INDIAN METALS & FERRO ALLOYS LIMITED

IMFA Building
Bhubaneswar -751010
Odisha, India

Corporate Identity No.
L27101OR1961PLC000428

TEL +91 674 2611000
+91 674 2580100
FAX +91 674 2580020
+91 674 2580145

mail@imfa.in

www.imfa.in

To
The Member Secretary (Non-coal Mining)
IA Division
Ministry of Environment, Forest and Climate Change
Indira Paryavaran Bhawan, Jorbagh Road, Aliganj,
New Delhi-110003

Letter No. IMFA/MPC/20/09
Date: 29.01.2020

Sub: Reply of ADS generated vide letter no. J-11015/204/2015-IA.II (M) dated 13.12.2019 regarding the project "Sukinda Mines (Chromite)" of M/s Indian Metals Ferro Alloys Limited with expansion of production from 3.51 LTPA to 6 LTPA, change in mining technology from opencast to opencast & underground and establishment of chrome ore beneficiation plant (COBP) of 40 TPH over a lease area of 116.76 ha. located at Village- Kaliapani, Tehsil- Sukinda, District- Jajpur, State- Orissa.

Ref: 1. File no: J-11015/204/2015-IA.II (M)
2. Proposal No. IA/OR/MIN/114264/2007

Dear Sir,
With reference to the ADS generated vide letter no. J-11015/204/2015-IA.II (M) dated 13.12.2019 by
MoEF&CC, we are hereby submitting the pointwise reply of queries generated in ADS.

Sl No.	ADS Dated 13.12.2019	Reply
i.	PP collected baseline data during October 2015-December 2015 which is 3 years old. The Committee asked the PP to collect fresh 1-month baseline data and analyse the data. In addition, the PP needs to submit comparative data and trend analysis considering the values obtained during earlier EC appraisal, baseline data collected during Oct-Dec 2015 period, regular monitoring and fresh 1-month baseline data for all relevant parameters.	One-month data for the period November 2019 has been collected and analyzed by NABL accredited laboratory. Test reports are attached as **Annexure 1a.** Comparative data and trend analysis considering the values obtained during earlier EC appraisal, baseline data collected during Oct-Dec 2015 period, regular monitoring and fresh 1-month baseline data for all relevant parameters has been carried out which is attached as **Annexure 1b.**
ii.	PP submitted a certified compliance report from RO, MoEF&CC, Bhubaneshwar vide letter no. 101-409/EPE dated 20.02.2017 which is about 2 years	Updated Certified compliance report has been obtained vide letter no 101-409/08/EPE dated 06.12.2019 and is attached as **Annexure 2a.** RO has made observations on two points regarding plantation and settling pond vide

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	old and reveals that some of the conditions are in the process of complying. The Committee is of the view that EC obtained in 2002 and still in the process of complying the conditions, so PP needs to submit updated compliance report for existing EC conditions.	letter no 101-409/08/EPE Dated 10.12.2019 which has been duly complied with and replied vide letter no IMFA/MPC/SMC/2019/92 Dated 16.12.2019. The letters are **attached as 2b and 2c respectively.**
iii.	PP proposed for chrome ore beneficiation plant (40 TPH) so, PP should perform the cumulative effect of mining and beneficiation plant in the EIA studies and submit the report separately. The report should also highlight the techno-economic benefit of beneficiation plant.	Cumulative effect of mining and beneficiation plant and Techno-economic benefit of the Chrome Ore Beneficiation Plant have been prepared and is attached as **Annexure 3.** As per the report the beneficiation plant is viable considering the fact that subgrade chrome ore mining will not incur any cost as it has already been mined out and stacked within the lease area. The sale price of the beneficiated product will outweigh the cost of beneficiation plant. Since beneficiation will be done through wet process hence there will be minimal impact on the environment due to this plant as given in **Annexure 3.**
iv.	Free Silica needs to be analyzed and documented by carrying fresh study from an accredited laboratory.	Free Silica has been analyzed by NABL accredited lab and attached as **Annexure 4**
v.	PP submitted that as part of the existing EC condition, PP made plantation, however, the PP was unable to show/explain the same in kml. PP needs to submit the revised kml file with plantation area and their corresponding coordinates. PP also requires to submit the details of plantation carried out in safety zone and along the lease boundary. PP needs to submit the photographic images of the same. In addition, PP requires to show the compliance status of the existing EC condition (xvi).	Details of plantation carried out in safety zone, overburden dump, other areas in the ML area, photos of plantation and compliance of existing EC condition is attached as **Annexure 5.** KML file showing the plantations in different areas as mentioned above attached.

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vi.	PP needs to submit details of total excavation (in the same unit) including mineral, overburden (OB), inter burden (IB), side burden (SB) and waste/topsoil production and etc.	Total excavation is **28.0 LTPA** including mineral (6.0 LTPA), and overburden (OB) (22.0 LTPA).
vii.	The site-specific wildlife conservation plan is approved on 18.11.2015, PP needs to submit a compliance status of the same from the Competent Authority and also submit the revised approved site-specific conservation plan as the proposal for expansion in production.	Compliance status given by DFO Cuttack on Approved site-specific conservation plan is attached as **Annexure 6.**
viii.	PP needs to evaluate the performance of ETP and submit the details of corresponding analytical data along with details of sludge management plan for ETP sludge.	Details of ETP and sludge management is attached as **Annexure 7.**
ix.	PP needs to submit details of steps taken for management of surface run off specifically mitigative measures.	Management of surface runoff along with mitigative measure is attached as **Annexure 8.**
x.	PP submitted that water requirement is 3500 KLD, the Committee is of the view that the water requirement is very high. So, the Committee asked the PP to submit the water budget for the same and also futuristic approach on decreasing the water requirement as well as rain water harvesting.	Total water requirement for the projectafter recalculation is 1240 Cu.m / Day (During peak summer season), in which 240 Cu.m / day for domestic uses and 1000 Cu.m for industrial uses. The freshwater requirement is only 240 Cu.m/day which is only for domestic uses and water requirement for industrial uses i.e. 1000 Cu.m will be met from mine seepage water after treatment. Once underground operation starts, the water requirement will be reduced by 50 percent for industrial uses. Further after full fledged underground operation there will be very less water requirement for sprinkling (dust suppression) to the OB dump, mine haulage roads and mine benches. **Details are given at Annexure 9.**
xi.	PP submitted compliance to the ToR conditions which are generic and not adequate. PP needs to	Revised compliance status with adequate details has been prepared and is attached as **Annexure 10.**

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	submit the revised compliance status of the ToR conditions.	
xii.	PP needs to revise the CER budget as per the provisions of OM No. F. No.22-65/2017-IA-III dated 01.05.2018	Revised CER budget as per the provisions of OM No. F. No.22-65/2017-IA-III dated 01.05.2018 attached as **Annexure 11.**
xiii.	PP needs to submit copy of CGWA approval since inception of mining and compliance status of conditions especially on installation of piezometers at suitable location for monitoring.	CGWA approval is attached as **Annexure 12 a.** Compliance status of installation of piezometers is attached as Annexure **12 b.**
xiv.	PP needs to submit details of environment management cell, performance including monitoring & educational backgrounds.	Details of Environment Management Cell, performance including monitoring & educational backgrounds is attached as **Annexure 13.**
xv.	PP needs to submit details of underground mining including precautionary steps planned and other safety procedures as per the government guidelines.	Details of underground mining including precautionary steps planned and other safety procedures as per the government guidelines is given at **Annexure 14.**
xvi.	PP requires to submit reasons for proposing common dumping along the lease boundary with M/s BAL. PP needs to show the current dumping yard with coordinates and details of handling of dump, if any. In addition, PP needs to submit the copy of permission obtained from Directorate General of Mines Safety vide letter no. BBR-JA/CH-2 & 12/P-111 (3)/2017/235-136 dated 15.02.2017.	Reasons for common dumping and permission letters from DGMS is attached as **Annexure 15.** KML file showing the common dumping attached.
xvii.	PP requires to submit the copy of document for NPV payment.	Copy of document for NPV payment is attached as **Annexure 16 .**
xviii.	PP submitted that change in technology from opencast to combination of opencast and underground mining, however, there is no change in the mining plan. Therefore, the Committee asked the PP to submit a letter in the form of affidavit that there is no change in the mining plan.	Affidavit is attached as **Annexure 17.**

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In view of details submitted as per requirement of ADS, we are requesting you to kindly consider our case for grant of EC at an early date.

Thanking You,

Yours Faithfully
For M/s Indian Metals Ferro Alloys Limited

(Sanjeev Das)
Sr. Vice President
Head- Mining Business Unit
Authorized Signatory

Enclosure: As above

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Annexure 1a- Results of baseline data November 2019

AMBIENT AIR QUALITY 2019_NOV

Location	Min.	Max.	98th Percentile	Mean	Min.	Max.	98th Percentile	Mean	Mean
	$PM_{2.5}$ (Standard – 60 µg/m³)				PM_{10} (Standard – 100 µg/m³)				CO (2 mg/m³)
A1 Onsite SW (Main Gate)	23.4	28.4	27.3	25.9	52.8	68.8	62.6	58.9	0.26
A2 Onsite SW (Site Office)	23.0	27.9	26.8	25.4	52.7	67.6	61.5	57.8	0.26
A3 Onsite NE (Near ETP)	22.6	27.4	26.4	24.9	50.9	66.3	60.4	56.8	0.25
A4 Onsite NE (Near Lab)	21.9	26.6	25.6	24.2	49.4	64.5	58.7	55.2	0.24
A5 Onsite NE (Near Electrical substation)	28.8	34.9	33.6	31.8	64.8	84.5	76.9	72.3	0.32
A6 Ostia	25.8	31.3	30.1	28.5	58.1	75.7	68.9	64.8	0.29
A7 Chingudipal	26.6	32.3	31.9	29.4	60	78.2	71.2	66.9	0.30
A8 Saruabi Village	21.3	25.9	24.9	23.5	48	62.6	57	53.5	0.24
A9 OMC Colony	26.2	31.8	30.6	28.9	59.7	77	70	65.9	0.29
A10 Mohulakhal	27.3	33.1	31.8	30.1	61.4	80.1	72.9	68.5	0.30

A11 Giringamali	29.4	35.7	34.3	32.5	66.2	86.4	78.6	73.9	0.33
A12 Ransol	27.7	33.6	32.3	30.6	62.4	81.4	74	69.6	0.31
A13 Garamian	28.1	34.1	33.8	31	63.3	86.4	78.6	70.7	0.33

Location	**Min.**	**Max.**	**98th Percentile**	**Mean**	**Min.**	**Max.**	**98th Percentile**	**Mean**
	SO_2(Standard – 80 µg/m^3)				**NO_2 (Standard – 80 µg/m^3)**			
A1 Onsite SW (Main Gate)	5.7	8.3	7.2	6.8	14.4	20	19.4	17.5
A2 Onsite SW (Site Office)	6	8.1	7	6.7	14.1	19.6	19.1	17.2
A3 Onsite NE (Near ETP)	5.5	8	6.9	6.6	13.8	19.2	18.7	16.9
A4 Onsite NE (Near Lab)	5.3	7.8	6.7	6.4	13.4	18.7	18.2	16.4
A5 Onsite NE (Near Electrical substation)	7	10.2	8.8	8.4	17.6	24.5	23.9	21.5
A6 Ostia	6.2	9.1	7.9	7.50	15.8	21.9	21.4	19.26
A7 Chingudipal	6.4	9.4	8.1	7.74	16.3	22.7	17.8	19.9
A8 Saruabil	5.2	7.5	6.5	6.2	13.1	18.1	17.7	15.9
A9 OMC Colony	6.3	9.3	8	7.6	16.1	22.3	21.7	19.6

A10 Mohulakhal	6.6	9.7	8.3	7.9	16.7	23.2	22.6	20.4
A11 Giringamali	7.1	10.4	9	8.5	18	25	24.4	22
A12 Ransol	6.7	9.8	8.5	8.1	17	23.6	21.4	20.7
A13 Garamian	6.8	10	8.6	8.2	17.2	23.9	23.4	21

WATER QUALITY NOV 2019

GROUND WATER QUALITY -CORE & BUFFER ZONE

Sample Code	Unit	IS 10500: 2012 (Drinking water standard)	Core Zone water Quality		Ground Water quality results of Buffer Zone					
			W1 Onsite (B.W.)	W2 Near Office (B.W.)	W3 Kaliapani (B.W.)	W4 Ostia village (B.W.)	W5 Chingudipal (B.W.)	W6 Giringamali (B.W.)	W7 Kampauli (B.W.)	W8 Garamiyan (B.W.)
Colour	Hazen	5	<1	<1	<1	<1	<1	<1	<1	<1
Odour	--	Unobjectionable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
Turbidity	NTU	5	<1	<1	<1	<1	<1	<1	<1	<1
pH Value		6.5-8.5	7.63	6.53	6.61	6.29	7.52	7.44	7.2	6.06
Temperature	ºC	_	21.6	21.5	21.6	21.1	21.2	21.2	21.5	21.3
Conductivity	µmho/cm	_	310.9	301.5	83.26	107.3	478.4	618.6	367.9	148.5
Total Dissolved Solids	mg/l	500	155.5	150.7	41.64	53.64	240	309.3	183.9	74.13
Chloride (as Cl)	mg/l	250	6	26	2	2	6	8	10	8
Fluoride (as F)	mg/l	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Hardness	mg/l	200	164	112	24	28	164	252	176	48
Calcium (as Ca)	mg/l	75	46.4	24	6.4	12.4	36.8	49.6	43.2	16
Magnesium (as Mg)	mg/l	30	11.66	12.64	1.94	2.92	17.5	31.1	16.52	1.94
Iron (as Fe)	mg/l	0.3	0.14	0.11	0.16	0.2	<0.1	0.16	0.22	0.31
Sulphate (as SO4)	mg/l	200	2.35	5.33	2.79	4.35	4.43	5.29	2.09	3.09
Nitrate Nitrogen	mg/l	45	0.34	22.37	1.04	0.58	0.04	0.17	3.9	0.32
Alkalinity	mg/l	200	20	30	8	10	92	100	40	14
Sodium (as	mg/l	_	7.16	12.09	1.85	0.97	27.9	27.53	9.88	4.82

Na)										
Potassium (as K)	mg/l	_	1.34	2.9	0.61	0.32	3.33	3.2	0.44	0.79
Total Chromium	mg/l	0.05	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Surface water quality Nov 2019

Parameter	Unit	SW 1 Quarry water	SW 2 Underground Mahagiri	SW 3 Impervious settling pond	SW4 Intermediate settling Tank	SW5 North Side Settling Pond	SW8 Ragda dam	SW 9 Balipura near Kumrada	CPCB Surface water quality criteria				
									Class 'A'	Class 'B'	Class 'C'	Class 'D'	Class 'E'
Colour	Haze n	1	1	1	1	1	<1	1	-	-	-	-	-
Odour	--	Agre eable	Agre eable	Agre eable	Agreea ble	Agree able	Agre eable	Agre eable	-	-	-	-	-
Turbidity	NTU	1	1	2	1.5	1	<1	1.5	-	-	-	-	-
pH Value		7.63	7.5	7.8	7.8	7.89	7.62	7.05	6.5-6 .8	6.5-8 .5	6.5-8 .5	6.5-8 .5	6-8.5
Temperatu re	ºC	21.2	21.7	23.7	22.4	21.2	21.1	21.3	-	-	-	-	-
Conductivi ty	µmh o/cm	192	480. 5	156. 6	82	190.1	60.5 4	76.0 3	-	-	-	-	2250
Total Dissolved Solids	mg/l	95.3	241. 2	84.8	41.5	94.65	30.2 9	37.9 8	-	-	-	-	-
Chloride (as Cl)	mg/l	10	40	12	8	4	4	2	-	-	-	-	-
Fluoride (as F)	mg/l	<0.1	0.24	0.21	0.15	<0.1	<0.1	<0.1	-	-	-	-	-
Total Hardness	mg/l	36	146	46	13	64	16	24	-	-	-	-	-
Calcium (as Ca)	mg/l	8	10.2	8	3.2	11.2	4.8	6.4	-	-	-	-	-
Magnesiu m (as Mg)	mg/l	3.9	23.5	25.7	1.2	8.75	0.97	1.94	-	-	-	-	-

