ore body at a depth of 19.45m and continues up to a depth of 23m. This borehole is located on the west side of quarry No.A at an inclination of 55° towards North. The bore hole Nos.2/90, 3/90, 4/90(located in the NW portion of quarry No.D) has intersected thick lodes of chrome ore as 1.00m, 1.20m, 1.05m and 0.45m thickness respectively. All the bore holes are at 55° inclinations from horizontal except bore hole No.5/90, which is vertical.

During the last approved plan period no of bore hole were drilled. Also exploration by 8 nos. of boreholes by wagon drill was carried out in the past to know the extent of the chrome load both laterally and at depth. The lessee has carried out exploration by drilling boreholes during the year 2001-02 in and around quarry no. B, C and D. Total 13 nos. of boreholes have been drilled, out of which 8 deep boreholes in quarry no. B and C and rest of the boreholes were drilled in quarry no. D. Summary of exploratory B/Hs carried out till date is given in table below :-

Table - 3.1

Summary of exploration carried out

B/H no.	Year	Given by (GSI / lessee)
BH- 24,18,25,23,42,22,26,35,16,	Completed during	G.S.I

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18,20,14,7,12,10,29,9,30,5, 3A,3,19,21,22.	1982	
BH - 1/90, 4/90	1990	lessee
BH - 23,21,7/60°,20/48°	-	lessee
BH- 1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,17	Prior to 1970	lessee
BH- 2/98,3/98,4/98,5/98,6/98,7/98,8/98,9/98, 10/98,11/98,12/98	1998	lessee
BH-24,18,26,23/55°,42,22/51°,35,16/45°, 18/45°,20/50°,7,12/55°,10/60°,9/45°,29,30,5/45°,3A/75°,3/45°,19,21,22,14	-	G.S.I
BH-4/01, 5/01, 7/01, 3/01, 2/01, 01	2001	lessee
BH - 24/42°	2001	
BH- 02/06, 03/06, 01/06, 04/06,05/06	2006	lessee
BH-,1/12, 2/12,3/12,4/12, 5/12, 6/12,7/12,8/12, 9/12,10/12,11/12,12/12,	2012	lessee

Recent Exploration carried out:

During the last approved scheme of mining 12 no. of bore hole were drilled around the quarry-D to know the lateral extension and depth of the Chromite lode. All the bore holes are inclined borehole. Five bore holes give negative result means this bore hole didn't encountered any chrome ore lode. The detail of the bore hole is given below in the table:

Table - 3.2

Details of Boreholes drilled around the quarry-7/ Qry-D during (2011-12)

Bore Hole No	Type of Borehole	Surface RL(m)	Bottom RL(m)	Depth (m)	Thickness (mRL)	LITHOLOGY	Cr_2O_3%
01/12	N 40° W (73°)	176.93	126.43	50.50	176.93-175.33	Alluvium Top Soil	1.61
					175.33-166.93	Lateritic Soil	1.39
					166.93-163.93	Laterite(Altered Ultramafic)	1.95
					163.93-158.93	Nickeliferous Limonite With Yellow Ochre(at places)	2.71
					158.93-153.93	Silicified Cherty Rock (Limonitised)	1.84
					153.93-146.93	Laterite (Altered ultramafics)	2.9
					146.93-140.93	Nickeliferous Altered(Ultramafics) With Yellow Ochre(at places)	2.9
					140.93-135.93	Silcified Cherty Rock (Limonitised)	1.85

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					135.93-134.43	Weathered Serpentine / Talc	
					134.43-131.93	Nickeliferous Altered (Ultramafics) With Yellow Ochre(at places)	2.71
					131.93-128.43	Silicified Cherty Rock (Limonitised)	1.6
88/12	S 40° E (73°)	184.75	121.25	63.50	184.75-182.25	Alluvium Top Soil	0.96
					182.25-177.25	Lateritic Soil	0.96
					177.25-169.75	Laterite (Altered Ultramafics)	1.01
					169.75-162.25	Nickeliferous Limonite With Yellow Ochre(at places)	2.02
					162.25-157.25	Laterite (Altered Ultramafics)	1.01
					157.25-149.75	Nickeliferous Limonite With Yellow Ochre(at places)	1.65
					149.75-144.75	Nickeliferous Altered(Ultramafics) With Yellow Ochre(at places)	1.17
					144.75-140.75	Silicified Cherty Rock(Limonitised)	1.01
					140.75-134.75	Weathered Serpentine / Talc	0.98
					134.75-127.25	Silicified Cherty Rock(Limonitised)	0.79
					127.25-121.25	Weathered Serpentine / Talc	0.76
03/12	S 40° E (60°)	184.29	146.29	38.00	184.29-178.79	Alluvium Top Soil	3.57
					178.79-174.49	Lateritic Soil	2.88
					174.49-170.79	Laterite (Altered Ultramafics)	1.56
					170.79-168.59	Nickeliferous Altered (Ultramafics) With Yellow Ochre(at places)	2.06
					168.59-162.69	Nickeliferous Limonite With Yellow Ochre(at places)	2.94
					162.69-151.69	Nickeliferous Altered (Ultramafics) With Yellow Ochre(at places)	2.14
					151.69-150.19	Chrome Ore(Low grade)	26.45
					150.19-149.29	Chrome Ore	48.58
					149.29-146.29	Silicified Cherty Rock (Limonitised)	9.08
04/12	N 40° W (60°)	170.86	114.86	56.00	170.86-165.86	Alluvium Top Soil	5.53
					165.86-164.86	Chrome Ore(Low grade)	30.16
					164.86-158.86	Laterite (Altered Ultramafics)	7.03

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					158.86-143.86	Nickelferous Limonite With Yellow Ochre(at places)	
					143.86-139.66	Nickelferous Altered (Ultramafics) With Yellow Ochre(at places)	4.75
					139.66-137.96	Chrome Ore	40.08
					137.96-135.81	Nickelferous Altered (Ultramafics) With Yellow Ochre (at places)	9.97
					135.81-134.56	Chrome Ore	45.25
					134.56-131.96	Weathered Serpentine / Talc	27.04
					131.86-128.96	Ultrabasic Rocks	42.72
					128.96-114.86	Grit With Opalescent Quartz	9.66
05/12	N 40° W (65°)	173.21	112.01	61.20	173.21-167.21	Alluvium Top Soil	3.26
					167.21-165.21	Chrome Ore(Low grade)	48.3
					165.21-157.71	Laterite (Altered Ultramafics)	2.71
					157.71-156.81	Chrome Ore(Low grade)	34.14
					156.81-149.21	Nickelferous Limonite With Yellow Ochre(at places)	4.3
					149.21-146.21	Chrome Ore(Low grade)	28.89
					146.21-143.41	Chrome Ore(Low grade)	26.12
					143.41-136.71	Chrome Ore	43.45
					136.71-133.41	Chrome Ore(Low grade)	25.71
					133.41-125.71	Nickelferous Limonite With Yellow Ochre(at places)	3.39
					125.71-121.21	Laterite (Altered Ultramafics)	5.16
					121.21-115.71	Weathered Serpentine / Talc	6.11
					115.71-112.01	Nickelferous Altered(Ultramafics) With Yellow Ochre(at places)	7.99
06/12	N 40° W (60°)	166.18	95.68	70.50	166.18-160.18	Alluvium Top Soil	1.22
					160.18-159.18	Lateritic Soil	2.56
					159.18-158.18	Laterite (Altered Ultramafics)	1.23
					158.18-157.18	Nickelferous Limonite With Yellow Ochre(at places)	2.31
					157.18-155.58	Silicified Charty Rock(Limonitised)	2.56

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					155.58-152.18	Nickeliferous Altered(Ultramafics) With Yellow Ochre(at places)	3.40
					152.18-142.18	Nickeliferous Limonite With Yellow Ochre(at places)	3.02
					142.18-140.18	Nickeliferous Altered (Ultramafics) With Yellow Ochre(at places)	3.26
					140.18-131.18	Laterite (Altered Ultramafics)	3.28
					131.18-125.48	Laterite (Altered Ultramafics)	2.86
					125.48-119.08	Nickeliferous Limonite With Yellow Ochre(at places)	3.21
					119.08-111.48	Nickeliferous Altered (Ultramafics) With Yellow Ochre(at places)	4.26
					111.48-108.28	Chrome Ore	50.16
					108.28-106.08	Chrome Ore(Low grade)	48.28
					106.08-101.38	Silicified Charty Rock(Limonitised)	6.24
					101.38-95.68	Grit With Opalescent Quartz	5.26
87/12	N 40° W (65°)	166.35	89.35	77.00	166.35-157.35	Alluvium Top Soil	6.75
					157.35-149.35	Lateritic Soil	7.96
					149.35-145.35	Chrome Ore(Low grade)	42.6
					145.35-144.35	Nickeliferous Altered (Ultramafics) With Yellow Ochre(at places)	6.43
					144.35-142.15	Laterite (Altered Ultramafics)	3.42
					142.15-138.75	Nickeliferous Altered(Ultramafics) With Yellow Ochre(at places)	7.88
					138.75-133.35	Chrome Ore(Low grade)	28.23
					133.35-129.35	Nickeliferous Limonite With Yellow Ochre(at places)	7.2
					129.35-124.35	Nickeliferous Limonite With Yellow Ochre(at places)	5.67
					124.35-116.95	Lateritic Soil	3.43
					116.95-114.35	Nickeliferous Limonite With Yellow Ochre(at places)	8.82
					114.35-110.35	Chrome Ore(Low grade)	27.46
					110.35-109.35	Nickeliferous Limonite With Yellow Ochre(at places)	5.91

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					109.35-108.35	Chrome Ore(Low grade)	1.00
					108.35-107.35	Chrome Ore(Low grade)	1.00
					107.35-102.85	Chrome Ore	4.50
					102.85-89.35	Weathered Serpentine / Talc	8.86
08/12	N 40° W (60°)	165.70	97.70	68.00	165.70-159.70	Lateritic Soil	8.31
					159.70-159.20	Chrome Ore(Low grade)	26.26
					159.20-151.70	Laterite (Altered Ultramafic)	7.99
					151.70-140.70	Nickeliferous Limonite With Yellow Ochre(at places)	1.52
					140.70-128.70	Lateritic Soil	1.27
					128.70-120.90	Laterite (Altered Ultramafic)	8.86
					120.90-119.70	Chrome Ore(Low grade)	26.59
					119.70-115.80	Chrome Ore(Low grade)	28.48
					115.80-111.10	Chrome Ore(Low grade)	28.32
					111.10-106.70	Chrome Ore(Low grade)	26.23
					106.70-97.70	Silicified Cherty Rock (Limonitised)	5.57
09/12	N 40° W (65°)	165.58	91.58	74.00	165.58-163.58	Alluvium Top Soil	2.03
					163.58-161.58	Lateritic Soil	1.72
					161.58-153.58	Nickeliferous Limonite With Yellow Ochre(at places)	1.81
					153.58-150.58	Nickeliferous Limonite With Yellow Ochre(at places)	4.15
					150.58-148.58	Nickeliferous Limonite With Yellow Ochre(at places)	2.75
					148.58-140.58	Laterite (Alter Ultramafics)	3.81
					140.58-134.58	Silicified Cherty Rock(Limonitised)	4.26
					134.58-128.58	Nickeliferous Limonite With Yellow Ochre(at places)	7.02
					128.58-123.58	Nickeliferous Limonite With Yellow Ochre(at places)	4.56
					123.58-122.58	Lateritic Soil	8.63
					122.58-119.78	Chrome Ore(Low grade)	26.11
					119.78-117.38	Chrome Ore(Low grade)	28.17
					117.38-104.08	Weathered Serpentine / Talc	3.79

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					104.08-96.58	Weathered Serpentine / Talc	
					96.58-91.58	Weathered Serpentine / Talc	
10/12	N 40° W (60°)	165.40	88.40	77.00	165.40-158.40	Alluvium Top Soil	9.85
					158.40-150.90	Nickeliferous Limonite With Yellow Ochre(at places)	6.62
					150.90-149.40	Silicified Cherty Rock (Limonitised)	4.62
					149.40-146.40	Weathered Serpentine / Talc	3.81
					146.40-143.40	Laterite (Altered Ultramafics)	3.49
					143.40-140.40	Laterite (Altered Ultramafics)	2.24
					140.40-139.40	Laterite (Altered Ultramafics)	6.69
					139.40-137.40	Laterite (Altered Ultramafics)	1.82
					137.40-136.80	Laterite (Altered Ultramafics)	2.24
					136.80-131.90	Laterite (Altered Ultramafics)	6.69
					131.90-131.00	Laterite (Altered Ultramafics)	1.82
					131.00-128.40	Laterite (Altered Ultramafics)	2.42
					128.40-126.90	Laterite (Altered Ultramafics)	2.61
					126.90-123.40	Nickeliferous Limonite With Yellow Ochre(at places)	6.9
					123.40-114.80	Laterite (Altered Ultramafics)	3.69
					114.80-110.40	Weathered Serpentine / Talc	3.42
					110.40-102.80	Weathered Serpentine / Talc	3.88
					102.80-97.40	Weathered Serpentine / Talc	2.42
					97.40-88.40	Laterite (Altered Ultramafics)	3.39
11/12	N 40° W (60°)	163.66	85.66	78.00	163.66-157.66	Lateritic Soil	1.68
					157.66-152.66	Lateritic Soil	1.68
					152.66-146.66	Nickeliferous Limonite With Yellow Ochre(at places)	2.23
					146.66-143.66	Nickeliferous Limonite With Yellow Ochre(at places)	1.08
					143.66-139.66	Lateritic Soil	2.38
					139.66-133.66	Lateritic Soil	2.28
					133.66-126.66	Lateritic Soil	1.68
					126.66-122.66	Lateritic Soil	3.02
					122.66-118.66	Lateritic Soil	4.6

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					118.66-117.66	Nickeliferous (Ultramafics) Yellow Ochre(at	
					117.66-113.66	Nickeliferous Altered(Ultramafics) With Yellow Ochre(at places)	6.64
					113.66-110.66	Laterite (Altered Ultramafics)	3.32
					110.66-108.66	Laterite (Altered Ultramafics)	2.68
					108.66-102.66	Laterite (Altered Ultramafics)	1.18
					102.66-98.66	Laterite (Altered Ultramafics)	1.28
					98.66-92.66	Laterite (Altered Ultramafics)	1.24
					92.66-85.66	Nickeliferous Altered (Ultramafics) With Yellow Ochre(at places)	1.02
12/12	N 40° W (65°)	164.13	93.13	71.00	164.13-160.73	Alluvium Top Soil	2.47
					160.73-156.13	Nickeliferous Limonite With Yellow Ochre(at places)	4.21
					156.13-152.13	Weathered Serpentine / Talc	2.26
					152.13-147.63	Weathered Serpentine / Talc	2.28
					147.63-141.13	Lateritic Soil	3.19
					141.13-138.63	Lateritic Soil	2.68
					138.63-136.13	Laterite (Altered Ultramafics)	6.8
					136.13-130.13	Nickeliferous Limonite With Yellow Ochre(at places)	2.75
					130.13-127.13	Nickeliferous Limonite With Yellow Ochre(at places)	2.61
					127.13-121.13	Laterite (Altered Ultramafics)	7.76
					121.13-116.13	Laterite (Altered Ultramafics)	4.21
					116.13-108.13	Weathered Serpentine / Talc	4.75
					108.13-105.13	Nickeliferous Limonite With Yellow Ochre(at places)	2.81
					105.13-93.13	Laterite (Altered Ultramafics)	1.75

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Exploration carried out in the lease area are summarized as :-

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) C=D+E+F+G					Remarks/ Comments including reason for not carrying out the exploration as per UNFC
			Year	G1 Level	G2 Level	G3 Level	Other Lease area/unexplored area	
A	B	C		D	E	F	G	H
1	**Lease-** Saruabil Chromite Mine **Lessee-** Misrilall Mines private Limited	246.858	Up to 2012	105.93	Nil	Nil	Virgin - 101.878 Camp- 22.340 COB - 1.850 Magazine 1.130 M. Storage 4.300 Barrier - 9.430 Total - 140.928	Bore hole was carried out in the past and at that time there was no UNFC norm

A copy of Form – K of exploration carried out by the Lessee for the year 2001, 2006, 2011-12 and copy of GSI report on estimated chrome ore reserve including Saruabil Chromite mines is enclosed as **Annexure – 12.**

c) Geological sections should be prepared at suitable intervals on a scale of 1:2000.

Geological sections from Lease boundary to lease boundary have been prepared on a scale of 1:2000 and given in **Plate – 7**.

d) Broadly indicate the year wise future programme of exploration, taking into consideration the future production programme planned in plan period as in table below:

As mentioned in the approved mining plan/scheme of mining, the mineral reserve of this area has been estimated considering the proved depth up to 80 meter. No further depth has been established though it is reported that the chrome ore lode of this area is continuing up to a depth of 200m. So, in order to establish full depth of mineralization and to obtain more information about the chrome lode, future exploration has been chalked out during this plan period.

It is proposed that exploration in the lease area shall be carried out by putting 34 numbers of inclined boreholes (inclination 75°) to explore the chrome lode around quarry-A,B & C and covering entire lease area at depth and its extension laterally. The depth of the hole shall be up to 200m from the surface. The detail of proposed boreholes is given in Table – 3.3 and location of these boreholes is shown in Geological Plan.

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Table - 3.3

Exploration proposed to be carried out during plan period

Year	Location	BH No.	No. of Boreholes	Depth of the Hole
2014-15	(S1800,W200)	PBH-1/14	7	200m
	(S1800,W400)	PBH-2/14		
	(S1600,W200)	PBH-3/14		
	WEST OF (S600,W600)	PBH-4/14		
	SE OF (S600,W600)	PBH-5/14		
	SE OF (S800,W400)	PBH-6/14		
	S OF (S600,W200)	PBH-7/14		
2015-16	NEAR POS IN QUARRY NO. C	PBH-8/15	7	200m
	NE OF(S800, W400)	PBH-9/15		
	SE OF(S800, W400)	PBH-10/15		
	N OF (S1000, W400)	PBH-11/15		
	W OF (S1000, W400)	PBH-12/15		
	N OF (S1200,W600)	PBH-13/15		
	SE OF (S1200,W600)	PBH-14/15		
2016-17	(S1400,E200)	PBH-15/16	5	200m
	(S1800,E100)	PBH-16/16		
	(S1600, E400)	PBH-17/16		
	(S1600,E600)	PBH-18/16		
	(S1600,E800)	PBH-19/16		
2017-18	(S1200, E400)	PBH-20/17	9	200 m
	(S1200, E200)	PBH-21/17		
	(S1000, W400)	PBH-22/17		
	(S1000,E200)	PBH-23/17		
	(S800,E200)	PBH-24/17		
	(S700, W1100)	PBH-25/17		
	(S300, W1000)	PBH-26/17		
	(S400, W800)	PBH-27/17		
	(S200, W800)	PBH-28/17		
2018-19	(00, 400W)	PBH-29/18	6	200 m
	(800S, 400W)	PBH-30/18		
	(00, 200W)	PBH-31/18		
	(200S, 200W)	PBH-32/18		
	(200S, 00)	PBH-33/18		
	(350S, 00)	PBH-34/18		
Total	-	-	34	-

The proved reserve as on date is sufficient enough to meet the requirement of more than next five years production target with the optimum level of production of 350000.00 MT per annum. Proved reserve has been estimated, down to a maximum depth of 80m. It is likely that the ore zone may continue further down. Keeping in view this contention, exploration by deep hole drilling has been proposed.

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a) Indicate geological and recoverable reserves and grade, duly supported by standard method of estimation and calculations along with required sections/plans split up of various categories i.e. proved, probable, possible). Indicate cut-off grade. Availability of resources should also be indicated for the entire lease hold.

In the last approved scheme of mining, total mineral reserve was estimated to the tune of 3040616 MT. The mining operation is temporarily discontinued from 05.10.2013 under the direction of Deputy Director of Mines, Jajpur, Odisha. The total production of the Chromite ore from the period of 2010-11 up to March' 2014 is 307927.81 MT. Considering the 5% mine losses the tonnage factor will be 1.052 multiplied with the production 307927.81 x 1.052 = 323940.05. So the depleted reserve as on date is (3040616- 323940.05) = 2716675.94 MT. The estimated reserve & resources during the last approved scheme is furnished below:

Mineral Reserve and Mineral Resources (UNFC)
(as per approved scheme of mining)

Category	Code As per UNFC	52% Cr_2O_3 & Above (M.T.)	+40% Cr_2O_3 to – 52% Cr_2O_3 (M.T.)	- 40% Cr_2O_3 (M.T.)	Sub-Grade	Total (M.T.)
Proved Reserve	111	7,69,718	66,339	6,65,912	3000	15,04,969
Probable Mineral Reserve	121	8,62,869	3,17,520	3,55,458	-	15,35,847
Total Reserve		**16,32,587**	**3,83,859**	**10,21,370**	**3000**	**30,40,816**
Indicated (inferred) Mineral Resources	332	5,78,938	1,92,720	2,31,000	-	10,02,658

Mineral resources and reserves have been estimated a fresh as per UNFC norms for the preparation of this mining plan. The parameters considered for the estimation of resources and reserves is detailed below:

ESTIMATION OF MINERAL RESOURCES & RESERVE:

The mineral resources and Reserves have been estimated a fresh as per UNFC norms for preparation of this mining plan. The resources have been estimated on the basis of the data observed directly from quarry exposures as well as boreholes done in the area in the past as well as during the last scheme period. The existing quarries within the lease provide the data of mineralization. The exploration done by 12 numbers of boreholes drilled near quarry – D during the last approved scheme of mining and existing pits, the Chromite lode has been interpreted. Taking the vertical projection from the section where the

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Chromite lode is encountered by the borehole, lode has been marked on the Geological Plan (Ref: Plate-6). The Chromite lode up to which depth is encountered by the bore hole is considered as proved depth. The proved depth has been varying from section to section. As mentioned above the area has been extensively worked by developing six numbers of quarries, namely quarry nos. A, B, C& D. At present quarry-B & C merges together and becomes a single quarry. The present status of the existing quarry is given in **Table – 3.4.**

Table- 3.4

Dimensions of existing Pits

Name of quarry	Length (m)	Width (m)	Depth (m)	Existing R.L. (m)	
				Top	Bottom
Q-A	320.00	178.00	29.45	148.29	113.63
Q-B	650.00	245.00	43.08	161.94	118.86
Q- C	690.00	312.00	63.42	182.22	118.18
Q-D	253.00	132.00	34.25	187.25	153.00

Parameters considered for estimation of Resources & Reserves:

For the estimation of the Mineral Resources and Reserves, the following parameters have been considered:

i) **Method of Estimation:** Cross-sectional method has been adapted for calculation of reserve. A cross-sectional area has been calculated from each of the main lode and side lode which multiplied by the length of influence considered for each category giving the volume of Chromite ore. The volume (cum) is then converted into MT considering the bulk density.

ii) **Thickness of the ore body:**

For the estimation of mineral reserve, depth of the ore body is considered as encountered in the bore holes drilled by lessee. The quarry-wise depth considered under G1 category is as follows:

Category	Qry No.	Depth Considered (M RL)	BH. No.
G1	A	95	23/55
	B	91	BH- 01/06, 02/06, 03/06, 04/06 & 05/06
	C	95	BH- 3/2001, 9/45, 31, 12/55, 5/45 & 7/60
	D	110.85	6/01

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(iii) Cut-off grade:

The ore having +40% Cr2O3 is considered under saleable ore. The reserve is estimated with the reference to economic cut-off grade +10% to -40% Cr2O3. The threshold value of the Chromite is considered as 10%. The grade between +10% to -40% is considered as low-grade ore which is used in our COB plant to improve the grade.

iv) Recovery:

Taking 100% recovery from the lode, reserve of the Chromite has been estimated.

v) Conversion factor:

For Chromite ore: 1 cum = 3.5 MT (For commercial grade ore, +40% Cr2O3)

1 cum = 2.5 MT (For material from the contact zone of the chrome lode with nickeliferous limonite & low grade ore from the side lode of quarry-4 and lode of Quarry-7, +10% to -40% Cr2O3. This material is being utilized in COB plant to improve the grade)
[As observed from the data of working mines]

Copy of documentary proof for Bulk density is enclosed as **Annexure - 31.**

MINERAL RESOURCES & RESERVES

(A) (MINERAL RESOURCES):

UNFC system has been adopted to categorize the mineral Resources. For the estimation of different mineral resources, Occurrences of mineral of intrinsic economic interest, location, grade, quantity, geological characteristic, Physical Characteristic, mineral content as well as tonnage factor etc has been studied in detailed. The measured and inferred mineral resource so estimated is given in **Table – 3.5**.

Table – 3.5

Table showing estimation of mineral resources (as on - 01/04/2014)

Category of Resources	Section line	Sectional area in m^2	Length of influence in m	Total volume cum	Total Mineral Resources in MT	
					60% recovery of +40% Cr_2O_3	20% recovery of +10 to -40% Cr_2O_3
Q-A						
Measured Mineral Resources	EE'	405.00	87.00	35235.00	(1 cum= 3.5 MT)	(1 cum= 2.5 MT)
	DD'	373.00	58.00	21634.00		
	CC'	602.00	57.00	34314.00		
	BB'	906.00	160.00	144960.00		

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Total				236143.00	661200.40	118071.50
Q-B (Main Lode)						
Measured Mineral Resources	ee'	532.00	130.00	69160.00	(1 cum= 3.5 MT)	(1 cum= 2.5 MT)
	FF'	452.00	85.00	38420.00		
	GG'	330.00	135.00	44550.00		
	HH'	419.00	115.00	48185.00		
	II'	318.00	170.00	54060.00		
Total				254375.00	712250.00	127187.50
Q-B (2nd Lode)						
Measured Mineral Resources	ee'	450.00	130.00	58500.00	(1 cum= 2.5 MT)	
	FF'	240.00	85.00	20400.00		
	GG'	345.00	135.00	46575.00		
	HH'	423.00	115.00	48645.00		
	II'	279.00	170.00	47430.00		
Total				221550.00	553875.00	
Q- C(Main Lode)						
Measured Mineral Resources	JJ'	664.00	115.00	76360.00	(1 cum= 3.5 MT)	(1 cum= 2.5 MT)
	KK'	299.00	120.00	35880.00		
	LL'	153.00	120.00	18360.00		
	MM'	142.00	120.00	17040.00		
	NN'	206.00	150.00	30900.00		
Total				178540.00	499912.00	89270.00
Q- C (2nd Lode)						
Measured Mineral Resources	JJ'	253.00	115.00	29095.00	(1 cum= 3.5 MT)	(1 cum= 2.5 MT)
	KK'	119.00	120.00	14280.00		
	LL'	75.00	120.00	9000.00		
	MM'	40.00	120.00	4800.00		
	NN'	42.00	150.00	6300.00		
Total				63475.00	177730.00	31737.50
Q-D						
Measured Mineral Resources	DD'	823.00	25.00	20575.00	(1 cum= 2.5 MT)	
	EE'	51.00	25.00	1275.00		
	EE'	1929.00	25.00	48225.00		
	FF'	624.00	25.00	15600.00		
	FF'	951.00	25.00	23775.00		
	FF'	336.00	25.00	8400.00		
	FF'	279.00	25.00	6975.00		
	FF'	630.00	25.00	15750.00		
	GG'	220.00	25.00	5500.00		
	GG'	321.00	25.00	8025.00		
	HH'	149.00	25.00	3725.00		
	HH'	60.00	25.00	1500.00		
	HH'	380.00	25.00	9500.00		
	HH'	210.00	25.00	5250.00		
	HH'	440.00	25.00	11000.00		
	II'	55.00	25.00	1375.00		
	II'	85.00	25.00	2125.00		
	II'	60.00	25.00	1500.00		
Total				190075.00	475187.50	

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Table – 3.6

Gist of the Mineral Resources (As on - 01/04/2014):

	Q-A		Q-B			Q- C				Q-D	Total
			(Main Lode)		(2nd Lode)	(Main Lode)		(2nd Lode)			
	80% recovery of +40%Cr_2O_3	20% recovery of +10% to -40% Cr_2O_3	80% recovery of +40%Cr_2O_3	20% recovery of +10% to -40% Cr_2O_3	(+10% to - 40% Cr2O3	80% recovery of +40%Cr_2O_3	20% recovery of +10 to -40% Cr_2O_3	80% recovery of +40%Cr_2O_3	20% recovery of +10% to -40% Cr_2O_3	(+10% to - 40% Cr2O3)	
Total Resource in MT	661200.40	118071.50	712200.00	127187.50	553875.00	499812.00	89270.00	177730.00	31737.50	475167.50	3446421.40
Total Resource in million ton	0.661	0.118	0.712	0.127	0.554	0.500	0.089	0.178	0.032	0.475	3.446
	0.779		1.393			0.799				0.475	

(B) MINERAL RESERVES:

Mineral reserve is that part of reserve which can be calculated based on taking ultimate pit slope of the working leaving 7.5m from the lease boundary. While assessing the mineral reserves of the deposit, measured categories of resources have been considered and accordingly the mineral reserves are calculated assuming loss due to pit slope and its proximity with the lease boundary. Same method has been considered here as considered for calculating the mineral resources. In this area, Chromite ore is also blocked due to power line barrier and the public road. The mineral reserve of Chromite ore has been estimated and given in **Table – 3.7.**