Iron (as Fe)	mg/l	0.516	<0.1	0.16	0.32	0.22	0.117	0.331	-	-	-	-	-
Sulphate (as SO4)	mg/l	8.12	6.4	8.6	3.6	5.78	3.57	2.68	-	-	-	-	-
Nitrate Nitrogen	mg/l	5.22	24.8	25.6	14.3	4.78	0.14	2.31					
Alkalinity	mg/l	20	124	16	14	20	8	8	-	-	-	-	-
Phosphate	mg/l	0.06	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-
Sodium (as Na)	mg/l	6.32	3.2	3.5	2.1	2.19	1.35	3.3	-	-	-	-	-
Potassium (as K)	mg/l	1.22	1.5	1.32	0.63	4.45	0.38	0.22	-	-	-	-	-
Total Chromium	mg/l	4.36	0.54	3.92	3.6	0.74	BDL	BDL	-	-	-	-	-
BOD	mg/l	7	2	1.8	4	8.2	5	5	≤2	≤3	≤3	-	-
COD	mg/l	24	16	16	24	32	16	24	-	-	-	-	-
DO	mg/l	4.2	4.8	4.6	5.1	4.2	4.6	4.8	≥6	≥5	≥4	-	-
TSS	mg/l	8	54	70	76	26	6	24	-	-	-	-	-

S.No	Parameters	Unit	**SW6 Damsal Nala Upstream (Surface water)**	**SW7 Damsal Nala Downstream (Surface water)**	**EPA Discharge standards**
1	Colour	Hazen	<1	<1	< 1
2	Odour	--	Agreeable	Agreeable	Agreeable
3	Turbidity	NTU	<1	<1	< 1
4	pH Value		7.78	7.98	5.5-9.0
5	Temperature	ºC	21.2	21.2	1-50
6	Conductivity	µmho/cm	155.3	153.8	-
7	Total Dissolved Solids	mg/l	77.7	76.9	-
8	Chloride (as Cl)	mg/l	6	4	-
9	Fluoride (as F)	mg/l	<0.1	<0.1	2

10	Total Hardness	mg/l	56	48	-
11	Calcium (as Ca)	mg/l	16	14.4	-
12	Magnesium (as Mg)	mg/l	3.8	2.9	-
13	Iron (as Fe)	mg/l	0.35	0.43	3
14	Sulphate (as SO4)	mg/l	7.94	4.36	-
15	Nitrate Nitrogen	mg/l	1.29	1.82	10
16	Alkalinity	mg/l	20	10	-
17	Phosphate	mg/l	0.1	0.1	5
18	Sodium (as Na)	mg/l	2.37	2.11	-
19	Potassium (as K)	mg/l	0.55	0.56	-
20	Total Chromium (Hexavalent)	mg/l	0.158	0.148	-
21	BOD	mg/l	8	7	30
22	COD	mg/l	32	32	250
23	DO	mg/l	4.6	4.8	-
24	TSS	mg/l	12	12	100

AMBIENT NOISE RESULTS:

S. No.	Locations	Class	L_{eq} Day noise level dB(A)	L_{eq} Night noise level dB(A)	Day time (6.00 A.M to 10.00P.M)	Night time (10.00 P.M to 6.00A.M)
					Standard (L_{eq} in dB(A)	Standard (L_{eq} in dB(A)
Core zone noise quality						
N1	Onsite (SW)	Industrial area	63.8	53.8	75	70
N2	Onsite (NE)	Industrial area	64.7	54.2	75	70
N3	On-site (Near ETP)	Industrial area	63.9	50.8	75	70
N4	On-site (Near Lab)	Industrial area	63.7	51.6	75	70
Buffer zone noise quality						
N5	Ostia	Residential area	55.4	46.7	55	45
N6	Chingudipal	Residential area	56.4	47.6	55	45
N7	OMC Colony	Residential area	57.2	48.5	55	45
N8	Mahulkhal	Residential area	57.0	46.5	55	45
N9	Ransol	Residential area	56.2	48.6	55	45
N10	Garamian	Residential area	57.1	47	55	45
N11	Giringamali	Residential area	51.3	46.1	55	45
N12	Saruabil	Residential area	57.1	47.3	55	45
N13	Kaliapani Road/Approach road	Commercial area	68.3	56.7	65	55

SOIL QUALITY RESULTS:

S. No.	Parameter	Unit	Core Zone Soil Quality Results			Buffer Zone Soil Quality Results					
			S1 Onsite (Office area)	S2 Onsite (Lab area)	S3 Onsite (ETP area)	S4 Chingudipal Village	S5 Gurujung Village	S6 Saraubil Village	S7 Giringamali Village	S8 Kampauli Village	S9 Garamiyian Village
Physical Properties of Soil											
1	Colour	-	3/4 (Brown)	4/3 (Dull Yellowish Brown)	4/3 (Dull Reddish Brown)	3/2 (Brownish Black)	4/3 (Dull Reddish Brown)	3/4 (Brown)	4/3 (Dull Reddish Brown)	3/4 (Brown)	3/2 (Brownish Black)
2	Composition	Sand %	14.8	15.8	16.8	34.4	21.7	17.3	18.3	20.4	16.9
		Silt %	50.4	53.4	51.4	37.3	44.1	47.1	50.8	10.8	44.5
		Clay %	34.7	30.7	31.7	28.2	34.1	35.5	30.8	68.7	38.5
3	Moisture Content	%	9.7	10.8	11.7	2.3	9.8	26.8	3.3	12.5	12.8
4	Conductivity	µS/cm	44.92	120.8	24.9	28.49	22.15	20.86	23.42	33.6	52.53
5	Bulk Density	g/cc	1.31	1.3	1.27	1.38	1.32	1.31	1.31	1.29	1.28
6	Porosity	%	23.5	23.8	24.3	22.4	23.3	23.7	23.5	24	24.1
Chemical Properties of Soil											
1	Texture	-	Silty Clay Loam	Silty Clay Loam	Silty Clay Loam	Clay Loam	Clay Loam	Silty Clay Loam	Silty Clay Loam	Clay	Silty Clay Loam
2	pH	-	7.4	7	5.9	5.5	5.6	5.3	5.4	5.4	5.3
3	Available Nitrogen	mg/kg	33.6	39.2	25.2	35	47.6	32.2	33.6	29.4	46.2
4	Available Phosphorous	mg/kg	6.6	7.9	12.1	11.4	6.2	8.4	73.3	27.1	18
5	Available Potassium	mg/kg	5.4	5.4	7.8	5.7	9.2	6.4	7.7	8.6	12.3
6	Available Calcium	mg/kg	28.4	16.3	27	21.2	43.6	31.3	4.4	50.8	38.4
7	Available	mg/k	19.8	25.4	15	19	20.6	16.6	14.2	13.4	21.4

	Magnesium	g									
8	Organic matter	%	0.3	0.4	0.3	0.4	0.3	0.3	0.2	0.2	0.6
9	Nitrate Nitrogen	mg/kg	22.4	32.2	19.6	14	28	18.2	28	11.2	33.6
10	Chloride	mg/kg	35.5	71	8.9	17.8	8.9	8.9	8.9	17.8	35.5
11	Available Sulphur	mg/kg	0.6	1.2	0.4	0.4	0.4	0.4	0.4	0.4	2.8
12	Available Sodium	mg/kg	16.9	10.3	15.4	16.8	12.8	24.3	21.4	18.9	23.2
13	Cation Exchange Capacity	(meq/100 gm)	15.9	18.9	18.5	15.9	19.2	18.3	14.5	17.6	15.2
14	Bi carbonate	mg/kg	109.8	97.6	85.4	73.2	73.2	61	73.2	61	61
15	Orthophosphate	mg/kg	2	0.9	3.1	1.1	2.1	3.8	2.1	0.7	12.1

Annexure 1b- Comparative data & trend analysis of baseline data

COMPARATIVE DATA AND TREND ANALYSIS REPORT OF BASELINE RESULTS

1. INTRODUCTION:

The trend analysis has been carried out as per the direction given by MoEF&CC vide letter no. **J-11015/204/2015-IA.II (M) dated 13.12.2019** stating that *PP needs to submit comparative data and trend analysis considering the values obtained during earlier EC appraisal, baseline data collected during Oct-Dec 2015 period, regular monitoring and fresh 1-month baseline data for all relevant parameters.*

At the time of EC appraisal in 2007 the baseline data was collected during summer season. The baseline data was collected during the Post Monsoon season (Oct - Dec 2015) at the time of appraisal for expansion application. Further one month (Oct 2018) baseline data was collected and submitted to MoEF&CC for appraisal. Now as per direction of MoEF&CC one month baseline data of Nov 2019 has been collected. Since the season of baseline data collected during 2007 was summer season hence this data cannot be directly compared with baseline data collected during Oct- Dec 2015, Oct 2018 and Nov 2019.

In view of above the comparison of baseline data has been carried out for data of 2015, 2018 and 2019. In addition the regular monitoring data of post monsoon seasons in 2016 and 2017 have been considered for comparison purposes.

2. COMPARATIVE STUDY OF BASELINE DATA

As stated above the comparative study has been carried out for the baseline data for following Environmental facets:

1. Air Quality
2. Noise Quality
3. Water Quality
4. Soil Quality

For the comparison purpose and for analysing the trend only common sites have been considered.

2.1 AIR QUALITY

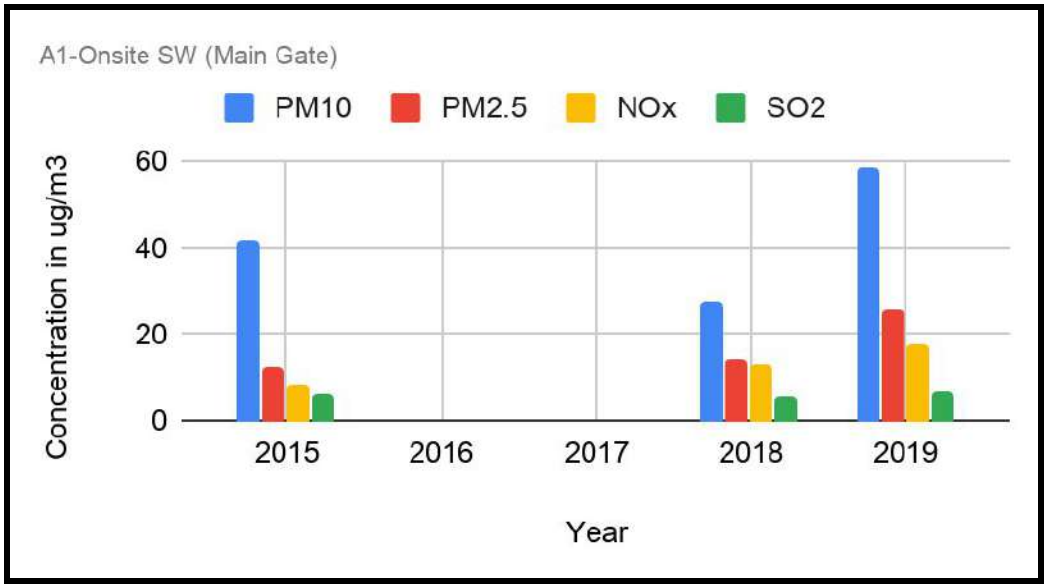
The parameters considered for comparative study of baseline data are PM_{10}, $PM_{2.5}$, SO_2, NOx and CO. The details for different parameters are given below in the tabular form as well as in graphical representation.

1. Comparative Study at location A1-Onsite SW (Main Gate)

Tabular Representation

A1-Onsite SW (Main Gate)						
Parameters	**Standard**	**2019**	**2018**	**2017**	**2016**	**2015**
PM_{10}	**100 µg/m³**	58.9	27.3	-	-	41.8
$PM_{2.5}$	**60 µg/m³**	25.9	14.3	-	-	12.6
NOx	**80 µg/m³**	17.5	13.3	-	-	8.3
SO_2	**80 µg/m³**	6.8	5.5	-	-	5.9
CO		0.26	0.14	-	-	-

Graphical Representation

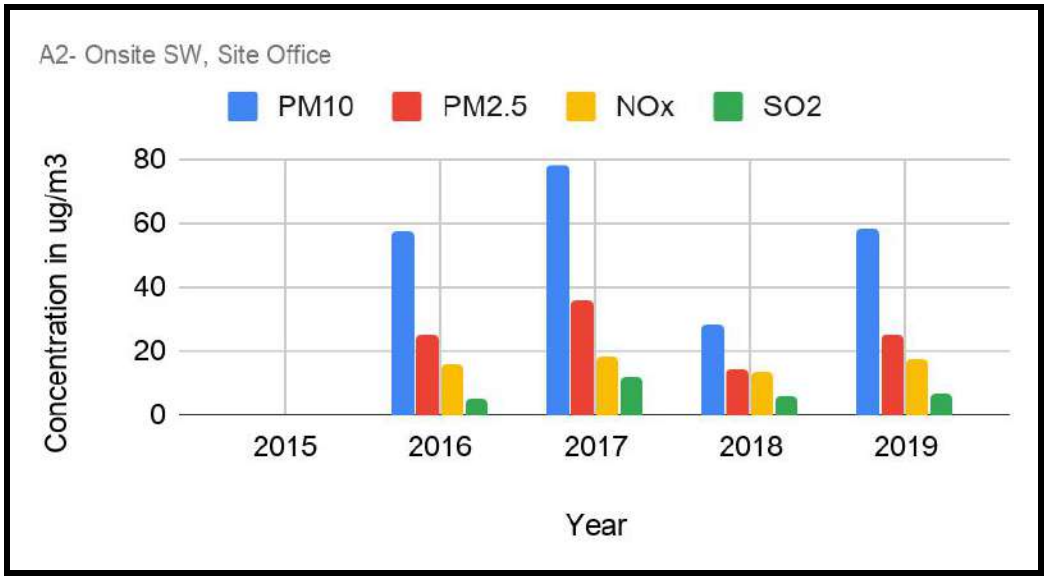


2. Comparative Study at location A2- Onsite SW, Site Office

Tabular Representation

A2- Onsite SW, Site Office						
Parameters	**Standard**	**2019**	**2018**	**2017**	**2016**	**2015**
PM_{10}	**100 µg/m³**	57.8	27.8	78.18	57.58	-
$PM_{2.5}$	**60 µg/m³**	25.4	14.6	35.63	24.72	-
NOx	**80 µg/m³**	17.2	13.5	18.41	15.91	-
SO_2	**80 µg/m³**	6.7	5.6	12.21	5.02	-
CO		0.26	0.15	0.84	<1.14	-

Graphical Representation

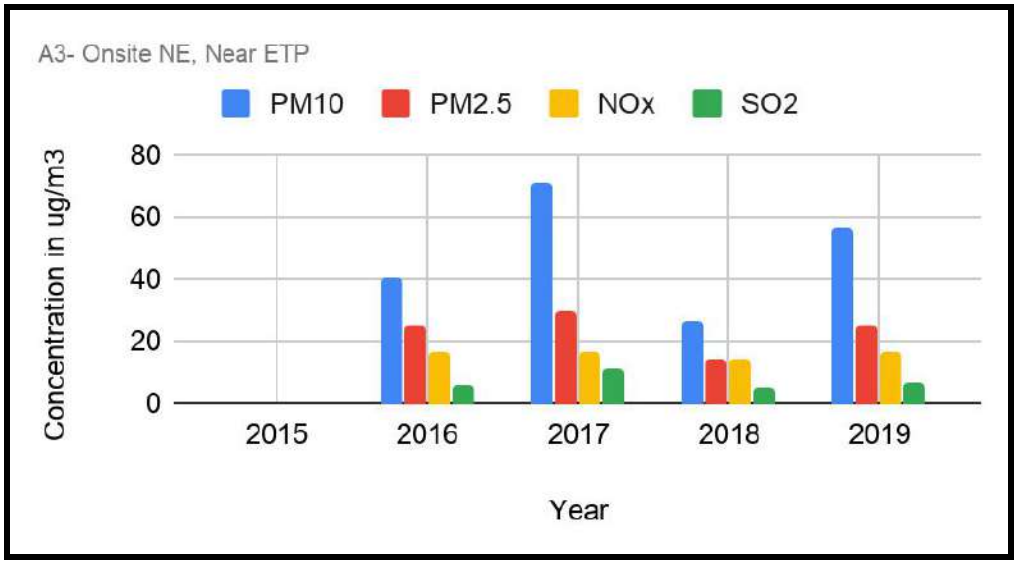


3. Comparative Study at location A3- Onsite NE, Near ETP

Tabular Representation

A3- Onsite NE, Near ETP						
Parameters	**Standard**	**2019**	**2018**	**2017**	**2016**	**2015**
PM_{10}	**100 µg/m³**	56.8	26.8	70.95	40.83	-
$PM_{2.5}$	**60 µg/m³**	24.9	14	29.63	25.43	-
NOx	**80 µg/m³**	16.9	14.4	16.97	16.31	-
SO_2	**80 µg/m³**	6.6	5.4	10.91	6.03	-
CO	³	0.25	0.14	0.77	<1.14	-

Graphical Representation

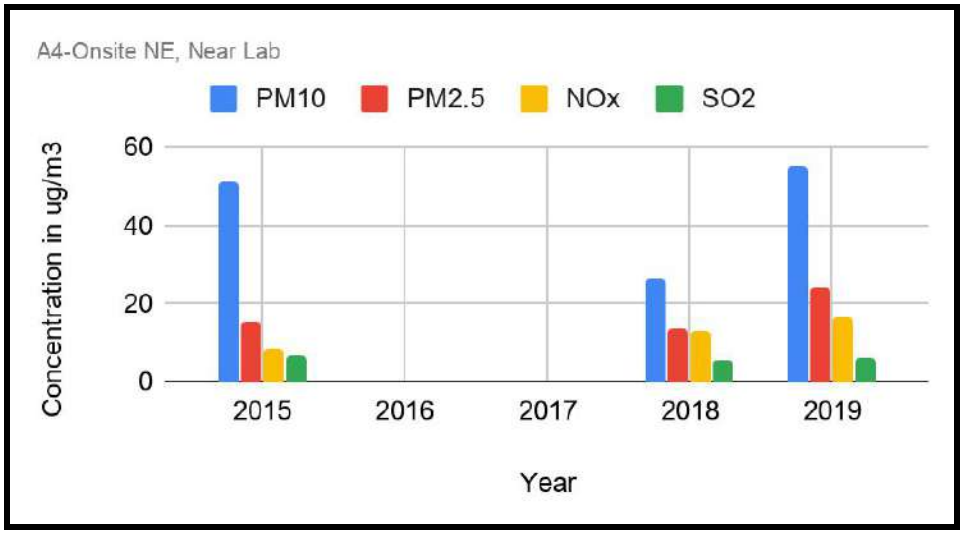


4. Comparative Study at location A4- Onsite NE, Near Lab

Tabular Representation

A4-Onsite NE, Near Lab						
Parameters	**Standard**	**2019**	**2018**	**2017**	**2016**	**2015**
PM_{10}	**100 µg/m³**	55.2	26.3	-	-	51.2
$PM_{2.5}$	**60 µg/m³**	24.2	13.8	-	-	15.1
NOx	**80 µg/m³**	16.4	12.8	-	-	8.7
SO_2	**80 µg/m³**	6.4	5.3	-	-	6.9
CO		0.24	0.14	-	-	-

Graphical Representation

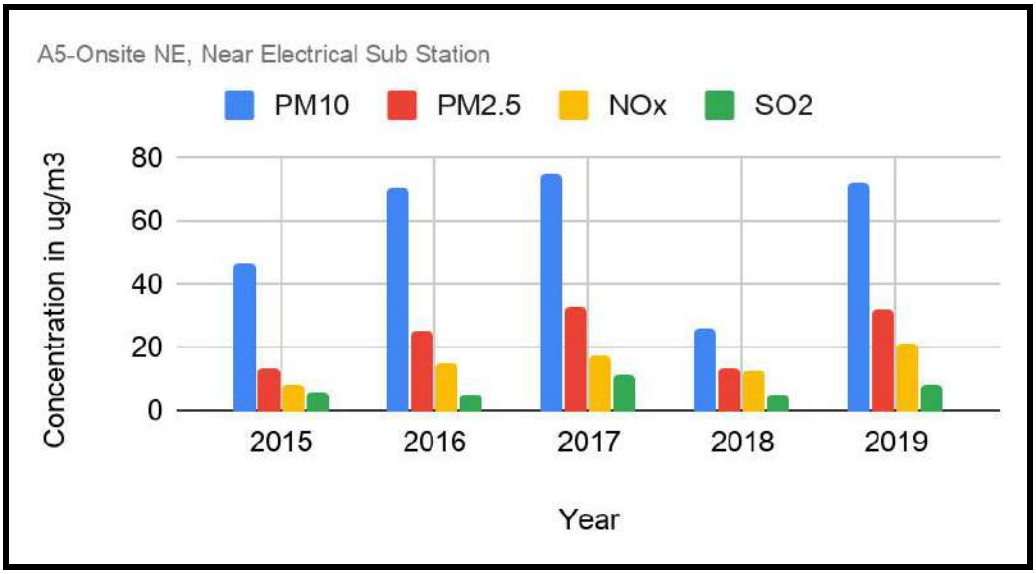


5. Comparative Study at location A5-Onsite NE, Near Electrical Sub Station

Tabular Representation

A5-Onsite NE, Near Electrical Sub Station						
Parameters	**Standard**	**2019**	**2018**	**2017**	**2016**	**2015**
PM_{10}	**100 µg/m³**	72.3	25.8	74.7	70.75	47
$PM_{2.5}$	**60 µg/m³**	31.8	13.5	32.78	25.36	13.8
NOx	**80 µg/m³**	21.5	12.5	17.76	15.11	8
SO_2	**80 µg/m³**	8.4	5.2	11.41	5.44	6.2
CO		0.32	0.14	0.85	<1.14	-

Graphical Representation

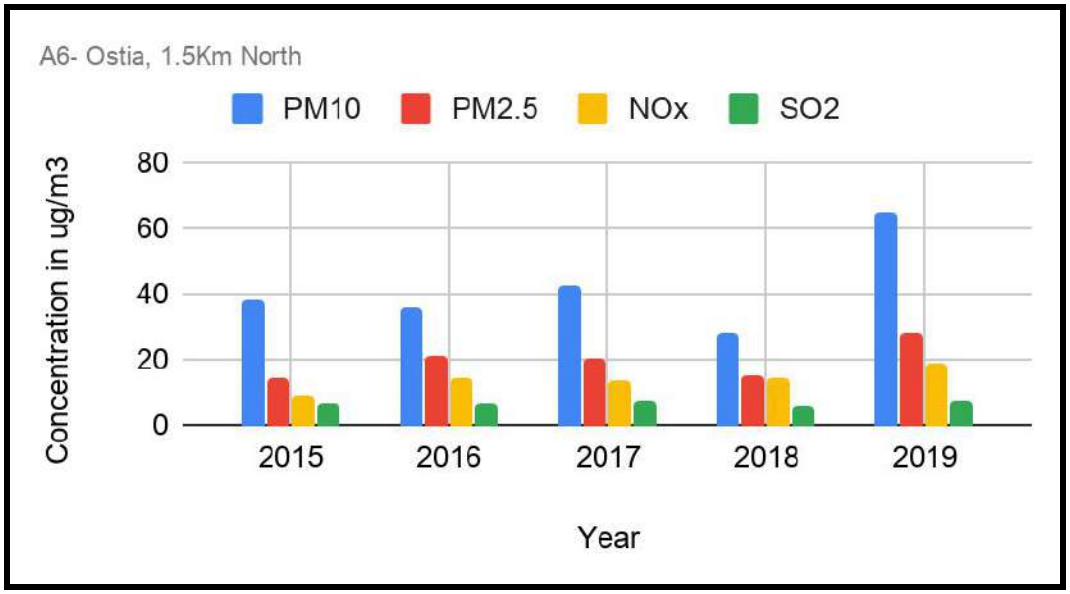


6. Comparative Study at location A6- Ostia, 1.5Km North

Tabular Representation

A6- Ostia, 1.5Km North						
Parameters	**Standard**	**2019**	**2018**	**2017**	**2016**	**2015**
PM_{10}	**100 µg/m³**	64.8	28.5	42.97	35.55	38.5
$PM_{2.5}$	**60 µg/m³**	28.5	14.8	20.42	21.43	14.2
NOx	**80 µg/m³**	19.26	14.4	13.41	14.185	8.7
SO_2	**80 µg/m³**	7.5	5.6	7.5	6.86	6.3
CO		0.29	0.16	0.54	<1.14	-

Graphical Representation

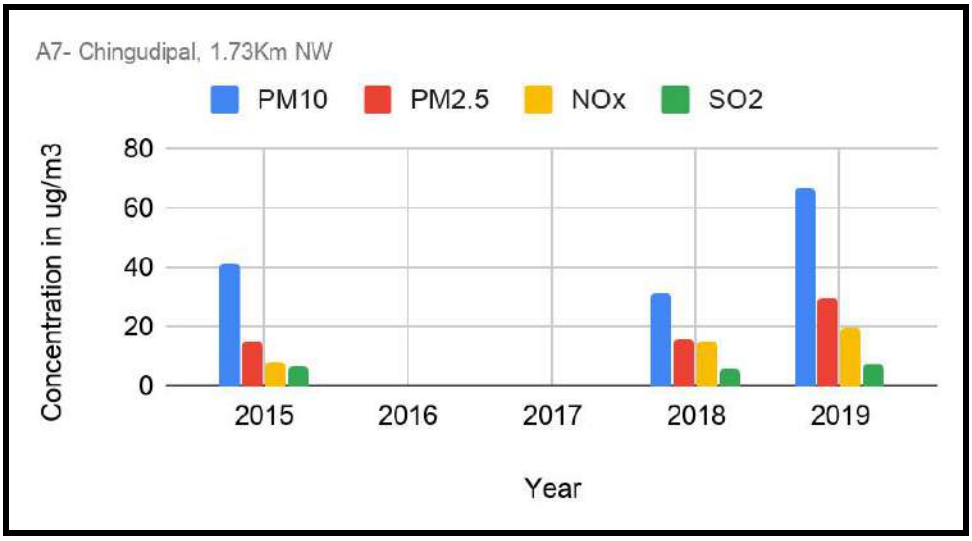


7. Comparative Study at location A7- Chingudipal, 1.73Km NW

Tabular Representation

A7- Chingudipal, 1.73Km NW						
Parameters	**Standard**	**2019**	**2018**	**2017**	**2016**	**2015**
PM_{10}	**100 µg/m³**	66.9	30.9	-	-	41
$PM_{2.5}$	**60 µg/m³**	29.4	16.2	-	-	14.7
NOx	**80 µg/m³**	19.9	15	-	-	8.5
SO_2	**80 µg/m³**	7.74	6.2	-	-	6.4
CO		0.3	0.16	-	-	-

Graphical Representation

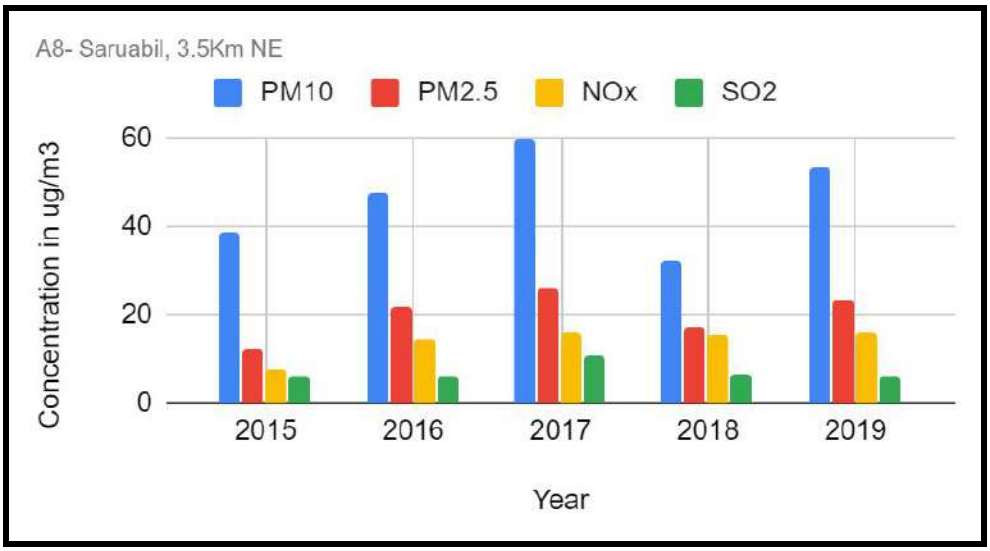


8. Comparative Study at location A8- Saruabil, 3.5Km NE

Tabular Representation

A8- Saruabil, 3.5Km NE						
Parameters	**Standard**	**2019**	**2018**	**2017**	**2016**	**2015**
PM_{10}	**100 µg/m³**	53.5	32.5	59.88	47.83	38.6
$PM_{2.5}$	**60 µg/m³**	23.5	17	26.17	21.73	12.4
NOx	**80 µg/m³**	15.9	15.8	15.9	14.585	7.7
SO_2	**80 µg/m³**	6.2	6.5	10.8	5.95	5.9
CO		0.24	0.17	0.78	<1.14	-

Graphical Representation

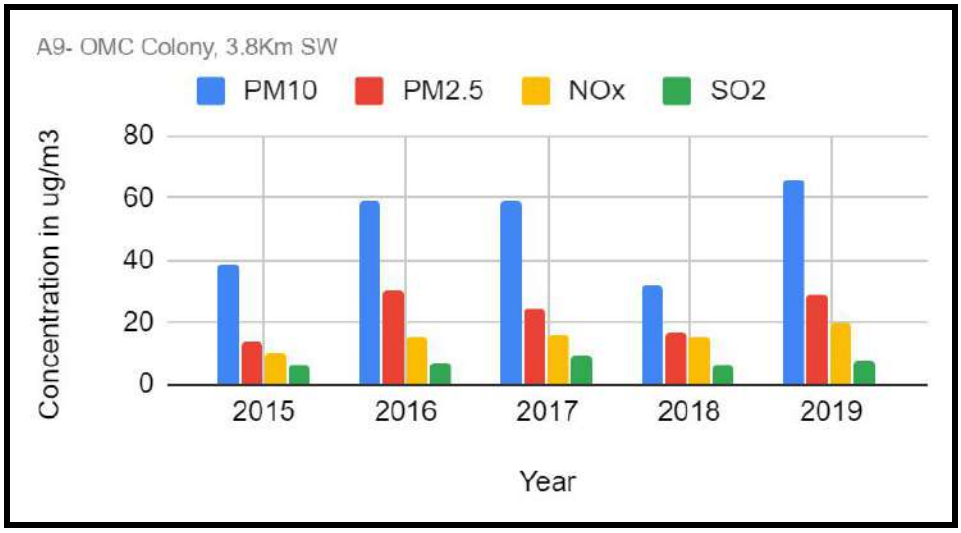


9. Comparative Study at location A9- OMC Colony, 3.8Km SW

Tabular Representation

A9- OMC Colony, 3.8Km SW						
Parameters	**Standard**	**2019**	**2018**	**2017**	**2016**	**2015**
PM_{10}	**100 µg/m³**	65.9	32	59.14	59.31	39
$PM_{2.5}$	**60 µg/m³**	28.9	16.7	24.51	30.06	13.4
NOx	**80 µg/m³**	19.6	15.5	16.35	14.915	9.6
SO_2	**80 µg/m³**	7.6	6.4	9.4	6.94	6.3
CO		0.29	0.17	0.69	<1.14	