Table – 3.7

ESTIMATION OF MINERAL RESERVE
(As on - 01/04/2014)

Category of Reserves	Section line	Sectional area in m^2	thickness of the lode	Total volume cum	Total Mineral Reserves in MT	
					80% recovery of +40%Cr_2O_3	20% recovery of +10% to -40%Cr_2O_3
Q-A						
Proved	DD'	37.00	58.00	2146.00	(1 cum= 2.8 MT)	(1 cum= 2.8 MT)
	CC'	162.00	57.00	9234.00		
	BB'	271.00	160.00	43360.00		
Total				54740.00	153272.00	27370.00
Q-B (Main Lode)						
Proved	ee'	202.00	130.00	26260.00	(1 cum= 3.5 MT)	(1 cum= 2.5 MT)
	FF'	452.00	85.00	38420.00		

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	GG'	189.00	135.00	25515.00		
	HH'	238.00	115.00	27370.00		
	II'	278.00	170.00	47260.00		
Total				**164825.00**	**461510.00**	**82412.50**
			Q-B(2nd Lode)			
Proved	ee'	68.00	130.00	8840.00	(1 cum= 2.5 MT)	
	FF'	158.00	85.00	13430.00		
	GG'	92.00	135.00	12420.00		
	HH'	183.00	115.00	21045.00		
	II'	279.00	170.00	47430.00		
Total				**103165.00**	**257912.50**	
			Q- C (Main Lode)			
Proved	JJ'	664.00	115.00	76360.00	(1 cum= 3.5 MT)	(1 cum= 2.5 MT)
	KK'	299.00	120.00	35880.00		
	LL'	153.00	120.00	18360.00		
	MM'	142.00	120.00	17040.00		
	NN'	206.00	150.00	30900.00		
Total				**178540.00**	**499912.00**	**89270.00**
			Q- C (2nd Lode)			
Proved	JJ'	253.00	115.00	29095.00	(1 cum= 3.5 MT)	(1 cum= 2.5 MT)
	KK'	119.00	120.00	14280.00		
	LL'	75.00	120.00	9000.00		
	MM'	40.00	120.00	4800.00		
	NN'	42.00	150.00	6300.00		
Total				**63475.00**	**177730.00**	**31737.50**
			Q-D			
Proved	DD'	823.00	25.00	20575.00	(1 cum= 2.5 MT)	
	EE'	51.00	25.00	1275.00		
	EE'	1796.00	25.00	44900.00		
	FF'	624.00	25.00	15600.00		
	FF'	951.00	25.00	23775.00		
	FF'	270.00	25.00	6750.00		
	FF'	249.00	25.00	6225.00		
	FF'	555.00	25.00	13875.00		
	GG'	220.00	25.00	5500.00		
	GG'	321.00	25.00	8025.00		
	HH'	149.00	25.00	3725.00		
	HH'	60.00	25.00	1500.00		
	HH'	380.00	25.00	9500.00		
	HH'	210.00	25.00	5250.00		
	HH'	440.00	25.00	11000.00		
	II'	55.00	25.00	1375.00		
	II'	85.00	25.00	2125.00		
	II'	60.00	25.00	1500.00		
Total				**182475.00**	**456187.50**	

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Table – 3.8

Gist of the Total Mineral Reserve
(As on - 01/04/2014)

MINERAL RESERVE	Q-A		Q-B			Q- C				Q-D	Total
			(Main Lode)		(2nd Lode) (+25% to -40% Cr2O3	(Main Lode)		(2^{nd} Lode)			
	80% recovery of +40% Cr_2O_3	20% recovery of +10% to -40% Cr_2O_3	80% recovery of +40% Cr_2O_3	20% recovery of +10% to -40% Cr_2O_3		80% recovery of +40% Cr_2O_3	20% recovery of +10% to -40% Cr_2O_3	80% recovery of +40% Cr_2O_3	20% recovery of +10% to -40% Cr_2O_3	+10% to -40% Cr2O3	
Total Reserves in MT	153272.00	27370.00	461510.00	82412.50	257912.50	499912.00	89270.00	177730.00	31737.50	456187.50	2237344.00
Total Reserves in million ton	0.153	0.027	0.462	0.082	0.258	0.500	0.089	0.178	0.032	0.456	2.237

Quarry-wise Gist of Mineral reserve

Quarry	Total Reserve in MT		Total Reserve in million ton	
	(+40% Cr2O3)	(+10% to -40% Cr2O3)	(+40% Cr2O3)	(+10% to -40% Cr2O3)
Q-A	153272.00	27370.00	0.153	0.027
Q-B(Main Lode)	461510.00	82412.50	0.462	0.082
Q-B (2nd Lode)	-	257912.50	-	0.258
Q- C	499912.00	89270.00	0.500	0.089
Q- C (2^{nd} Lode)	177730.00	31737.50	0.178	0.032
Q-D	-	456187.50	-	0.456
Total	**1292424.00**	**944890.00**	**1.293**	**0.944**

FEASIBILITY MINERAL RESOURCES (As on - 01/04/2014):

It has been found that at ultimate stage, some ore will be blocked due to 7.5m safety barrier, pit slope, H.T Line barrier and road barrier which has been estimated below:

Table – 3.9

Category of Resources	Section line	Sectional area in m^2	thickness of the lode	Total volume cum	Total Mineral Resources in MT	
					80% recovery of +40%Cr_2O_3	20% recovery of +10% to -40%Cr_2O_3
Q-A						
Feasibility	EE'	405.00	87.00	35235.00	(1 cum= 3.5 MT)	(1 cum= 2.5 MT)
	DD'	336.00	58.00	19488.00		
	CC'	440.00	57.00	25080.00		

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	BB'	635.00	160.00	101600.00		
Total				181403.00	507928.40	90701.50
Q-B= (Main Lode)						
Feasibility	ee'	330.00	130.00	42900.00	(1 cum= 3.5 MT)	(1 cum= 2.5 MT)
	GG'	141.00	135.00	19035.00		
	HH'	181.00	115.00	20815.00		
	II'	40.00	170.00	6800.00		
Total				89550.00	250740.00	44775.00
Q-B(2nd Lode)						
Feasibility	ee'	382.00	130.00	49660.00	(1 cum= 2.5 MT)	
	FF'	82.00	85.00	6970.00		
	GG'	253.00	135.00	34155.00		
	HH'	240.00	115.00	27600.00		
Total				118385.00	295962.50	
Q-D						
Feasibility	EE'	133.00	25.00	3325.00	(1 cum= 2.5 MT)	
	FF'	66.00	25.00	1650.00		
	FF'	30.00	25.00	750.00		
	FF'	75.00	25.00	1875.00		
Total				7600.00	19000.00	
G. Total				396938.00	1263298.00	

Table – 3.10

Gist of the Feasibility Mineral Resources
(As on - 01/04/2014)

RESOURCES	Q-A		Q-B			Q- C		Q-D	Total
			(Main Lode)						
	80% recovery of +40% Cr_2O_3	20% recovery of +10% to -40% Cr_2O_3	80% recovery of +40% Cr_2O_3	20% recovery of +10% to -40% Cr_2O_3	(2nd Lode) (+10% to -40% Cr2O3)	(Main Lode) (+40% Cr2O3	(2nd Lode) (+40% Cr2O3	(+10% to -40% Cr2O3)	
Total Feasibility Resources in MT	507928.40	90701.50	250740.00	44775.00	295962.50	-	-	19000.00	1209107.40
Total Feasibility Resources in million ton	0.508	0.091	0.251	0.045	0.296	-	-	0.019	1.21

Quarry	Total Feasibility Resources in MT		Total Feasibility Resources in million ton	
	(+40% Cr2O3)	(+10% to -40% Cr2O3)	(+40% Cr2O3)	(+10% to -40% Cr2O3)
Q-A	507928.40	90701.50	0.508	0.090
Q-B (Main Lode)	250740.00	44775.00	0.251	0.045
Q-B (2nd Lode)	-	295962.50	-	0.296
Q-C	-	-	-	-

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Q- C (2nd Lode)	-	-	-	
Q-D	-	19000.00	-	0.019
Total	758668.40	450439.00	0.759	0.450

CLASSIFICATION OF RESERVE AS PER UNFC SYSTEM:

UNFC system has been adopted to categorize the mineral Resources and reserves. For the estimation of different mineral reserves, Occurrences of mineral of intrinsic economic interest, location, grade, quantity, geological characteristic etc has been studied in detailed and are given hereunder:

Table – 3.11

For (121) category of Mineral Reserve:

UNFC axis and code	Guideline		Studies Done
G1 (Detailed Exploration)	1	**Geological survey** (i) Mapping for coal mapping1:5000 for other minerals1:1000 (ii) Preparation of detailed topographical-cum-geological map including all the surface geological features, extent of deposit, structure, location of boreholes, assay plan and section of exploratory mine development and borehole data. (iii) Topo-grid/triangulation stations/identified fiducialy linking in the map.	Detailed geological survey has been done on 1:2000 scale. Detailed topographical-cum-geological map including all required features has been prepared. The total ML area is structurally deformed and formed a synclinal basin. The total area is regionally folded. The Chromite is occuring mainly as magmatic segregation in ultrabasic rocks of Archean age. Chromite mainly occurs as main lode and side lode. The maximum elevation of the area is 192 mRL located towards south eastern boundary of the area whereas minimum elevation is 137 mRL on the North-west of leasehold area. General sloping is towards Westerly. Exploration was carried out GSI as well as lessee to explore the extension of the Chromite lode. Exploration during the last approved scheme period was carried out by putting 12 numbers of boreholes around quarry no. D. But Five bore hole give the negative result. Based on the lode exposed in the existing quarries and bore holes encountered the Chromite lode, mineralized zone G1 has been marked. The Chromite lode extend approximately 2.5 km in the lease are. It is revealed

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			from the borehole data that Chromite ore is continuing maximum up to the depth of 80. The proved depth has been considered up to which depth the bore hole encountered the Chromite lode which is varying from section to section. From the section the Chromite lode has been marked on the surface geological plan around quarry-D by taking the vertical projection from it. Based on the exposed chrome lode in the exposed quarry and the exploration carried out during the last approved scheme of mining the fresh reserve has been estimated on the basis of the UNFC classification.
	2.	**Geochemical survey:** Detailed grid pattern sampling and analysis.	Not Done.
	3.	**Geophysical survey** Detailed and specific borehole geophysical survey.	As the geological study was carried out by studying the open quarries and exploration carried out in the area, Geophysical survey is not necessary.
	4.	**Technological** 1. Pitting-2.5per square Km. For sample deposit 2. Trenching-At spacing of 200-300m 3. Drilling-closer spaced (with definite grid pattern)then that for G2 category);(a)For coal density of boreholes to be 12-15 per sq.KM depending on the complexities for geo-structural proving;(b)For opencast project grid spacing may be 100X50m depending on the geology, weather mantle cover, burning nature of coal seams. **4.** Exploratory mining and check drilling results if possible;	The leasehold area is explored by putting no. of bore holes by the lessee, from time to time to prove the presence of Chromite lode. The area is also explored by GSI. The total area consists of six no. of quarries. But at present quarry- B & C merges into the single quarry. During the last approved scheme of mining exploration was carried out by putting 12 numbers bore hole around the quarry no. D. From the drill hole data it is clear that the Chromite lode extend up to 80m at depth and the depth of the Chromite lode is variable from quarry to quarry depending upon the bore hole encountered the Chromite lode. Based on that the mineralized zone has been marked at depth as well as on the surface geological plan taking the vertical projection.
	5.	Sampling- systematic pit and trench sampling core and sludge sampling for laboratory scale and bulk samples for the pilot plant scale beneficiation studies.	Since it is an old working mine, Sampling and analysis of Chromite is a regular practice and has been carried out regularly. The nickeliferous limonite was stacked separately in the leasehold for future. The analysis report of the Chromite from the quarry is enclosed as

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			Annexure- 10.
	6.	Petrographic and mineragraphic study: Refining of data on the petrographic characters of rocks of the deposits and its surroundings, alternations (if any), including study of grain size texture gangue and its liberation characteristics for further refining of data.	Not required.
	7.	Geo-statistically analysis of borehole data. Thickness of ore, waste encountered in holes assays values of samples if considered necessary.	From the borehole data, thickness of the ore body has been determined, analysis of samples are carried out.
F2 (Feasibility Study)	1.	**Geology:** Geology of area and project, detailed exploration, closed spaced drilling, ore body modeling, bulk samples for beneficiation, geotechnical and ground water & surface water studies to be carried out depending upon coal qualities.	Detailed geological studies have been carried out on the basis of exposed ore body in the quarries and exploration carried out in the past as well as during last approved scheme. Topographically, this mine represents almost undulated hilly terrain with hillocks and valleys. The area is structurally deformed. A perennial stream situated towards the northern portion of the lease boundary flowing from eastern to western portion of the area. A tributary also join with this perennial nala. Based on the lode exposed in the existing quarries and bore holes encountered the Chromite lode, mineralized zone G1 has been marked. The Chromite lode extend approximately 2.5 km in the lease area. It is revealed from the borehole data that Chromite ore is continuing maximum up to the depth of 80m. The existing lease period has expired on 14.05.2014 and thereafter, mining lease is under the renewal process. FC for the renewal of the lease is still awaited and lessee till not gets the fresh EC of 350000 MT, the feasibility of total reserve will come under the F2 category.
	2.	**Mining:** Mining plan, mine recoveries and efficiencies, equipment selection, manpower requirement.	The mining operation is carried out by open cast fully mechanized method of mining. All the quarries are being operated by adopting a system of deep-hole blasting and deployment of heavy machinery for excavation and removal of OB. The same method will be continued by a combination of L&T Back-Hoe Komatsu 2.1cum bucket capacity with 22

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			tonne and 10 ton capacity dumpers. The height of individual bench shall be kept at 6 meter with a width of 12m. A platform of 15 m width shall be left after every four benches to maintain the slope stability of the bench. Bench slope is kept at 70° with an overall pit slope of 22° to 25°. 12m-width haulage road at 1:16 gradient and short ramp at 1:10 gradient are made and maintained to reach the quarry floor. Wherever felt necessary deep-hole blasting by 4" diameter wagon drill is done. The details of machinery deployed in the mine is listed and given in **Chapter-4.**
	3.	**Environment:** EIA studies and EMP including socioeconomic impact, rehabilitation of project affected persons, waste disposal/reclamation, and detailed land use data.	Lessee has got the EC for the production capacity of 0.136 million tons of chrome ore. Further, lessee wants to enhance the production capacity from 0.136 million TPA to 0.350 million TPA. EIA/EMP has been prepared and submitted to MOEF, New Delhi. The final presentation on the above was held and EC for production capacity of 0.350 million TPA is expected soon.
	4.	**Processing:** Pilot scale/industrial scale investigation data ,list of equipment, manpower and environmental considerations like waste disposal tailing etc.	The ore of -150 mm having 25% to 40% Cr_2O_3 generated from the mines in course of mining is fed to the plant. The feed ore from the stock pile is brought to the plant site in dumpers and fed directly into the feed Hopper. Ore is drawn from the hopper with the help of reciprocating feeder. The detail of beneficiation process, feed grade, recovery after beneficiation, its grade etc is explained in **chapter – 10**.
	5.	**Infrastructure and services, construction activities :** **Full details.**	A pucca R.C.C. roof constructed mine administrative office, work-shop & store, Laboratory, Dispensary and other statuary infrastructure like V.T. Center, Canteen, Creche, Site office cum First-Aid room, worker's recreation center etc. exist in the leasehold area. A colony having residential quarters for workers and staff, Guesthouse, Director's Bungalow, Security barrack, Weigh Bridge, Electrical Substation, School, market complex etc. existing inside the lease-hold. There is also a P.W.D road passes through the leasehold area.

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	6.	**Costing:** Detailed breakup of capital cost, operating cost, detailed working capital	Detailed breakup of capital cost, operating cost, working capital etc. are regularly done by the chartered accountant which is described in the Feasibility study
	7.	**Marketing:** Overview, specific market aspects	Chromite used to harden steel, to manufacture stainless steel and to form alloys, in plating to produce a hard, beautiful surface and to prevent corrosion, used by the aircraft and in refractory industries. From the total production 0.20 mt will be used for captive ferrochrome plant (2 nos.) and 0.10 mt will be used for the COB plant situated within lease. Rest of the production shall be sold to different consuming industries.
	8.	**Economic viability:** Cash flow forecast, inflation affects sensitivity studies.	It is done by the chartered accountant.
	9.	**Other factors:** Statutory provisions relating to labour, land, mining, taxation etc.	All statutory provisions have been taken care of in the mining plan, subsequent Scheme of Mining and will be regularly complied with. Lease is under Renewal.
E1 (Economic)	1.	**Detailed exploration**	Detailed exploration was carried out in the area by core drilling from time to time by the lessee and GSI and on that basis mineral reserve has been estimated. The ore of this mine is suitable for different industries and for export also.
	2.	**Mining report /Mining Plan/Working Mines**	Presently mining operation in Saruabil Chromite mine is temporary discontinued from 05.10.2013 under the direction of Deputy Director of Mines, Jajpur, Odisha but there is no such violation under MCR, MMRD, MCDR or any other rules/Act.
	3.	**specific end use grades of reserves (above economic cutoff grade)**	The mine produces Chrome ore which is very much suitable for different consuming industries. The ore contain +40% and above Cr_2O_3 will be utilized for captive Ferro Chrome plant whereas ore contains +25% to -40% Cr_2O_3 will be utilized for captive Chrome Ore Beneficiation plant. The Chrome ore of this mine has good market for export and domestic consumer as per their requirement in both quality and quantity. The name of some of the consignee industries are given in chapter – 8.

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			The Chemical Analysis report of [illegible] one from NABL accredited lab [illegible] enclosed as **Annexure-18**.
	4	**Specific knowledge of forest/non-forest and other land use data.**	An area of 241.318 Ha falls under Forest category and is under Athagarh Forest Division, Odisha.

The estimated mineral reserve and resources has been presented below in **Table – 3.12**.

Table - 3.12

PRESENTATION OF MINERAL RESOURCES AS PER UNFC
(As on :- 01/04/2014)

	Category	Code	Quantity in million tonne	Grade %
Total Resources	(A + B)	-	3.446	(+10% Cr2O3)
A. Reserve	Proved	(111)	-	-
	Probable	(121)	1.293	(+48% Cr2O3)
			0.944	(+10% to -48% Cr2O3)
		(122)	-	-
B. Remaining Resources	Feasibility Mineral Resources	(221)	0.759	(+48% Cr2O3)
			0.450	(+10% to -48% Cr2O3)
	Pre-feasibility Mineral Resources	(222)	-	
	Measured Mineral Resources	(331)	-	
	Indicated Mineral Resources	(332)	-	
	Inferred Mineral Resources	(333)	-	
	Reconnaissance Mineral Resources	(334)	-	

Estimation of life of the mine:

Based on the previous exploration, present status of the chrome lode exposed in the quarry fresh reserve has been estimated. The total amount of reserve is 2237314.00 MT for the entire lease area. So, taking the maximum production target of 0.350 million tons per annum, the anticipated life of the mine is 6.39 year.

Parameters	Within entire lease
Mineral Reserve of ROM (MT)	2237314.00
Proposed Production of ROM / year (max) (million tons)	0. 350
Life of the mine (Years)	6.39

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[**Note:** IBM/ GSI estimated total in-situ reserve of 8.86 million ton of all categories taking the maximum depth is 200m **(Ref. Annexure-12, page no. 17)**. From this period the total production up to 2010 of the Chromite of all grades is 1.21 million ton. So the anticipated life of the mine is 21.85 years considering the depth of the Chromite lode is 200 m form the surface.]

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4.0 MINING

a) Briefly describe the existing / proposed method for developing /working the deposit with all design parameters.

The period of approved Scheme of Mining of this mine was up to 14.05.2014 and the current lease period is also going to expire on 14.05.2014. As the lease area contains both forest and non-forest land and lessee has got forest clearance over the entire forest land but after expiry of the lease, as per the FC Act 1980, there is no diverted forest land and the valid forest clearance is co-terminus with lease period (14.05.2014). Application has been made for the forest clearance over total area. Therefore, mining operation can be started only after getting the forest clearance. However, this mining plan has been prepared under Rule 24A of MCR, 1960 for the next five years period from **15.05.2014 (2014-15) to 2018-19** and accordingly the development and production proposals have been chalked out for the said period.

Existing Quarries: The area has been extensively worked by developing seven numbers of quarries, namely Quarry Nos. 1&2, 4, 5, 5A & 6 and 7. Since some of the quarries have been merged, the name of the quarries has been changed as **Quarry – A** (for qry 1&2), **Quarry – B** (for Qry 8), **Quarry – C** (for qry 5,5A & 6) and **Quarry – D** (for qry 7). For the next five years plan period, it has been planned to work all the existing quarries. The quarry-wise information is give as under:

Quarry-A (1&2):

This quarry is located in the north-west corner of the leasehold. During the next five years plan period developmental proposal of this quarry A has remaining same as there is no development work was carried out during the last scheme period. The present dimension of the quarry is 320 m x 178 m (approx.). The number of benches on both hang wall and footwall sides are 7 manual 3 mechanical and 16 manual, 5 mechanical respectively. The quarry has reached a maximum depth of 29.45 m (113.63 mRL).

Quarry-B(4):

The ore raised from this quarry is friable and high grade. During the last scheme period, this quarry was worked by mechanical method. The proposal of the development is remaining same during this plan period. The present quarry dimension is 650 m x 245 m (approx.).

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There are 9 number of benches on hang wall side and 6 numbers on footwall side. The present depth reached is 43.08 m (118.86 mRL).

Quarry-C (5 & 5A and 6) :-

At present Quarry-5 & 5A and 6 merges together and form into a single quarry named as Quarry - C. These quarries are located adjacent to Quarry No. B (East) on the southern limb of the fold. The general strike of the formation is N 30° E – S 30° W with a dip of 50° – 75° at N 60° W. On the southern end of quarry C the ore body has been dragged by an oblique fault and the strike became N 40° W – S 40° E. The nature of the ore in these quarries is mostly friable and high grade. This quarry is located on the south-western side of Quarry C near the western boundary of the lease and is situated at a higher elevation. On the eastern portion low to medium grade ore is exposed with a band of Talc-Serpentine. The grade of the ore improves on the south-western end of the quarry. The present quarry dimension is 690 m x 312 m (approx.). There are 14 number of benches on hang wall side and 8 numbers on footwall side. The present depth reached is 63.42 m (118.60 mRL).

Quarry-D (7):

Quarry D is situated on the South-western part of the leasehold. Chrome ore occurs in the form of thin veins varying is erratic in nature. The strike of the ore body is in the quarry towards NE–SW direction dipping towards SE. The ore is mostly friable and of low grade. The quarry was worked manually in the past. No work has been carried out during the last scheme period. The same proposal is given during the plan period. The ore is of low-grade in nature and suitable for upgrading by beneficiation in our own chrome ore beneficiation plant. The present quarry dimension is 253 m x 132 m (approx.). The present depth reached is 34.25 m (153.00 mRL). Details of Quarry Dimension, strike length and depth reached by each quarry is given in Table - 4.1

Table – 4.1

Sl. No.	Name of the Quarry		Avg. Dimension of Quarry (in m)	Strike Length (m)	Depth reached (mRL)
	New Name	Old Name			
1	A	1&2	320 x 178 (approx.)	350	113.68
2	B	4	650 x 245 (approx.)	655	119.85
3	C	5,5A&6	690 x 312 (approx.)	725	118.18
4	D	7	253 x 132 (approx.)	285	153.00

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Dimension of Existing Waste, scattered dump, Nickeliferous Limonite Dump, sub-grade dump and Ore stack

Dump No.	Location	Spread (m^2)	Dimension (Lxb)	Height (m)
Waste Dump				
WD-1	Northern western part of Quarry-A	10920	168x65	12.20
WD-2/3	South Western part of lease area	128241	493x260	45.00 (partly)
WD-4	Amalgamated with Dump 2/3			
WD-6	Nothern part of Qry-B	21320	290x73	7.22
WD-8 &9	SE part of Qry-C	26074	205x127	7.90
WD-10	Northern part of Qry-D	17801	175x102	19.00
WD-11	Centre of lease area	205137	622x328	36.00
Scattered Dump				
SWD-1	East side of Qry-A	3673	100x36	1.45
SWD-2	East side of Qry-A	4861	75x64	4.27
SWD-3	North east of Qry-C	7268	134x54	2.83
SWD-4	North east of Qry-C	5790	85x68	5.02
SWD-5	South of reservoir	16707	160x104	0.72
SWD-6	SE of Qry-C	28536	600x47	0.5
SWD-7	SE of Qry-C	5568	100X55	8.06
SWD-8	SE of Qry-C	1214	55X22	2.05
SWD-9	East of reservoir	7641	100x76	1.59
Nickel Dump				
ND-A	SE of Qry-C	2423	68x35	6.50
ND-B	SE of Qry-C	1691	43x40	6.10
ND-C & D	Near reservoir	21629	170x127	10.0
ND-E	Western part of Qry-A	2244	65x34	7.10
SUB GRADE DUMP				
SG-1	Northern part of lease area	3939	90x64	8.0
MINERAL STORAGE				
PO-1	Western part of Qry-B	9060	140x64 (19157.49 MT)	2.01
PO-2	Western part of Qry-B	16174	170x95 (28441.30 MT)	2.16
PO-3	Northern side Qry-B	6628	150x44 (39339.71MT)	3.4
PO-4	North east part	2005	62x32	2.12

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	of Qry-B		(1330.22 MT)	
PO-5	Eastern part of Qry-C	9115	100x92 (7401.546 MT)	9.12

The analysis report of existing dumps is enclosed as **Annexure – X**.

Existing Mining Method:

The mining operation is carried out by open cast fully mechanized method of mining. All the quarries are being operated by adopting a system of deep-hole blasting and deployment of heavy machinery for excavation and removal of OB. The same method will be continued by a combination of L&T Back-Hoe Komatsu 1.7cum bucket capacity with 22 tone and 10 ton capacity dumpers. The height of individual bench shall be kept at 6 meter with a width of 12 m. A platform of 15 m width shall be left after every four benches to maintain the slope stability of the bench. Bench slope is kept at 70° with an overall pit slope of 22° to 25°. 12m-width haulage road at 1:16 gradient and short ramp at 1:10 gradient are made and maintained to reach the quarry floor. Whenever felt necessary deep-hole blasting by 4" diameter wagon drill is done.

Generally the excavation OB is being carried out to get the ore. After proper development the R.O.M is being raised and stacked in the earmarked area as approved mining scheme. After proper analysis, we get different grade of processed ore which are being stacked separately in the ear-marked area.

Proposed Mining Method:

The lease area contains both forest and non-forest land and accordingly mining and allied activities have been carried out in both the areas. Lessee has got the forest clearance over entire forest land but as the current lease period is going to be expired on 14.05.2014. After expiry of the lease, as per the FC Act 1980, there is no diverted forest land and the valid forest clearance is co-terminus with lease period (14.05.2014). Application has been made for the forest clearance over total area. Therefore, mining operation can be started only after getting the forest clearance.

Same method of mining is proposed in the plan period. The height of individual bench is kept at 6m with a width of 12m. Bench slope is kept at 70° with an overall pit slope of 22° to 25° with a width of 15m. Bench slope is kept at 70° with an overall pit slope of 22° to 25°. 15 m width haulage road at 1:16 gradient and short ramp at 1:10 gradient are made and maintained to reach quarry floor.

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Salient features of chrome ore deposit to be exploited in the coming years are as under:-

1). Mineable Reserve of chrome ore = 2329630.00 MT

2). Average depth of deposit to be worked by O/C method = 80 m from the surface level

3). Strike of deposit: Varying from E-W to NE-SW to WNW-ESE to NW-SE.

4). Amount of dip: Varying from 10^0 to 80^0 mostly 40^0 to 50^0.

5). Average Chemical Composition =

Cr_2O_3 = +10 to +52 % & above
Fe = 11 to 17 %
SiO_2 = 3.5 to 7.5 %

6) Nature of Ore : Mostly friable form.

7). Ore: OB Ratio: 1: 4.52 (ton/m^3) during last approved Scheme of Mining (2010-11 to 2014-15)

The detail of development schedule and the parameters considered pertaining to recovery and conversion factor is given below.

a) Recovery = 100 % of main lode (80% is +40% Cr2O3 and 20% (+10% to -40% Cr2O3 from main lode.

b) For chromite ore: 1 cum = 3.5 MT (For +40% Cr2O3 grade ore)

1 cum = 2.5 MT (For +10% to -40% Cr2O3 ore from the contact zone of the main chrome lode, low grade ore from the side lode of quarry-4 and lode of Quarry-7. This ore is being utilized in COB plant to improve the grade)
[As observed from the data of working mines]

The details of Excavation and production for this five years plan period from the area are given in table below:

Year-wise Excavation and Development During the five year Plan period (2014-15 to 2018-19):

Quarry Layout:

The present pit position and the proposed pit configuration and layout of benches at the end of first, second, third, fourth and fifth year of excavation based on the mineral reserve and projected schedule are given in **Plate- 9(A-E)**. Efforts have been made to prepare the plans on the basis of proposed year-wise development and production. In the next five years, excavator (1.7 cum and 4.0 cum bucket capacity) with combination of 16 cum and 30.33 cum dumper shall be deployed for both production and development work. The calculations and capacity of the machine is given accordingly. Based on the targeted production for

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every year during the plan period the benches have been designed and reflected in Plate 9(A-E). 6 meters high and 12 meters wide benches are proposed. A platform of 15 m after every four benches shall be left to maintain the slope stability. Also ramps have been provided to reach the quarry floor and for smooth movement of HEMM and dumpers, keeping an overall pit slope of 26°.

Plan period:

1st Year Development (2014-15):

In the 1st year of plan period i.e. (2014-15), it has been planned to work quarry no. A, B, C and D to achieve the targeted production of chromite ore. The total production will be achieved from section BB' to DD' of quarry no A, ee' to HH' of quarry-B for both main vein and 2nd vein; JJ' to KK' of the quarry-C; ss' to uu' of quarry-D for the above production. Work shall be carried out both laterally as well as at depth maintaining the overall pit slope 22°-26° and bench slope 70° with proper bench parameter 6m height and 12m width with 15m platform after every four benches. During the last scheme period no work was carried out in the quarry- A and D. In Quarry- A, the proposed working RL shall be 121.00 to 118.00 m, in quarry- B, the working RL shall be 132.15 to 113.00 for the main lode and 136.28 to 113.00m for the side lode and 125.00 to 113.00 m for the Quarry- C. The total excavation in this year due to development of these benches shall be 1092811.00 cum to produce the 239607.20 MT of saleable ore, 42787.00 MT low grade ore from contact zone, 87605.00 MT low grade ore will be generated. The total generation of waste is given in chapter no. 7. The detail of bench-wise excavation is given in **Table -4.2** and shown in development plan **(Plate –9A)**.

Table -4.2

Table showing First year Excavation of Ore (2014-15)

Quarry	Section	Working RL	Sectional Area (Sq. m)	Length of influence (m)	Volume (Cum)
Qry A	BB'	121.00-118.00	53.26	110.00	5859.00
	Total				-
Qry B (Main Vein)	ee'	132.15-125.00	73.00	70.00	5110.00
	ee'	125.00-119.00	72.00	55.00	3960.00
	FF'	125.00-119.00	25.00	85.00	2125.00
	GG'	124.90-119.00	10.00	135.00	1350.00
	HH'	126.30-119.00	8.00	115.00	920.00
	FF'	119.00-113.00	87.00	85.00	7395.00

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	GG'	119.00-113.00	64.00	135.00	
	HH'	119.00-113.00	60.00	115.00	
	Total				36400.00
Qry No.- B (Low Grade, 2nd Vein)	HH'	136.26-131.00	41.50	120.00	4980.00
	ee'	132.15-125.00	35.00	70.00	2450.00
	FF'	132.15-125.00	32.50	85.00	2762.50
	FF'	125.00-119.00	26.00	85.00	2210.00
	GG'	127.81-122.17	4.50	135.00	607.50
	FF'	119.00-113.00	12.00	85.00	1020.00
	Total				14030.00
Qry No. C (MainVein)	KK'	125.00-119.00	5.00	120.00	600.00
	JJ'	119.00-113.00	80.00	115.00	9200.00
	KK'	119.00-113.00	78.00	120.00	9360.00
	Total				19160.00
Qry No. C (2nd Vein)	JJ'	126.83-119.00	31.00	100.00	3100.00
	KK'	125.00-119.00	30.00	120.00	3600.00
	JJ'	119.00-113.00	36.00	115.00	4140.00
	KK'	119.00-113.00	38.00	120.00	4560.00
	Total				15400.00
Qry No. C (MainVein)	LL'	119.00-113.00	58.00	110.00	6380.00
	Total				6380.00
Qry No.C (2nd Vein)	LL'	125.00-119.00	19.00	125.00	2375.00
	Total				2375.00
Qry No.D (Low Grade Ore)	ee'	155.00-149.00	15.00	150.00	2250.00
		149.00-143.00	25.13	150.00	3769.00
	e'	161.00-155.00	23.31	100.00	2331.00
		155.00-149.00	23.31	100.00	2331.00
		149.00-143.00	23.31	100.00	2331.00
	Total				13012.00

Table showing First year Excavation of waste & Nickeliferous limonite (2014-15)

Year & Quarry No.	Section	Excavation from Nickeliferous Limonite zone (In-situ)			Excavation from Waste Overburden (In-situ)		
		Sectional area (sq.m.)	Influence Length (m)	Quantity (Cu.m.)	Sectional area (sq.m.)	Influence Length (m)	Quantity (Cu.m)
Qry No.A	B-B'	435.00	100.00	43500.00	406.00	100.00	40600.00
Total				43500.00			40600.00
Qry No. B	e-e'	378.00	70.00	26,460.00	83.00	70.00	5,810.00
	F-F'	163.00	85.00	13,855.00	296.00	85.00	25,075.00
	G-G'	63.00	135.00	8,505.00	455.00	135.00	61,425.00
	H-H'	129.00	115.00	14,835.00	419.00	115.00	48,185.00

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Total				63,655.00			
Qry No. C	J-J'	79.00	115.00	9,085.00	888.00	115.00	102,120.00
	K-K'	148.00	120.00	17,760.00	761.00	120.00	91,320.00
	L-L'	210.00	120.00	25,200.00	388.00	120.00	46,560.00
Total				52,045.00			240,000.00
Qry. No. D	W	-	-	-	1130.00	150.00	169500.00
	E	-	-	-	1280.0	180.00	230400.00
Total							399900.00
Total				159200.00			820995.00

Table showing proposed production of chromite Ore during 2014-15

Quarry	Total excavation in ore	(+40% Cr2 O3) Ore (80% of A)		(+10 to -40% Cr2 O3) from Contact Zone (20% of A)		(+10 to -40% Cr2 O3) ore	
	A	B		C		D	
	Cum	Cum	1 Cum= 3.5 MT	Cum	1Cum=2.5 MT	Cum	1Cum=2.5 MT
QRY A	5859.00	4687.20	16405.20	1171.80	2929.50	-	-
QRY- B	36400.00	29120.00	101920.00	7280.00	18200.00	14030.00	35075.00
QRY- C	19160.00 15400.00	27648.00	96768.00	6912.00	17280.00	-	-
	34560.00						
QRY- C	6380.00 2375.00	7004.00	24514.00	1751.00	4377.50	-	-
	8755.00						
QRY- D	-	-	-	-	-	13012.00	32530.00
Total	85574.00		239607.20		42787.00	27042.00	67605.00

Summary:

Excavation from ore zone	= 112616.00 cum
Excavation from Waste zone	= 820995.00 cum
Excavation from N/Limonite zone	= 159200.00 cum
Total Excavation	= 1092811.00 cum
Saleable ore	= 239607.20 MT (+40% Cr2 O3)
Low-grade ore From Contact Zone	= 42787.00 MT (+10 to -40% Cr2 O3)
Low grade ore	= 67605.00 MT (+10 to -40% Cr2 O3)
Total Production	= 349999.20 MT

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Balance sheet of mineral reserve at the end of 1st year plan period (2014 -15)

Chrome ore in M.T.					
Opening balance on 15.05.2014		Production		Closing Balance on 31.03.2015	
(+40% Cr2O3)	(+10% to -40% Cr2O3)	(+40% Cr2O3)	(+10% to -40% Cr2O3)	(+40% Cr2O3)	(+10% to -40% Cr2O3)
1292424.00	944690.00	239607.20	110392.00	1052816.80	834498.00

2nd Year Development (2015-16):

In the 2nd year of plan period i.e. (2015-16), it has been planned to work to meet the targeted production of chromite ore from quarry no. A, B, C and quarry- D. The total production will be achieved from section BB' to DD' of quarry no A, ee' to HH' of quarry- B for both main vein and 2nd vein; JJ' to KK' of the quarry- C; ss' to uu' of quarry-D for the above production. Work shall be carried out both laterally as well as at depth maintaining the overall pit slope 22°-26° and bench slope 70° with proper bench parameter 6m height and 12m width with 15m platform after every four benches. In Quarry- A the proposed working RL shall be 121.00 to 109.00m, in quarry- B the working RL shall be 119.00 to 107.00 for the main lode and 131.00 to 107.00 m for the side lode, 131.00 to 113.00 m for the Quarry- C. The total excavation in this year due to development of these benches shall be 1932114.57cum excavation to produce the 250000.00 MT of saleable ore, 44642.85 MT low grade ore from contact zone, 55357.00 MT low grade ore will be generated. The total generation of waste is given in chapter no. 7. The detail of bench-wise excavation is given in Table -4.3 and shown in development plan (**Plate –9B**).

Table -4.3

Table showing the second year Excavation of Ore (2015-16)

Quarry	Section	Working RL.	Sectional Area (Sq. m)	Length of Influence (m)	Volume (Cum)
Qry A	BB'	121.00-115.00	42.00	90.00	3780.00
	CC'	115.00-109.00	95.448	80	7635.71
	Total				**11415.71**
Qry B (Main Vein)	ee'	119.00-113.00	77.00	77.00	5929.00
	ee'	113.00-107.00	77.00	65.00	5005.00
	FF'	113.00-107.00	89.00	85.00	7565.00
	GG'	113.00-107.00	89.00	135.00	9315.00
	HH'	113.00-107.00	63.00	120.00	7560.00
	Total				**35374.00**
Qry No.- B	ee'	131.00-125.00	16.00	101.00	1616.00

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(Low Grade, 2nd Vein)	GG'	131.00-125.00	20.00	135.00		
	ee'	125.00-119.00	47.00	89.00		
	GG'	125.00-119.00	10.00	135.00		1350.00
	FF'	119.00-113.00	31.00	85.00		2635.00
	FF'	113.00-107.00	34.00	85.00		2890.00
	Total					**29654.00**
Qry No. C (Main Vein)	mm'	125.00-119.00	5.00	87.00		435.00
	MM'	119.00-113.00	51.00	145.00		7395.00
	mm'	119.00-113.00	57.00	75.00		4275.00
	Total					**12105.00**
Qry No.C (2nd Vein)	MM'	131.00-125.00	1.00	145.00		145.00
	MM'	125.00-119.00	10.00	145.00		1450.00
	mm'	125.00-119.00	18.00	87.00		1566.00
	MM'	119.00-113.00	11.00	145.00		1595.00
	mm'	119.00-113.00	19.00	75.00		1425.00
	Total					**30391.00**
Qry No.D(Low Grade Ore)	aa'	185.00-179.00	4.31	80.00		344.80
		179.00-173.00	13.00	80.00		1040.00
		173.00-167.00	13.00	80.00		1040.00
		167.00-161.00	13.00	80.00		1040.00
		161.00-155.00	13.00	80.00		1040.00
		155.00-149.00	13.00	80.00		1040.00
		149.00-143.00	13.00	80.00		1040.00
	tt'	143.00-137.00	18.00	100.00		1800.00
	aa'	143.00-137.00	18.00	150.00		2700.00
	Total					**11054.80**

Table showing Second year Excavation of waste & Nickeliferous limonite (2015-16)

Quarry No.	Section	Nickeliferous Limonite Overburden (In-situ)			Waste Overburden (In-situ)		
		Sectional area (Sqm)	Influence Length (m)	Quantity (Cum)	Sectional area (Sqm)	Influence Length (m)	Quantity (Cum)
Qry. No. A	B-B'	255.00	90.00	22950.00	126.00	90.00	11340.00
	C-C'	456.00	80.00	36480.00	925.00	80.00	74000.00
Total				**59430.00**			**85340.00**
Qry. No. B	e-e'	360.00	70.00	25,200.00	1046.00	70.00	73,220.00
	F-F'	125.00	85.00	10,625.00	1,022.00	85.00	86,870.00
	G-G'	98.00	135.00	7,560.00	1255.00	135.00	169,425.00
	H-H'	1.00	115.00	115.00	160.00	115.00	18,400.00

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	I-I'	66.00	170.00	9,520.00	813.00	170.00	[illegible]
Total				**53,020.00**			
Qry No. C	J-J'	91.00	115.00	10,465.00	754.00	115.00	86,710.00
	K-K'	189.00	120.00	22,680.00	1240.00	120.00	148,800.00
	M-M'	244.00	120.00	29,280.00	1300.00	120.00	156,000.00
	n-n'	248.00	165.00	40,920.00	2344.00	165.00	386,760.00
Total				**103,345.00**			**778,270.00**
Qry -D	uu'	-	-	-	32.00	80.00	2560.00
	tt'	-	-	-	1200.00	100.00	120000.00
	ss'	-	-	-	1100.00	150.00	165000.00
Total							**287560.00**
Total				**215795.00**			**1586295.00**

Table showing proposed production of chrome Ore during 2015-16

Quarry	Total excavation in ore	(+40% Cr2 O3) Ore (80% of A)		(+10 to -40% Cr2 O3) from Contact Zone (20% of A)		(+10 to -40% Cr2 O3) ore	
	A	B		C		D	
	Cum	Cum	1Cum=3.5 MT	Cum	1Cum=2.5 MT	Cum	1Cum=2.5 MT
QRY- A	11415.71	9132.57	31964.00	2283.14	5707.85	-	-
QRY- B	35374.00	28299.20	99047.20	7074.80	17687.00	11058.00	27645.00
QRY- C	-	-	-	-	-	-	-
QRY- C	12105.00 30391.00	33996.80	118988.80	8499.20	21248.00	-	-
	42496.00						
QRY- D	-		-		-	11084.66	27712.00
Total	**89285.71**		**250000.00**		**44642.85**	**40738.86**	**55357.00**

Summary:

Excavation from ore zone	= 130024.57 cum
Excavation from Waste zone	= 1586295.00 cum
Excavation from N/Limonite zone	= 215795.00 cum
Total Excavation	= 1932114.57cum
Saleable ore	= 250000.00 MT (+40% Cr2 O3)
Low-grade ore From Contact Zone	= 44642.85MT (+10 to -40% Cr2O3)
Low grade ore	= 55357.00 MT (+10 to -40% Cr2 O3)
Total Production	= 349999.85 MT

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Balance sheet of mineral reserve at the end of 2nd year plan period (2015 –2016)

Chrome ore in M.T.					
Opening balance on 01.04.2015		Production		Closing Balance on 31.03.2016	
(+40% Cr2O3)	(+18% to -40% Cr2O3)	(+40% Cr2O3)	(+18% to -40% Cr2O3)	(+40% Cr2O3)	(+18% to -40% Cr2O3)
1052816.80	534498.00	250000.00	99999.85	802816.80	734498.15

3rd Year Development (2016-17):

In the 3rd year of plan period i.e. (2016-17), it has been planned to work the same quarries to achieve the targeted production of chromite ore. The total production will be achieved from section BB' to DD' of quarry no A, ee' to ll' of quarry-B for both main vein and HH', II' for the 2nd vein, JJ' to KK' of the quarry- C; ss' to uu' of quarry- D for the above production. Work shall be carried out both laterally as well as at depth maintaining the overall pit slope 22°-26° and bench slope 70° with proper bench parameter 6m height and 12m width with 15m platform after every four benches. In Quarry- A, the proposed working RL shall be 121.00 to 112.00m, in quarry- B, the working RL shall be 119.00 to 101.00 for the main lode and 131.00 to 119.00 m for the side lode, 113.00 to 101.00 m for the Quarry- C. The total excavation in this year due to development of these benches shall be 1933933.53 cum excavation to produce the 250000.00 MT of saleable ore, 44642.85 MT low grade ore from contact zone, 55357.00 MT low grade ore will be generated. The total generation of waste is given in chapter no. 7. The detail of bench-wise excavation is given in Table -4.4 and shown in development plan (Plate –9C).

Table -4.4

Table showing Third Year Excavation in ore (2016-17)

Quarry	Section	Working RL.	Sectional Area (Sq. m)	Length of influence (m)	Volume (Cum)
Qry A	CC'	121.00-115.00	23.00	60.00	1380.00
		115.00-112.00	32.00	60.00	1920.00
	DD'	121.00-115.00	19.00	60.00	1140.00
		115.00-112.00	50.36	60.00	3021.71
	Total				7461.71
Qry B (Main Vein)	ll'	119.00-113.00	56.00	130.00	7280.00
	ll'	113.00-107.00	58.00	130.00	7540.00
	HH'	113.00-107.00	59.00	120.00	7080.00
	ee'	107.00-101.00	52.00	50.00	2600.00

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	FF'	107.00-101.00	88.00	85.00	[illegible]
	GG'	107.00-101.00	64.00	135.00	[illegible]
	Total				**40620.00**
Qry - B (Low Grade, 2nd Vein)	HH'	131.00-125.00	36.00	120.00	4320.00
	II'	131.00-125.00	36.00	130.00	4680.00
	HH'	125.00-119.0	42.00	120.00	5040.00
	Total				**14040.00**
Qry No. C (Main Vein)	KK'	113.00-107.00	65.00	120.00	7800.00
	JJ'	107.00-101.00	88.00	115.00	10120.00
	Total				**17920.00**
Qry No. C (2nd Vein)	JJ'	113.00-107.00	7.00	115.00	805.00
	JJ'	107.00-101.00	33.00	115.00	3795.00
	KK'	113.00-107.00	38.00	120.00	4560.00
	Total				**9160.00**
Qry No. C (Main Vein)	LL'	113.00-107.00	67.00	125.00	8375.00
	Total				**8375.00**
Qry No.C (2nd Vein)	LL'	119.00-113.00	23.00	125.00	2875.00
	LL'	113.00-107.00	23.00	125.00	2875.00
	Total				**5750.00**
Qry No.D (Low Grade Ore)	UU'	143.00-137.00	22.50	80.00	1800.00
	UU'	137.00-131.00	22.53	80.00	1802.82
	TT'	137.00-131.00	18.00	100.00	1800.00
	SS'	137.00-131.00	18.00	150.00	2700.00
	Total				**8102.82**

Table showing Third year Excavation of waste & Nickeliferous limonite (2016-17)

Quarry No.	Section	Nickeliferrous Limonite Overburden (In-situ)			Waste Overburden (In-situ)		
		Sectional area (sqm)	Length of influence (m)	Quantity (Cum)	Sectional area (sqm)	Influence Length (m)	Quantity (Cum)
Qry. No. A	C-C'	320.00	60.00	19200.00	203.00	60.00	12180.00
	D-D'	502.00	60.00	30120.00	130.00	60.00	7800.00
Total				**49320.00**			**19980.00**
Qry. No. B	e-e'	171.00	70.00	11970.00	1072.00	70.00	71890.00
	F-F'	88.00	85.00	7480.00	690.00	85.00	58650.00
	G-G'	56.00	135.00	7560.00	762.00	135.00	102870.00

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	H-H'	100.00	115.00	11500.00	1467.00	115.00	
	I-I'	257.00	170.00	43690.00	736.00	170.00	
Total				82200.00			527235.00
Qry No.C	J-J'	88.00	115.00	9890.00	1102.00	115.00	126730.00
	K-K'	160.00	120.00	19200.00	1414.00	120.00	169680.00
	L-L'	224.00	120.00	26880.00	2272.00	120.00	272640.00
Total				55970.00			569050.00
Qry No D	uu'	-	-	-	2300.00	80.00	184000.00
	tt'	-	-	-	1330.00	100.00	133000.00
	ss'	-	-	-	1345.00	150.00	201750.00
Total							518750.00
G. Total				187490.00			1635015.00

Table showing production of Saleable Ore and low grade Ore

Quarry	Total excavation in ore	(+40% Cr2 O3) Ore (80% of A)		(+10 to -40% Cr2 O3) from Contact Zone (20% of A)		(+10 to -40% Cr2 O3) ore	
	A	B		C		D	
	Cum	Cum	1Cum=3.5 MT	Cum	1Cum=2.5 MT	Cum	1Cum=2.5 MT
QRY- A	7460.71	5968.57	20890.00	1492.14	3730.35		-
QRY- B	40620.00	32496.00	113736.00	8124.00	20310.00	14040.00	35100.00
QRY- C	17920.00 9160.00	21664.00	75824.00	5416.00	13540.00	-	-
	27080.00						
QRY- C	8375.00 5750.00	11300.00	39550.00	2825.00	7062.50	-	-
	14125.00						
QRY- D	-		-		-	8102.80	20256.00
Total	89285.71		250000.00		44642.85	22142.82	55357.00

Summary:

Excavation from ore zone = 111428.53 cum
Excavation from Waste zone = 1635015.00 cum
Excavation from N/Limonite zone = 187490.00cum
Total Excavation = 1833933.53cum
Saleable ore = 250000.00 MT (+40% Cr2 O3)
Low-grade ore From Contact Zone = 44642.85MT (+10 to -40% Cr2 O3)
Low grade ore = 55357.00 MT (+10 to -40% Cr2 O3)
Total Production = 349999.85 MT

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Balance sheet of mineral reserve at the end of 3rd year plan period (2016-17)

Chrome ore in M.T.					
Opening balance on 01.04.2016		Production		Closing Balance on 31.03.2017	
(+40% Cr2O3)	(+10% to -40% Cr2O3)	(+40% Cr2O3)	(+10% to -40% Cr2O3)	(+40% Cr2O3)	(+10% to -40% Cr2O3)
802816.80	734498.15	250000.00	99999.85	552816.80	634498.30

4th Year Development (2017-18):

In the 4th year of plan period i.e. (2017-18), it has been planned to work to achieve the targeted production of chrome ore of 3,50,000 MT from quarry no. A, B, C main lode. The total production will be achieved from section BB' to DD' of quarry no A, ee' to ll' of quarry-B for both main vein and HH', II' for the 2nd vein; JJ' to KK' of the quarry- C; ss' to uu' of quarry-D for the above production. Work shall be carried out both laterally as well as at depth maintaining the overall pit slope 22°-26° and bench slope 70° with proper bench parameter 6m height and 12m width with 15m platform after every four benches. In Quarry-A, the proposed working RL shall be , in quarry- B, the working RL shall be 107.00 to 101.00 for the main lode, 113.00 to 95.00 m for the Quarry- C. The total excavation in this year due to development of these benches shall be 1848814.31cum excavation to produce the 250000.00 MT of saleable ore, 40951.35 MT low grade ore from contact zone, 59048.65 MT low grade ore will be generated. The total generation of waste is given in chapter no. 7. The detail of bench-wise excavation is given in Table -4.5 and shown in development plan **(Plate –9D).**

Table -4.5

Table showing Fourth Year Excavation in ore (2017-18)

Quarry	Section	Working RL.	Sectional Area (Sq. m)	Length of Influence (m)	Volume (Cum)
Qry A	CC'	109.00-103.00	39.66	60.00	2380.00
		109.00-103.00	25.57	60.00	1534.07
	DD'	109.00-103.00	49.28	88	4336.64
	Total				**8250.71**
Qry B (Main Vein)	HH'	107.00-101.00	60.00	120.00	7200.00
	II'	107.00-101.00	60.00	130.00	7800.00
	Total				**15000.00**
Qry No. C	KK'	113.00-107.00	40.00	120.00	4800.00

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(Main Vein)	KK'	107.00-101.00	32.00	120.00	
	JJ	101.00-95.00	102.00	160.00	
	Total				**24960.00**
Qry No. C (2nd Vein)	JJ	101.00-95.00	40.00	160.00	6400.00
	KK	107.00-101.00	42.00	120.00	5040.00
	Total				**11440.00**
Qry No. C (Main Vein)	LL'	107.00-101.00	72.00	125.00	8640.00
	MM'	113.00-107.00	61.00	115.00	7015.00
	mm'	113.00-107.00	66.00	180.00	11880.00
	Total				**27535.00**
Qry No.C (2nd Vein)	LL'	107.00-101.00	28.00	125.00	3500.00
	MM'	113.00-107.00	12.00	115.00	1380.00
	mm'	113.00-107.00	25.00	180.00	4500.00
	Total				**9380.00**
Qry No. D (Low Grade Ore)	uu'	143.00-137.00	98.37	80.00	7869.60
	tt'	131.00-125.00	75.00	100.00	7500.00
	ss'	131.00-125.00	55.00	150.00	8250.00
	Total				**23619.60**

Table showing Fourth year Excavation of waste & Nickeliferous limonite (2017-18)

Year & Quarry No. Total	Sections	Nickeliferous Limonite Overburden (Insitu)			Waste Overburden (Insitu)		
		Sectional area (sq.m.)	Influence Length (m)	Quantity (Cu.m.)	Sectional area (sq.m.)	Influence Length (m)	Quantity (Cu.m)
Qry No. B	HH'	100.00	120.00	12000.00	1247.00	120.00	161640.00
	tt'	104.00	113.00	11752.00	809.00	113.00	98197.00
Total				**23752.00**			**259837.00**
Qry No.C	JJ'	91.00	115.00	10465.00	983.00	115.00	109595.00
	KK'	134.00	120.00	16080.00	1201.00	120.00	144120.00
	LL'	166.00	125.00	20750.00	998.00	125.00	124750.00
	MM'	167.00	100.00	16700.00	1597.00	100.00	159700.00
	mm'	153.00	70.00	3710.00	1721.00	70.00	120470.00
Total				**67705.00**			**658635.00**
Qry No. D	uu'	-	-	-	2200.00	80.00	176000.00
	ss'	-	-	-	2078.00	150.00	311700.00
	tt'	-	-	-	2310.00	100.00	231000.00
Total							**718700.00**
Total				**91457.00**			**1637172.00**

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Table showing production of Saleable Ore and low grade

Quarry	Total ROM	Saleable Ore (80% of A)		Low-grade ore from Contact Zone (20% of A)		Low grade ore	
	A	B		C		D	
	Cum	Cum	1Cum=3.5 MT	Cum	1Cum=2.5 MT	Cum	1Cum=2.5 MT
QRY A	8250.71	6600.57	23102.00	1650.14	4125.35	-	-
QRY-B	15000.00	12000.00	42000.00	3000.00	7500.00	-	-
QRY-C	24960.00 11440.00 36400.00	29120.00	81536.00	5824.00	14560.00	-	-
QRY-C	27535.00 9380.00 36915.00	29532.00	103362.00	5906.40	14766.00	-	-
QRY-D	-	-	-	-	-	23619.46	59048.65
	96565.71		**250000.00**		**40951.35**	23619.46	**59048.65**

Summary:

Excavation from ore zone	= 120185.31 cum
Excavation from Waste zone	= 1637172.00cum
Excavation from N/Limonite zone	= 91457.00cum
Total Excavation	= 1848814.31cum
Saleable ore	= 250000.00 MT (+40% Cr2 O3)
Low-grade ore From Contact Zone	= 40951.35 MT (+10 to -40% Cr2 O3)
Low grade ore	= 59048.65 MT (+10 to -40% Cr2 O3)
Total Production	= 350000 MT

Balance sheet of mineral reserve at the end of 4th year plan period (2017-2018)

Chrome ore in M.T.					
Opening balance on 01.04.2017		Production		Closing Balance on 31.03.2018	
(+40% Cr2O3)	(+10% to -40% Cr2O3)	(+40% Cr2O3)	(+10% to -40% Cr2O3)	(+40% Cr2O3)	(+10% to -40% Cr2O3)
552516.80	534498.30	250000.00	100000.00	302816.80	534498.30

5th Year Development (2018-19):

In the 5th year of plan period i.e. (2018-19), it has been planned to work to achieve the targeted production of chrome ore of 350000 MT from quarry no. A, B, C main lode. The total production will be achieved from section BB' to DD' of quarry no A, ee' to ll' of quarry-B for both main vein and FF' to ll' for the main vein; KK' to mm' of the quarry-C; ss' to uu' of quarry-D for the above production. Work shall be carried out both laterally as well as at depth maintaining the overall pit slope 22°-26° and bench slope 70° with proper bench

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parameter 6m height and 12m width with 15m platform after every four benches. In Quarry- A, the proposed working RL shall be 115.00 to 103.00m, in quarry- B, the working RL shall be 101.00 to 95.00 for the main lode, 113.00 to 101.00 m for the Quarry- C. The total excavation in this year due to development of these benches shall be 1650791.57 cum excavation to produce the 250000.00 MT of saleable ore, 44642.85 MT low grade ore from contact zone, 55357.15 MT low grade ore will be generated. The total generation of waste is given in chapter no. 7. The detail of bench-wise excavation is given in Table -4.6 and shown in development plan (**Plate –9E**).