Graphical Representation

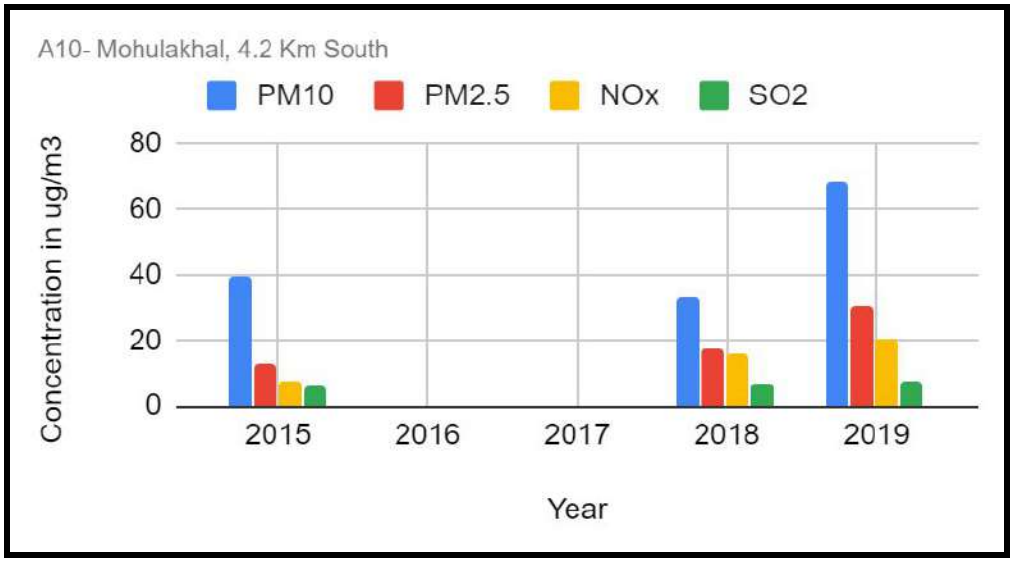


10. Comparative Study at location A10- Mohulakhal, 4.2 Km South

Tabular Representation

A10- Mohulakhal, 4.2 Km South						
Parameters	**Standard**	**2019**	**2018**	**2017**	**2016**	**2015**
PM_{10}	**100 µg/m³**	68.5	33.5	-	-	39.2
$PM_{2.5}$	**60 µg/m³**	30.1	17.6	-	-	13.1
NOx	**80 µg/m³**	20.4	16.3	-	-	7.6
SO_2	**80 µg/m³**	7.9	6.7	-	-	6.1
CO		0.3	0.18	-	-	-

Graphical Representation

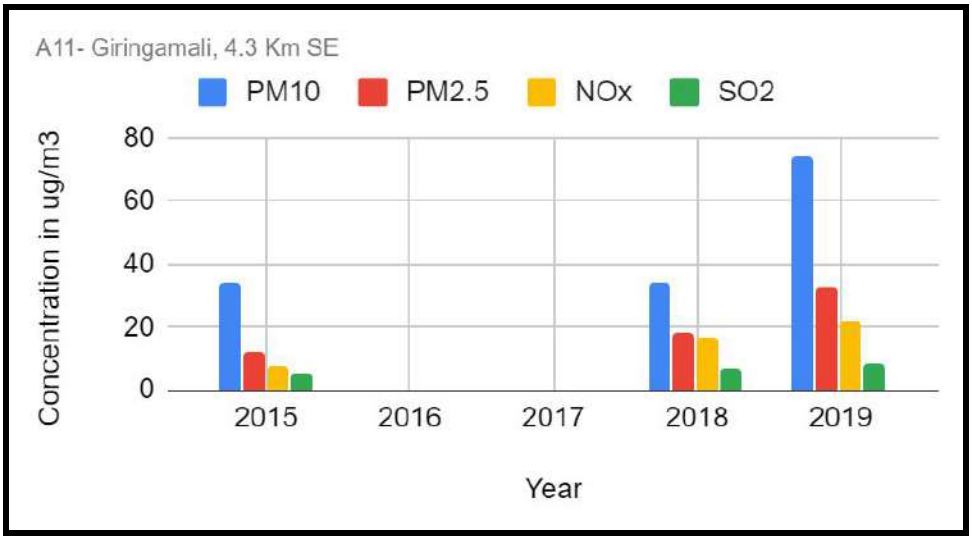


11. Comparative Study at location A11- Giringamali, 4.3 Km SE

Tabular Representation

A11- Giringamali, 4.3 Km SE						
Parameters	**Standard**	**2019**	**2018**	**2017**	**2016**	**2015**
PM_{10}	**100 µg/m³**	73.9	34.5	-	-	34.2
$PM_{2.5}$	**60 µg/m³**	32.5	18	-	-	12.4
NOx	**80 µg/m³**	22	16.9	-	-	7.4
SO_2	**80 µg/m³**	8.5	6.7	-	-	5.6
CO		0.33	0.18	-	-	-

Graphical Representation

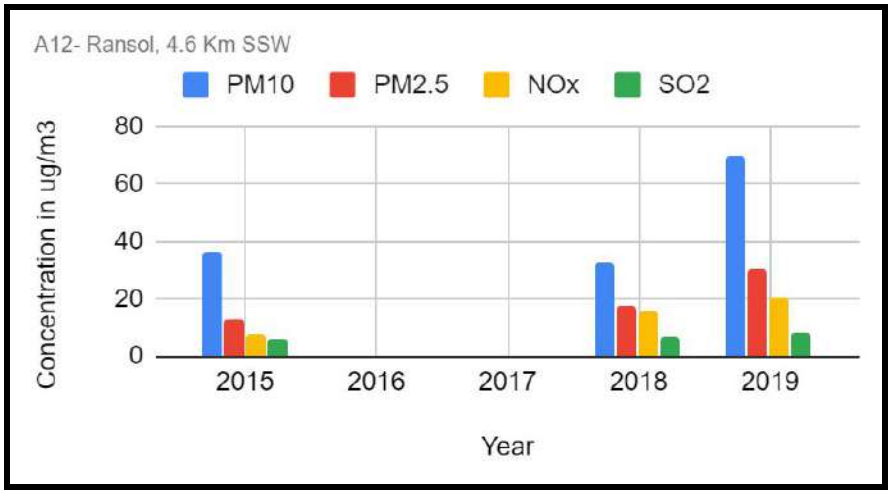


12. Comparative Study at location A12- Ransol, 4.6 Km SSW

Tabular Representation

A12- Ransol, 4.6 Km SSW						
Parameters	**Standard**	**2019**	**2018**	**2017**	**2016**	**2015**
PM_{10}	**100 µg/m³**	69.6	33	-	-	36.3
$PM_{2.5}$	**60 µg/m³**	30.6	17.3	-	-	13.1
NOx	**80 µg/m³**	20.7	16	-	-	7.6
SO_2	**80 µg/m³**	8.1	6.6	-	-	5.9
CO		0.31	0.17	-	-	-

Graphical Representation

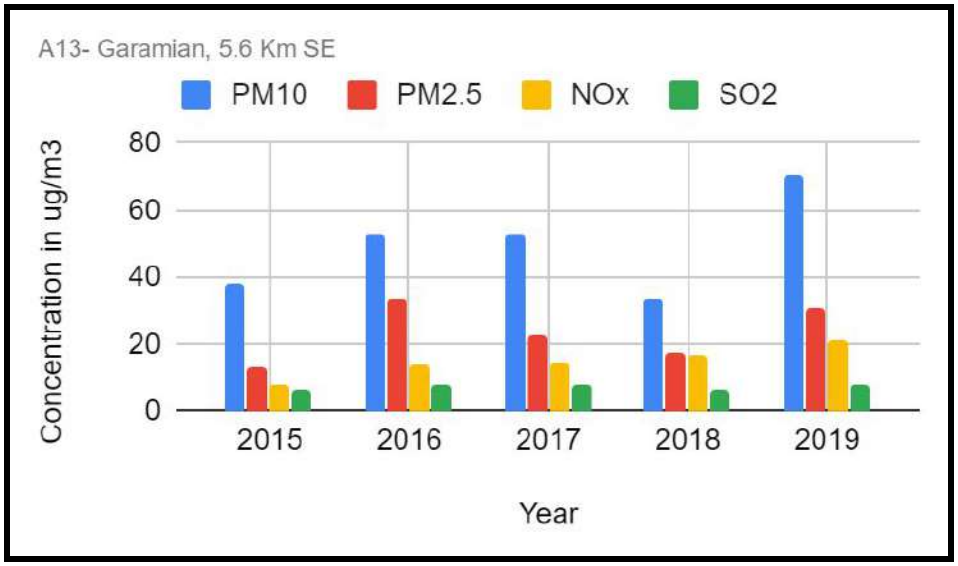


13. Comparative Study at location A13- Garamian, 5.6 Km SE

Tabular Representation

A13- Garamian, 5.6 Km SE						
Parameters	**Standard**	**2019**	**2018**	**2017**	**2016**	**2015**
PM_{10}	**100 µg/m³**	70.7	34	52.64	52.69	37.9
$PM_{2.5}$	**60 µg/m³**	31	17.8	22.68	34.03	12.9
NOx	**80 µg/m³**	21	16.5	14.52	14.07	8.1
SO_2	**80 µg/m³**	8.2	6.8	8.22	7.65	6.3
CO		0.33	0.18	0.56	<1.14	-

Graphical Representation



2.1.1 DATA INTERPRETATION:

On the perusal of both tabular and graphical representation of PM_{10}, $PM_{2.5}$, SO_2 and NOx, it is evident that all the parameters at all the monitoring locations are within the limits of National ambient air quality standards.

2.2 NOISE QUALITY

The Ambient Noise Quality results of day and Night are summarized below for last five year in tabular form:

1. **Comparative study for Noise result at location N1-Onsite SW**

Tabular Representation

N1-Onsite SW	Standard (L_{eq} in dB(A)	2019	2018	2017	2016	2015
Leq Day Noise level dB(A)	**75**	63.8	63.7	70.84	38.7	-
Leq Night Noise level dB(A)	**70**	53.8	58.9	60.21	32.7	-

2. **Comparative study for Noise result at location N2-Onsite NE**

Tabular Representation

N2- Onsite NE	Standard (L_{eq} in dB(A)	2019	2018	2017	2016	2015
Leq Day Noise level dB(A)	**75**	64.7	64.5	65.88	60.9	48.2
Leq Night Noise level	**70**	54.2	59.3	57.12	50.1	43.9

dB(A)						

3. Comparative study for Noise result at location N3-Onsite Near ETP

Tabular Representation

N3- Onsite Near ETP	**Standard (L_{eq} in dB(A)**	**2019**	**2018**	**2017**	**2016**	**2015**
Leq Day Noise level dB(A)	**75**	63.9	63.6	76.26	40.2	-
Leq Night Noise level dB(A)	**70**	50.8	58.5	64.82	33.9	-

4. Comparative study for Noise result at location N4-Onsite Near Lab

Tabular Representation

N4-Onsite Near Lab	**Standard (L_{eq} in dB(A)**	**2019**	**2018**	**2017**	**2016**	**2015**
Leq Day Noise level dB(A)	**75**	63.7	63.9	70.84	-	-
Leq Night Noise level dB(A)	**70**	51.6	58.1	60.21	-	-

5. Comparative study for Noise result at location N5- Ostia, 1.88 Km NE

Tabular Representation

N5- Ostia, 1.88 Km NE	**Standard (L_{eq} in dB(A)**	**2019**	**2018**	**2017**	**2016**	**2015**
Leq Day Noise level dB(A)	**55**	55.4	57.6	45.09	45.2	47.7
Leq Night Noise level dB(A)	**45**	46.7	49.6	38.32	40.2	43.6

6. Comparative study for Noise result at location N6-Chingudipal, 1.98Km NW

Tabular Representation

N6- Chingudipal, 1.98Km NW	**Standard (L_{eq} in dB(A)**	**2019**	**2018**	**2017**	**2016**	**2015**
Leq Day Noise level dB(A)	**55**	56.4	57.5	-	-	-
Leq Night Noise level	**45**	47.6	49.3	-	-	-

dB(A)						

7. Comparative study for Noise result at location N7-OMC Colony, 2.5Km SW

Tabular Representation

N7- OMC Colony, 2.5Km SW	**Standard (L_{eq} in dB(A)**	**2019**	**2018**	**2017**	**2016**	**2015**
Leq Day Noise level dB(A)	**55**	57.2	58.1	48.35	45.9	43.3
Leq Night Noise level dB(A)	**45**	48.5	49.8	41.1	37.1	39.1

8. Comparative study for Noise result at location N8-Mohulakhal, 4.30 Km SSW

Tabular Representation

N8- Mohulakhal, 4.30 Km SSW	**Standard (L_{eq} in dB(A)**	**2019**	**2018**	**2017**	**2016**	**2015**
Leq Day Noise level dB(A)	**55**	57.0	57.6	-	-	-
Leq Night Noise level dB(A)	**45**	46.5	48.7	-	-	-

9. Comparative study for Noise result at location N9-Ransol, 4.32 Km SW

Tabular Representation

N9- Ransol, 4.32 Km SW	**Standard (L_{eq} in dB(A)**	**2019**	**2018**	**2017**	**2016**	**2015**
Leq Day Noise level dB(A)	**55**	56.2	57.5	-	-	43.2
Leq Night Noise level dB(A)	**45**	48.6	48.5	-	-	38.9

10. Comparative study for Noise result at location N10- Garamian, 4.63 Km SE

Tabular Representation

N10- Garamian, 4.63 Km SE	**Standard (L_{eq} in dB(A)**	**2019**	**2018**	**2017**	**2016**	**2015**
Leq Day Noise level dB(A)	**55**	57.1	57.9	54.34	44.3	47.8
Leq Night Noise level dB(A)	**45**	47	49.3	46.19	38.2	43.6

11. Comparative study for Noise result at location N11-Giringamali, 4.75 Km ESE

Tabular Representation

N11- Giringamali, 4.75 Km ESE	Standard (L_{eq} in dB(A)	2019	2018	2017	2016	2015
Leq Day Noise level dB(A)	**55**	51.3	58.2	-	-	44.4
Leq Night Noise level dB(A)	**45**	46.1	49.5	-	-	40.1

12. Comparative study for Noise result at location N12-Saruabil Village, 5.32 Km NE

Tabular Representation

N12- Saruabil Village, 5.32 Km NE	Standard (L_{eq} in dB(A)	2019	2018	2017	2016	2015
Leq Day Noise level dB(A)	**55**	57.1	58	55.57	50.8	45.9
Leq Night Noise level dB(A)	**45**	47.3	49.8	47.24	44.9	41.6

13. Comparative study for Noise result at location N13-Kaliapani Road/Approach Road, Adjacent

Tabular Representation

N13- Kaliapani Road/Approach Road, Adjacent	Standard (L_{eq} in dB(A)	2019	2018	2017	2016	2015
Leq Day Noise level dB(A)	**65**	68.3	67.9	51.94	47.8	-
Leq Night Noise level dB(A)	**55**	56.7	62.5	44.15	40.6	-

2.2.1 DATA INTERPRETATION

From the above comparative table it is concluded that the noise levels measured at the core zone during the day and night time are within the standard limit of Industrial area~75 dB and ~70 dB respectively. However, the noise levels of buffer areas during the day and night time vary and they are slightly higher than the standard limit of residential & commercial areas. The increase in noise level in the villages is slightly higher due to variance in vehicular traffic and other noise related activities.

2.3 WATER QUALITY

The parameters considered for comparative study of baseline data are given below individually in tabular form.

1. Comparative study for pH

Tabular Representation

Location	pH (Standard 6.5-8.5)				
	Oct- Dec 2015	**Dec 2016**	**Dec 2017**	**Oct 2018**	**Nov-Dec 2019**
Onsite (GW)	-	6.79	7.29	6.5	7.63
Near Office (GW)	-	-	-	6.9	6.53
Kaliapani (GW)	7.21	6.1	7.58	7.1	6.61
Ostia Village (GW)	8.14	-	-	6.9	6.29
Chingudipal (GW)	6.04	-	-	7.5	7.52
Giringamali (GW)	7.82	5.6	6.79	6.8	7.44
Kampauli (GW)	6.75			6.7	7.2
Garamian (GW)	6.24	4.9	6.95	6.9	6.06
Open Quarry water	-	6.5	-	7.6	7.63
Underground Mahagiri	-	-	-	7.7	7.5
Impervious Settling pond	-	-	-	7.8	7.8
Intermediate Settling tank	-	-	-	8.2	7.8
North side Settling Pond	-	-	-	7.4	7.89
Damshal Nala Upstream	7.8	6.6	7.61	7.9	7.78
Damshal Nala Down stream	7.92	-	7.42	7	7.98
Ragada Dam	8.02	-	-	7.5	7.62
Balipura near kumrada	7.67	-	-	7.2	7.05

2. Comparative study for TDS(mg/l)

Tabular Representation

Location	TDS in mg/l (Standard- 500 mg/l)				
	Oct- Dec 2015	**Dec 2016**	**Dec 2017**	**Oct 2018**	**Nov-Dec 2019**
Onsite (GW)	-	182.24	267	53	155.5
Near Office (GW)	-	-	-	110.3	150.7
Kaliapani (GW)	110	215	310	145.5	41.64
Ostia Village (GW)	44	-	-	148.6	53.64
Chingudipal (GW)	38	-	-	33.1	240
Giringamali (GW)	50	310.6	196	86.8	309.3
Kampauli (GW)	268	-	-	217.1	183.9
Garamian (GW)	92	92.66	382	224.3	74.13
Open Quarry water	-	-	-	38.5	95.3
Underground Mahagiri	-	-	-	228.2	241.2
Impervious Settling pond	-	-	-	239	84.8
Intermediate Settling tank	-	-	-	32.5	41.5
North side Settling Pond	-	-	-	30	96.65
Damshal Nala Upstream	145	NA	289	71.6	77.7
Damshal Nala Down stream	126	NA	284	59	76.92
Ragada Dam	68	-	-	42.3	30.29
Balipura near kumrada	142	-	-	68.5	37.98

3. Comparative study for SO_4^{2-}(mg/l)

Tabular Representation

Location	SO_4^{2-} mg/l (Standard- 200 mg/l)				
	Oct- Dec 2015	**Dec 2016**	**Dec 2017**	**Oct 2018**	**Nov-Dec 2019**
Onsite (GW)	-	4.25	-	2	2.35
Near Office (GW)	-		-	2	5.33
Kaliapani (GW)	2	2.86	-	3.2	2.79
Ostia Village (GW)	3	-	-	2	4.35
Chingudipal (GW)	1.4	-	-	3.6	4.43
Giringamali (GW)	2	4.78	-	2	5.29
Kampauli (GW)	12		-	3.3	2.09
Garamian (GW)	5	2.12	-	0.54	3.09
Open Quarry water	-	-	-	6.2	8.12
Underground Mahagiri	-	-	-	7.8	6.4
Impervious Settling pond	-	-	-	10.9	8.6
Intermediate Settling tank	-	-	-	2.5	3.6
North side Settling Pond	-	-	-	5.3	5.78
Damshal Nala Upstream	2	-	15	16.7	7.94
Damshal Nala Down stream	3	-	14	14.4	4.36
Ragada Dam	4	-	-	3	3.57
Balipura near kumrada	1	-	-	4.1	2.68

4. Comparative study for Chloride(mg/l)

Tabular Representation

Location	Chloride mg/l (Standard- 250 mg/l)

	Oct- Dec 2015	Dec 2016	Dec 2017	Oct 2018	Nov-Dec 2019
Onsite (GW)	-	23.9	48	13	6
Near Office (GW)	-	-	-	19	26
Kaliapani (GW)	23	27.99	29	35	2
Ostia Village (GW)	8	-	-	33	2
Chingudipal (GW)	13	-	-	10	6
Giringamali (GW)	8	33.99	27	32	8
Kampauli (GW)	75	-	-	44	10
Garamian (GW)	13	42.99	56	45	8
Open Quarry water	-	-	-	8	10
Underground Mahagiri	-	-	-	41	40
Impervious Settling pond	-	-	-	38	12
Intermediate Settling tank	-	-	-	6	8
North side Settling Pond	-	-	-	6.5	4
Damshal Nala Upstream	15	-	19	7	6
Damshal Nala Down stream	10	-	17	8	4
Ragada Dam	5	-	-	8	4
Balipura near kumrada	18	-	-	6	2

5. Comparative study for Total chromium(mg/l)

Tabular Representation

Location	**Total chromium mg/l (**Standard- 0.05 mg/l**)**				
	Oct- Dec 2015	**Dec 2016**	**Dec 2017**	**Oct 2018**	**Nov-Dec 2019**
Onsite (GW)	-	0.04	BDL	0.52	BDL
Near Office (GW)	-	-	-	0.48	BDL
Kaliapani (GW)	-	0.04	BDL	0.34	BDL

Ostia Village (GW)	-	-	-	0.4	BDL
Chingudipal (GW)	-	-	-	0.33	BDL
Giringamali (GW)	-	0.02	BDL	0.38	BDL
Kampauli (GW)	-			0.36	BDL
Garamian (GW)	-	0.03	BDL	0.37	BDL
Open Quarry water	-	0.48	-	1.11	4.36
Underground Mahagiri	-	-	-	0.42	0.54
Impervious Settling pond	-	-	-	0.6	3.92
Intermediate Settling tank	-	-	-	0.4	3.6
North side Settling Pond	-	-	-	0.1	0.74
Damshal Nala Upstream	-	1.86	0.09	0.27	0.158
Damshal Nala Down stream	-	-	BDL	0.21	0.148
Ragada Dam	-	-	-	0.37	BDL
Balipura near kumrada	-	-	-	0.31	BDL

6. Comparative study for Total Alkalinity (mg/l)

Tabular Representation

Location	**Total Alkalinity mg/l (**Standard- 200 mg/l**)**				
	Oct- Dec 2015	**Dec 2016**	**Dec 2017**	**Oct 2018**	**Nov-Dec 2019**
Onsite (GW)	-	120	127	34	20
Near Office (GW)	-	-	-	50	30
Kaliapani (GW)	55	140	218	107	8
Ostia Village (GW)	20	-	-	94	10
Chingudipal (GW)	10	-	-	20	92

Giringamali (GW)	55	130	61	86	100
Kampauli (GW)	110			130	40
Garamian (GW)	15	50	264	135	14
Open Quarry water	-	-	-	22	20
Underground Mahagiri	-	-	-	126	124
Impervious Settling pond	-	-	-	115	106
Intermediate Settling tank	-	-	-	13.5	14
North side Settling Pond	-	-	-	15	68
Damshal Nala Upstream	90	-	147	8	52
Damshal Nala Down stream	75	-	152	36	56
Ragada Dam	40	-	-	19	8
Balipura near kumrada	85	-	-	9	8

7. Comparative study for Total Hardness(mg/l)

Tabular Representation

Location	Total Hardness mg/l (Standard- 200 mg/l)				
	Oct- Dec 2015	**Dec 2016**	**Dec 2017**	**Oct 2018**	**Nov-Dec 2019**
Onsite (GW)	-	156	104	36	164
Near Office (GW)	-			52	112
Kaliapani (GW)	85	296	166	110	24
Ostia Village (GW)	40	-	-	96	68
Chingudipal (GW)	15	-	-	24	164
Giringamali (GW)	65	180	99	88	252
Kampauli (GW)	190	-	-	134	176
Garamian (GW)	20	52	198	142	48

Open Quarry water	-	-	-	28	36
Underground Mahagiri	-	-	-	134	146
Impervious Settling pond	-	-	-	126	64
Intermediate Settling tank	-	-	-	16	13
North side Settling Pond	-	-	-	14	64
Damshal Nala Upstream	95	-	135	24	56
Damshal Nala Down stream	85	-	161	40	48
Ragada Dam	50	-	-	22	16
Balipura near kumrada	90	-	-	13	24

8. Comparative study for Fluoride(mg/l)

Tabular Representation

Location	Fluoride mg/l (Standard- 1 mg/l)				
	Oct- Dec 2015	**Dec 2016**	**Dec 2017**	**Oct 2018**	**Nov-Dec 2019**
Onsite (GW)	-	0.24	0.28	<0.1	<0.1
Near Office (GW)	-	-	-	0.11	<0.1
Kaliapani (GW)	0.2	0.2	BDL	0.22	<0.1
Ostia Village (GW)	0.1	-	-	0.68	<0.1
Chingudipal (GW)	0.1	-	-	0.1	<0.1
Giringamali (GW)	0.1	0.1	0.32	0.28	<0.1
Kampauli (GW)	0.2			1.28	<0.1
Garamian (GW)	0.1	0.06	0.71	1	<0.1
Open Quarry water	-	0.1	-	0.33	<0.1
Underground Mahagiri	-	-	-	0.27	0.24

Impervious Settling pond	-	-	-	0.35	0.21
Intermediate Settling tank	-	-	-	0.21	0.15
North side Settling Pond	-	-	-	0.17	<0.1
Damshal Nala Upstream	0.1	0.42	BDL	0.33	<0.1
Damshal Nala Down stream	0.2	-	0.18	0.27	<0.1
Ragada Dam	0.1	-	-	0.41	<0.1
Balipura near kumrada	0.1	-	-	0.38	<0.1

9. Comparative study for BOD (mg/l)

Tabular Representation

Location	BOD mg/l				
	Oct- Dec 2015	**Dec 2016**	**Dec 2017**	**Oct 2018**	**Nov-Dec 2019**
Open Quarry water	-	2	-	1.8	7
Underground Mahagiri	-	-	-	1.9	2
Impervious Settling pond	-	-	-	5.1	1.8
Intermediate Settling tank	-	-	-	5	4
North side Settling Pond	-	-	-	4.6	8.2
Damshal Nala Upstream	-	4	-	3.6	8
Damshal Nala Down stream	-	-	-	8.4	7
Ragada Dam	-	-	-	1.5	5
Balipura near kumrada	-	-	-	4.1	5

10. Comparative study for DO(mg/l)

Tabular Representation

Location	DO(mg/l)				
	Oct- Dec 2015	Dec 2016	Dec 2017	Oct 2018	Nov-Dec 2019
Open Quarry water	-	4.6	-	5.1	4.2
Underground Mahagiri	-	-	-	4.9	4.8
Impervious Settling pond	-	-	-	5.2	4.6
Intermediate Settling tank	-	-	-	5.3	5.1
North side Settling Pond	-	-	-	4.5	4.2
Damshal Nala Upstream	-	4.2	-	5.2	4.6
Damshal Nala Down stream	-	-	-	5.4	4.8
Ragada Dam	-	-	-	5.3	4.6
Balipura near kumrada	-	-	-	5.1	4.8

11. Comparative study for COD(mg/l)

Tabular Representation

Location	COD (mg/l)				
	Oct- Dec 2015	Dec 2016	Dec 2017	Oct 2018	Nov-Dec 2019
Open Quarry water	-	8	-	24	24
Underground Mahagiri	-	-	-	16	16
Impervious Settling pond	-	-	-	24	16
Intermediate Settling tank	-	-	-	16	24
North side Settling Pond	-	-	-	24	32
Damshal Nala Upstream	-	28.4	-	16	32

Damshal Nala Down stream	-	-	-	40	32
Ragada Dam	-	-	-	16	16
Balipura near kumrada	-	-	-	24	24

2.3.1 DATA INTERPRETATION

From the perusal of data with respect to water parameters in the core zone as well as in buffer zone, it is observed that total chromium is below detection limit in ground water at all locations.

2.4 SOIL QUALITY

Results of soil quality for parameters pH, Electrical Conductivity, Phosphorus, Potassium, Nitrogen, Sodium, Calcium, Magnesium and Chloride are given below in tabular form.

1. Comparative data for pH

Tabular Representation

LOCATIONS	pH		
	Oct- Dec 2015	Oct 2018	Nov-Dec 2019
Onsite (Office area)	-	7.9	7.4
Onsite (Lab area)	-	8.1	7
Onsite ETP area	-	6.6	5.9
Chingudipal village	-	8	5.5
Gurujung Village	4.92	7	5.6
Saraubil Village	4.94	7.4	5.3
Giringamali	5.31	6.4	5.4
Kampauli Village	5.12	6.6	5.4
Garamian Village	4.94	6.2	5.3

2. Comparative data for EC ((µS/cm)

Tabular Representation

LOCATIONS	EC (µ mhos)	EC (µS/cm)	EC (µS/cm)
	Oct- Dec 2015	Oct 2018	Nov-Dec 2019
Onsite (Office area)	-	136.3	44.92
Onsite (Lab area)	-	38.5	120.8

Onsite ETP area	-	43.8	24.9
Chingudipal village	-	28.9	28.49
Gurujung Village	95	50.7	22.15
Saraubil Village	133	22.3	20.86
Giringamali	113	37.2	23.42
Kampauli Village	78	68.9	33.6
Garamian Village	1049	87.4	52.53

3. Comparative data for Phosphorus (Kg/Ha)

Tabular Representation

LOCATIONS	Phosphorus as P_2O_5, kg/ha	Phosphorus, Kg/Ha	Phosphorus, Kg/Ha
	Oct- Dec 2015	Oct 2018	Nov-Dec 2019
Onsite (Office area)	-	5.6	13
Onsite (Lab area)	-	10.6	15.4
Onsite ETP area	-	16.2	23.1
Chingudipal village	-	10.6	23.6
Gurujung Village	13	14.9	12.3
Saraubil Village	16	11	16.3
Giringamali	46	20.6	144
Kampauli Village	14	23.2	52.4
Garamian Village	32	15.1	34.6

4. Comparative data for Potassium (Kg/Ha)

Tabular Representation

LOCATIONS	Potassium as K_2O, kg/ha	Potassium, Kg/Ha	Potassium, Kg/Ha
	Oct- Dec 2015	Oct 2018	Nov-Dec 2019
Onsite (Office area)	-	40.9	10.6
Onsite (Lab area)	-	31.5	10.5
Onsite ETP area	-	72.3	14.9
Chingudipal village	-	43	11.8
Gurujung Village	2842	28.2	18.2

Saraubil Village	221	33.8	12.6
Giringamali	4000	62.8	15.1
Kampauli Village	5380	61.9	16.6
Garamian Village	4211	90.5	23.6

5. Comparative data for Nitrogen (Kg/Ha)

Tabular Representation

LOCATIONS	Nitrogen (kg/hec)	Nitrogen (Kg/Ha)	Nitrogen (Kg/Ha)
	Oct- Dec 2015	Oct 2018	Nov-Dec 2019
Onsite (Office area)	-	146.1	66
Onsite (Lab area)	-	132.6	76.4
Onsite ETP area	-	135.4	48
Chingudipal village	-	139.4	72.5
Gurujung Village	160	159.9	94.2
Saraubil Village	119	124.2	63.3
Giringamali	220	158.4	66
Kampauli Village	156	149.5	56.9
Garamian Village	110	186.7	88.7

6. Comparative data for Sodium

Tabular Representation

LOCATIONS	Sodium as Na, ppm	Sodium as Na, Kg/Ha	Sodium as Na, kg/ha
	Oct- Dec 2015	Oct 2018	Nov-Dec 2019
Onsite (Office area)	-	78.7	33.2
Onsite (Lab area)	-	27.4	20.1
Onsite ETP area	-	35.8	29.3
Chingudipal village	-	43.8	34.8
Gurujung Village	706	25.2	25.3
Saraubil Village	250	34.4	47.7
Giringamali	460	58.7	42.1
Kampauli Village	1180	23.8	36.6

Garamian Village	1380	45	44.5

7. Comparative data for Calcium

Tabular Representation

LOCATIONS	Calcium as Ca, ppm	Calcium as Ca, Kg/Ha	Calcium as Ca, Kg/Ha
	Oct- Dec 2015	Oct 2018	Nov-Dec 2019
Onsite (Office area)	-	162.1	55.8
Onsite (Lab area)	-	44.6	31.8
Onsite ETP area	-	40.4	51.4
Chingudipal village	-	29.8	43.9
Gurujung Village	3640	49.4	86.3
Saraubil Village	1760	23.5	61.5
Giringamali	1400	50.1	8.6
Kampauli Village	1440	58.4	98.3
Garamian Village	3200	106.3	73.7

8. Comparative data for Magnesium

Tabular Representation

LOCATIONS	Magnesium as Mg, ppm	Magnesium as Mg, Kg/Ha	Magnesium as Mg, Kg/Ha
	Oct- Dec 2015	Oct 2018	Nov-Dec 2019
Onsite (Office area)	-	23.8	38.9
Onsite (Lab area)	-	20.6	49.5
Onsite ETP area	-	26.3	28.6
Chingudipal village	-	18.6	39.3
Gurujung Village	316	21.4	40.8
Saraubil Village	730	16.5	32.6
Giringamali	632	27.2	27.9
Kampauli Village	732	26.8	25.9
Garamian Village	1216	23.5	41.1

9. Comparative data for Chloride

Tabular Representation

LOCATIONS	Chloride as Cl, ppm	Chloride as Cl, Kg/Ha	Chloride as Cl, Kg/Ha
	Oct- Dec 2015	Oct 2018	Nov-Dec 2019
Onsite (Office area)	-	119.2	69.8
Onsite (Lab area)	-	35.5	138.5
Onsite ETP area	-	52.4	17
Chingudipal village	-	21.3	36.8
Gurujung Village	10	61.8	17.6
Saraubil Village	20	16.4	17.5
Giringamali	20	46.7	17.5
Kampauli Village	10	73.9	34.4
Garamian Village	40	88	68.2

2.4.1 DATA INTERPRETATION

The result shows that, pH is 4.92 to 8.1, the Available Nitrogen 48 kg/ha to 220 kg/ha which is low to medium and Available Potassium 10.5 Kg/ha in year 2019 to 5380 kg/ha is low to high while the Available Phosphorus 5.6 Kg/ha in the year 2018 to 144 kg/ha in the year 2019 is low to high.