Table -4.6

Table showing Fifth Year Excavation in Ore (2018-19)
Table showing Fifth year Excavation of waste & Nickeliferous limonite (2018-19)

Quarry	Section	Working RL.	Sectional Area (Sq. m)	Length of Influence (m)	Volume (Cum)
Qry A	CC'	109.00-103.00	4.73	60.00	283.71
	DD'	115.00-109.00	49.28	88	1232.00
	Total				**1515.71**
Qry B (Main Vein)	FF'	101.00-95.00	92.00	90.00	8280.00
	GG'	101.00-95.00	65.00	135.00	8775.00
	HH'	101.00-95.00	59.00	115.00	6785.00
	II'	101.00-95.00	39.00	135.00	5265.00
	Total				**29105.00**
Qry No. C (Main Vein)	KK'	107.00-101.00	72.00	120.00	8640.00
	KK'	101.00-95.00	55.00	120.00	6600.00
	Total				**15240.00**
Qry No. C (2nd Vein)	KK'	101.00-95.00	38.00	120.00	4560.00
	Total				**4560.00**
Qry No. C (Main Vein)	LL'	101.00-95.00	72.00	125.00	8640.00
	MM'	101.00-95.00	45.00	115.00	7015.00
	mm'	101.00-95.00	48.00	180.00	11880.00
	Total				**27535.00**
Qry No.C (2nd Vein)	LL'	101.00-95.00	28.00	125.00	3500.00
	MM'	107.00-101.00	14.00	115.00	1610.00
	mm'	107.00-101.00	16.00	180.00	2880.00
	Total				**7990.00**
Qry No.D (Low Grade Ore)	II'	131.00-125.00	21.00	80.00	1680.00
	uu'	143.00-137.00	9.62	100.00	961.86
	uu'	137.00-131.00	36.01	100.00	3601.00
	uu'	131.00-125.00	96.00	100.00	9600.00
	ss'	131.00-125.00	42.00	150.00	6300.00
	Total			-	**22142.86**

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Quarry No.	Section	Nickelliferous Limonite Overburden (In-situ)			Waste Overburden (In-situ)		
		Sectional area (sqm)	Influence Length (m)	Quantity (Cum)	Sectional area (sqm)	Influence Length (m)	Quantity (Cum)
Qry No. B	F-F'	144.00	74.00	10656.00	1395.00	74.00	103230.00
	G-G'	29.00	108.00	3132.00	1148.00	108.00	123984.00
	H-H'	100.00	104.00	10400.00	356.00	104.00	37024.00
	I-I'	125.00	113.00	14125.00	444.00	113.00	50172.00
Total				**38313.00**			**314410.00**
Qry No.C	J-J'	91.00	115.00	10465.00	1161.00	115.00	133515.00
	K-K'	164.00	120.00	19680.00	1493.00	120.00	179160.00
	L-L'	118.00	125.00	14750.00	1300.00	125.00	162500.00
	MM'	133.00	100.00	13300.00	1350.00	100.00	135000.00
	nnn'	113.00	70.00	7910.00	1250.00	70.00	87500.00
Total				**66105.00**			**699975.00**
Qry No D	uu'	-	-	-	2005.00	80.00	160400.00
	tt'	-	-	-	1800.00	100.00	180000.00
	ss'	-	-	-	1890.00	150.00	283500.00
Total							**623900.00**
Total				**104418.00**			**1638285.00**

Summary:

Excavation from ore zone	= 108088.57 cum
Excavation from Waste zone	= 1638385.00cum
Excavation from N/Limonite zone	= 104418.00cum
Total Excavation	= 1850791.57cum
Saleable ore	= 250000.00 MT (+40% Cr2 O3)
Low-grade ore From Contact Zone	= 44642.85 MT (+10 to -40% Cr2 O3)
Low grade ore	= 55357.15 MT (+10 to -40% Cr2 O3)
Total Production	= 350000 MT

Balance sheet of mineral reserve at the end of 5th year plan period (2018 –2019)

Chrome ore in M.T.					
Opening balance on 01.04.2018		Production		Closing Balance on 31.03.2019	
(+40% Cr2O3)	(+10% to -40% Cr2O3)	(+40% Cr2O3)	(+10% to -40% Cr2O3)	(+40% Cr2O3)	(+10% to -40% Cr2O3)
302816.80	534498.30	250000.00	100000.00	52816.80	434498.30

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Table-4.7

TABLE SHOWING YEAR-WISE SALEABLE ORE, LOW-GRADE ORE FOR C.O.B FEED, OVERBURDEN & ORE: OB RATIO

Year	Saleable Ore (M.T.)	Low grade ore from contact zone (M.T)	Low grade ore from 2nd vein (M.T.) & Qry No.D (M.T)	N/Limonite + Over-burden Waste (Cum)	Ratio in (Ore : OB) (M.T/Cum)
2014-15	239907.20	42767.00	67605.00	980195.00	1: 2.80
2015-16	250000.00	44642.85	55357.00	1802090.00	1: 5.15
2016-17	250000.00	44642.85	55357.00	1822505.00	1 : 5.21
2017-18	250000.00	40951.35	59048.65	1728629.00	1 : 4.90
2018-19	250000.00	44642.85	55357.15	1742703.00	1 : 4.98
Total	**1239607.20**	**217666.90**	**1457274.10**	**8076122.00**	

Note: The above projected production is applicable subjected to Environmental Clearance of 3,50,000 MT.

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Proposed method of working:

The mining method is remaining same during this plan period. The mining operation in this area has been carried out mechanized opencast mining method, Wagon Drill, Excavator, Pay Loader, Air Compressor, Jackhammer, Tippers etc for the excavation work. The massive hard lateritic bed would be excavated mechanically method after breaking through drilling & blasting. Drilling would be done by Compressed air with wagon drill. The blasted material would be loaded by loader into tipper for transportation. The ore contain +40% and above Cr_2O_3 will be utilized for captive Ferro Chrome plant whereas ore contains +10% to -40% Cr_2O_3 will be utilized for captive Chrome Ore Beneficiation plant. The chrome ore required for the above two plants are approx 0.20 million tons per annum whereas for beneficiation plant approx 0.10 million tons per annum of +10% to -40% Cr2O3. Rest 0.05 million tons chrome ore shall be sold to the different consuming industries.

Bench Parameters:

In present system of mining bench height is restricted to 6.0m with width 12m. A platform of 15 m should be kept after the four benches to maintain the slope stability of the benches. Bench slope is kept at 70° with an overall pit slope of 22° to 25° with a width of 15m. Bench slope is kept at 70° with an overall pit slope of 22° to 25°. 10-15 m width haulage road at

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1:16 gradient and short ramp at 1:10 gradient are made and maintained to bottom most floor.

b) Indicate quantum of development and tonnage and grade of production expected pit-wise as in Table below :

The quantity of development and production proposed during the plan period from the mine is given in Table – 4.8.

Table- 4.8

Table showing year-wise excavation and production for the next 5 years of the plan period

Year	Volume of Excavation (cum)	Proposed production in MT	
		Saleable Ore (+40% Cr2O3)	Low Grade ore (+10% to -40% Cr2O3)
2014-15	1092811.00	239607.20	110392.00
2015-16	1932114.57	250000.00	99999.85
2016-17	1933933.53	250000.00	99999.85
2017-18	1648814.31	250000.00	100000.00
2018-19	1850891.57	250000.00	100000.00
Total	**9658564.98**	**1239607.20**	**510391.70**

Extent of Mechanization:

Existing mining machineries deployed in the mine

Since it is a running mine, all mines machinery and equipment necessary for mining and mining related work have been provided. The detail of the machineries used in this mine is discussed under:

Type of Machinery	Capacity of each unit	No of units	H.P. of each unit
Backhoe-Tata Hitachi	0.9 cum bucket capacity	1	123 (Non- electrical)
Backhoe- L&T Komatsu	1.7 cum bucket capacity	3	242 (Non- electrical)
Front & Loader	2 cum bucket capacity	2	180(Non- electrical)
BEML Dozer	21100 Kg	4	180 (Non- electrical)
Tata Dumper-1618	7.6 cum	6	176 (Non- electrical)
Tata Dumper-1210	5 cum	2	111 (Non- electrical)
Tata Tipper-2516	16 cum	5	232 (Non- electrical)
Dumper Leyland Tarsus	16 cum	2	180 (Non- electrical)
Dumper AMW	16 cum	6	232 (Non- electrical)
Water Tanker	12 kl capacity	3	111 (Non- electrical)
Compressor XAHQ10 Atlas copco 450cfm	450 cum	2	180 (Non- electrical)
Wagon drill	———	2	(Non- electrical)
Jack Hammer	———	2	(Non- electrical)
Electric pump	28lit/Sec	1	40 (Electrical)
Diesel pump	28lit/Sec	2	40(Non- electrical)

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Requirement of mining machineries for the plan period

b EXCAVATOR

A) L & T Komastsu of 1.7 cum bucket capacity Excavator for ore handling.

L & T Komastsu of 1.7 cum bucket capacity is already deployed for handling of ROM and the same machine shall be continued during the plan period.

Specification of excavators		
Bucket capacity (**q**)	:	1.7 Cum
Bucket fill factor (**f**)	:	0.85
Time cycle pass at 90^{0} swing (**T1 and T2**)	:	30 sec
Swell factor (**s**)	:	0.85
Production efficiency factor (**e**)	:	0.85
Time scheduling		
Working days per year (**w**)	:	300
Number of working shifts per day (**k**)	:	2
Working hours per shift	:	8
Effective working hours per day (h)	:	6
Seconds in hour (t)	:	3600
Output /1.7 CuM shovel/annum (O) O = [q x f x s x e x w x h x t)Xk] ÷ T1	:	(1.7 x 0.85 x 0.85 x 0.85 x 300 x 6 x 3600) X 2/30 = 451013.40Cum Say 4,50,000Cum

Table- 4.9

Table showing year-wise requirement of Excavator for ore handling

	1st year	2nd year	3rd year	4th year	5th year
Year-wise quantity of ore to be excavated and loaded. (cum)	112616.00	130024.57	111428.53	120185.31	108068.57
Year-wise quantity of ore to be excavated. (with swelling factor 1.25) (cum)	140770.00	162530.71	139285.66	150231.64	135110.71
Capacity of excavator per annum (cum) in two shift	450000	450000	450000	450000	450000
No. of working excavator required in two shift.	0.31 or 01	0.36 or 01	0.30 or 01	0.33 or 01	0.30 or 01

From the above table, it is clear that total max. 02 no. of excavator including 01 for backup is required during the plan period.

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Since, quantity of overburden removal is on higher side, it is proposed to engage 4.0 cum bucket capacity excavator for overburden removal. Calculation of 4.0 cum bucket capacity excavator is given below:

B) <u>4.0 cum bucket capacity Excavator (Proposed) for O/B & Nickeliferous Limonite handling.</u>

Hydraulic excavators of 4.00 m^3 capacity have been deployed for overburden handling. Average swell factor tonnage factor & fill factor is taken into consideration for the purpose of calculation. The detail year wise calculation and requirement of machine has been given below:

a) Bucket fill Capacity	= 4.00 cum
b) Effective capacity of the Bucket	= 3.60 cum
c) Capacity of the dumper	= 16 cum
d) Effective capacity of the dumper of 0.9 factor	= 14.4 cum
e) No. of bucket require to fill a bucket	= (14.4/3.60) = 4
f) Average cycle time for excavation, loading of material to a dumper	= 6 minutes.
g) Working hours per shift	= 8 hours
h) Effective working hours per day	= 6 hours or 360 min.
h) Number of cycle per shift	= (360/6) = 60.
i) Average excavation, loading capacity of Excavator per shift	= (60 x 14.4) = 864 cum
j) Total working day in a year	= 300 days
K) Total Excavation and Loading capacity/shift	= 259200 cum.
l) Total Excavation and Loading capacity in two shift	= 518400 cum.

<u>Table – 4.10</u>

<u>Table showing year-wise requirement of Excavator for waste handling</u>

	1st year	2nd year	3rd year	4th year	5th year
Year-wise quantity of waste material to be excavated and loaded. (cum)	980195.00	1802090.00	1822505.00	1729629.00	1742803.00
Year-wise quantity of waste material to be excavated (with swelling factor 1.25) (cum)	1225243.75	2252612.50	2278131.25	2160786.25	2178503.75
Capacity of excavator per annum (cum) in two shift	518400	518400	518400	518400	518400
No. of working excavator required in two shift	2.36 or 03	4.34 or 05	4.39 or 05	4.16 or 05	4.20 or 05

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From the above table, it is clear that total max. 05 no. of excavator is required for ore handling during the plan period.

ii) CALCULATION FOR REQUIREMENT OF DUMPERS

For handling of ore :

The chrome ore to be produced shall be transported to their respective sites. For this, 16 cum dumpers exist in the mine and shall be used. The detailed calculation is given hereunder:

a) Dumper Data Capacity = 16 Cum
b) Fill factor = 0.56
c) Swell Factor = 0.85
d) Loading capacity = 16X 0.56 X 0.85 = 7.6 Cum
e) Lead up & down = 4Km
f) Time taken for 4Km at 15 kmph = 16 minutes
g) Average loading time = 3 minutes
h) Average un-loading time = 2 minutes
i) Queuing time or placement time = 2 minutes
j) Total time taken = 23 minutes
k) In one hour, one dumper can handle 7.6 X 60/23 = 19.8Cum
l) Effective working time per shift = 360 minutes
m) Hauling capacity of dumper per shift = 118.80 cum
n) Hauling capacity of dumper per shift per annum = 35640 cum
o) Total Hauling capacity of dumper in two shift = 71280 cum

Table – 4.11

Year-wise requirement of Dumpers for ore handling

	1st year	2nd year	3rd year	4th year	5th year
Year-wise quantity of ore to be handled (cum)	112616.00	130024.57	111428.53	120185.31	108068.57
Year-wise quantity of ore to be handled (with swelling factor 1.25) (cum)	140770.00	162530.71	139285.66	150231.64	135110.71
Capacity of dumper per annum (cum) in two shift.	71280	71280	71280	71280	71280
No. of dumper required to handle the ore in two shift.	1.97 or 02	2.28 or 03	1.95 or 02	2.10 or 03	1.89 or 02

So, from the above table it is clear that max. 04 dumpers including 01 dumper for backup of 16 cum capacity is required to handle the ore during this plan period.

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For handling of waste & Nickeliferous Limonite :

Since, quantity of overburden removal is on higher side, it is proposed to engage 30.33 cum capacity of BEML dumpers fitted with exhaust conditioner for overburden removal. Calculation of 30.33 cum capacity of Hyva dumpers is given below:

Average distance of haul for over burden & average material handling capacity is taken into consideration.

a) Average Hauling distance both way (2 kms x 2)	=	4.0Kms.
b) Average traveling time both way @ 20kmph	=	12 minutes
c) Average Placement time	=	2 minutes
d) Average Loading time	=	6.21 minutes
e) Average un-loading time	=	2 minutes
f) Average cycle per trip	=	22.21 minutes
g) Effective working time per shift	=	360 minutes
h) Average no. of trips per shift per dumper	=	360/22.21
	=	16.20 nos.
h) Effective capacity of the Dumper	=	30.33cum
i) Hauling capacity of dumper per shift	=	491.35 cum
j) Hauling capacity of dumper per shift per annum	=	147405 cum
l) Total Hauling capacity of dumper in two shift	=	294810 cum

Table – 4.12

Year-wise requirement of Dumpers for waste removal

	1st year	2nd year	3rd year	4th year	5th year
Year-wise quantity of waste material to be excavated and loaded (cum)	980195.00	1802090.00	1822505.00	1728629.00	1742803.00
Year-wise quantity of waste material to be excavated (with swelling factor 1.25) (cum)	1225243.75	2252812.50	2278131.25	2160786.25	2178503.75
Capacity of dumper per annum (cum) in two shift	294810	294810	294810	294810	294810
No. of dumpers required	4.15 or 05	7.64 or 08	7.72 or 08	7.32 or 08	7.38 or 08

So, from the above table it is clear that max. 09 dumpers including 01 dumper for backup of 30.33 cum (50 Tons) capacity is required to handle the waste during this plan period.

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iv) **Drilling:**

In Saruabil Chromite Mines, in general, the holes are blasted as per the formation encountered. During the course of mining operation since last many years, hard patches are almost removed and at present only 20% of the excavation encountered the hard patches. These hard patches are required drilling and blasting, for which deep hole drill by wagon drill is practiced in the mine.

Estimation of wagon drill requirement:

a) Rate of drilling	-	12 m/hr
b) Drilling per day per shift (6 hr working)	-	12 x 6 = 72m
c) Number of holes drilled per day	-	10.2 or say 10
d) Material blasted by one blast hole	-	Burden x spacing x depth
	=	3.0 x 3.0 x 7.0 = 63 cum
e) Quantity of material to be excavated per Drill machine per day	=	10 x 63 tons = 630 cum
f) Average Yearly total excavation	=	1731692.99 cum
g) Average daily excavation at 300 annual working days	=	5773 cum
h) Considering 20% of hard patch, No. of hole required to meet the daily Handling of Excavation	=	1155 cum ÷ 63 = 18 holes

Hence, only two wagon drill is required during the plan period. The existing wagon drill is sufficient to meet the requirement of drilling during the plan period.

As village/human settlement exists nearby quarry A & B, NONEL system of blasting is proposed for getting optimum blast result. The detail of Nonel blasting system and typical charging pattern is given in chapter – 5.

MANPOWER REQUIREMENT:

Since, this is an operating mine, there already exists employees for smooth operation of the mine. The existing manpower is as follows:

(i) **Existing:**

Sl. No.	Description	No.
01	Mining Engineer – B.E (Mining)	02
02	Mining Engineer – Diploma in Mining	03

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03	Mining Geologist - M.Sc (Geology)	02
04	Surveyor	02
05	Foreman/ Mate	05
06	Other Administrative Clerical and Technical supervisory Staff	22
Total		**36**

(ii) **Proposed**

Sl. No.	Description	No.
01	Mining Engineer – B.E (Mining)	03
02	Mining Engineer – Diploma in Mining	03
03	Mining Geologist - M.Sc (Geology)	02
04	Surveyor	02
05	Foreman/Mining Mate	10
06	Technical Supervisor/Clerk/Accountant	30
Total		**50**

Labour (Skilled/Semi Skilled/Unskilled):

The mining operation is carried out by mechanical means. Workers are required for mining activities at the face and for other mining associated work. Also some workers are required for day to day maintenance work of the mine. For this about 194 workers are engaged in the mine. However, additional manpower may be engaged if required. For welfare of the employees, within the leasehold, following amenities has been provided:

A township within the leasehold for accommodation of the executives of the company.

1. The township consists of marketing complex to fetch the daily need of the residents of township.
2. A health centre with full time Doctor has been provided.
3. The township also has recreation facilities like Cricket/Football ground, children's play area etc.
4. Ample plantation has been done to make the environment of the township clean.
5. The plantation also works as dust suppressor and noise insulator.
6. Potable drinking water facilities has also been provided within the township.

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Occupational Health & Safety

To avoid any adverse effect on the health of the workers due to dust, noise and vibration due to any mining or allied activity caused due to mining operation, following measures will be taken and are proposed for implementation of the same.

1. Potable drinking water for the workers employed in the mine to provided at a suitable and convenient place.
2. The place with the arrangement of drinking water shall be properly maintained in full hygiene and has "DRINKING WATER" written over it in local language to understand the common workers employed.
3. The arrangement of drinking water shall be at a distance of not less than 100m from the wash rooms/toilets.
4. Water sprinkling arrangements near the areas producing dust.
5. If possible selecting alternative method of fracturing the rock.
6. Regular repair and maintenance of machineries used.
7. Regular overhauling of the machines used.
8. Periodic repair & maintenance of the machines used.
9. Proper hygiene shall be maintained at the rest shelters.
10. More safety in working and training for implementation of safety and use of protective gears against dust, noise and vibration. Creating awareness for safety while working.
11. Continuing with training of employees for use of safety appliances and first aid.
12. Operating the mine scientifically.
13. Since, the workmen employed are prone to exposure of Cr^{+6}, a toxic and carcinogenic agent, periodic medical checkup of the workmen will be carried out.
14. Suitable measures have been proposed to reduce the contamination of water with the carcinogenic Cr^{+6}.
15. Creating awareness by organizing seminars on the possible causes of Cr^{+6}.
16. All these can be achieved by adopting scientific mining methodology.

c) Attach composite plans and year wise sections (in case of 'A' Class Mine):

Year wise composite development plan and sections has been illustrated in **Plate 9 (A-E)**.

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d) Attach supporting composite plan and section showing pit layout, dumps, stacks of sub-grade mineral, if any, etc.

Pit layout has been shown in development plan (**Ref. Plate 9A-E**) and a detail of year-wise dumping has been shown in Dump Plan and section (**Refer Plate 10**). The 80% of the total ROM is taken as saleable ore from main lode and rest of it is calculated as low grade. The grade of the chrome ore ranges from +10% to 40%Cr2O3. There is no sub-grade generated from the mine. During the excavation, total amount of generated waste shall be dumped over the existing waste dump and generated nickeliferous limonite will be stacked over the existing nickeliferous dump.

e) Indicate proposed rate of production when the mine is fully developed, and the expected life of the mine and the year from which effected

Based on the previous exploration, present status of the chrome lode exposed in the quarry fresh reserve has been estimated. The total amount of reserve is 2237314.00 MT for the entire lease area. So, taking the maximum production target of 0.350 million tons per annum, the anticipated life of the mine is 6.39 year.

[Note: IBM/ GSI estimated total in-situ reserve of 8.46 million ton of all categories taking the maximum depth is 200m. From this period the total production up to 2010 of the chromite of all grades is 1.21 million ton. So the anticipated life of the mine is 20.71 years considering the depth of the chromite lode is 200 m form the surface.

Parameters	Within entire lease
Mineable Reserve of Chrome Ore (MT)	2237314.00
Proposed Production of Chrome Ore / year (max) (million tons)	0. 350
Life of the mine (Years)	6.39

f) Attach a note furnishing a conceptual mining plan for the entire lease period based on the geological mining and environmental considerations.

During this plan period quarry-A, B, C and D are considering for the production of the chromite ore. The lease hold area consists of both the forest and the non-forest land. The quarries are exposed mainly in the forest area.

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i) Exploration programme:

As mentioned in the approved mining plan/scheme of mining, the mineral reserve of the area has been estimated considering the proved depth up to 80 meter. No further depth has been established though it is reported that the chrome ore lode of this area is continuing up to a depth of 200m. So, in order to establish full depth of mineralization and to obtain more information about the chrome lode, future exploration has been chalked out during this plan period.

It is proposed that exploration in the lease area shall be carried out by putting 34 numbers of inclined boreholes (inclination 75°) to explore the chrome lode around quarry-A,B & C and covering the entire lease area at depth and its extension laterally. The depth of the hole shall be up to 200m from the surface. The detail of proposed boreholes is given in Chapter-3, Table – 3.2 and location of these boreholes is shown in Geological Plan.

Ultimate pit boundary:

The proved depth of the ore body is considered as the 80 m depth form the surface. Keeping 30 m at the base and maintaining the 26° overall pit slope the ultimate pit limit has been marked. At the ultimate stage the area of total excavation will 83.16 ha.

iii) Disposal of waste rocks and in-saleable ores

During the plan period the total quantity of generated waste and the nickeliferous limonite shall be stacked over the existing dump separately over the existing O/B dump and the nickeliferous dump. At the ultimate stage the total 6950830 cum of waste and 721620 cum nickeliferous limonite shall be generated and dumped separately outside the ultimate pit boundary covering 112.368 ha. The total area of the dump at the ultimate stage is shown in the Plate-11. The entire dumps shall be rehabilitated by plantation at this stage.

Reclamation & Rehabilitation :

None of the quarry or part thereof is exhausted so, reclamation by backfilling of mined out area is not possible. However, 11.94 ha area has been rehabilitated by plantation. During the plan period there is a proposal of reclamation and rehabilitation by the way of plantation over the existing dump. At the ultimate stage, the entire lease area shall be rehabilitated by plantation except quarry portion.

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Existing Land use:

The lease area contains both forest as well as non-forest land. Lessee has obtained forest clearance over the entire forest area. At present, total 157.53 ha area has been degraded due to mining and allied activities, out of which, 51.59 ha is due to excavation by pits.

Land use at the end of plan period:

Due to the development of pit and dumping of waste during the plan period, an additional 33.18 ha area shall be degraded. So, by the end of plan period, total 190.71 ha area shall be degraded.

Reclamation during plan period: In the plan period, ore body is not going to be exhausted in any quarry or part of any quarry. As such, reclamation of mined out area is not applicable. However, rehabilitation by plantation on the lower level, over slopes and on the terrace of waste dumps, safety zone area and outside the lease area shall be carried out to develop the green belt.

Land use at conceptual stage:

The ultimate extent and size of the pit has been calculated based on sectional projection at 80m depth and shown in the conceptual Plan (**Ref. Plate – 11 & 12**). Generation of overburden waste and nickeliferous limonite up to the ultimate pit limit comes to 6950830 cum and 721620 cum respectively. At this stage, total 246.858 ha area shall be utilized for mining, dumping, road and other mining related activities.

At present no reclamation has been done in the excavated area as the ore body is not exhausted in any part of the quarries. No reclamation of the quarries has been proposed, as the proved reserve of mineral will not be exhausted in the next five years. Dumping of over burden and nickeliferous limonite is proposed over the existing overburden dumps and additional area of 25.80 ha will be required for dumping purpose. For stabilization of dumps, plantation has been done on the lower level, over slopes and on the terrace. The overburden dump already rehabilitated by means of plantation is 10.89 hectares. At present total area covered by dumps is 66.89 hectares.

During the next five years plan period, about 11.17 hectares area (covering dead dumps, green belt along 7.5m of ML boundary, road barrier) shall be rehabilitated by means of plantation. Further, as per clause 5 of part III of model form of Mining Lease Deed in Form K, under regulation 109(1) of MMR, 1961, no work shall be carried out within 50m of public

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road. Due to this restriction of public road near quarry A, no further extension is proposed on the hang wall side after the plan period. The lessee shall approach to the State Government to divert the public road outside the lease area so that quarry no. A and part of qry. B may not be affected at ultimate depth of 80m/100m subjected to the approval by the State Government. Otherwise, efforts will be made to divert the road over the filled up area of quarry no. A with necessary permission from the appropriate authority.

At ultimate stage, the entire overburden dumps, sides of haul roads, surroundings of E. T. Plant, Screening plant, camp area and green belt zone shall be rehabilitated by plantation and converted into green cover. The voids created by mined out area shall be converted in to lagoon. The top benches of these quarries shall be reclaimed and rehabilitated by plantation.

Afforestation:

A scheme of plantation has been chalked out to develop a green belt for this plan period which is given in chapter – 11.

The existing land use, land to be degraded at the end of plan period and at ultimate stage is given below:

Table showing degradation of land for different purposes during the next five years and ultimate stage

Sl. No.	Category	Existing land use in Ha			At the end of the plan period			Land to be degraded at conceptual period
		Forest	Non-forest	Total	Forest	Non-forest	Total	Total
1	Quarry and roads	51.43	0.16	51.59	56.31	0.16	56.47	83.16
2	Dump - OB Dump Nickel Dump	59.88	7.01	66.89	83.65	9.04	92.69	112.368
3	Colony/ Township	19.61	2.73	22.34	19.61	2.73	22.34	22.34
4	COB	1.85	–Nil–	1.85	1.85	–Nil–	1.85	1.85
5	Magazine	1.13	–Nil–	1.13	1.13	–Nil–	1.13	1.13
6	Mineral storage	3.98	0.32	4.30	3.98	0.32	4.30	0.05
7	E. T. P.	Included in Quarry area		–Nil–	Included in Quarry area		–Nil–	-
8	Plantation area							
	a) Safety Zone	3.40	0.27	3.67	3.40	0.27	3.67	3.67

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	b) Nala Barrier	2.31	0.23	2.54	2.31	0.23	2.54	
	c) Road Barrier	2.68	0.54	3.22	5.18	0.54	5.72	
	d) Over Dump (Already included in Dump area)	24.21	0.30	24.51	29.21	0.30	29.51	92.69
	e) Township area (Already included in Colony/low noise)	8.59	-	-	-	-	-	-
Total		146.27	11.26	157.53	177.42	13.29	190.71	246.858

g) Opencast mines

i) Describe briefly giving salient features of the mode of working (mechanized....., semi-mechanised....., manual.....)

By open cast fully mechanized method

ii) Describe briefly the layout of mine working, the layout of faces and sites for disposal of overburden/waste. A reference to the plans enclosed under 4(b) and 4(d) will suffice:

Layout of mine working with year wise bench formation are shown in **Plate No 9(A-E).**

h) Underground Mines: Not applicable at this stage. However, after reaching the ultimate pit limit, the underground mining shall be proposed considering the continuity of ore body as reported in GSI borehole.

i) Extent of Mechanization:

Describe briefly including the calculation for adequacy and type of machinery and equipment proposed to be used in different mining operations.

Table – 4.13

Brief description of machineries to be used :

Type of Machinery	Capacity of each unit	No of units		H.P. of each unit
		Existing	Proposed	
Backhoe-Tata Hitachi	0.9 cum bucket capacity	1	2	123 (Non- electrical)
Backhoe- L&T	1.7 cum bucket	3		242 (Non- electrical)

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Komatsu	capacity			
Excavator	4.0 cum bucket capacity	-	5	DIESEL ENGINE
Front & Loader	2 cum bucket capacity	2	2	360 (Non- electrical)
BEML Dozer	21100 Kg	4	4	180 (Non- electrical)
Tata Dumper-1618	7.0 cum	6	6	176 (Non- electrical)
Tata Dumper-1210	5 cum	2	4	111.50 (Non- electrical)
Tata Tipper-2516	16 cum	5	4	232 (Non- electrical)
Dumper Leyland Tarsus	16 cum	2		160 (Non- electrical)
Dumper AMW	16 cum	6		232 (Non- electrical)
Dumper BMW	30.33 cum	-	9	
Water Tanker	12 kl capacity	3	3	35 (Non- electrical)
Compressor XAH210 Atlas copco 450cfm	450 cum	2	2	180 (Non- electrical)
Wagon drill	00	2	2	(Non- electrical)
Jack Hammer	00	2	-	(Non- electrical)
Electric pump	00	1	2	40 (Electrical)
Diesl pump	00	2	2	40(Non- electrical)

v) **Loading equipment:**

Machine loading is practiced in the mine. Ore and overburden is being loaded by machine. The same practice shall be continued in the next 5 years of the plan period also.

vi) **Haulage and Transport equipment:**

Haulage within the mining leasehold. The reject material shall be transported in a earmarked site whereas Chromite ore to the consumers plant by hire truck. The requirement of dumpers for ore as well as reject transportation is given above.

vii) **Transport from mine-head to the destination. Describe briefly the transport system (Please specify):**

Ore transpocted by trucks/dumpers.

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viii) **Miscellaneous:**

Describe briefly and allied operations and machineries related to the mining of the deposit not covered earlier:

There is no allied operation. All machinery related to the future mining of the deposit has been covered earlier.

Maintenance of Haul Road

The mine haul road maintenance strategy is the key to realizing the economic benefits of reduced transport costs. However, mine haul road maintenance is generally managed subjectively and not tailored to the complex interactions of wearing course functionality, road traffic volumes and vehicle operating and maintenance costs. Thus, an optimized approach is required with which to minimize total road-user costs and the maintenance management system for mine haul roads has been developed to meet these needs. Mine haul road maintenance management systems potential to generate significant cost benefits when used dynamically, in conjunction with production planning, to optimize mine haul road maintenance activities for particular combinations of wearing course material, traffic volumes and vehicle types.

Opencast mine economy depends on the cost of haul road design, construction as well as its maintenance in addition to other factors. These roads are used by heavy earth moving equipments. Production suffers, accident and breakdown occurs if they are not properly laid, constructed and maintained. Truck haulage costs can account for up to 50% of the total operating costs incurred by a surface mine and any savings generated from improved road design and management benefit the mining company directly as a reduced cost per ton material hauled.

In Saruabil Chromite Mine, the haul roads are well maintained. 12m-width haulage road at 1:16 gradient and short ramp at 1:10 gradient are made and maintained to reach the quarry floor. The water spraying through water tanker is continuously done to suppress the dust. The haul roads are compact and suitable for carrying the loaded tippers and heavy machines. The routine maintenance is carried out on mine haul roads almost daily, depending on the functionality of the road and the traffic volume. The principal goals are:

➢ To restore the road functionality to a level adequate for efficient vehicle travel with the aim of augmenting productivity and minimizing total road user costs.

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➤ To conserve the integrity of the road wearing course by returning or redistributing the gravel surface.

In the plan period, it is proposed to continue the same precautionary measures and maintenance of haul roads.

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5.0 BLASTING

Describe briefly:

a) Broad blasting parameters like charge per hole, blasting pattern, charge per delay, maximum number of holes blasted in a round, manner and sequence of firing, etc.

It has been explained in Chapter – 3 that the rock type exposed in the area is quartzite, silicified cherty rocks, laterite, nickeliferous limonite and talc serpentine. The laterites and thin bands of serpentine are exposed in the central and in the northern part of the area. The Chrome ore occurs in the form of thick stratiform deposit with almost uniform thickness. It is confined within talc serpentine schist, silicified rock and nickeliferous limonites.

In Saruabil Chromite Mines, in general, the holes are blasted as per the formation encountered. During the course of mining operation since last many years, hard patches are almost removed and at present only 15% of the excavation encountered the hard patches. These hard patches are required drilling and blasting, for which deep hole drill by wagon drill is practiced in the mine.

I) For Deep Hole Drilling :

Deep hole drilling is carried out at the places where hard patches are encountered. This is only 20% of the total excavation.

Pattern of holes

Depth of Hole	:	6.6m. (Bench height = 6mt)
Spacing of Hole	:	3m
Burden of hole	:	2.5m.
Dia of hole	:	115mm.

Explosives used

Slurry Explosive in cartridge form having dia 83mm. (Weight of Cartridge 2.778 Kg) Such as – Nova prime, Nova column, Aquadyne, Power Gel-C, Expro etc. These are Class-2 Explosives. Also Loose Ammonium Nitrate, Ordinary Detonator, Relay, Safety Fuse and Detonating Fuse are being used and shall be used in the mine.

As it is hard rock charge per Cum = 0.5Kg

Volume of blasted material per hole =6.6 X 3 X 2.5 = 50Cum

Quantity of explosive require per hole = 50 X 0.5 = 25

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Hence No. of Cartridge required = 25/ 2.778 = 8.99 = 9 Nos. (Say)

Conversion for insitu blasted rock 2MT/Cum.

So Powder factor = 50 Cum X2 / 25 = 4

At present consumption of explosives varies from month to month due to irregular strata condition.

Consumption of Explosives during 2010-11 to 2012-13 years

The consumption of explosive during the past three years is given below:

Explosive used in last three years

Year	Loose Ammonium Nitrate in Kg.	Slurry Explosive in Kg.	Ordinary Detonator in Nos.	Relay in Nos.	Safety Fuse in mts.	Detonating Fuse in mts.
2010-11	4000	25	56	6	130	4,625
2011-12	5200	7075	118	31	270	10,750
2012-13	—Nil—	11,675	108	13	250	10,750

Estimation of wagon drill requirement:

a) Rate of drilling = 12 m/hr

b) Drilling per day per shift (6 hr working) = 12 x 6 = 72m

c) Number of holes drilled per day = 10.9 or say 11

d) Material blasted by one blast hole = Burden x spacing x depth
2.5 x 3.0 x 6.6 = 49.5 cum or Say 50Cum

e) Quantity of material to be excavated per Drill machine per day = 11 x 50 cum = 550 cum

f) Average Yearly Total excavation = 1731692.99 cum

g) Average daily excavation at 300 annual working days = 5772 cum

h) Considering 15% of hard patch, No. of hole required to meet the daily Handling of excavation = 866 cum ÷ 50 = 17 holes

From the above calculation, it is clear that two numbers of wagon drills is required. The existing wagon drill is sufficient to meet the requirement of drilling during the plan period.

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b) Type of explosive used/to be used:

Slurry Explosive in cartridge form having dia 83mm(Weight of Cartridge 2 [illegible] Kgs each) as – Nova prime, Nova column, Aquadyne, Power Gel-C, Expro etc.

These are Class-2 Explosives

Also Loose Ammonium Nitrate, Ordinary Detonator, Relay, Safety Fuse and Detonating Fuse are being used and shall be used in the mine.

c) Drilling pattern:

Holes should be drilled in triangular / staged pattern and holes at face should be inclined. Up to three lines can be blasted by using relay and delay.

d) Whether secondary blasting is needed, if so describe in brief:

Not applicable.

e) Storage of explosives (like capacity and type of explosive magazine):

Storage of Explosives is made in the permanently constructed Magazine of 'L' type located in the South of quarry No.4 West (Ref. Plate - 5) having Magazine Licence No. E/EC/OR/22/235(E13684).

Capacity of Magazine:

Explosive -Class 2	:	1850 Kgs.
Safety Fuse Class 6	:	10,000 m
Detonatic Fuse Class 6	:	5,000 m
Detonator	:	E.D. – 1500 nos. O.D. – 5000 nos.

A.N.F.O. Mixing shed is located near dump no. 2 &3. License No. E/EC/OR/38/6(E17560).

Capacity: 1850 Kgs At one time.

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Vibration – pattern of blast holes and design of blast with details of sufficient number of experimental blast conducted

To control the air blast and vibration, delay-detonator were used and controlled blasting was enforced in the limited drilling-blasting work. Ground vibration studies due to blasting was carried during the plan period keeping different parameters such as burden, spacing, depth of hole, total charge, charge per hole, maximum delay charge etc. in number of holes. Blast vibration studies were conducted and the results showed that the ground vibration was well within the norms prescribed by the D.G.M.S. Copy of Blast vibration report conducted is enclosed as **Annexure – 20**.

However, it is proposed to :-

(I) Keep the drilling and blasting to the minimum restricted to only the harder formation.

(II) Use delay-detonator to keep vibration level to the minimum.

(III) Conduct ground vibration studies from time to time to know the level of vibration.

(IV) Use of safe charge/delay, proper burden, inclined holes in conformity with the slope of bench, sequential blasting, clearing of loose pieces rocks from the blast site and proper stemming of holes are proposed to bring reduction in blast induced ground vibration.

(V) In order to ensure effective control over vibration and related damage, regular in-house monitoring is proposed.

(vi) As village/human settlement exists nearby, NONEL system of blasting is proposed for getting optimum blast result.

NONEL SYSTEM OF BLASTING

In Nonel blasting system, row to row delay will be 42 / 65 ms. Blasting sites are selected on geological information. No. of holes blasted per blast ranges from 30 to 40 whereas charge per delay will be not be allowed to exceed 200 -250 kg. Left out toes and humps are drilled with primary drills & blasted and no jack hammer drilling/blasting will be practiced.

115 mm & 150 mm holes will be drilled on benches of 6 m height. Sub grade drilling of 10% will be practiced to deal with toe problem and high wall face will be kept inclined to vertical by drilling 5° to 10° inclined holes to ease the loading operation. Single row as well as multiple row blasting will be practiced. Holes are drilled on staggered pattern as well as square pattern depending on method of initiation. Sequence of firing of holes and typical charging pattern is given in figure for holes of 115 mm as well as 150 mm.

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For 115 mm hole of 6 m depth, 30 kg of ANFO explosive together with 5.5[illegible] will be required per hole. Proportion of column charge and booster is likely to change depending on site specific conditions. In Nonel system booster will be provided only at bottom. Booster will be power gel & drill cuttings are used as stemming for top 3 m portion. In Nonel (Non Electric initiation) initial firing will be by ordinary detonator & subsequent holes are fired in succession through respective detonating relays. Delay of 25 ms will be maintained in adjacent holes in a row whereas in multi row blasting 42/65 ms delay will be kept between two rows Maximum four rows are blasted at a time.

Types of Explosive to be used:

Booster used will be slurry explosive under trade name Power Gel C which will be basically a nitrate mixture. Column charge will be ANFO consisting 5% fuel oil mixed with prilled ammonium nitrate. Booster explosive will be available in 2.78 kg packets whereas ANFO will be poured as such in the hole. Cortex fuse, Nonel detonating tubes, safety fuse, ordinary and electric detonators are other explosive material that are required for blasting.

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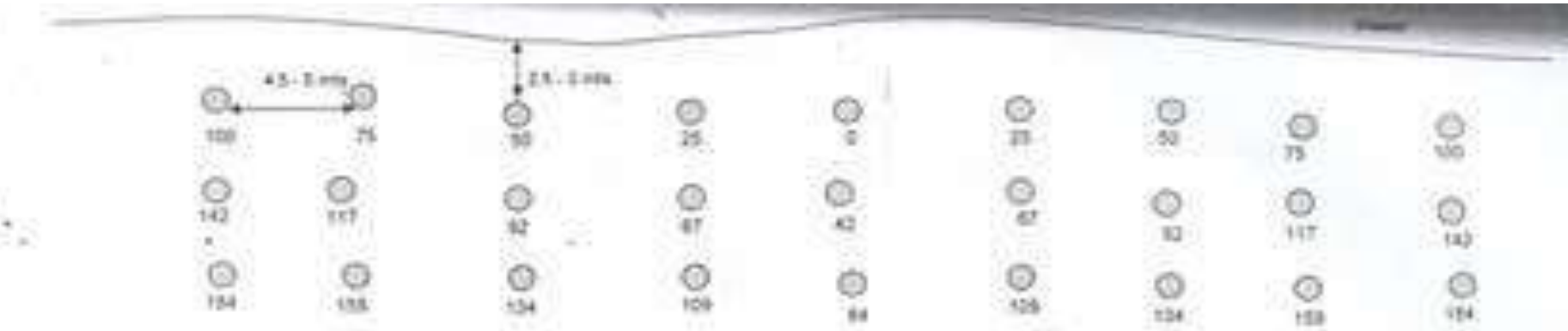
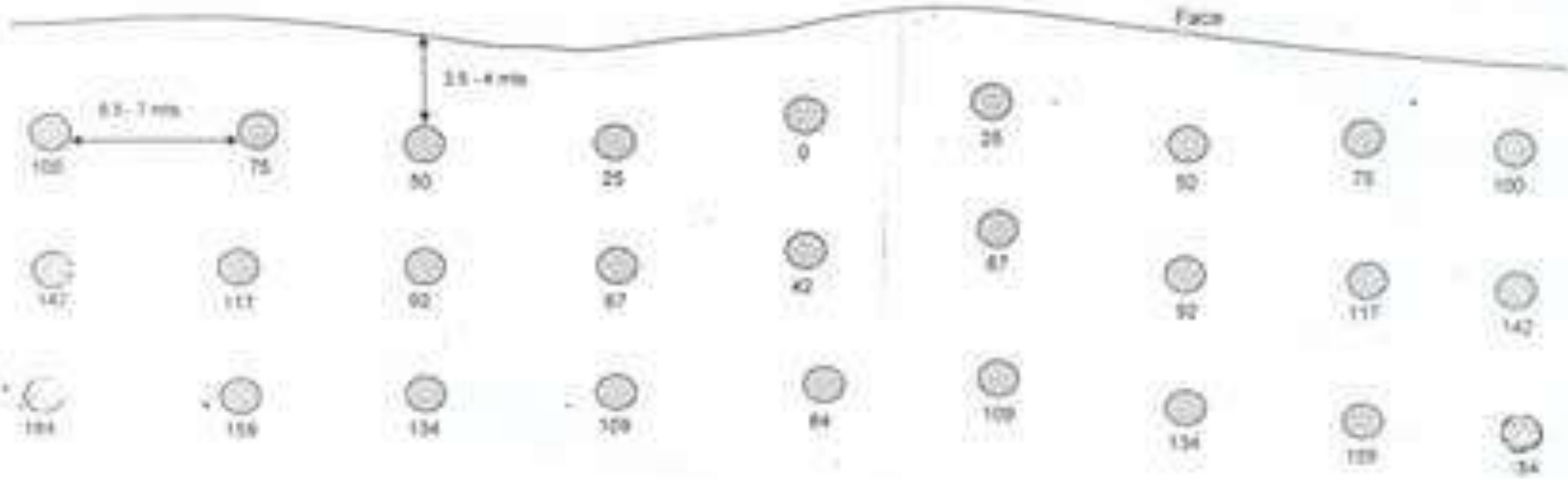


Hole Diameter = 115 mm

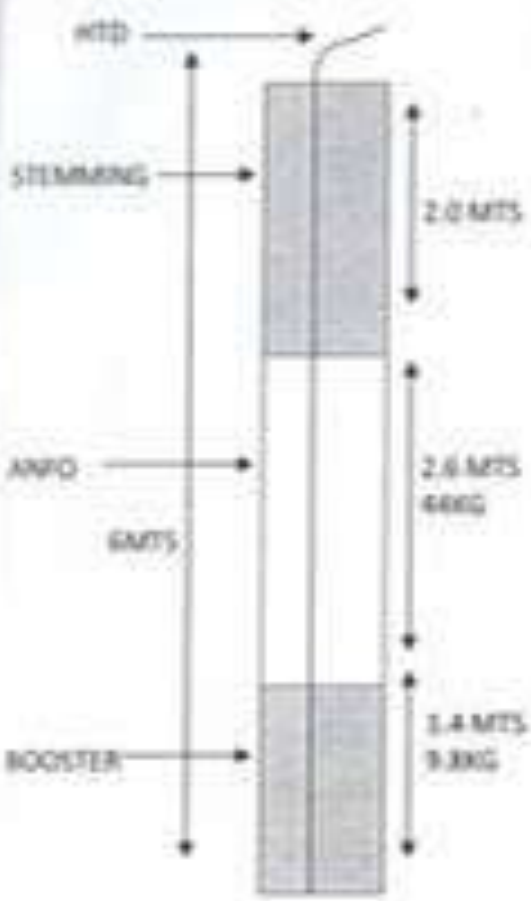
Row to row delay is 42 ms



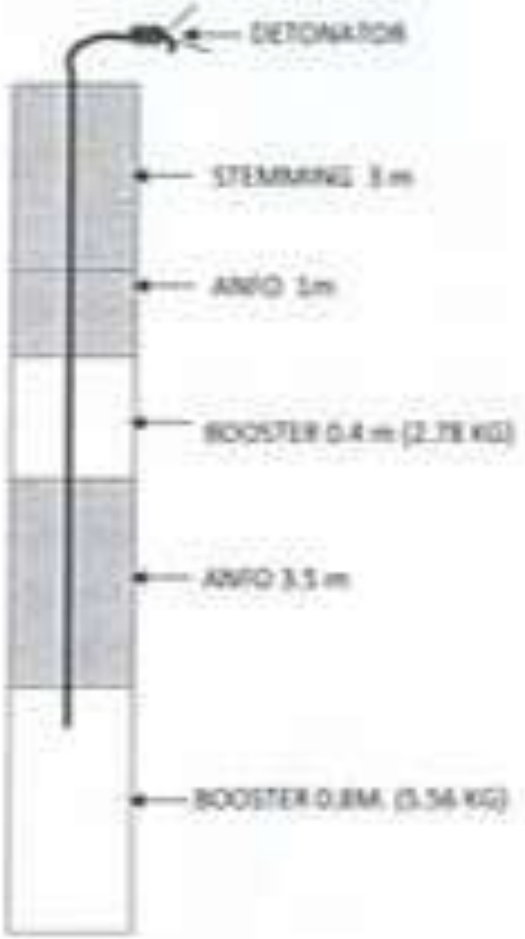
Hole Diameter = 150 mm

NONEL BLASTING SYSTEM

CHARGING PATTERN (HOLE DIAMETER =155 MM)



NONEL SYSTEM



CHARGING PATTERN

6.0 MINE DRAINAGE

a) Likely depth of water table based on observations from nearby wells and water bodies.

Topographically, Saruabil Chromite Mine represents a moderately hilly terrain. Sukinda valley represents a gently rising terrain mostly with plain land. The elevation ranges as observed within the leasehold area is 192mRL on SE side to a lowest of 137mRL on northern side of the lease area. Perennial Dharmsala nala flows from the northern side of the leasehold and forms northern boundary of the lease. The water table as observed from the nearby wells is at 3 -6m from the surface RL.

There are a number of thin streams in fan shape which are formed due to the topographic and structural feature of the area. These rivulets originate from Daitari and Mahagiri hills in north and south of the leasehold respectively. 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 main stream known as Damsal nala is cutting across the Chromite belt and flows from East to west on the Northern part of the area. It further joins the main Brahmani river due South of the area.

Generally, the ground water in these formations occurs within the secondary porosity such as joints, fractures and bedding plains. Groundwater occurs in the weathered residuum under unconfined condition and circulates through fractures and fissures below. The hydro-geological study carried out in the area shows following major hydro-geological units occurring in the area, which is as follows:

Laterite-Limonite-Chert
Laterite-Weathered and fractured ultramafics
Colluvium and channel fill deposits
Other units including orthopyroxinite

Continuous weathering has lead to the formation of all the above formations, which are highly erratic in nature. Predominantly limonite is found as host rock in the leasehold. It has been observed from the nearby wells and tube wells that the water table is at about 3-6m as such, the water table has already been intersected by working quarry. Hydrogeological study of the area was carried out and a report on Hydrogeology and ground water resource is enclosed as **Annexure – 18**.

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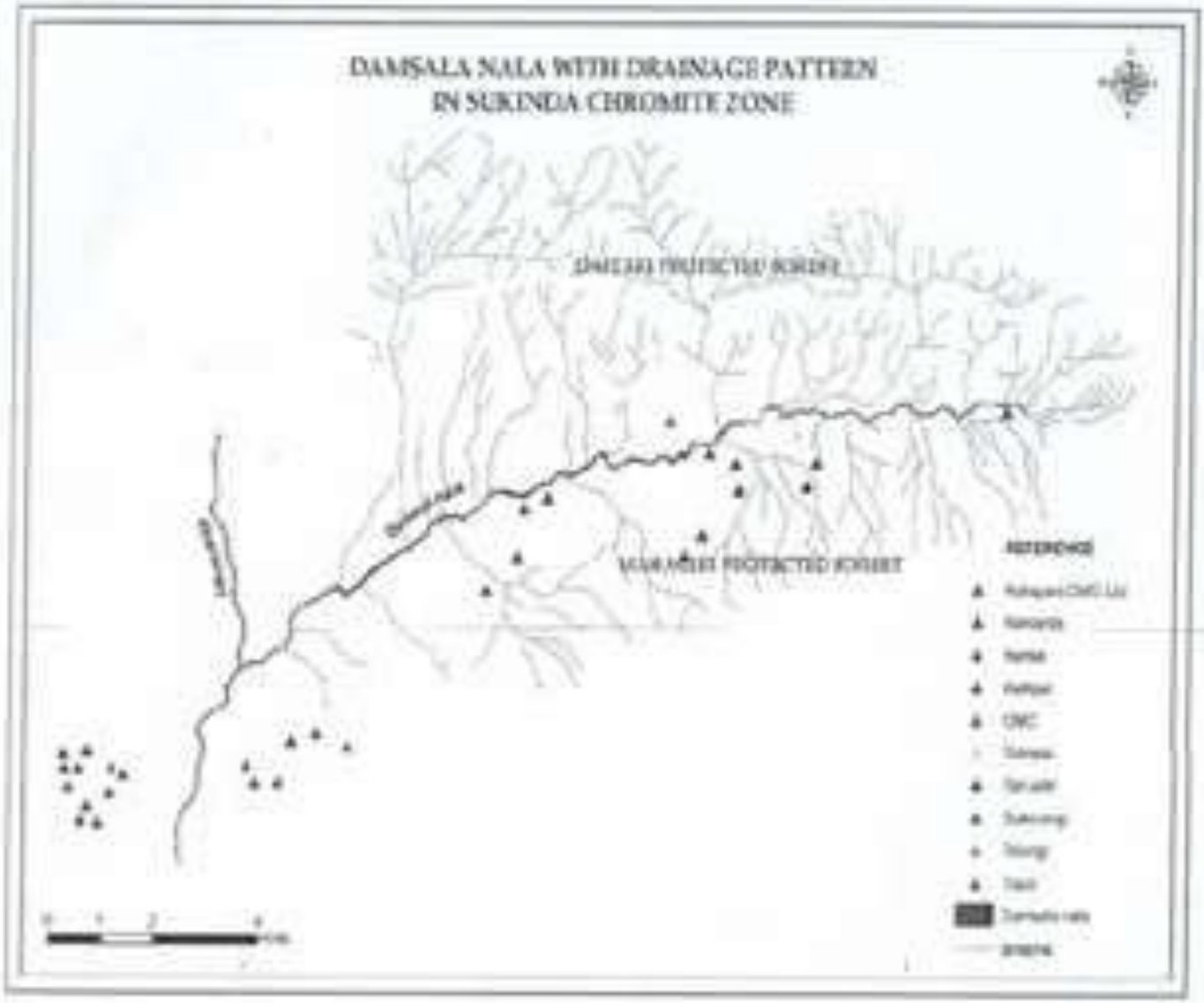
MAP SHOWING DENDRITIC TYPE DRAINAGE PATTERN OF DHAMSALA NALA FORM THE MAIN WATERSHED IN SUKINDA VALLEY WITH LOCATION OF OTHER CHROMITE MINES ETC.



b) Workings expected to be.....m above/reach below water table by the year.....

The water table is touched in number of working quarries. Heavy seepage of water is observed and noted in all the quarries of the mine especially during peak monsoon season.

Since, the water table is at 3-6m, the working of the quarry has already intersected the water table. The water percolates through the side walls and bottom of the quarry. There are total of six number of running quarries. The expected working depth of these quarries by the end of this plan period is given below:

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Table showing depth of quarries – Existing, at the end of plan period & at the end of Conceptual period

NAME OF QUARRY	EXISTING DEPTH (mRL)		AT THE END OF PLAN PERIOD (mRL)		AT THE END OF CONCEPTUAL PERIOD (mRL)	
	TOP	BOTTOM	TOP	BOTTOM	TOP	BOTTOM
Quarry 1 & 2 (Quarry – A)	143.08	113.63	143.08	97.00	140.00	97.00
Quarry 4 (Quarry – B)	161.94	118.86	167.00	95.00	162.52	85.40
Quarry 5, 5A & 6 (Quarry – C)	182.22	118.80	181.35	95.00	182.22	70.00
Quarry 7 (Quarry – D)	187.25	153.00	187.25	119.00	192.00	107.00

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.

All quarries of Saruabil Chromite mine have already encountered the water table, as such, there is percolation of water through seepage from the weak plane of rocks and bottom of the quarry. The water gushing in is collected in a sump made for and is pumped out. Since, it has been studied worldwide that the water coming out from the quarry contains harmful carcinogenic & toxic Hexavalent Chromium, as such, the water from the quarry is pumped out to the ETP (Effluent Treatment Plant) for treatment of the water. The details regarding the treatment have been explained in the **Chapter- 11**. A Copy of report on Design for Chromium Effluent Treatment plant (ETP) of M/s Misrilall Mines Pvt. Ltd. in Saruabil Chromite Mines of Sukinda valley, prepared by Department of Civil Engineering, IIT, Kharagpur in May 2013 is enclosed as **Annexure – 24.** Plan and section of Effluent Treatment Plant is enclosed as Plate – 13 (A-B).

The mine drainage, where the subsoil water is coming through the ore, constitutes the wastewater generation in the mining process. Mine drainage water is pumped from sump to ETP. The main source of mine drainage water is rainfall and subsurface water. The excess water, which cannot be consumed in the process of dust suppression and allied use, is termed as wastewater. The quantity of total water generated varies from season to season.

i) During rainy season, mining operations are at seasonal low but surface run off constitutes major water in mining area.

ii) In dry season the subsoil percolation is a main source of mine drainage water.

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Dewatering of accumulated quarry water is done by 1 diesel pump + 2 electric Pumps deployed in different quarries. It is proposed to have agreement of more electricity supply and then pumping of water will be done by electric pumps only. This will become necessary as make-up of water will increase with the mining at depth. The capacity of pumps already deployed and make up of water in Quarry – B (including Qry - C) during peak monsoon season is given as under:

Quarry No.	Make of water in Ltrs/hr	Pump Capacity in H.P. (Existing)	No. of Pumps
B & C	200 Kl/hr	40 H.P	2 No (Electric)
Standby Pump	----	40 H.P	1 No. (Electric)

The accumulated water is not discharged directly to any water course rather it is pumped out from the mine to Effluent Treatment Plant situated near quarry - B, wherein it is treated for Hexavalent Chromium. The treated water is used for water sprinkling on haul roads, plantation and other industrial purposes. The rest of the treated water is discharged to the Damsal nala, controlling the drainage pattern of the area. A Copy of report on the water quality with regards to presence of hexavalent chromium in Damsal nala of Sukinda mining area, prepared by Epg Odisha is enclosed as **Annexure – 25**.

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7.0 STACKING OF MINERAL REJECTS AND DISPOSAL OF WASTE

a) Indicate briefly the nature and quantity of top soil, overburden/waste and mineral rejects likely to be generated during the next five years

The area considered and targeted for development during the plan period (from 15.05.2014 to 2018-19) is within the area already working and opened up. Quarry-4, 5, 5A, 6 are almost merged and became a single quarry. To mine out the mineral economically from the main lode and side lode, the overburden which mainly consists of Nickeliferous Limonite, Laterites, lateritic soil, weathered serpentine, talc Schists and serpentine talc schists, silicified cherty rocks, quartzite is to be removed and dump separately. Also, during the course of mining operation, there will be generation of nickeliferous limonite which shall be stored separately. The overlying strata of limonite consist with percentage of Ni as 0.5%.

During the plan period, the mine has been design with a production capacity of 0.350 mtpa chrome ore keeping in view that the EC for this quantity will be obtained soon. For this, quarry 1&2, 4,5,5A,6 and 7 are proposed to work.

The overburden waste to be encountered and generated during mining operation mainly consists of:

Laterites Talc Schists and serpentine Talc schists Silicified Cherty Rock Nickeliferous Limonite Quartzite	**Overburden**

Laterite occurs as flat gentle sloping pavements and is confined as outcrop to the slopes of the mounds. Talc schists and serpentine Talc schists are mainly exposed in the south-western and South-eastern part of the area. Silicified Cherty rocks are massive and appear to be transverse by vein lets of amorphous silica and quartz. They are uniform except where they engulf with serpentines and limonitised rocks. These rocks are exposed in the southern part of the leasehold as well as in quarries.

Nickeliferous limonite is light and highly porous. These have been generally observed on both the footwall and hang wall sides of the Chromite bodies. The thickness varies from 5 to 15m. Nickeliferous Limonite is being stored separately for future use if any, as it contains

0.5% Ni. It has been assumed, that if any viable technology comes for beneficiation of Nickeliferous Limonite, the waste can be used. The other type of waste generated area topsoil, lateritic soil, Laterite, serpentine/ talc etc. The Nickeliferous Limonite is stacked separately.