Annexure 2a- Certified Compliance report dated 06.12.2019

Government of India/ भारत सरकार
Ministry of Environment, Forest & Climate Change/ पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
Eastern Regional Office/ पूर्वी क्षेत्रीय कार्यालय
A/3, Chandrasekharpur/ ए/३, चन्द्रशेखरपुर
Bhubaneswar - 751 023/ भुवनेश्वर - ७५१ ०२३

सत्यमेव जयते

Telephone: 0674-2301213, 2301248, 2302452, 2302453. Fax: 0674-2302432. E-mail: roez.bsr-mef@nic.in

संख्या 101-409/08/ई.पी.ई स्पीड पोस्ट 06.12.2019

सेवा में,

श्री सुदीप,
वैज्ञानिक-एफ, गैर-कोयला खनन,
पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय,
इंदिरा पर्यावरण भवन, जोरबाग रोड,
अलीगंज, नई दिल्ली- 110 003।
ई-मेल: sundeep.moef@gmail.com, sundeep.cpcb@nic.in

विषय: मैसर्स IMFA लिमिटेड की सुकिन्दा क्रोमाइट माइन्स के निरीक्षण के संबंध में |

संदर्भ: मंत्रालय का पत्र संख्या- J-11015/346/2007-IA.II(M) दिनांक 18.06.2008, 22.05.2012 एवं 11.08.2014.

महोदय,

मुझे यह सूचित करने का निर्देश हुआ है कि इस कार्यालय द्वारा दिनांक 09.11.2019 को उपोरोक्त परियोजना की मोनीटरिंग की गई | इस सन्दर्भ में अनुपालन पत्र की प्रमाणित पत्र आप के आवश्यक कारवाई हेतु संग्लग्न है |

भवदीय,

06/12/19

(डॉ0 पी0 सुरेश बाबु)
वैज्ञानिक-सी

संग्लनक : उपरोक्त

प्रतिलिपि: **निदेशक,** मेसर्स इंडियन मेटल्स एंड फेरो अलॉयज़ लिमिटेड, गाँव कालीपानी, तहसील सुकिंडा, जिला जाजपुर, उड़ीसा. ई-मेल: debaparija@imfa.in के बारे में अधिक जानकारी के लिए और आवश्यक कार्यवाही के लिए।

वैज्ञानिक-सी

Government of India/ भारत सरकार
Ministry of Environment, Forest & Climate Change/ पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
Eastern Regional Office/ पूर्वी क्षेत्रीय कार्यालय
A/3, Chandrasekharpur/ ए/३, चन्द्रशेखरपुर
Bhubaneswar - 751 023/ भुवनेश्वर - ७५१ ०२३

सत्यमेव जयते

Speed Post

Telephone: 0674-2301213, 2301248, 2302452, 2302453. Fax: 0674-2302432. E-mail: roez.bsr-mef@nic.in

File No. 101-409/08/EPE

Date: 06.12.2019

To

Shri Sandeep,
Scientist-F, IA-Non-Coal Mining,
Ministry of Environment, Forest and Climate Change,
Indira Paryavaran Bhawan, Jorbagh Road,
Aliganj, New Delhi- 110 003.
E-mail ID: sundeep.moef@gmail.com, sundeep.cpcb@nic.in

Sub: Issue of Certified Compliance Report in respect of Expansion of Sukinda Chromite Mining Project of M/s Indian Metals and Ferro Alloys Ltd. Located in village Kaliapani, Tehsil Sukinda, District Jajpur, Orissa. -reg.

Ref: Ministry's Environmental Clearance Letter No. J-11015/346/2007-IA.II(M) dated 18.06.2008, 22.05.2012 and 11.08.2014 (Extension).

Sir,

I am directed to draw your kind attention to the subject and reference letter cited above and to state that the above project has been monitored by undersigned on 09.11.2019 for issue of Certified Compliance Report. Based on the observations made while monitoring of project, the detailed Certified Compliance Report has been prepared and enclosed for kind information and further needful action.

Yours faithfully,

06/12/19

(Dr. P. Suresh Babu)
Scientist-C

Encl: as above

Copy to: **The Director,** M/s Indian Metals and Ferro Alloys Ltd. village Kaliapani, Tehsil Sukinda, District Jajpur, Orissa E-mail: debaparija@imfa.in for kind information and further necessary action.

Scientist-C

Government of India/ भारत सरकार
Ministry of Environment, Forest & Climate Change/ पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
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सत्यमेव जयते
Telephone: 0674-2301213, 2301248, 2302452, 2302453. Fax: 0674-2302432. E-mail: roez.bsr-mef@nic.in

प्रमाणित अनुपालन रिपोर्ट / Certified Compliance Report

SN	Item	Details
1.	परियोजना का प्रकार **Type of Project**	Mining (Chromite Mine)
2.	परियोजना का नाम **Name of Project**	i.Expansion of Sukinda Chromite Mining Project of M/s Indian Metals and Ferro Alloys Ltd. Located in village Kaliapani, Tehsil Sukinda, District Jajpur, Orissa. ii.Sukinda Chromite Mines of M/S IMFA Ltd.
3.	परियोजना प्राधिकरण का पता **Address of project authorities**	The Director, M/s Indian Metals and Ferro Alloys Ltd. village Kaliapani, Tehsil Sukinda, District Jajpur, Orissa
4.	पर्यावरणीय स्वीकृति पत्र सं0 एवं तिथी **Env. Clearance Letter No. & Date**	i. J-11015/346/2007-IA.II(M) dated 18.06.2008, 22.05.2012 and 11.08.2014. ii. J-11015/28/2001-IA.II(M) dated 24.12.2002
5.	क्षेत्रीय कार्यालयपत्र सं0 **Regional Office File No.**	i.101-409/08/EPE ii.101-124/07/EPE
6.	स्थल दौरातिथी **Date of Site Visit**	08.11.2019
7.	परियोजना की स्थिति **Status of Project**	Operational

8. परियोजना की वर्तमान स्थिति / Present status of the Project:

The project site was monitored by the undersigned on 08.11.2019. During Shri Susheel Naik, DGM, Shri Deba Prasad Parija, Manager, Shri M. Manikandan, Manager (Env.) and other Officials of project were present. As per the discussions held during monitoring and information provided by Project Authorities (PAs), the total mine lease area is 116.76 ha. The lease was executed on 04.09.1999 and mining operations in the area commenced from 15.09.1999 and is continuing. The first Environmental Clearance (EC) was accorded to project vide letter no. J-11015/28/2001-IA.II(M) dated 24.12.2002 for production of 2.55 LTPA. Environmental Clearance (EC) for production of 3.51 LTPA (ROM) by the opencast method was accorded a vide letter dated 18.06.2008 for a period up to March, 2012. Subsequently, Ministry has accorded extension of EC vide letter dated 22.05.2012, for the continuation of production of 3.51 Lakh Tones per Annum (LTPA) of Chromite

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/Govt. of India
पर्यावरण वन एवं जल्प मंत्रालय/ Min. of Env. Forest & C
पूर्वी क्षेत्रीय कार्यालय/ Eastern Regional Off
भुवनेश्वर/ Bhubaneswar-751023

ore by opencast method for captive use up to 31.05.2014. Subsequently, Ministry has extended the EC till 31.03.2026 vide letter dated 11.08.2014. The photograph from the mine from the viewpoint is as follows:

It has been observed that the Stage II of Forest Clearance has obtained for an area of 115.05 ha vide letter F.No. 8-16/2016-FC dated 22.06.2018. Mining Plan has approved on 31.10.2018 vide letter No. MS/FM/27- ORI/BHU/2018-19 Valid till 31.03.2024. As per the information provide, the details regarding the generation of Ore, OB, Sub grade and Nickel for last five years are as follows:

S.No.	Year	Ore (MT)	OB (m^3)	Sub grade (MT)	Nickel waste (m^3)
1	2019 – 20 (Till Oct, 19)	171113	257962	6000	Nil
2	2018 – 19	341003	510272	Nil	Nil
3	2017 -18	350112	597295	Nil	Nil
4	2016 – 17	350512	649700	Nil	Nil
5	2015 – 16	273548.8	670182	Nil	14545.16
6	2014 - 15	258580.4	548024	Nil	13239.74

It has been observed that the PAs have complied or are in process of complying with the conditions stipulated by the Ministry. The detailed compliance status of the conditions are as follows:

(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
क्षेत्रीय कार्यालय/ Eastern Regional Office
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9. Stipulated Conditions:

Environmental Clearance: J-11015/346/2007-IA.II(M) dated 18.06.2008

A. Specific Conditions

i. **The environmental clearance shall be up to March, 2012 based on existing approved mine plan/scheme as modified from time to time. For environmental clearance beyond March 2012 will be considered after the proposal for management of over burden/waste is firmed up and is reflected in the approved mine plan / mine scheme. If no such approved mine plan /scheme is submitted to the ministry of Environment and forests, well in time, the environmental clearance shall seize to be valid beyond March 2012.**

Status: Being complied

It has been observed that the Environmental Clearance for production of 3.51 LTPA (ROM) by the opencast method was accorded a vide letter of even no. dated 18th June, 2008 for a period up to March, 2012 with a special condition for submission of an approved mining plan for working beyond March, 2012. Then Ministry had accorded extension of environmental clearance vide letter of even no. dated 22nd May, 2012, for the continuation of production of 3.51 Lakh Tones per Annum (LTPA) of Chromite ore by opencast method for captive use up to 31st March, 2014. Further, considering the grant of Environmental Clearance beyond March, 2014, Ministry had sought firmed up a proposal for management of overburden / waste and which is to be rectified in the mine plan / mine scheme. The PAs have informed that common boundary dumping along with the firmed-up proposal of management of OB/Waste for the whole life of opencast mine has been incorporated in the 3rd scheme of mining (2014-15 to 2018-19) along with PMCP and has been approved by IBM on 3rd July 2013. Permission of dumping of overburden within 7.5 meters of the common boundary between Kalipani Chromite Mines of M/s Balasore Alloys Ltd (BAL) and Sukinda Mines (Chromite) of M/s IMFA Ltd has been accorded by DGMS on 13.02.2013. This would facilitate an increase of dump capacity by another 14.5 Cu.M. The Ministry has examined the application under the EIA notification, 2006 and acceded extension of environmental clearance i.e. already granted vide letter no. J-11015/346/2007-IA.II (M) dated 18.06.2008 up to 31.03.2026 through vide letter no. J- 11015/346/2007-IA.II(M) dated 11.08.2014 for production of 3.51 LTPA Chrome Ore over mining lease area of 116.76 Ha. The EC is valid up to 31.03.2026.

ii. **The project proponent shall obtain consent to establish from the state Pollution Control Board, Orissa and effectively implement all the conditions stipulated therein.**

Status: Being complied

It has observed that PAs have obtained Consent-To-Establishment (CTE) from

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पूर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
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State Pollution Control Board, Odisha (OSPCB) for 0.351 MTPA vide Order No.3155/Ind-II-NOC-4869 dated 04.03.2010. It has been observed that PAs have implemented almost all the conditions stipulated in CTE and informed the same to OSPCB vide letter no. IMFA/SMC/10/736 dated 17.04.2010.

iii. **The project proponent shall ensure that no natural watercourse / water body shall be obstructed due to any mining operation.**

Status: Being complied

During the day of monitoring, it has been observed that there no natural watercourse / water body present in the mine lease. It has been informed that no watercourse and water bodies are being obstructed due to the mining operation.

iv. **The topsoil, if any, shall temporarily be stored at earmarked site(s) only and it should not be kept un-utilized for long. The topsoil should be used for land reclamation and plantation.**

Status: Being complied

It has been observed that the topsoil is not being generated from the mine. It has been informed that the earlier generation has been fully utilized for plantation and coir matting applications. No topsoil was stored for a long period beyond three years.

v. **The solid waste in the form of over burden, sub-grade ore and Nickel ore bearing material shall be stacked separately.**

Status: Being complied

It has been observed that the Solid waste in the form of OB, Sub-grade ore, Nickel ore is being stacked in separately as per approved IBM mining plan/scheme with proper protection measures. Plantation, coir mat, bamboo terracing plantation, grass thatching etc are in progress. As per the information provide, the details regarding the generation of Ore, OB, Sub grade and Nickel for last five years are as follows:

S.No.	Year	Ore (MT)	OB (m^3)	Sub grade (MT)	Nickel waste (m^3)
1	2019 – 20 (Till Oct, 19)	171113	257962	6000	Nil
2	2018 – 19	341003	510272	Nil	Nil
3	2017 -18	350112	597295	Nil	Nil
4	2016 – 17	350512	649700	Nil	Nil
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(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पूर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
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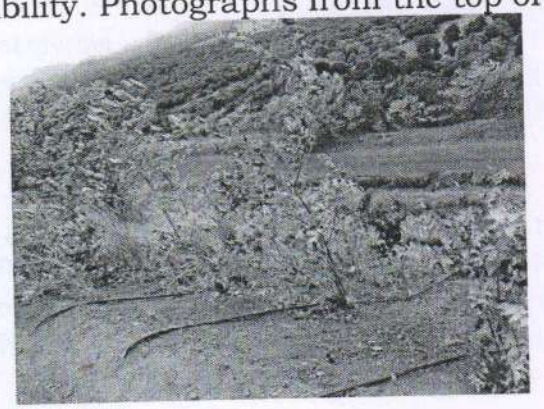
vi. **The overburden generated shall be stacked at earmarked dump site only and it should not be kept active for a long period of time and its phase-wise stabilization shall be carried out. The total height of the dump shall not exceed 60 m. Proper terracing of OB dump should be carried out so that the overall slope shall not exceed 28 degree. The OB dump should be scientifically vegetated with suitable native species to prevent erosion and surface run off. In critical areas, use of geo textiles shall be undertaken for stabilization of the dump. Monitoring and management of rehabilitated areas should continue until the vegetation becomes self sustaining. Compliance status shall be submitted to the Ministry of Environment & Forests and its Regional Office located at Bhubaneswar on six monthly basis.**

Status: Being complied

It has been observed that the overburden is being stacked at an earmarked dumpsite as per approved mining plan/scheme with proper protection measures by maintaining proper terracing, height, overall slope of the dump, providing garland drain, retaining wall at toe of the dump. OB dump has three stages of 20 m height each and is being maintained with a 60-meter overall height with overall slope of around 27°. The dump surface is being stabilized yearly basis through plantation/geotextile application. The species for dump plantation has been selected by native and planted scientifically. It has been observed that the PAs are in process of implementing the recommendations made by the Central Institute of Mining and Fuel Research are for dump slope stability. Photographs from the top of OB dump is as follows:



(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पुर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
भुवनेश्वर/ Bhubaneswar-751023

vii. **Catch drains and siltation ponds of appropriate size shall be constructed for the working pit. OB and mineral dumps to prevent run off of water and flow of sediments directly into the Damsala Nallah and other water bodies. The water so collected should be utilized for watering the mine area, roads, plantation etc. The drains should be regularly de-silted and maintained properly. Garland drains, settling tanks and check dams of appropriate size, gradient and length shall be constructed both around the mine pit and over burden dumps to prevent run off of water and flow of sediments directly into the Damsala Nallah and other water bodies and sump capacity should be designed keeping 50% safety margin over and above peak sudden rainfall (based on 50 years data) and maximum discharge in the area adjoining the mine site. Sump capacity should also provide adequate retention period to allow proper settling of silt material. Sedimentation pits should be constructed at the corners of the garland drains and desilted at regular intervals. Storm water return system should be provided. Storm water should not be allowed to go to the effluent treatment plant during high rainfall/ super cyclone period. A separate storm water sump for this purpose should be created.**

Status: Being complied

It has been observed that the PAs have constructed catch drains and siltation ponds of appropriate size for the working pit, OB and mineral dumps to prevent run off of water and flow of sediments directly into the Damsala Nallah and other water bodies. It has been informed that the PAs have done a detailed study on run-off management & prepared site-specific run-off management plan with consideration of all technical parameters like maximum rainfall intensity, drainage pattern & land pattern. Based on the study report following implementations have been carried out in and around the mines ML area.

Catchment & Garland Drainage: Mines run-off water bifurcates in eight catchment areas and collected into existing three settling pits & bottom quarry through proper garland drainage. The total capacity of the settling pit is 13090 Cu.M excluding opencast quarry bottom pit. Total length of the drainage is 2852 RM.