The analytical result of the samples collected from time to time during the course of mining shows that the grade of Chrome ore ranges from +25% Cr_2O_3 to 52% Cr_2O_3 or even more. The cut off grade has been considered at +25% Cr_2O_3. The ore from +25% to -40% Cr_2O_3 is considered as low grade whereas, ore having +40% Cr_2O_3 is considered as high grade ore. As such, the future planning has been done based on ROM (+40% Cr_2O_3). The ore having +25% to -40% Cr_2O_3 is being and shall be treated in the COB (Chrome Ore Beneficiation) Plant to make the finished product as per requirement of the consuming industries.

It was mentioned in the approved scheme that about 6355000 cum waste shall be generated during the scheme period which shall be dumped over the existing dumps. But during the approved scheme period, total 1393657 cum waste was generated which was dumped in dump no. 2&3 and 11. The generation of less waste is due to the restriction of the production within granted EC of 0.136 million tons.

During this plan period, the waste likely to be generated during the course of mining operation has been furnished below in **Table – 7.1.**

Table – 7.1

Year-wise generation of the total nickeliferous limonite, waste from nickeliferous limonite and total waste

Year	Quantity of Nickeliferous Limonite zone (In-situ) (cum)	Generation of nickeliferous limonite (In-situ) (9.6% of A) (cum)	Waste from nickeliferous zone (In-situ) (cum)	Quantity of Waste Overburden (In-situ) (cum)	Total waste (In-situ) (cum)
	A	B	C = (A-B)	D	E = C + D
2014-15	159200.00	15283.20	143916.80	820995.00	964911.80
2015-16	215795.00	20716.32	195078.68	1586295.00	1781373.68
2016-17	187490.00	17999.04	169490.96	1635015.00	1804505.96
2017-18	91457.00	8779.87	82677.13	1637172.00	1719849.13
2018-19	104418.00	10024.13	94393.87	1638285.00	1732678.87
Total	**758360.00**	**72802.56**	**685557.44**	**7317762.00**	**8003319.44**

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Existing old dumps:

(a) Waste Dump:

As this is a case of operational mining area, there is presence of dumps. The waste dumps have been noticed within the leasehold area, which have been formed due to the generation and stacking of waste. As per the recent field survey, presence of almost 19 numbers of dumps has been noticed including nickeliferous limonite dump, waste dump & scattered waste dump.

It has already stated that the nickeliferous waste has been stacked separately, whereas the other waste excluding topsoil is dumped separately. There are total of six nos. of waste dumps, out of which, the largest dump 2/3 and 11 are active. It was proposed to continue dumping of waste overburden over active dump no. 2/3 till the height reaches 45m. A terrace of 25m has been left all along the dump. Further, regarding dump no. 11, it was proposed to attain the height of 25m. The existing spread and height of all overburden dumps are given in **Table – 7.2**. There are four Nos. of nickel dump, in which, the nickeliferous limonite generated during the scheme period was dumped over existing nickel dump C & D. The spread and height of each waste O/B and nickeliferous limonite dump is given in **Table – 7.2.** Also the locations of these dumps have been shown in **Plate – 5.**

Table – 7.2

Dimension of Existing Waste, scattered dump, Nickeliferous Limonite Dumps, sub-grade dump and Ore stack

Dump No.	Location	Spread (m^2)	Dimension (LxB)	Height (m)
Waste Dump				
1	Northern western part of Quarry-A	10920	168x65	12.20
2/3	South Western part of lease area	128241	493x260	45.00 (partly)
4	Amalgamated with Dump 2/3			
6	Nothern part of Qry-B	21320	290x73	7.22
8 &9	SE part of Qry-C	26074	205x127	7.90
10	Northern part of Qry-D	17801	175x102	19.00
11	Centre of lease area	205137	620x328	36.00

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Scattered Dump				
SWD-1	East side of Qry-A	3673	100x36	1.45
SWD-2	East side of Qry-A	4861	75x64	4.27
SWD-3	North east of Qry-C	7288	134x54	2.83
SWD-4	North east of Qry-C	5790	85x68	5.02
SWD-5	South of reservoir	16707	160x104	0.72
SWD-6	SE of Qry-C	28526	600x47	0.5
SWD-7	SE of Qry-C	5558	100X55	8.06
SWD-8	SE of Qry-C	1214	55X22	2.05
SWD-9	East of reservoir	7641	100x76	1.59
Nickel Dump				
ND-A	SE of Qry-C	2423	68x35	5.50
ND-B	SE of Qry-C	1691	43x40	6.10
ND-C & D	Near reservoir	21629	170x127	10.0
ND-E	Western part of Qry-A	2244	65x34	7.10
SUB GRADE DUMP				
SG-1	Northern part of lease area	3939	90x44	8.0
MINERAL STORAGE				
PO-1	Western part of Qry-B	9060	140x64	2.01
PO-2	Western part of Qry-B	16174	170x95	2.16
PO-3	Northern side Qry-B	6628	150x44	3.4
PO-4	North east part of Qry-B	2005	62x32	2.12
PO-5	Eastern part of Qry-C	9115	100x92	5.12

The analysis report of existing nickeliferous dumps is enclosed as **Annexure – 11**.

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Protective work already carried out around the existing Dump

Protective Works	Waste Dump						Camp site	Road side	Nala Barrier	Green Belt	Village site
	2/3	11	1	8	8,9	SWD -8					
Retaining wall	804m	387m	-	-	-	-	-	-	-	-	-
Garland Drain	961m	1622m	698m	492m	910m	-	-	-	-	-	-
Proper terracing	2	2	-	-	-	-	-	-	-	-	-
Plantation	33500	13250	2700	5300	8750	1500	1400	8300	14900	8900	6250
Area covered by plantation (ha)	12.63	5.30	1.09	2.13	2.60	0.76	0.59	3.32	2.54	3.57	2.50
	24.51 ha										

Proposed Protective work Proposed to be carried out around the Dump Etc.

Protective Works								Year	Remarks
Construction of Parapet Walls/Retaining wall at the toe of dump		Construction of Settling ponds		Construction of Garland Drain		Afforestation on dumps & Road barriers			
Area (ha)	Quantity m^3	Area m^2	Quantity m^3	Area m^2	Quantity m^3	Area (ha)	No of Plants		
1071m^3	2142	16	64	720	1080	1.50	4750.00	2014-15	Construction of Retaining wall at the foot of the WD-2/3, 10,11 & ND- C&D. Construction of Garland drain at the foot of the WD-2/3, 10,11 & ND- C&D. Total setting pond shall proposed in between the garland drains. Slope of dump No.2/3, Southern side of Hurtling No.3, Northern side Green belt, Over old plantation area, Village area within 5Km radius of lease boundary.
1071m^3	2142	16	64	720	1080	1.50	4750.00	2015-16	
1071m^3	2142	16	64	720	1080	1.50	4750.00	2016-17	
1071m^3	2142	16	64	720	1080	1.50	4750.00	2017-18	
1071m^3	2142	16	64	720	1080	1.50	4750.00	2018-19	

b) Land chosen for disposal of waste with proper justification:

Selection of dumping site:

Presently dumping of waste is being continued over active dump nos. 2/3, 10 and 11. Dump no. 2/3 has attained a height of 45m (partly) – 25m in first phase and 20m in second phase whereas dump no. 11 is having a height from 36m. Based on the recent survey and Exploration already carried out by Lessee in the year 2011-12, BH No.- 10/12, 11/12 & 12/12 shows negative result near quarry - 7. Also, old boreholes no. 3,19,21,22 and 23 shows negative result wherein dumping was started in the past and now dump no. 2/3

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exists. Further, exploration by boreholes has now been proposed during first year of this plan to prove the barrenness of the area suitable for waste disposal. It is proposed that the waste generated during the next five year of the plan period will be dumped laterally and over dump no.2/3,10 and 11. Keeping the lead factor within control, dumping pattern has been chalked out. Further, it has been proposed that any spoil bank, which will exceed 25m in height, shall be benched so that no bench exceeds 25m height and the individual slope does not exceed 28° from the horizontal. A terrace of 25m will be left all along the dump to start the 2nd phase. During first year of this plan period Scattered dump (SWD No.- 5, 7 & 8) shall be removed and shifted to Dump no.11 which can accommodate about 47567.74 cum. So, in first year (2014-2015), about 990769.02cum (943201.28Cum + 47567.74cum) material shall be dumped laterally and over the Dump no-11.

The year wise dump plan and section has been shown in dump plan and section and also shown in Environmental management plan **(Plate-14)**. The detail of year wise dumping, its location, spread area etc is given in **Table-7.3.**

Table – 7.3

Table showing waste to be dumped (Insitu, Loose and Compact)

Year	Total waste (In-situ) (cum)	Loose (In-situx1.15) (cum)	Compact (85% of loose) (cum)
2014-15	964911.80	1109648.57	943201.28
2015-16	1781373.68	2048579.73	1741292.77
2016-17	1904505.96	2075181.85	1763904.58
2017-18	1719649.13	1977826.49	1681152.52
2018-19	1732678.87	1992580.70	1693693.60
Total	**8003319.44**	**9203817.34**	**7823244.75**

Table showing year-wise spread & Height of Proposed dump during plan period

Year	Location of proposed dumping	Waste to be accommodated (Cum) (compact)	Avg. Spread Area (Hectares)	Proposed RL (m)		
				Top R.L	Bottom R.L	Proposed Height (m)
2014-15	WD - 11	990769.02 (1st year waste + scattered dumps)	17.47	172.00	166.61	5.39

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2015-16		1741292.77	17.34	182.04	172.00	
2016-17		1763904.58	14.85	193.91	182.04	
2017-18		1681152.52	13.80	206.09	193.91	12.18
2018-19		473693.60	11.25	210.30	206.09	4.21
2018-19	WD - 2/3	476000.00	2.80	157.00	140.00	17.00
2018-19	WD - 10	744000.00	7.44	164.37	154.37	10.00

Nickeliferous Dump

It has been seen during the last few years working that about 9.6% of the total nickeliferous limonite comes under the category of having nickel percentage more than 0.5. This material will be dumped over dump no C&D. The capacity of this dump is sufficient to accommodate the above material and the dump height will be attain 10m and an additional area required for dumping nickel is 0.94 ha. During this plan period, the material from existing nickel Dump (A & B) shall be removed and shifted to Dump - C & D during the course of mining operation.

Spread & Height of the Proposed Dump of Nickeliferous Limonite over Nickel Dump

Year	Generation of nickeliferous limonite (In-situ) (cum)	Loose (In-situx1.15) (cum)	Compact (85% of loose) (cum)	Location	Spread Area in m^2	Avg. height in M.	Proposed RL (m)	
							Top	Bottom
2014-15	15283.20	17575.68	14939.33	Dump-C &D	1376.86	11.10	165.20	156.30
2015-16	20716.32	23823.77	20250.20		1770.62	11.70	155.10	166.80
2016-17	17999.04	20698.90	17594.06		1475.33	12.20	154.90	167.10
2017-18	8779.87	10096.85	8582.32		665.92	12.80	154.70	167.50
2018-19	10024.13	11527.75	9798.59		748.06	13.40	154.40	168.00
Total	72802.56	83722.95	71164.50	-	-	-	-	-

Table showing year-wise area covered due to proposed dumping

Sl. No.	OB Dump No.	Existing area occupied by OB dump (Ha.)	Additional area required for plan period (Ha).	Total Area occupied by dump after 5 years (Ha.)
1.	WD –2/3	12.82	3.34	16.16
3.	WD- 10	1.78	6.70	8.48
4.	WD -11	20.51	14.82	35.33

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Nickel Dump				
t.	ND - C&D	2.16	0.94	

Precaution for confinement of dumps:

It has been proposed to take necessary steps to stabilize the existing waste dump by taking the following steps:

a) To check surface wash-off during the rainy season, it is proposed to erect toe wall around the foot of the dump.

b) A garland drain shall be provided all along the dump with some soak pits to arrest any wash-off. The garland drain will help in gravitational settling of the solid waste and clean water will pass downwards.

c) For the stability of dump, the slope of the dump shall be made and maintained at 28°. Further, foot of the dump shall be stabilized by plantation or grass.

d) A terrace of 25m will be left all along the dump to start the 2nd phase.

c) Attach a note indicating the manner of disposal and configuration sequence of buildup of dumps along with the proposals for the stacking of sub grade ore to be indicated item wise:

The cut of grade is considered at +25% Cr2O3 and threshold value is 10% Cr2O3. The ore between +10% to -25% Cr2O3 is considered under sub-grade. In this mine, there is no sub-grade ore. The ore having +25% to -40% Cr2O3 is treated in the COB plant whereas ore having +40% Cr2O3 is utilized in company's own Ferro chrome plant as well as for domestic sale. As such, selection of land for sub-grade dumping is not required.

Top-Soil: The area targeted for development during the plan period does not contain any topsoil. As the development work shall be carried out mainly in the already worked out quarry during the plan period, so there is no chance of top soil generation.

Tailing Dump: The tailing generated from the COB plant is channelized in a concrete settling tank situated within the COB plant area. The existing tailing pond and proposal for this five years plan period is given below:

Existing Dimension	No. of pond	Proposal during this plan period	Dimension of the pond/compartment
30m x 7.0m x 3.0m	01	Additional - 02 ponds	50m x 25m x 3.0m
20m x 7.0m x 3.0m	02	Dry Tailing compartment	65m x 25m

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8.0 USE OF MINERAL :

a) Describe briefly the end use of the mineral (sale to intermediary parties, captive consumption, export, industrial use)

Chromium was first discovered as a metal in the 17th century, but it was only in the 18th century before it was used commercially. In the 20th century, the use of chromium exploded due to the industrialization and surge in demand for stainless steel. Chromium usage can be divided into 3 categories:

Metallurgy: 90%

Chemical: 5%

Refractory and Foundry: 5%

In metallurgy, chromite is used in the manufacturing of chromium metal and various alloys with iron, nickel, cobalt, tungsten, molybdenum, etc. Chromium imparts additional strength, hardness and toughness to its alloys. It also shows resistance to corrosion to steel abrasion, reduces oxidation and flow of electricity. Stainless steel, high-speed tool steel, corrosion and heat-resistant steel are some of the important varieties of chromium steel. Ferrochrome is of two types: (i) high carbon (containing 4-8% carbon) and (ii) low carbon (containing up to 2% carbon). The amount of chromium used in steel varies with the purpose. Low chromium steels (less than 5% chromium and small amount of nickel) are used in rails, automobiles, armor plates, armor piercing projectiles, etc. Intermediate chromium steels (3-12% Cr and small amounts of W, Mo or Si) are used in high-speed tools, valves for engines and other equipment requiring resistance to abrasion, corrosion and oxidation. Chromium steels include stainless steels (12-18% Cr) and super-stainless steels (12-30% Cr and 7-10% Ni) which are used for cutlery and cooking utensils and in aircraft and high speed trains, respectively. Chromium (17%) with iron (83%) is also used as ferritin stainless steel to manufacture coins. Chromite is used in refractory industry because of its resistance to corrosion, high temperature and ability to withstand sudden temperature changes and its chemically neutral character. The ore is used in the form of lumps, bricks or cement in linings, especially of steel furnaces.

Chromite ores are converted into Ferro chrome through smelting with carbon or silicon. Metallurgical Ferro chrome usage is the production of stainless steel. Chromium's biggest

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benefit in the metallurgy Ferro chrome usage is its corrosion resistance, hardness, strength and bright finish. These benefits allow Ferro chrome to be used in the production of stainless steels, and heat resistant steel. In the production of stainless steel, the use of Ferro chrome has no substitute, so as long as stainless steels are being produced worldwide, the demand for Chromite ores will exist. Up to 25% of the weight of stainless steel is Ferro chrome.

Typical Usage:

1. Used to harden steel, to manufacture stainless steel and to form alloys
2. Used in plating to produce a hard, beautiful surface and to prevent corrosion.
3. Used by the aircraft and other industries for anodizing aluminium.
4. The refractory industry uses chromite for forming molds and shapes, as it has a high melting point, moderate thermal expansion and stable crystalline structure.

The mine produces Chrome ore which is very much suitable for different consuming industries. The ore contain +40% and above Cr_2O_3 will be utilized for captive Ferro Chrome plant whereas ore contains +25% to -40% Cr_2O_3 will be utilized for captive Chrome Ore Beneficiation plant. The Chrome ore of this mine has good market for export and domestic consumer as per their requirement in both quality and quantity. The name of some of the consignee industries are given below:

Grade of Ore	Purpose	Name of the consuming industry
+52% & above Cr_2O_3 +40% to -52% Cr_2O_3 -40% Cr_2O_3	**Captive Consumption**	M/s Misrilall Mines (P) Ltd. (Pankpal)
+52% & above Cr_2O_3 +40% to -52% Cr_2O_3 -40% Cr_2O_3	**Captive Consumption**	M/s Misrilall Mines (P) Ltd. (Karmakhyanagar), Dhenkanal, Odisha.
+25% to -40% Cr_2O_3	**Captive Consumption**	COB plant within lease.
+52% & above Cr_2O_3	Domestic Sale	M/s Shreekhem Industries Ltd, Rourkela.
+52% & above Cr_2O_3	Domestic Sale	M/s Bell Mountain Company, Belpahar.
+52% & above Cr_2O_3	Domestic Sale	M/s Associate Chemical Work, Fatepur.
+52% & above Cr_2O_3	Domestic Sale	M/s Mineral Trade Corporation, Chaibasa.
+52% & above Cr_2O_3	Domestic Sale	M/s Mines Worth Minerals, Chaibasa.
+52% & above Cr_2O_3	Domestic Sale	M/s Tawi Chemicals, Jammu.

+52% & above Cr_2O_3	Domestic Sale	M/s Lords Chemical Limited, Kolkata
+52% & above Cr_2O_3	Domestic Sale	M/s Unichem India, Kanpur.
+52% & above Cr_2O_3	Domestic Sale	M/s Shetty Chemicals and Engineering (P) Ltd.
+52% & above Cr_2O_3	Domestic Sale	M/s Indoton Chemical Ltd, Bighati, Mirilall Jain & Son

Self Industry Requirement:

The lessee has two numbers of Ferro-chrome Plant – one is situated in Pankpal, Odisha whereas other one is situated in (Kamakhyanagar), Dhenkanal, Odisha. The chrome ore required for the above two plants are approx 0.20 million tons per annum of +52% & above Cr_2O_3, +40% to -52% Cr_2O_3 and -40% Cr_2O_3. Besides, there is chrome ore beneficiation plant within the leasehold where approx 0.10 million tons per annum Low grade chrome ore (+25% to -40% Cr2O3) will be required. So, out of the total production of 0.35 million tons per annum, approx 0.30 million tons chrome shall be utilized in self industries. Rest 0.05 million tons chrome ore shall be sold to the different consuming industries.

Table showing yearly consumption of chrome ore from Mine

Consumption of chrome ore		chrome ore in million tons per annum	Grade
Ferro-chrome Plant Pankpal, Odisha Dhenkanal, Odisha	Captive consumption	0.20	+52% & above Cr_2O_3, +40% to -52% Cr_2O_3 and -40% Cr_2O_3
chrome ore beneficiation plant within the leasehold	Captive consumption	0.10	(+25% to -40% Cr2O3)
To be sold to the different consuming industries	Domestic sale	0.05	+52% & above Cr_2O_3,
Total		**0.35**	

b) Indicate physical and chemical specifications stipulated by buyers:

The economic cut off grade of the ore is +25% Cr_2O_3. Ore above this is being sold to various end users. Also, the low grade is beneficiated in company's own COB plant within the lease and is used in the industry. A part of the production, being high grade, is in demand and is exported. The Chrome ore produced from the mine has been analyzed. The analysis of the chrome ore of this mine is given below:

▶	Cr_2O_3	FeO	SiO_2	Al_2O_3	CaO	MgO	P_2O_5	SO_3	LOI	Ni%
Sample - 1	52.28	17.641	2.59	11.54	2.82	10.47	0.016	0.13	1.63	0.297
Sample - 2	51.54	17.699	2.91	11.40	3.20	10.75	0.014	0.014	1.90	0.357
Sample - 3	52.67	17.454	2.44	11.50	2.99	10.72	0.016	0.016	1.78	0.267

The analysis report of chrome ore from the mine is also given in **Annexure – 10.**

c) <u>Give details in case blending of different grades of ores is being practiced or is to be practiced at the mine to meet specifications stipulated by buyers:</u>

No blending of different grades of ore is being taken up to meet the specification of the consuming industries. Low-grade ore containing +25% to -40% Cr2O3 produced from the mine mainly from contact zone of the main lode, side lode of quarry -B and from quarry -D will be utilized in Company's own Chrome Ore Beneficiation plant to upgrade. The lessee has established a Chrome ore beneficiation plant with existing capacity of 20TPH to upgrade the low grade Chrome which is going to be enhanced to 30 TPH. The location of the COB plant is shown in the Surface Plan and detail is shown in **Plate – 14**.

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9.0 OTHERS:

9.1 SITE SERVICES:

This a running mines. All the site services have been provided within the leasehold. The lessee has provided all the amenities for the mine workers and executives employed in the company. A residential colony with all the facilities has been constructed within the leasehold. The township includes Director Bungalow, Healthcare centre, playground etc. For the residents of township place of worship has been provided. Postal & Telecommunication facilities are available at Kalrangi, Kaliapani & Kansa. Telephone exchange is at Kaliapani. A market complex for daily needs has been built at the township. Apart from the market complex, weekly market is at Saruabil, which generally comes alive on Sunday as Haat. The nearest market place Kaliapani has more advance market to fetch the requirement of the local residents. The health centre provided at the township is well equipped and has a full time Doctor.

Apart from this, an Effluent Treatment Plant has also been constructed in which the mine discharge water is treated for toxic & carcinogenic Hexavalent Chromium, and is used for other industrial purposes and plantation. The leasehold area is connected to State Highway connecting Jajpur & Sukinda. The expressway connecting Paradeep and Daitari is at a distance of 15Kms. All necessary infrastructures are in the lease area. A COB (Chrome ore Beneficiation) plant is also within the leasehold. Workshop has been provided for day to day maintenance of the machines being used in mining. The major repairs, if any, is being done at Jajpur.

9.2 EMPLOYMENT POTENTIAL:

Since, this is an operating mine, there already exists employees for smooth operation of the mine. The existing manpower is as follows:

(a) Management and supervisory Personnel:

(i) Existing:

Sl. No.	Description	No.
01	Mining Engineer – B.E (Mining)	02
02	Mining Engineer – Diploma in Mining	03
03	Mining Geologist - M.Sc (Geology)	02

04	Surveyor	
05	Foreman/ Mate	05
06	Other Administrative Clerical and Technical supervisory Staff	22
Total		**36**

(ii) **Proposed**

Sl. No.	Description	No.
01	Mining Engineer – B.E (Mining)	03
02	Mining Engineer – Diploma in Mining	03
03	Mining Geologist - M.Sc (Geology)	02
04	Surveyor	02
05	Foreman/Mining Mate	10
06	Technical Supervisor/Clerk/Accountant	30
Total		**50**

(b) Labour (Skilled/Semi Skilled/Unskilled):

The mining operation is carried out by mechanical means. Workers are required for mining activities at the face and for other mining associated work. Also some workers are required for day to day maintenance work of the mine. For this about 194 workers are engaged in the mine. However, additional manpower may be engaged if required. For welfare of the employees, within the leasehold, following amenities has been provided:

1. A township within the leasehold for accommodation of the executives of the company
2. The township consists of marketing complex to fetch the daily need of the residents of township.
3. A health centre with full time Doctor has been provided.
4. The township also has recreation facilities like Cricket/Football ground, children's play area etc.
5. Ample plantation has been done to make the environment of the township clean.
6. The plantation also works as dust suppressor and noise insulator.
7. Potable drinking water facilities has also been provided within the township.

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Occupational Health & Safety

To avoid any adverse effect on the health of the workers due to dust, noise and vibration or due to any mining or allied activity caused due to mining operation, following measures will be taken and are proposed for implementation of the same.

1. Potable drinking water for the workers employed in the mine to provided at a suitable and convenient place.
2. The place with the arrangement of drinking water shall be properly maintained in full hygiene and has "DRINKING WATER" written over it in local language to understand the common workers employed.
3. The arrangement of drinking water shall be at a distance of not less than 100m from the wash rooms/toilets.
4. Water sprinkling arrangements near the areas producing dust.
5. If possible selecting alternative method of fracturing the rock.
6. Regular repair and maintenance of machineries used.
7. Regular overhauling of the machines used.
8. Periodic repair & maintenance of the machines used.
9. Proper hygiene shall be maintained at the rest shelters.
10. More safety in working and training for implementation of safety and use of protective gears against dust, noise and vibration. Creating awareness for safety while working.
11. Continuing with training of employees for use of safety appliances and first aid.
12. Operating the mine scientifically.
13. Since, the workmen employed are prone to exposure of Cr^{+6}, a toxic and carcinogenic agent, periodic medical checkup of the workmen will be carried out.
14. Suitable measures have been proposed to reduce the contamination of water with the carcinogenic Cr^{+6}.
15. Creating awareness by organizing seminars on the possible causes of Cr^{+6}.
16. All these can be achieved by adopting scientific mining methodology.

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10.0 MINERAL PROCESSING

a) If processing/beneficiation of the ore or minerals mined is planned to be conducted on site or adjacent to the extraction area, briefly describe the nature of processing/beneficiation. This should indicate site and grade of feed material and concentrate (finished marketable product), recovery rate.

Lessee has established a chrome ore Beneficiation plant within the lease area with all necessary equipments required for beneficiation of low-grade friable chrome ore in wet gravity separation method.

The existing beneficiation plant set-up by M/s Misrilall Mines Pvt. Ltd at Saruabil Chromite Mines is based on gravity separation process with a capacity of 30TPH comprises of feed Hopper, Reciprocating feeder, Mechanical Scrubbing unit, conveyors, Single deck screening unit, Crushing unit, Milling unit and processing unit consists of Slurry pump, Stub & Normal cyclone, dewatering cone, stock piling area, ground water reservoir & zero discharge tailing pond.

Beneficiation processes:

The ore of -150mm having 25% to 40% Cr2O3 generated from the Mines in course of mining is fed to the Plant. The feed ore from the stock pile is brought to the plant site in Dumpers & fed directly into the feed Hopper. Ore is drawn from the Hopper with the help of Reciprocating Feeder and goes to scrubber.

In scrubber scrubbed ore of+4mm to -150mm and-4mm to -1mm size are separated. Then -4mm to -1mm is fed to a wet single deck primary vibrating screen where water is added. Again the scrubber over size +4mm to -150mm goes to swing Hammers Crusher where the total material crushed and the product generate -12mm size. Further the output of Crusher material goes to single deck secondary vibrating screen having 1 mm aperture. The under size of both the primary & secondary vibrating screen (i.e. -1mm) goes to two stages Hydro Cyclone with the help of slurry pump. Both primary & secondary vibrating screen over size (i.e. +1mm to -12mm) is conveyed to a Rod Mill for grinding. The grinded material of Rod mill is passed through a bank of stub cyclones. The under flow of stub cyclone are fed to Fluidized Bed Concentrator (F. B. C) to improve the concentrate grade, to get low silica and to decrease the tailing grade. The overflow of all the stub cyclones is taken to a bank of Normal hydro cyclone. The underflow of the Normal cyclone are fed to the another

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Fluidized Bed Concentrator (F.B.C.) to improve the concentrate grade, to get low silica and to decrease the tailing grade. Then both F.B.C. products passes through -8mm sieve fitted to a Rotary Screen. From rotary screen underflow treated as a final product and overflow courser particle send to Rod Mill for regrinding.

The overflow of the said cyclones passes through series of dewatering cone, then under flow of dewatering cone passes through Fluidized Bed Concentrator (F.B.C.) for retreating. Overflow of the dewatering cone and overflow of the F.B.C comes as a tailing through series of setting pit and the final tailing send to a multi compartment zero- discharge tailing pond.

Also the drained water from different Concentrate stock pile and plant floor washing water is collected in a common sump from where it goes to the zero discharge tailing pond through pipe line.

Time to time tailing is being remove from tailing pond and kept on a tailing stock yard for drying. As per our Ferro Chrome plant requirement the dry tailing will be dispatched to the plant, where the tailing will be utilized to replace the mill scale added to the chrome ore.

The plant has been designed to operate under the following parameters:-

(i) Hourly throughout capacity: 30 tons

(ii) Feeding :

Type of feeding (Friable Ore)
Chrome ore 100%(-150mm)

(iii)Screen Analysis (Dry):

(+) 12 (-) 150 mm	: 08%
(-) 12 (+) 8 mm	: 12%
(-) 6 to +1mm	: 20%
(-) 1mm	: 40%
Slime	: 20%

(iv) Avg. Feed grade: Cr_2O_3 - 34 %
SiO2 =13% - 17%
Cr/Fe =1.4

(v) Bulk density: 1.6 t/cum

(vi) Sp. Gravity: 3 to 3.3

(vii) Recovery percentage: 55 %

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(viii) **Recovery grade:** Cr_2O_3 = 53% - 54%
SiO_2 = 3% - 3.5%

(ix) **Tailing percentage:** 44 -45%

(x)**Tailing grade Cr2o3:** 8.81% -9.55%
Cr/Fe = 2.5 -3.0

Material Balancing Against 100MT

Feeding grade Cr_2O_3 = 34 x 100 = 3400 grade Tones

Con. grade Cr2O3 52% = 54 x 55 = 2970 grade Tones

Tailing grade Cr_2O_3 9.55% = 9.55 x 45 = 430 grade Tones

Total grade Tones = 3400

Con. grade Cr2O3 54% = 54 x 55 = 2970 grade Tones

Tailing grade Cr_2O_3 9.55% = 9.55 x 45 = 430 grade Tones

Total grade Tones = 3400

The year wise and the grade wise quantity to feed in chrome ore beneficiation plant is given in table below:

Year	Quarry	Type	Quantity(MT)	Recovery (Average)	
				By volume	By grade
2014-15	Qry-A,B,C&D	Feed	72,000		34-35% Cr_2O_3
		Concentrates	39600	55%	53-54% Cr_2O_3
		Tailing	32400	45%	8.81-9.55% Cr_2O_3
2015-16	Qry-A,B,C&D	Feed	72,000		34-35% Cr_2O_3
		Concentrates	39600	55%	53-54% Cr_2O_3
		Tailing	32400	45%	8.81-9.55% Cr_2O_3
2016-17	Qry-A,B,C&D	Feed	72,000		34-35% Cr_2O_3
		Concentrates	39600	55%	53-54% Cr_2O_3
		Tailing	32400	45%	8.81-9.55% Cr_2O_3
2017-18	Qry-A,B,C&D	Feed	72,000		34-35% Cr_2O_3
		Concentrates	39600	55%	53-54% Cr_2O_3
		Tailing	32400	45%	8.81-9.55% Cr_2O_3
2018-19	Qry-A,B,C&D	Feed	72,000		34-35% Cr_2O_3
		Concentrates	39600	55%	53-54% Cr_2O_3
		Tailing	32400	45%	8.81-9.55% Cr_2O_3

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b) Explain the disposal method for tailings or waste from the processing plant (Quantity and quality of tailings proposed to be discharged, size and capacity of tailing pond, toxic effect of such tailings, if any, with process adopted to neutralize any such effect before their disposal and dealing of excess water from tailing dam)

The year-wise generation of tailings from COB plant is given in table above. The tailing generated from the COB plant is channelized in a concrete settling tank situated within the COB plant area. There are three tailing ponds exist within the COB plant area. These tailing ponds can accommodate 1470 cum tailings. From the above table, it is clear that about 32400 MT tailings will be genetated per annum, 108 MT/day or (67.5cum/day). This shows that the existing tailing ponds are sufficient to accommodate the tailings of only 22 days. It is a general practice that time to time tailing is being removed from tailing pond and kept on a tailing stock yard for drying. So, the tailings so accumulated in the tailings pond shall be removed and kept on a tailing stock yard for drying. Further, the tailings so generated was tested in lessee's own Ferro Chrome plant and found suitable to replace the mill scale added to the chrome ore. So, the dry tailing will be consumed in the lessee's own Ferro Chrome plant, where the tailing will be utilized to replace the mill scale added to the chrome ore. The detail of existing tailing pond is given below:

Existing Dimension	No. of pond	Capacity	Location
30m x 7.0m x 3.0m	01	630 cum	Within COB plant area
20m x 7.0m x 3.0m	02	420 x 2 = 840 cum	

Since the existing tailing ponds are sufficient only for 22 days, hence keeping in view the production during plan period, it is proposed to made two additional tailing ponds and one dry tailing compartment to meet the disposal of proposed generated tailings.

The proposal for additional requirement of tailing pond during this plan period is given below:

Proposal during this plan period	Dimension of the pond/compartment	Capacity	Location
Additional - 02 ponds	50m x 25m x 3.0m	3750 cum x 2 = 7500 cum	Within COB plant area
Dry Tailing compartment	65m x 25m	1625 sq.m	

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So, after this proposed tailing pond, total capacity of the tailing ponds will become 8676 cum and can accommodate the tailings of at least 132 days i.e. almost five months. Also, the same practice i.e. time to time removal of tailing from tailing pond and kept on a tailing stock yard for drying shall be continued. The year wise generation of tailings, its average recovery and average grade is given in table above. The quantity of existing tailings is about 1500 MT and the average grade is 8.81-9.55% Cr2O3. The analysis report of tailing s is given in Annexure – 11. The existing and proposed tailing pond design is shown in Plate – 15.

Tailing Dam Management:

The unit is having a zero discharge chrome beneficiation plant and the tailing generated in course of low-grade chrome ore beneficiation is pumped out to multi R.C.C compartment tailing pond. The tailing is allowed to form a cake and is rehandled mechanically by H.E.M.M. time to time and is buried at higher elevated dump after packing in thick polythene bags. Seepage of water into the ground is restricted due to R.C.C compartment. The compartment of the tailing pond has been made in such a fashion that the clear water is received at last compartment. The chromites present in the ore are quite stable and leaching of harmful hexavalent chromium by rain water and pollution of under ground water resources is extremely remote. However, to take care of such an exigency, solution of ferrous sulphate and alum is added into tailing pond to reduce any hexavalent chromium ion to trivalent chromium which is not harmful and will be precipitated. The water from the last compartment is reclaimed and reuse in the COB circuit.

The process being wet, no dust will be generated during the processing of ore. However, dust generation is anticipated during dumping and truck movement, which will be suppressed by sprinkling of water at regular interval using a water tanker. The Chromite present in the ore is quite stable and leaching of harmful hexavalent chromium by rainwater and pollution of underground water resources is extremely remote. However, to take care of such exigency solution of ferrous sulphate and Alum will be dosed into tailing pond. This solution will reduce any hexavalent chromium ion to trivalent chromium, which will be precipitated.

To control Noise pollution, which will be caused by the rod mill, it is proposed to use replaceable rubber liner in the rod mill, which will maintain the noise level within permissible

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limit. Hammer Crusher will cause some noise but it will be much less than the standard norms as because the ore is friable in nature and it would be totally rubber lined machine.

Moreover, Environment Management work will also include massive plantation periphery of the plant. The density of plants will be increased much more than that of existing level.

d) Specify quantity and type of chemicals to be used in the processing plant.

Not applicable. No chemical is used in beneficiation process.

e) Specify quantity and type of chemicals to be stored on site/plant.

Not applicable as stated above.

f) Indicate quantity (Cum per day) of water required for mining and processing and sources of supply of water. Disposal of waste water and extent of recycling

The process of processing includes use of water. The required quantity of water for various processes is as follows:

Sl. No.	Purpose	Quantity
1.	**Source of Water (Mines drainage Water)**	350KL/Day
1	Dust Suppression	120KL/Day
2	COB Plant	70KL/day
3	Servicing of Vehicle	2KL/day
4	Plantation	5KL/day
153KL/ Day (Approx.) Water goes out-side the lease hold area after treatment.		
5	Drinking Purpose	25KL/Day.

Mine drainage water after treatment used as dust suppression, Servicing of vehicle, Plantation and Chrome ore beneficiation plant and the rest of water goes to Damsal nala. 150 to 200KL/day water goes to Damsal nala in Monsoon and Lean season respectively.

The requirement of potable water 25m^3/day for drinking and other domestic purposes is fulfilled from bore well situated near mines office.

g) A flow sheet of schematic diagram of the processing procedure should be attached.

Floe sheet of COB plant is given below:

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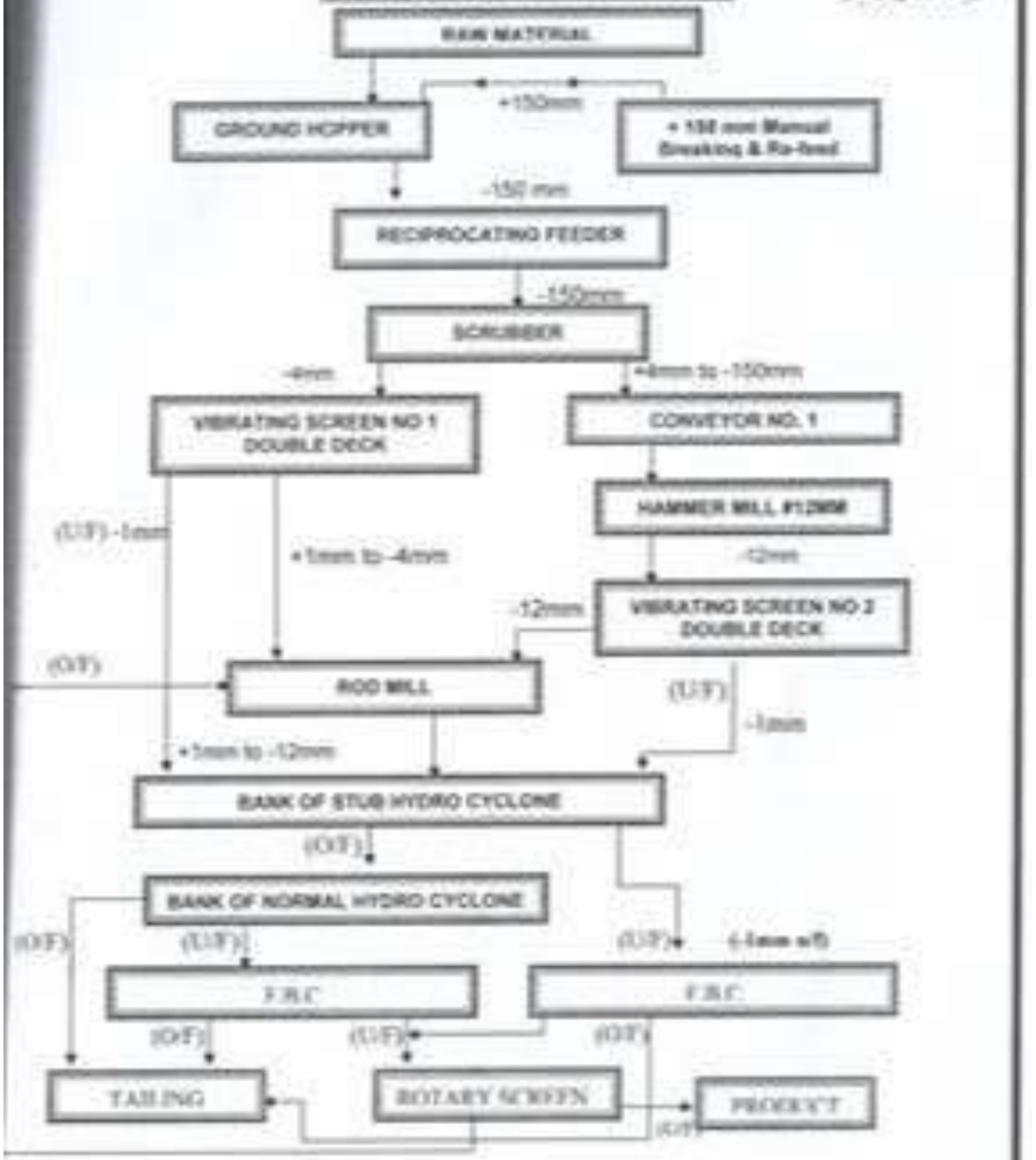
FLOW SHEET OF C.O.B. PLANT



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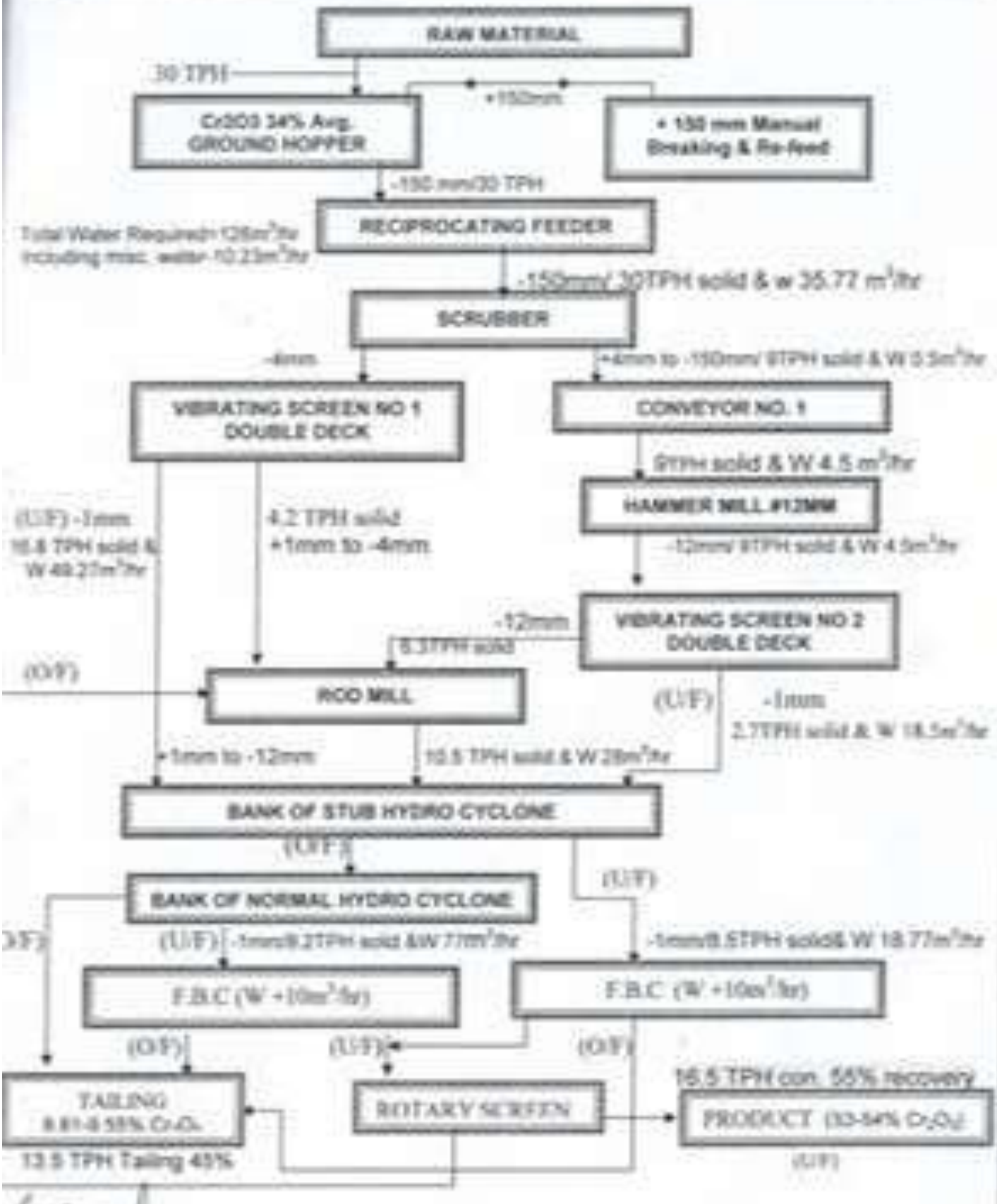
h) A flow sheet of schematic diagram of the processing proce[illegible] attached.

FLOW SHEET OF C.O.B. PLANT WITH WATER & MASS BALANCE 30TPH



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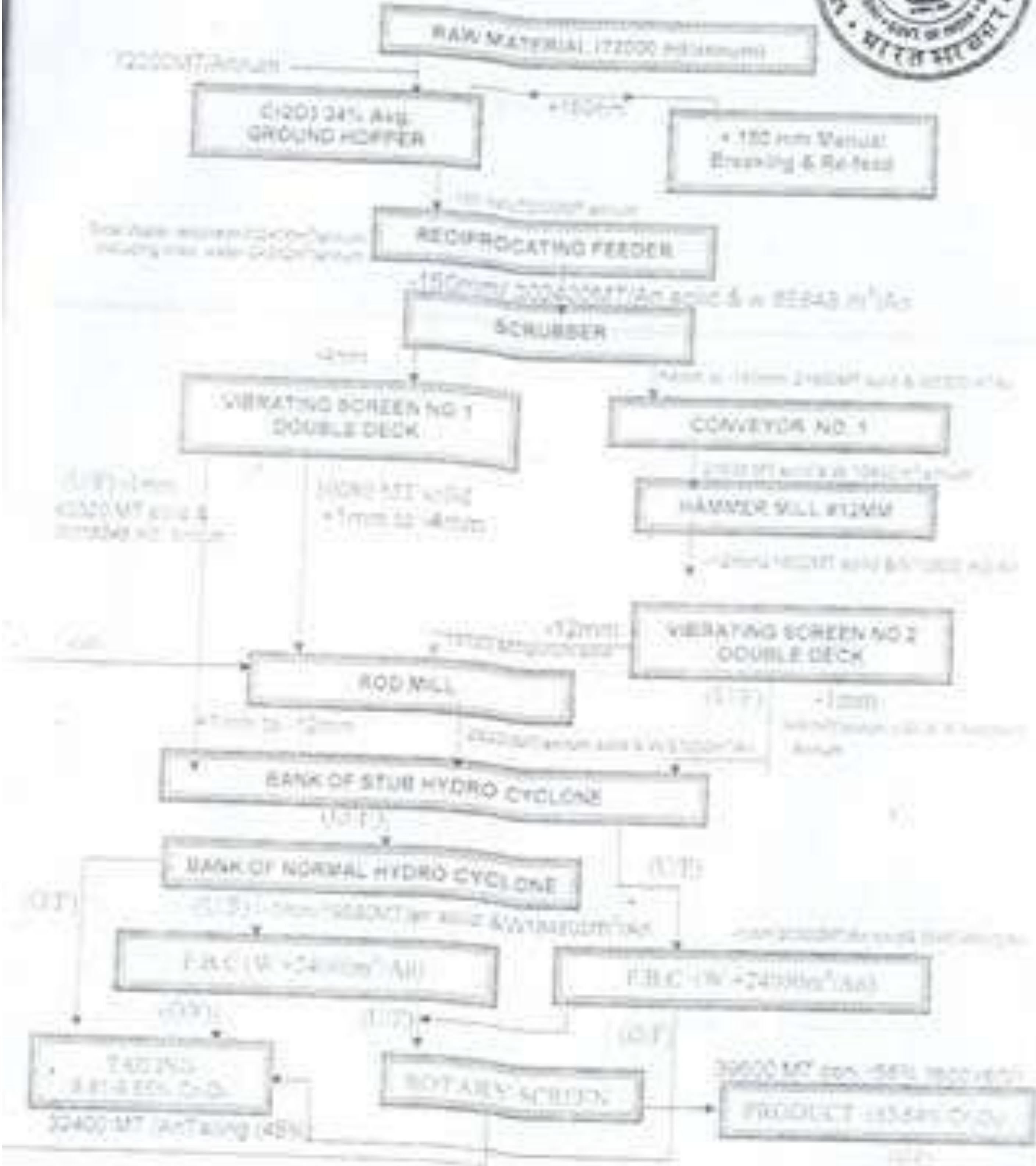
FLOW SHEET OF C.O.B. PLANT WITH WATER & MATERIAL [illegible] MATERIAL PER ANNUM



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PART – B

11.0 ENVIRONMENT MANAGEMENT PLAN

The concept of environment surrounding any area whether- mining or otherwise involves various parameters. It primarily consists of many biotic and biotic components and more precisely connected with the area of activity. The identification of such parameters involves firstly the earth itself consisting of soil, rocks of various nature with their structural diversities, the topographical features, the flora and fauna and so on. Secondly the various water sources both surfacial and underground, the precipitation pattern and natural storage facilities including ponds, lakes etc. Thirdly, the source of energy e.g. the heat energy, chemical energy etc; the temperature pattern of the area, their variation etc. Fourthly, the vast air surrounding us with all the gases composing it. Lastly, the wider space which also forms a part of the environment.

Hence, any project whether mining or non-mining, whether large scale or small scale, it creates a disturbance in the environment. The disturbance or imbalance may be large or small. Such imbalance needs identification and follow up action. The present day conceptual planning of environmental management involves the following:-

1. Base line information.
2. Environmental Impact Assessment Statement (EIAS).
3. Environmental Management Plan (EMP).

The present report covers all the relevant aspects related to environmental control of the Saruabil Chromite Mines at Saruabil Village, Jajpur District, Odisha. Saruabil Chromite Mines of M/s Misrilall Mines (P) Ltd. has been worked for last 60 years for production of chrome ore for export and for internal consumption. While developing the mine, there has been general development of the area but some ecological imbalance has occurred. Thus the need of restoration of ecological balance cannot be over emphasized. It is obligatory to restore the mined out land to a condition capable of supporting the use prior to mining of even better use.

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a) Attach a note on the status of base line information with regard to the following:

i) Existing land use pattern indicating the area already degraded due to quarrying/pitting, dumping, roads, processing plant workshop, township etc. in a tabular form:

Saruabil Chromite Mine is an operating mine and hence there is degradation of land due to mining and allied activities. Base-line generation of the environmental data has been done, time to time to study the impact of mining on the prevailing environment. The existing land use of the area has been calculated as under:

Existing Land Use Pattern:

This is a working mine as such the area has been degraded by way of quarry, dump, road and other mining related ancillary works. In forest area, lessee has got forest clearance over 224.63 ha. The surface right has been acquired over 241.617ha. So, all the mining and allied activities the leasehold is confined in the acquired area and within this granted forest area. Because of these mining activities, total 157.53 ha land has been degraded. It has been estimated that about 63.40 % of the lease area has been used. The item-wise land utilized for different purposes is given in **Table - 11.1**.

Existing Land-Use

TABLE - 11.1

Sl. No.	Category	Existing land use in Ha		
		Forest	Non-forest	Total
1	Quarry and roads	51.43	0.16	51.59
2	Dump : OB Dump Nickel Dump	59.88	7.01	66.89
3	Colony/ Township	19.61	2.73	22.34
4	COB	1.85	–Nil–	1.85
5	Magazine	1.13	–Nil–	1.13
6	Mineral storage	4.30	–Nil–	4.30
7	E. T. P.	Included in Quarry area		–Nil–
8	Plantation area			
	a) Safety Zone	3.40	0.27	3.67
	b) Nala Barrier	2.31	0.23	2.54
	c) Road Barrier	2.68	0.54	3.22
	d) Over Dump (Already included in Dump area)	24.21	0.30	24.51
	e) Township area (Already included in Colony/township)	0.89	-	-
Total		146.27	11.26	157.53

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Total area reclaimed and rehabilitated:

a) By Plantation over overburden dump	- 10.89 ha
b) Green Belt/safety Zone	- 0.46 ha
c) Township area	- 0.59 ha
Total	**- 11.94 ha**

ii) Water Regime:

The area is moderately undulating, with a depression in the west central part of the leasehold near quarry 5, 5A. The terrain is gently rising from north towards southern side. The highest attained elevation is on the south-eastern corner of the leasehold with an elevation of 192.00m R.L. The drainage pattern of this area has great influence of the topographic, structural and climatic features of the Mahagiri hill range due to which there is radial drainage system. These river flows with high velocity through the valleys and feed the run-off to the main stream. A perennial surface water source, Damsal Nala is flowing from the northern side forming the northern boundary of the leasehold. The water table has already been encountered during the course of mining operation. The water percolates through the side walls of the quarry. The water gushing in is collected in a sump and is being pumped out to the ETP (Effluent Treatment Plant) for treatment of the water and is then finally discharged in to Damsal Nala. Since, it has been studied by the R & D work carried out by various agencies in Chromite Mine worldwide and in Sukinda valley, that the Cr^{+6}, often termed as Hexavalent Chromium is carcinogenic, it is now mandatory to treat the water to bring down the Hexavalent Chromium to Trivalent Chromium Cr^{+3}, before being discharged to any water course. The procedure of treatment of water has been explained in detail in the respective paragraph.

iii) Flora & Fauna:

a) Flora

The Saruabil sector is a eastern part of Sukinda area which lies in a westerly sloping valley, bounded to the North, East and South by steep hills towering up to maximum 690 mts above average valley level. The extent of the field is about 40 Sq.kms. corresponding approximately to the limits of the westerly sloping valley. The valley is a gently sloping plain land, dotted with small knolls rising 10 to 20 mts. above the surrounding levels. The elevation ranges as observed within the leasehold area is 192mRL on SE side to a lowest of 137mRL on northern side of the lease area. The vegetation is a sub-tropical forest with

local savannah type grassy patches. The dominant species includes Hora Robusta (Sal), Terminalia Tomentosa (Asan) etc. The area consists of mostly village forest having low tree density (less than 30 trees/hectare).

b) Fauna

The surrounding thickly forest area was quite rich in wild life which includes elephant, tiger, bear, wild boar, Sambhar, barking deer. Their abundance is dwindling day by day due to increased mining and prospecting activities. The domestic animals include cows, goats, buffalo, dogs etc. Parrot, wild hens, peacocks, green pigeons, sparrows etc. are found abundantly in the area.

iv) Quality of Air, ambient noise level and water:

The mining operation in the area is carried out by open cast fully mechanized method. It is proposed to continue the same mining method during the plan period also. All the machineries used in the mines were properly maintained so that the engine gave complete combustion of fuel. Fugitive dust was controlled by using water-injecting system in wagon drills. Dust generated by shoveling & hauling by dumpers were suppressed by water sprinkling arrangement. The workers were enforced to use dust respirator while working. Green belt has been developed, massive plantation has been carried out along roadside, on the slope of the dump, along nala barrier etc The AAQ quality of the area was regularly monitored and the results are well within the norms. The monitoring report is enclosed as **Annexure – 17.**

Source of generation of noise is due to drilling, blasting and other mining machineries like compressor, excavator, loader, transport vehicles etc. All the machineries deployed in the mine are properly maintained as prescribed by their manufactures in our workshop / garage under the guidance of competent mechanical personnel. For this periodical maintenance scheduled for every machine has been chalked out and strictly followed under the supervision of qualified mechanical engineer. Further, Noise level at source were measured regularly by Environmental Consultant with the help of dB meter fortnightly. The workers those who are prone to noise area are provided ear muffs/ear plugs and are well trained for their use. Year wise plantation is also carried out to reduce the noise level. The noise monitoring reports are given in **Annexure- 17.**

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Saruabil Chromite Mine represents a moderately hilly terrain. Sukinda valley is characterised by gently rising terrain mostly with plain land. The main stream known as Damsal nala is cutting across the Chromite belt and flows from East to west on the Northern part of the area. It further joins the main Brahmani river due South of the area. It has been observed from the nearby wells and tube wells that the water table is at about 3-6m. All quarries of Saruabil Chromite mine have already encountered the water table, as such; there is percolation of water through seepage from the weak plane of rocks and bottom of the quarry. Hydro-geological study of the area was carried out and a report on Hydrogeology and ground water resource is enclosed as **Annexure – 18**.

The water gushing in is collected in a sump made for and is pumped out. Since, it has been studied worldwide that the water coming out from the quarry contains harmful carcinogenic & toxic Hexavalent Chromium, as such, the water from the quarry is pumped out to the ETP (Effluent Treatment Plant) for treatment of the water. A Copy of report on Design for Chromium Effluent Treatment plant (ETP) in Saruabil Chromite Mines of Sukinda valley, prepared by Department of Civil Engineering, IIT, Kharagpur in May 2013 is enclosed as **Annexure – 24.** Plan and section of Effluent Treatment Plant is enclosed as Plate – 13.

The accumulated water is not discharged directly to any water course rather it is pumped out from the mine to Effluent Treatment Plant situated near quarry - 4, wherein it is treated for Hexavalent Chromium. The treated water is used for water sprinkling on haul roads, plantation and other industrial purposes. The rest of the treated water is discharged to the Damsal nala, controlling the drainage pattern of the area. A Copy of report on the water quality with regards to presence of hexavalent chromium in Damsal nala of Sukinda mining area, prepared by Epg Odisha is enclosed as **Annexure – 25**.

The water from workshop and garage, which are situated at one place, is allowed to pass through a soaking pit made for the purpose and the contamination free water flowed to the natural drainage. Further a zero discharge Oil & Grease trap has been established to collect Oil & Grease from washing water of vehicles. The water quality of the area is being regularly monitored and the results are found well within the norms. The noise monitoring reports are given in **Annexure- 17.**

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v) Climatic Condition:

The climate is sub-tropical. The area experiences salubrious climate for most [illegible] leaving small spell of summer and severe winter months. The maximum and minimum temperature varies from 46°C to 9°C respectively. The rainfall is abundant during monsoon months of June to September varying between 150mm to 350mm per month. The relative humidity is 10 percent during summer months to about 100 percent during rainy season. The wind velocity varies from 2 km/hr. to 60km/hr.

vi) Human Settlement:

The human population in the valley mainly includes, aboriginals belonging to the Sadar and Munda tribes. The nearby village Saruabil, about 1 Km. from the leasehold area, has thin population. The main livelihood of the population is from mining job or agriculture.

vii) Public buildings, places of worship & monuments

The area is devoid of any notable public worship and monuments. However there is a lord Shiva Temple just outside the lease area in Saruabil village constructed by the lessee. There is no National Park or Sanctuary or biosphere reserve in and around the area within a radius of 25kms. There is no natural lake or tourist centre in the vicinity. The scenic beauty of the area is adorable.

viii) Does the area (partly or fully) fall under notified area under water (prevention & control of pollution) Act 1974.