Treatment: The collected water from runoff and mines discharge is being pumped to common Effluent Treatment Plant for treatment and allowed for final discharge after confirming the discharge norms as mentioned in the approved consent to operate. The final discharge parameters are being ensured as per prescribed norms.

Reuse & Recycle: The treated water in ETP is being used for mines dust suppression, plantation, vehicle washing and drilling.

Soil Erosion control measures: Plantation has been done in various

(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
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भुवनेश्वर/ Bhubaneswar-751023

locations to avoid the soil erosion and pollution load to the water body.

Retaining wall: Total 2020 Running Meter of retaining wall has been constructed at the toe of the waste dump and other required areas. The retaining wall dimensions are 1.2 M (Height) x 0.3 (Width) X 1.

Stormwater Sump: Arrangement has been made for the stormwater sump.

De-siltation of drains: The drains are de-silted before the monsoon period and whenever required.

Photographs of the settling ponds are as follows:

During the day of monitoring, it has been observed that the settling ponds were filled with silt. It is required to desilt the settling ponds on regular basis.

viii. **Dimension of retaining wall at the toe of over burden dump and OB benches within the mine to check run off and siltation shall be based on the rainfall data.**

Status: Being complied

As per the discussions held during monitoring and information provide by PAs, it has been observed that about 2020 RM long retaining wall of dimensions 1.2 m (H) x 0.3 m (W) has been provided in the toe of the dump to check runoff and siltation. Photograph of retaining wall is as follows:

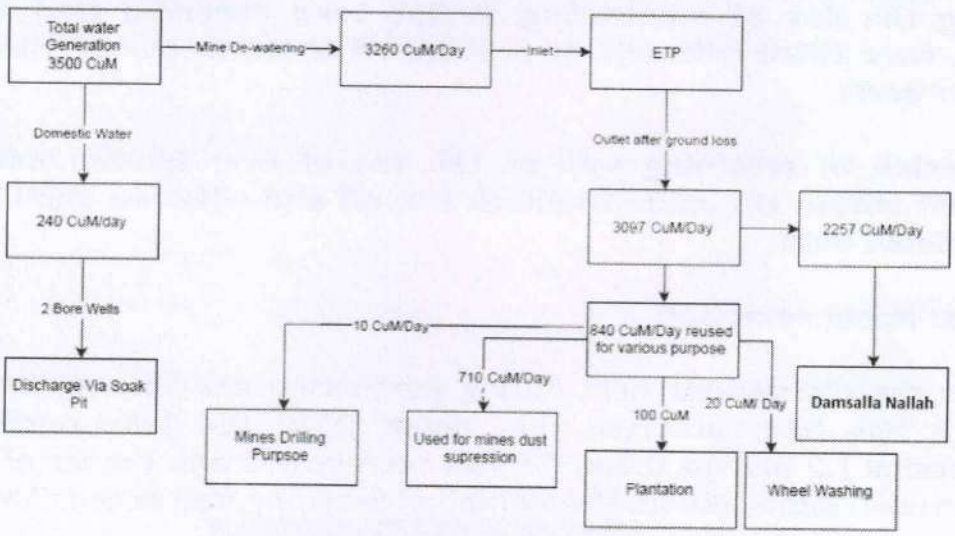
(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पुर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
भुवनेश्वर/ Bhubaneswar-751023

ix. **Mine water discharge and/or any waste water shall be properly treated to meet the prescribed standards before reuse/discharge. The run off from OB dump and other surface run off should be analyzed for Cr^{+6} and in case its concentration is found higher than the permissible limit, the waste water should be treated before discharge/ reuse.**

Status: Being complied

As per the discussions held during monitoring and information provided by PAs, it has been observed that the water generated from the quarry & OB dump area along with wastewater generated from the adjacent Mahagiri Chromite Mines of M/s IMFA are being channelized to common ETP-4 for treatment before discharge/reuse. The capacity of ETP is 360 m^3/hr. The treated water being discharged to Damsalla Nala after confirming the prescribed standards. It has been observed that the PAs have installed real time monitoring of Cr^{+6}, TSS & pH at the discharge point of effluent and the data being transferred to OSPCB website. The wastewater generated from the workshop i.e. vehicle washing unit is being recycled through existing CPI (Corrugated Plate Interceptors) separator and treated water is being used for the same vehicle washing purpose. No water discharged from the workshop. Presently there is no mineral separation plant installed in the mine lease area. As per the information provided, the detailed water balance sheet of the mine is as follows:

Water Balance Flowchart of Sukinda Mines (Chromite) of M/s. IMFA Ltd.



** The flow chart shows with respect to maximum pumping qty.

x. **Effluents containing Cr^{+6} shall be treated to meet the prescribed standards before reuse/ discharge. Effluent Treatment Plant shall be provided for treatment of mine water discharge and waste water generated from the workshop and mineral separation plant.**

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/Govt. of India
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पुर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
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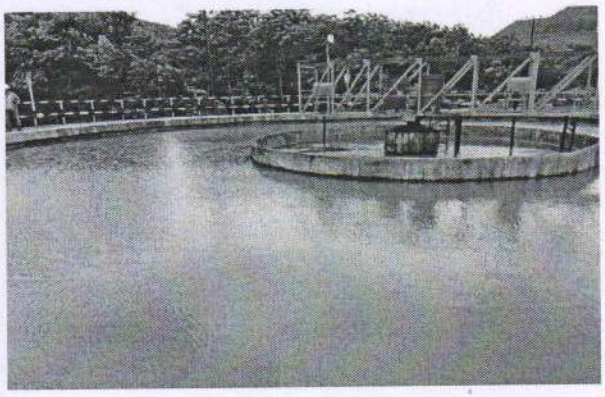
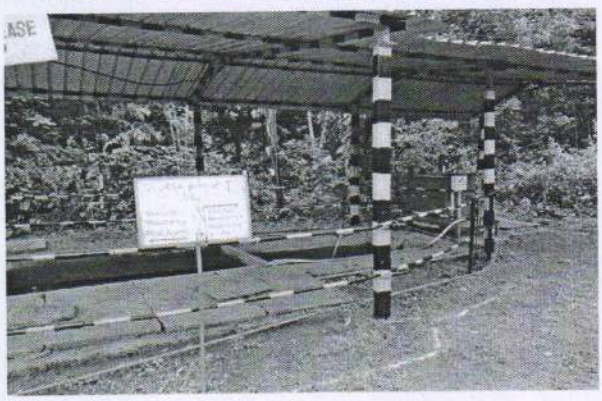
Status: Being complied

As per the discussions held during monitoring and information provided by PAs, it has been observed that the water generated from the quarry & OB dump area along with wastewater generated from the adjacent Mahagiri Chromite Mines of M/s IMFA are being channelized to common ETP-4 for treatment before discharge/reuse. The capacity of ETP is 360 m^3/hr. The treated water being discharged to Damsalla Nala after confirming the prescribed standards. It has been observed that the PAs have installed real time monitoring of Cr^{+6}, TSS & pH at the discharge point of effluent and the data being transferred to OSPCB website. The wastewater generated from the workshop i.e. vehicle washing unit is being recycled through existing CPI (Corrugated Plate Interceptors) separator and treated water is being used for the same vehicle washing purpose. No water discharged from the workshop. Presently there is no mineral separation plant installed in the mine lease area. Photographs of ETP, Oil and grease trap and wheel washing are as follows:





(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पूर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
भुवनेश्वर/ Bhubaneswar-751023

xi. **Separate impervious concrete pits for disposal of sludge shall be provided for the safe disposal of sludge generated from the mining operations.**

Status: Being complied

It has been informed that in mine process Sludge is being generated only from common ETP plant which is being stored in the impervious pit and disposed off through Common Hazardous Waste Treatment Storage Disposal Facility (CHWTSDF) At- Village Kanchichuva, Po-Mangalpur, Via-Sukinda, Jajpur in the name and style M/s Orissa Waste Management Project and operated by M/s Ramky Enviro Engineers Ltd. In this regard, PAs have obtained Hazardous Waste Authorization from State Pollution Control Board, Odisha. Photographs are as follows:

xii. **The first order natural stream / channel originating from near the northern side of the ML shall be undisturbed and protected.**

Status: Being complied

During the day of monitoring, it has been observed that there no natural watercourse / water body present in the mine lease. It has been informed that there is no natural water course/water body is existing within the ML area and no disturbance for first-order natural stream/ channel originating from near the northern side of the ML area.

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पूर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
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xiii. **Regular monitoring of water quality upstream and downstream of Damsal nallah shall be carried out and record of monitoring data should be maintained and submitted to the Ministry of Environment and Forests, its Regional Office, Bhubaneswar, the Central Groundwater Authority, the Regional Director, Central Ground Water Board, the State Pollution Control Board and the Central Pollution Control Board.**

Status: Being complied

It has been observed that regular monitoring of water quality i.e. upstream and downstream of Damsala Nallah, Ground water are being carried out for Winter, Pre-Monsoon, Monsoon & Post Monsoon and records are being maintained. PAs are regularly submitting the monitoring reports along with six monthly compliance reports to Regional Office, Bhubaneswar. As per the report submitted, the parameters are within the prescribed limits.

xiv. **The project proponent shall ensure that the quality of decanted effluents from the tailing pond, if any, confirm to the prescribed standards before discharge. The decanted water from the tailing pond shall be recirculated within the mine and there shall be zero discharge from the mine.**

Status: Not applicable

The condition is not applicable as there there is no tailing pond in the lease area.

xv. **The project proponent shall explore the possibility to reduce concentration of Cr^{+6} in the tailing pond, if any, in consultation with an expert scientific institution like NEERI.**

Status: Not applicable

The condition is not applicable as there is no tailing pond in the lease area.

xvi. **Plantation shall be raised in an area of 73.01 ha including a 7.5 m wide green belt in the safety zone around the mining lease by planting the native species around ML area, OB dump, roads etc. in consultation with the local DFO/Agriculture Department. The tree density should be two thousand trees per hectare. At least 1500 trees per year shall be planted.**

Status: Partially complied

It has been observed that PAs are in process of developing plantation in an area of 73.01 hectares. It has been informed that around 23.66 Ha of plantation done till 2018-19 with the density of 2000 trees per ha. It has been informed that, minimum of 1500 saplings were planted per year in and around the mine in consultation with DFO / Agriculture Department. It has also been

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पूर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
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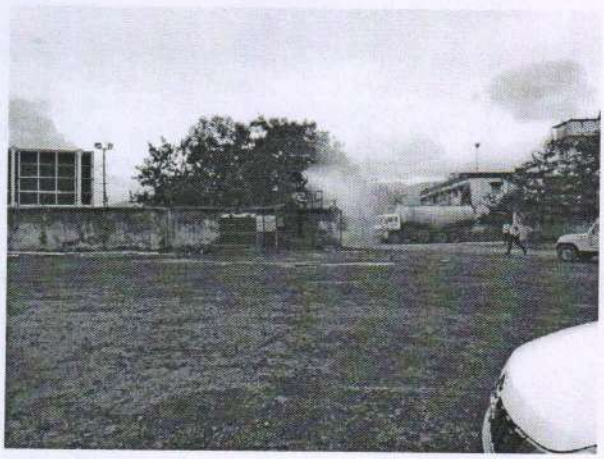
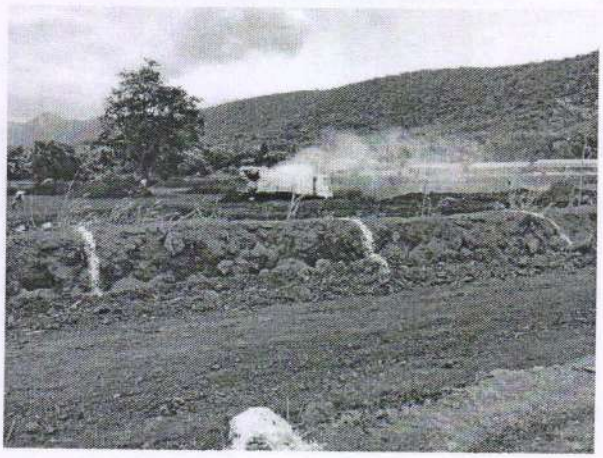
informed that safety zone plantation has been carried out in the earmarked two patches under FC i.e. the northern & southern side of lease boundary over an area of 4.138 Ha with due approval of State Govt. approval. It has been informed that the rest of plantation will be carried out during the reclamation and rehabilitation period as per the approved Mining Plan under Indian Bureau of Mines. **It is required to develop plantation in an area of 73.01ha including a 7.5m wide green belt in the safety zone around the mining lease by planting the native species around ML area, OB dump, roads etc. in consultation with the local DFO/Agriculture Departments.**

xvii. **Regular water sprinkling should be carried out in critical areas prone to air pollution and having high levels of PM-10 and PM-2.5 such as haul road, loading and unloading point and transfer points. It should be ensured that the Ambient Air Quality parameters conform to the norms prescribed by the Central Pollution Control Board in this regard.**

Status: Being complied

It has been observed that the PAs are in process of controlling air pollution by regular water sprinkling at haul road, loading and unloading point and transfer points. It has been informed that regular water sprinkling is performed in critical areas that are prone to air pollution and have high PM_{10} and $PM_{2.5}$ levels such as roads, loading and unloading points. As per the information provided, PAs have engaged four no.s of portable water tankers in this regard, and the PAs have installed a 2.2 KM automatic fixed water sprinkler system in the permanent haul road of the mines. A mist cannon was also installed and operated for dust suppression at the mines main gate. As per the Ambient Air Quality (AAQ) monitoring reports submitted, it has been observed that the AAQ levels are within prescribed limits. Photographs are as follows:





xviii. **The project authority should implement suitable conservation measures to augment ground water resources in the area in consultation with Regional Director, Central water Board.**

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
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Status: Being complied

It has been observed that PAs have implemented common rainwater harvesting structures (artificial recharging) at Mahagiri Enclave (colony) in respect of Sukinda Mines (Chromite), Mahagiri Mines (Chromite) and Mahagiri Enclave, in consultation with the Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar. It has been informed that an average of 50400 m^3/Year of rainwater is being recharged. In. addition, sin consultation with the Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar, PAs have also implemented a common rooftop rainwater harvesting structure in the Mines Administration Building, with this an average of 600 m^3/Year of rainwater is being recharged.

xix. **Regular monitoring of ground water level and quality should be carried out by establishing a network of existing wells and constructing new piezometers in and around the mine lease. The monitoring should be carried out four times in a year, pre-monsoon (April-May), monsoon (August), post-monsoon (November) and winter (January) and the data thus collected may be sent regularly to the Ministry of Environment and Forests, its Regional Office located at Bhubaneswar, Central Ground Water Authority and Regional Director, Central Ground Water Board.**

Status: Being complied

It has been observed that PAs are regular monitoring of the level and quality of ground water by establishing a network of wells in and around the mine leased area. Monitoring is being carried out four times a year, pre-monsoon (May), monsoon (August), post-monsoon (November) and winter (January) through the external agency, and the data collected are being submitted regularly along with six monthly compliance reports to the Regional Office, Bhubaneswar. It has been informed that the data is also forwarded to the Central Ground Water Authority and to the Regional Director of the Central Ground Water Board. As per the groundwater level and quality monitoring reports submitted, the parameters are within the prescribed limits. Photographs are as follows:

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पूर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
भुवनेश्वर/ Bhubaneswar-751023

xx. **Permission from the competent authority should be obtained for drawl of ground water, if any, required for the project.**

Status: Being complied

It has been observed that the project has been obtained No objection Certificate from the Central Ground Water Authority vide permission No- CGWA / NOC / MIN / REN/1/2018/5556 dated 14.12.2018 and valid till 06.04.2021 for groundwater withdrawal of 240 m^3/day and mine water discharge of 3260 m^3/day.

xxi. **Suitable rain water harvesting measures on long term basis shall be planned and implemented in consultation with the Regional Director, Central Ground Water Board.**

Status: Being complied

It has been observed that PAs have implemented common rainwater harvesting structures (artificial recharging) at Mahagiri Enclave (colony) in respect of Sukinda Mines (Chromite), Mahagiri Mines (Chromite) and Mahagiri Enclave, in consultation with the Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar. It has been informed that an average of 50400 m^3/Year of rainwater is being recharged. In. addition, sin consultation with the Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar, PAs have also implemented a common rooftop rainwater harvesting structure in the Mines Administration Building, with this an average of 600 m^3/Year of rainwater is being recharged.

xxii. **Vehicular emissions shall be kept under control and regularly monitored. Measures shall be taken for maintenance of vehicles used in mining operations and in transportation of mineral. The vehicles shall be covered with a tarpaulin and shall not be overloaded.**

Status: Being complied

It has been informed that the vehicle emissions are controlled through pre-planned maintenance and periodic maintenance for the equipment's and vehicles used in mining activities. It has been informed that, PAs have engaged M/s Choudhury Auto Mobile, a pollution testing center for the periodic monitoring of equipment and vehicles used in mining operations. Transport vehicles are allowed inside the mines for mineral transport after checking the valid PUC and no vehicle is allowed without a valid PUC certificate. It has also been informed that, in order to avoid the spilling of minerals on public roads, all transport vehicles are covered with tarpaulin. This is ensured in the main mine gate prior to the existence of the vehicle. PAs have also installed a wheel washing system at the exit gate of the vehicle for control of emissions.