This area does not fall under notified area under water (prevention and control of pollution) Act 1974.

b) Attach an Environmental Impact Assessment Statement describing the impact of mining and beneficiation on environment on the following over the next five years.

An attempt has been made here to assess the impact of the proposed mining activities on the various environmental attributes. The important environmental attributes of the study area may broadly be grouped under

i) Land area indicating the area likely to be degraded due to quarrying/pitting, dumping, roads, workshop processing plant, township etc.

At present land degradation due to mining activities is 157.53 hectares within forest and non-forest area. Lessee has got the forest clearance over entire forest land but as the current lease period is going to be expired on 14.05.2014. After expiry of the lease, as per

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the FC Act 1980, there is no diverted forest land and the valid forest [illegible] terminus with lease period (14.05.2014). Application has been made [illegible] clearance over total area. Therefore, mining operation can be started only after getting the forest clearance. It is anticipated that about 190.71 ha of land shall be degraded due to mining and allied activities by the end of this plan period. The area proposed to be degraded at the end of the mining plan period is given in Table – 11.2.

TABLE - 11.2

Existing & proposed Land-Use

Sl. No.	Category	Existing land use in Ha			At the end of the plan period		
		Forest	Non-forest	Total	Forest	Non-forest	Total
1	Quarry and roads	51.43	0.16	51.59	56.31	0.16	56.47
2	Dump - O/B Dump Nickel Dump	59.88	7.01	66.89	83.65	9.04	92.69
3	Colony/ Township	19.61	2.73	22.34	19.61	2.73	22.34
4	COB	1.85	–Nil–	1.85	1.85	–Nil–	1.85
5	Magazine	1.13	–Nil–	1.13	1.13	–Nil–	1.13
6	Mineral storage.	3.98	0.32	4.30	3.98	0.32	4.30
7	E. T. P.	Included in Quarry area		–Nil–	Included in Quarry area		–Nil–
8	Plantation area						
	a) Safety Zone	3.40	0.27	3.67	3.40	0.27	3.67
	b) Nala Barrier	2.31	0.23	2.54	2.31	0.23	2.54
	c) Road Barrier	2.68	0.54	3.22	5.18	0.54	5.72
	d) Over Dump (Already included in Dump area)	24.21	0.30	24.51	29.21	0.30	29.51
	e) Township area (Already included in Colony/township)	0.59	-	-	-	-	-
otal		146.27	11.26	157.53	177.42	13.29	190.71

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ii) Air Quality

Mining activities i.e. drilling, blasting, transportation, loading, dumping etc. and mineral processing i.e. handling of ore, operation of crusher and screen etc will have significant effect on the air quality of the core zone. The mining operation in the area is being carried out by open cast fully mechanized method. It is proposed to continue the same mining method during the plan period also. Generation of air pollution will be during the operation of mining machineries, from loaders and dumpers. The quality of ambient air will depend upon the background concentration of specific contaminants, the emission sources and meteorological conditions. The Industrial impact on air quality mainly depends on the method of construction, technology adopted for production, storage facilities & mode of transport for material.

The AAQ of the area is being regularly monitored and found within the prescribe norms. Copy of monitoring report is enclosed as **Annexure – 17**. However, the intensity of operation is directly related to the rate of production. Fugitive emission from the mining and crushing process is expected. The transport of chrome ore by surface transport system is likely to increase the suspended particulate matter emissions. Thus the impact on air quality is expected to be increased with the increase in production capacity.

iii) Water Quality:

As mentioned above, because of presence of CR^{+6}, commonly and often termed as Hexavalent Chromium, the water quality of surface water and ground water is getting affected due to mining activity. The mechanism of effect on human body has been studied in detail and has been illustrated below:

The mechanism of Carcinogenicity of Hexavalent Chromium relies on trivalent chromium, an intracellular reduction product after its penetration into the cell. Chromium goes into the body through the lungs, gastrointestinal tract and to a lesser extent through skin. Inhalation is the most important route for occupational exposure, whereas non-occupational exposure occurs via ingestion of chromium-containing food and water. Regardless of route of exposure Cr^{+6} is more readily absorbed which accounts for its toxicological activity and carcinogenicity. All the ingested Cr^{+6} are reduced to Cr^{+3} before entering in the blood stream. The main routes for the excretion of chromium are via kidney/urine and the bile/feces.

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The effect of carcinogenicity has been studied in detail. It has been proved that prolonged exposure of Cr^{+6} has adverse effects on human beings as well as it also disturbs totally the environment disturbing the bio-diversity and affecting the environment.

The possible effects of Cr^{+6} on Human lives as per EIA/EMO report are illustrated in detail below:

a) Effect of Hexavalent chromium on respiratory system
b) Effect of hexavalent chromium on lungs
c) Effect of hexavalent chromium on immune system

To reduce the carcinogenic effect of Hexavalent Chromium, from the discharge water of Saruabil Chromite mines, a water Effluent treatment Plant has been constructed and is in use in Saruabil Chromite Mines. The detail of the process of treatment and layout of the plant has been mentioned in treatment & disposal of water from mine is given in management.

iv) Noise levels:-

Running of machines, movement of trucks within the area and blasting are the source of noise pollution. The generation of noise, because of activities cited above, is obvious and it cannot be averted. To reduce the effect of noise, plantation is being carried out regularly to work as an insulator for the noise produced. Since the lease area is dominated physiologically by hilly terrain in northern, eastern and southern part, the forest cover over these areas absorb the generated noise. Regular maintenance of the equipment also reduces the noise, which is in general practice at Saruabil Mine. By taking preventive measures the noise level has been kept within the permissible limit. The noise level has been regularly monitored and found that in most cases noise levels are within permissible limits of 85 dB(A) for maximum 8 hrs exposure. Copy of Noise monitoring report is enclosed as **Annexure – 17**.

v) Vibration levels (due to blasting):-

The Chromite ore body in Saruabil Chromite mine is mostly friable in nature which does not requires blasting. The hard formation such as hard Laterite and cherty quartzite occurs in patches, at places, in quarry overburden. At such places, necessary drilling and blasting is performed. To reduce vibration caused due to blasting, a definite pattern of blast hole is designed and on the basis of that the holes for blasting is done. For getting required amount of fragmentation, powder factor has been calculated and on that basis the hole is

charged. As such, the vibration caused due to blasting is almost negligible. Also, a study related to effects caused due to ground vibration has been done, and the effects have been studied in detail, a copy of which is enclosed as **Annexure – 20**.

vi) Socio-economic & Tribal Issues:

Saruabil Chromite Mine is located in economically and socially underdeveloped area of Odisha, where general living condition of the people is below poverty line. Agriculture was the main source of their livelihood before opening of the mine. Agriculture, in this part of Odisha has not been developed to the extent it should have been. People, therefore, prior to the initiation of mining activities, were dependent mostly on the limited agriculture & forest produces. After the initiation of Mining activities, now they are dependent upon mines for their livelihood. This has got a positive impact on the living condition of the local inhabitants. The Direct employment of the local residents has been in the mines, although indirect engagement may be two to three times. Mining activity in the area has brought some positive effect like better employment potentiality, better health care, better living, better sanitation conditions, better education facilities etc. In the years to come, the continuation of mining operation and related transportation of the mine products shall continue to generate work for the local tribal. To this extent, the impact will be significantly beneficial since un-employment is the main socio-economic problem faced by the tribal people of this locality.

However, apart from the economical independency of the local residents because of this mining operation, the other part of the mining operation is the threat caused by the presence of Hexavalent Chromium in Damsal Nala and in the Nickeliferous Dumps. The presence of Cr+6 is carcinogenic as studied by various agencies. Most prone to this threat are the local inhabitants as well as the mine workers.

On the basis of the studies carried out, it has now become mandatory to treat the mine discharge water before discharging it to the Damsal Nala. The Mine discharge water is taken to ETP (Effluent Treatment Plant), where the carcinogenic, cytotoxic Cr^{+6} or often termed as Hexavalent Chromium, is transformed to non-carcinogenic, non-toxic Cr^{+3}. The possible remedy to reduce the effect of Hexavalent chromium has been elaborated in Environment Management Plan.

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The legal factors like tribal issues have not been observed in the area. The lease area is away from densely populated region and there is only one human settlement Nuapur within the township of the mine within the mining lease hold area. CSR activities like distribution of study materials to the school children, provision of drinking water to the nearby villagers through deep bore well, provision of tube wells in the nearby villages, donation for the local cultural festival of local tribal people, like mage etc are being carried out by the management.

The area is devoid of any notable public buildings, any notable historical monuments, places of worship etc. There is no Natural Parks of tourist interest or wild life sanctuary in core as well as buffer zone. The other mines located in buffer zone are: Tata Iron & Steel Company Limited, Orissa Mining Cooperation, Ferro Alloys Corporation, M/s B.C. Mohanty & Sons Pvt. Ltd. Indian Metals & Ferro Alloys Limited, Jindal Stainless, Industrial Development Corporation and Balasore Alloys Ltd. etc. The area also does not report to form corridor for Schedule-I fauna. In addition, DFO , Cuttack Forest Division vide their letter dated 17.07.2007 mentioned that the mine lease area does not form any part of national park, Sanctuary, Bio-sphere reserve, Elephant Reserve and Tiger Reserve and elephant corridor. The Mahagiri Protected Forest (PF) is located at a distance of 1 km from the mine lease boundary.

viii) Historical Monuments etc.:

The area is devoid of any notable historical monuments.

c) Attach an Environment Management Plan (supported by appropriate plans and sections) defining the time-bound action proposed to be taken with sequence & timing in the following areas (or diagrams should be used):

The impact study reveals that the proposed mining requires mitigative measures in certain areas including air environment, water environment and noise environment during the operation phase. This chapter accordingly proposes an Environment Management Plan (EMP) for the existing mining facility. The mitigation measures recommended in the environmental management plan are described for those specific impacts of environment which are likely to have adverse impact as predicted earlier for various activities. The measures shall be integral part of the project and implemented at desired level for better environmental management.

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Temporary storage and utilization of top soil:

Part of the area is covered with alluvial soil. The top soil occurs in [illegible] discontinuous layer, the thickness of which varying from 0.06m to 0.5m. Since, the topsoil occurs in a very thin and discontinuous layer, it is very difficult to calculate exacts quantity of topsoil. However, the quantity of topsoil is anticipated during the mining operation from quarry No.7. The top soil generated during the course of mining is stored in the place earmarked for the same. The top soil so generated is being utilized for the purpose of plantation.

Year wise proposal for reclamation of land affected by abandoned quarries and other mining activities during first five years:

At present no reclamation has been done in the excavated area as the ore body is not exhausted in any of the quarries. No reclamation of the quarries has been proposed, as the proved reserve of mineral will not be exhausted in the next five years. However, for stabilization of dumps, plantation shall be done on the lower level, over slopes and on the terrace. During the plan period, area to be rehabilitated by plantation, for which a scheme of year-wise plantation has been chalked out and given in para below.

Program of afforestation year wise for the plan period indicating numbers of plants with name of species to be afforestated under different areas in hectares:

For successful afforestation programme, availability of the required species of seedlings is a basic requirement. Hence a nursery shall be developed in the lease area at a suitable place. The seeds of required species shall be obtained and germinated in the nursery beds from where the seedlings are transplanted into polythene bags filled with mixture of top soil and cow dung manure. The seedlings shall be allowed to grow about 0.30m height in the polythene bags for about 30 days before plantation.

Green Belt Development Plan

The main objective of the green belt is to provide a barrier between the source of pollution (impact zone) and the surrounding environment. The green belt helps to capture the fugitive emissions and to attenuate the noise generated apart from improving the aesthetics. Development of green belt and other forms of greenery shall also prevent soil erosion and washing away of top soil besides helping in stabilizing the functional ecosystem, make the climate more conducive and restore water balance. Plantation along the boundary will be done as proposed. Local Gardner, (Mali) is engaged for this purpose. Improvements in the green belt and green cover will be done to the best extent possible.

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It is worthy to be mentioned here that the major part of the lease area is covered under forest. So in the safety zone gap plantation can be possible under the guidance of the local forest authorities. A year-wise plantation is envisaged for the five years of the mining plan period. Plantation proposed to be carried out during the five years mining plan period is given in **Table – 11.3**.

TABLE – 11.3

TABLE SHOWING PROPOSED PLANTATION PROGRAMME WITHIN LEASE DURING THE PLAN PERIOD

Year	Location	Plant Species	No. of Plants	Area covered ha.
2014-15	• Dump No.2/3 slope (Northern side slope). • Along Road Barrier • Over already plantation area on the western side safety zone – 7.5m	Chhatiana, Neem, Karanja, Simarua, Bamboo, Teak, Kaju, Bara, Radhachuda,Amala, Jhaun, Jammun, Asan, Harida, Bahara, Mango	• 2500 • 1250 • 1000	1.00 0.50 -
2015-16	• Dump No.2/3 slope (Western side slope). • Along Road Barrier • Over already plantation area on the SW side safety zone – 7.5m	Chhatiana, Neem, Karanja, Simarua, Bamboo, Teak, Kaju, Bara, Radhachuda,Amala, Jhaun, Jammun, Asan, Harida, Bahara	• 2500 • 1250 • 1000	1.00 0.50 -
2016-17	• Dump No.2/3 slope (Western side). • Along Road Barrier • Over already plantation area on the southern side safety zone – 7.5m	Chhatiana, Neem, Karanja, Simarua, Bamboo, Teak, Kaju, Bara, Radhachuda,Amala, Jhaun, Jammun, Asan, Harida, Bahara	• 2500 • 1250 • 1000	1.00 0.50 -
2017-18	• Dump No.2/3 slope (Top of dump). • Along Road Barrier • Over already plantation area on the SE side safety zone – 7.5m	Chhatiana, Neem, Karanja, Simarua, Bamboo, Teak, Kaju, Bara, Radhachuda,Amala, Jhaun, Jammun, Asan, Harida, Bahara	• 2500 • 1250 • 1000	1.00 0.50 -
2018-19	• Dump No.11 slope (Northern side slope). • Along Road Barrier • Over already plantation area on the Eastern side safety zone – 7.5m	Chhatiana, Neem, Karanja, Simarua, Bamboo, Teak, Kaju, Bara, Radhachuda,Amala, Jhaun, Jammun, Asan, Harida, Bahara	• 2500 • 1250 • 1000	1.00 0.50 -
TOTAL			23750	7.50

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Measures to control erosion/ sedimentation of water courses:

The perennial water course Damsal Nala flows from the northern boundary pillars demarcating the northern boundary of the leasehold area. The quarry discharge water, after being treated, is discharged into this nala. Surface run-off also flows through this nala and fall finally in Brahmani River controlling the regional drainage pattern. The water quality of the area is affected because of mining. As a precautionary measure, following steps is being taken up.

Treatment and disposal of water from mine:

The quarry discharge water, before being discharged to the water course, will be treated for carcinogenic and toxic Hexavalent Chromium Cr^{+6}, in the Effluent Treatment Plant set up for the purpose. The treated water which, after treatment, has Cr^{+3}, is non-carcinogenic. A layout of the Effluent Treatment Plant is given below:

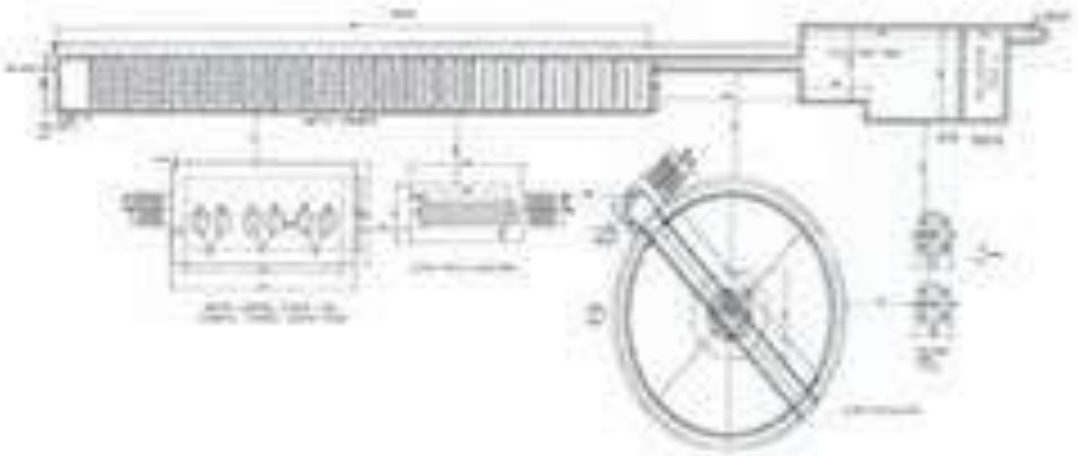

Fig: Layout of water treatment plant at Saruabil chromite mine of Misrilall Mine pvt. Ltd

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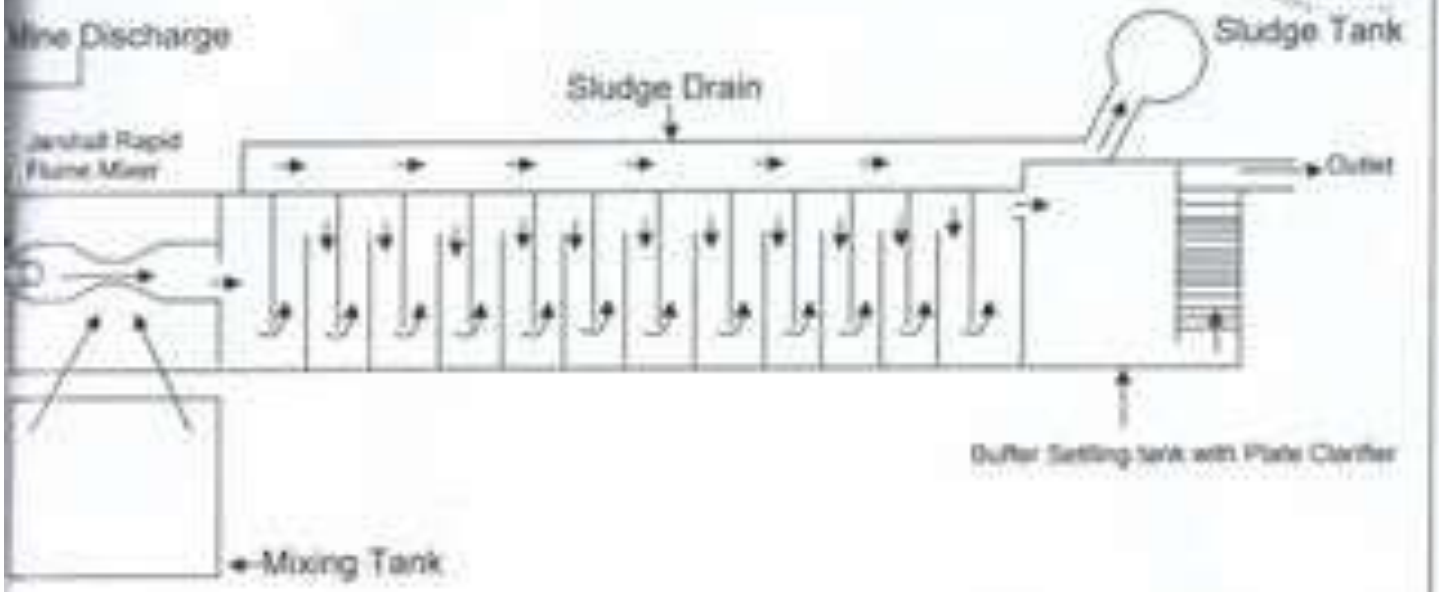

The flow diagram of Hexavalent Chromium Treatment Plant of Saruabil

Measures for minimizing adverse effects on water regime:

The possible remedies suggested for the above mentioned problems arising due to mining of Chromite are as follows:

- Each and every anthropogenic activity that contributes hexavalent chromium to the environment should be regulated in such a manner so that the adverse impacts are containable within reasonable limits.
- Regulatory authorities and environmental scientists should formulate an acceptable and economically viable proposal so that at the beginning of the activities the possible adverse impacts are regulated. Their needs should be preferably concurrent with the mining activity.
- Nickel ore is not produced in India. R & D efforts should be made to use limonite for extraction of nickel. This will sort out the problem of accumulation of overburden dump. The existing dumps may be stabilized properly.
- Once these dumps are reclaimed there should be a provision to reutilize the said area if nickel extraction is economically viable.
- More R & D efforts may be taken up for bio-remediation of Cr+6.
- Sincere effort is required for fixing of hexavalent chromium by bacteria as laboratory tests by some of the researchers are found to be encouraging.
- Post mine closure monitoring of ground as well as surface water is desired.

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- Suitability of use of water from the reservoirs for agricultural purp[illegible] confirmed as some of the literature available are in favor of accumul[illegible] paddy crop.
- Check dams, gulley plugging, garland drains, etc. may be provided at selected locations to arrest soil erosion and reduce suspended particulate matter in the runoff.
- All the major mines in Sukinda valley will close with open cast mining due to want of adequate R & D effort on feasibility of underground mining where the host rock is Weathered limonite.
- Agricultural practice may be encouraged to utilize the stretch of land available to the west of Dhamsala Nala. This will facilitate engagement of the local workers even after mine is closed.
- Water from these reservoirs can be utilized for beneficiation of low grade chrome ore after closure of mine but the tailing pond should be properly lined to prevent leaching.
- The regulatory authorities through legal procedure should see that the ground water is not contaminated even after closure of all the mining operation.
- Surface run off from the catchment area of individual mines needs to be treated before it goes out of individual mining lease area.

Other than the measures mentioned above, some studies carried out on Sukinda valley also shows the ways to reduce CR^{+6}. Treatment systems based on the Cr(VI) reduction can be biological or abiotic and is often a combination of these two. Some of the systems have been discussed here under:

Chemical Reduction

The term chemical reduction refers to abiotic in-situ or ex-situ reduction with an electron donor such as S, Fe(II) or Fe(0). The newly formed Cr(III) then precipitates out of solution. This approach achieves both a reduction in Cr toxicity and removal of the Cr from aqueous solution. Chemical reduction includes naturally occurring reduction by soil oxides and natural organic material. Engineered chemical reduction technologies involve the addition or in-situ injection of an electron donor such as hydrogen sulfide (H2S) (Thornton and Amonette, 1999), sodium dithionite (Na2S2O4) (Fruchter et al., 2000), sodium metabisulfite (NaHSO3), calcium metabisulfite (CaHSO3), FeSO4, calcium polysulfide (CaS5) (Jacobs et al., 2001), Fe(II) (Seaman et al., 1999), Fe(0) (Ponder et al., 2000), or tin(II) chloride (SnCl2). The pH is adjusted to optimize electrostatic surface interactions between Cr(VI) anionic species and the electron donor. Alternatively, for high Cr(VI) concentrations, such

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as those encountered in industrial waste streams, pH is increased so that [illegible] S^{2-} and/or OH^- precipitates. Metal sulfides are far less soluble than metal [illegible]. Except for alkali-metal sulfides, metal sulfides are relatively insoluble over the pH range of most naturally occurring groundwater.

A more precise method of delivering liquid chemicals to the subsurface uses high-pressure injection technology, also called jetting. There are two main methods of jetting: one uses a direct push drilling technology method where chemicals are sprayed into the subsurface through specially designed steel injection rods, typically 25 to 50 mm in diameter. The rods are pushed into the subsurface using the probe rig. One method is to push the rods to the target depth and inject chemicals up to 41 atm (600 psi) as the rods are retracted from the borehole. The other method uses a 6.35 to 12.7 mm outer diameter lance system for the delivery of treatment chemicals (Jacobs, 2001). Hand-held jetting lances operate at tip pressures up to 340 atm (5000 psi) and allow accessibility in limited access areas such as underneath railways and buildings, around tanks, pipelines and subsurface utilities. Chemical compatibility of the injection equipment components and safety procedures become critical with the injection of strong chemicals. In low permeability soil, permeability enhancement can be performed in the subsurface prior to chemical injection. Higher injection tip pressures on the lance or injection probe rods are used to induce hydro fracturing in low permeability sediments, allowing for additional movement of the treatment chemicals into the target zone

Microbial Reduction

Microorganisms can catalyze redox reactions by a combination of several mechanisms, including enzymatic extra-cellular reduction, nonmetabolic reduction by bacterial surfaces and intra-cellular reduction and precipitation. Microorganisms capable of reducing Cr(IV) to Cr(III) include bacteria (*Pseudomonas, Micrococcus, Escherichia, Enterobacter, Bacillus, Aeromonas, Achromobacter, and Desulfomaculum*) (McLean and Beveridge, 1999), algae (Cervantes et al., 1994), yeasts, and fungi. External reduction reactions that are biologically mediated still require the presence of an external electron donor, such as Fe, Mn, or oxidized organic matter. The process is the same as chemical reduction, but is biologically mediated and is thus kinetically advantageous to nonbiological reactions, particularly under aerobic conditions. Alternatively, sulfur-reducing bacteria are stimulated to produce H_2S, which serves as the reductant. Recent work by Fein et al. (2001) has

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shown that bacterial surfaces can also catalyze Cr reduction. Green algae [illegible] than red or brown algae. Bioremediation strategies used for Cr(VI) remediation include monitorednatural attenuation (MNA), biostimulation, and bioaugmentation.

Phytoremediation

Like biological and chemical reduction, phytoremediation is a multi-faceted approach towards Cr remediation. Plants contain the Cr by converting it to the less mobile Cr(III) (phytostabilization) and simultaneously reduce its toxicity. In addition, phytoremediation can be a removal technology, if Cr is sequestered in plant tissue and the plants are harvested (phytoextraction and rhizofiltration). Phytoaccumulation one of the most common forms of Cr(VI) phytoremediation, consists of the uptake of the Cr from the soil to the plant roots and ultimately into the above ground parts of the plants. Some plants can accumulate very large amounts of a specific metal, such as Cr. The plant, *Leptospermum scoparium* was found to contain soluble Cr in the leaf tissue as the trioxalatochromium (III) ion $(Cr(C_2O_4)_3)^{3-}$. The function of the chromium-organic acid complex was to reduce the toxicity of the Cr. Phytostabilization is perhaps the least advanced technology of the three currently in development. This method is sometimes viewed as a temporary measure until phytoextraction is further developed. Plant and other biological secretions can stabilize Cr in the root zone. These can change pH or complex the Cr as Cr (III). In addition, plant roots minimize erosion and the migration of contaminated sediment. Phytostabilization is most useful for low concentration contamination or large polluted areas, when conventional chemical-physical methods are most expensive. Phytostabilization can be combined with best management practices such as phosphorus amendments, lime, or organic matter to enhance immobilization and avoid leaching.

Protective measures for ground vibrations/air blast caused by blasting:

This is an opencast fully mechanized mine. The main source of generation of noise and vibration is due to drilling, blasting which carried out almost regular basis and other mining activities where machineries like compressor, excavator, loader, bulldozer, dumper for transportation. Minimum drilling and blasting shall be adopted for excavation. Therefore, ground vibration /air blast caused by blasting does not have a significant affect.

To control the air blast and vibration, delay detonator is used. During mine operations to ensure minimum impact, following will be followed:

- Ground vibration studies due to blasting was carried out during [illegible] keeping different parameter such as burden, spacing, depth of hole, [illegible] charge, charge per hole, maximum delay charge etc. in number of holes.
- Water sprinkling on the dust prone areas such as haul road, loading and unloading sites, etc.
- Plantation over dumps has been done to prevent the wash-off material during the rainy season.
- Preventive maintenance for all the machineries eg. Drills, compressor, loader, bull-dozers shovels transport vehicles etc. was done by competent personal under the supervision of electrical and mechanical engineer.
- Proper and regular repair and maintenance of machinery.
- Periodical monitoring of air, dust fall and noise level etc.

Measures for protecting historical monuments and for rehabilitation of human settlements likely to be disturbed due to mining activity:

The area is devoid of any notable historical monuments and rehabilitation of human settlements will not be effected due to mining activity. There are few human settlements are found in Kaliapani, Saruabil, Kansa, Sukurangi.

Socio economic benefits arising out of mining:

The entire study area is rural in character. There are 34 villages in the buffer zone with total population of 33876. Out of that 17568 are male population and 16249 are female.

The level of the literacy is low. Education facilities such as Primary and Middle school are available in Sukurangi, Kaliapani, Kansa and in other villages whereas High School and College facilities are not available within the 10 km radius. The lessee Misrilall Mines Pvt. Ltd. has set up two primary schools, one is in Saruabil village and other is in the colony of the mining lease area.

Lessee has set up a fully equipped dispensary under the charge of a qualified doctor. An ambulance is provided at the dispensary to carry patients from the colony & works site to the dispensary & also to send patients at Jajpur road & or Cuttack when emergencies occur. Regular medical camp is being set up by the mines management in the buffer zone. An open well are inside the lease area near the mine office which serve drinking water purpose for the local people of the colony and also the nearby areas. Postal and telecommunication facilities are available Kalaringiatta, Kaliapani & Kansa. There is an

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