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पूर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
भुवनेश्वर/ Bhubaneswar-751023

xxiii. **Blasting operation shall be carried out only during the daytime. Controlled blasting should be practiced. The mitigate measures for control of ground vibrations and to arrest fly rocks and boulders should be implemented.**

Status: Being complied

During the day of monitoring, no blasting operations were carried out. It has been informed that the blasting operation is only carried out during the day. Controlled blasting is performed by the use of detonator relays with an appropriate spacing and burden of blast holes to control ground vibrations and to prevent fly rocks.

xxiv. **Drills shall either be operated with dust extractors or equipped with water injection system.**

Status: Being complied

It has been observed that the drills are operated with a water injection system to prevent dust generation due to the drilling operation.

xxv. **Consent to operate shall be obtained from SPCB before starting enhanced production from the mine.**

Status: Being complied

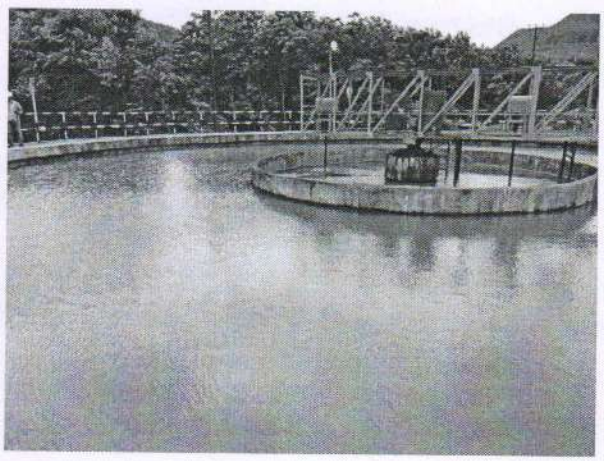
It has been observed that the PAs have obtained Consent-To-Operate (CTO) vide letter no. 2483/IND-I-CON-2274 dated 06.02.2016 with Consent Order No. 1151 for production of 0.351 MTPA Chrome Ore. The CTO is valid till 31.03.2021.

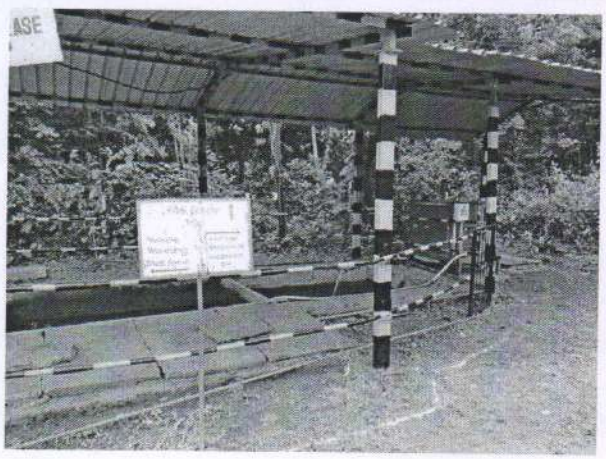
(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पूर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
भुवनेश्वर/ Bhubaneswar-751023

xxvi. **Sewage treatment plant should be installed for the colony. ETP should also be provided for the workshop and waste water generated from the mining operations.**

Status: Being complied

It has been observed that the domestic wastewater generated in the colony is discharged to the pit via the septic tank. PAs are in progress of installing STP for treatment of sewerage generated from the colony. As stated earlier, it has been observed that the water generated from the quarry & OB dump area along with wastewater generated from the adjacent Mahagiri Chromite Mines of M/s IMFA are being channelized to common ETP-4 for treatment before discharge/reuse. The capacity of ETP is 360 m^3/hr. The treated water being discharged to Damsalla Nala after confirming the prescribed standards. It has been observed that the PAs have installed real time monitoring of Cr^{+6}, TSS & pH at the discharge point of effluent and the data being transferred to OSPCB website. The wastewater generated from the workshop i.e. vehicle washing unit is being recycled through existing CPI (Corrugated Plate Interceptors) separator and treated water is being used for the same vehicle washing purpose. No water discharged from the workshop. Photographs of ETP, Oil and grease trap and wheel washing are as follows:





(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
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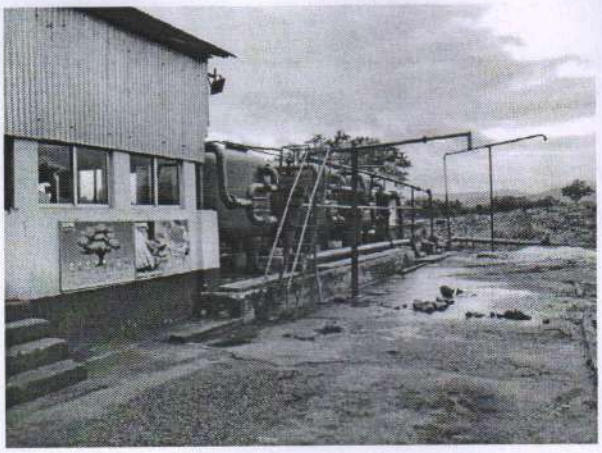

xxvii. **Mineral handling area shall be provided with adequate number of high efficiency dust extraction system. Loading and unloading areas including all the transfer points should also have efficient dust control arrangements. These should be properly maintained and operated.**

Status: Not applicable at present

The condition is not applicable at present as there is no mineral handling plant in the mines.

xviii. **The project proponent shall take all precautionary measures during mining operation for conservation and protection of endangered fauna such as four horned antelope, mouse dear, great Indian hornbill, common pea fowl, python etc., spotted in the study area. Action plan for conservation of flora and fauna shall be prepared and implemented in consultation with the State Forest and Wildlife Department. Necessary allocation of funds for implementation of the conservation plan shall be made and the funds so allocated shall be included in the project cost. Copy of action plan may be submitted to the Ministry and its Regional Office, Bhubaneswar within 3 months.**

Status: Being complied

It has been informed that the Site-Specific Wildlife Conservation Plan has been approved by Chief Conservator of Forests (Wildlife) & Chief Wildlife Officer Orissa by vide letter no 10061/1WL-SSP-181/2015 dated 18.11.2015 which is valid till 31.03.2025. The total cost of the project is 320.77 Lakh. In which the Rs. 63.77 lakh is to be implemented by PAs and are in progress. The balance payment was paid to DFO Cuttack & Dhenkanal.

xxix. **The project proponent shall effectively address the concerns raised by the locals in the public hearing as well as during consideration of this project, while implementing this project.**

Status: Being complied

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
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It has been informed that the concerns raised by locals at the public hearing as well as during the project's consideration are effectively resolved.

xxx. **A Final Mine Closure Plan along with details of Corpus Fund should be submitted to the Ministry of Environment & Forests 5 years in advance of final mine closure for approval.**

Status: Assured to comply

It has been observed that the mine is presently in operational condition. It has been informed that the condition shall be complied with in due course.

B. General Conditions

i. **No change in mining technology and scope of working should be made without prior approval of the Ministry of Environment & Forests.**

Status: Being complied

It has been observed that there is no change in mining technology and scope of working made without prior approval of the Ministry.

ii. **No change in the calendar plan including excavation, quantum of mineral chromite ore and waste should be made.**

Status: Being complied

It has been observed that there is no change in the calendar plan. As per the information provide, the details regarding the generation of Ore, OB, Sub grade and Nickel for last five years are as follows:

S.No.	Year	Ore (MT)	OB (Cu.M)	Sub grade (MT)	Nickel waste (Cu.M)
1	2019 – 20 (Till Oct, 19)	171113	257962	6000	Nil
2	2018 – 19	341003	510272	Nil	Nil
3	2017 -18	350112	597295	Nil	Nil
4	2016 – 17	350512	649700	Nil	Nil
5	2015 – 16	273548.8	670182	Nil	14545.16
6	2014 - 15	258580.4	548024	Nil	13239.74

iii. **Periodic monitoring of ambient air quality should be carried out for RPM, SPM, SO_2 and NOx. Location of the monitoring stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets and frequency of monitoring should be undertaken in consultation with the State Pollution**

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण, वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
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Control Board. The data so collected should be regularly submitted to the Ministry including its Regional Office located at Bhubaneswar and the State Pollution Control Board/ Central Pollution Control Board once in six months.

Status: Being complied

As per the monitoring reports submitted, it has been observed that, PAs are conducting AAQ monitoring weekly twice at eight (08) locations viz., Mines Admin Building, Mines Electrical Substation, Mines Staff colony, Mines Effluent Treatment Plant, Village Goramian, OMC Labor colony, Village Saruabil and Village Ostia. Out of eight locations, four locations are situated within the core zone and four locations are located in the buffer zone. AAQ being monitored for PM_{10}, $PM_{2.5}$, SO_2, NOx and CO. It has been informed that the location of the monitoring stations has been decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets. It has been observed that PAs are regularly submitting all monitoring reports regularly with six monthly compliance reports to Regional Office, Bhubaneswar. It has been informed that PAs are also submitting the same to State Pollution control board/ Central Pollution control Board once in six months during submission of six-monthly EC compliance report. As per the monitoring reports summitted the emission levels are within prescribed limits.

iv. **Measures should be taken for control of noise levels below 85 dBA in the work environment. Workers engaged in operations of HEMM, etc should be provided with ear plugs/ muffs.**

Status: Being complied

It has been observed that adequate measures like regular maintenance of the HEMM, acoustic enclosures with the DG sets etc have been implemented to control the noise levels. Workers engaged in operations of HEMM, etc have been provided with ear plugs/ muffs. AC cabin has been provided in HEMM. Noise monitoring is being carried out in every month. As per the noise monitoring reports submitted, the levels are within prescribed limits.

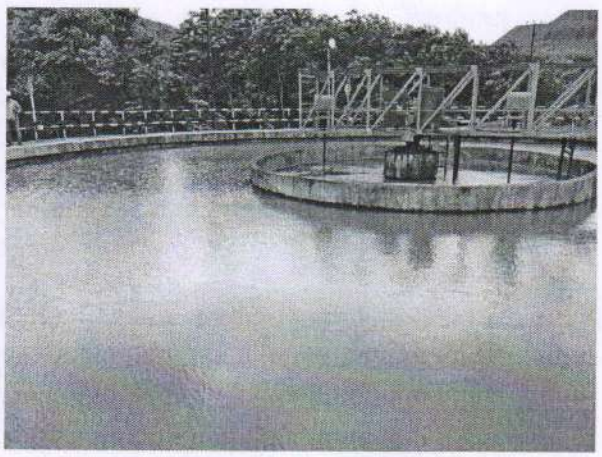
v. **Industrial wastewater (workshop and wastewater from the mine) should be properly collected, treated so as to conform to the standards prescribed under GSR 422 (E) dated 19th May, 1993 and 31st December, 1993 or as amended from time to time. Oil and grease trap should be installed before discharge of workshop effluents.**

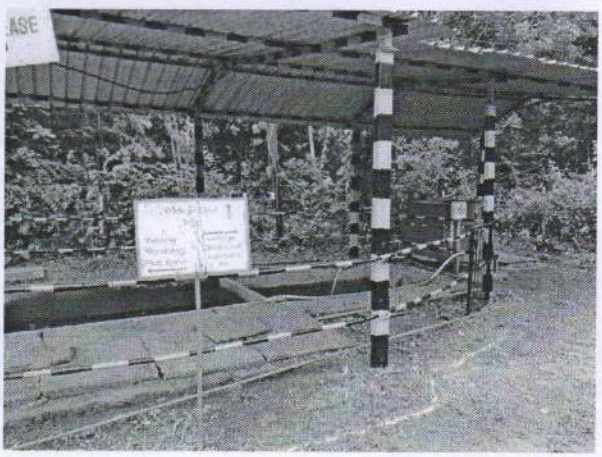
Status: Being complied

It has been observed that the domestic wastewater generated in the colony is discharged to the pit via the septic tank. PAs are in progress of installing STP

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पूर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
भुवनेश्वर/ Bhubaneswar-751023

for treatment of sewerage generated from the colony. As stated earlier, it has been observed that the water generated from the quarry & OB dump area along with wastewater generated from the adjacent Mahagiri Chromite Mines of M/s IMFA are being channelized to common ETP-4 for treatment before discharge/reuse. The capacity of ETP is 360 m^3/hr. The treated water being discharged to Damsalla Nala after confirming the prescribed standards. It has been observed that the PAs have installed real time monitoring of Cr^{+6}, TSS & pH at the discharge point of effluent and the data being transferred to OSPCB website. The wastewater generated from the workshop i.e. vehicle washing unit is being recycled through existing CPI (Corrugated Plate Interceptors) separator and treated water is being used for the same vehicle washing purpose. No water discharged from the workshop. It has been observed that, PAs have installed Oil and Grease trap for removal of Oil and grease from wastewater generated from workshop. Photographs of ETP, Oil and grease trap and wheel washing are as follows:





(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पूर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
भुवनेश्वर/ Bhubaneswar-751023

vi. **Personnel working in dusty areas should wear protective respiratory devices and they should also be provided with adequate training and information on safety and health aspects. Occupational health surveillance programme of the workers should be undertaken periodically to observe any contractions due to exposure to dust and take corrective measures, if needed.**

Status: Being complied

It has been informed that nose masks have been provided to persons working in dusty areas. Adequate training also provided to persons those who are working in the dusty areas regarding safety and health aspects. Occupational health surveillance i.e. IME & PME is being carried out periodically to observe any contractions due to exposure to dust. As per the information provided, workers including permanent and contractual employees gone for the occupational health surveillance for last three years are as follows:

Sl. No.	Year	Total Manpower	New Appointment	Total IME done	Total PME Due	Total PME done
1	2019-20 (Till October)	1766	42	42	138	138
2	2018-19	1738	265	265	303	303
3	2017-18	1500	224	224	132	132

vii. **A separate environmental management cell with suitable qualified personnel should be set-up under the control of a Senior Executive, who will report directly to the Head of the Organization.**

Status: Being complied

It has been observed that the PAs have established an Environmental Cell headed by Sr. General Manager to look after the implementation of the various pollution control measures and other Environment management System requirements.

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पूर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
भुवनेश्वर/ Bhubaheswar-751023

viii. **The project authorities should inform to the Regional Office located at Bhubaneswar regarding date of financial closures and final approval of the project by the concerned authorities and the date of start of land development work.**

Status: Complied

As per the discussions held during monitoring and information provided by PAs, it has been informed that the lease was executed on 04.09.1999 for a period of 30 years, which is deemed approved up to 50 years. It has been informed that the mining operations in the area commenced from 15.09.1999 and is continuing.

ix. **The funds earmarked for environmental protection measures should be kept in separate account and should not be diverted for other purpose. Year wise expenditure should be reported to the Ministry and its Regional Office located at Bhubaneswar.**

Status: Being complied

It has been informed that the funds earmarked for environmental Protection are being utilized for the same only. As per the information provided, the expenditure detail for the financial year 2019-20 is follows below.

Head	April-19 to Sep-19
For pollution control	5452853
For Environmental Monitoring	630005
For green belt development	250533
For occupational health & Environment awareness	287997
Total	6621389

x. **The Regional Office of this Ministry located at Bhubaneswar shall monitor compliance of the stipulated conditions. The project authorities should extend full cooperation to the officer(s) of the Regional Office by furnishing the requisite data/ information/ monitoring reports.**

Status: Being complied

As per the Regional Office file records, it has been observed that PAs are regular in submission of six monthly compliance report along with all monitored data.

xi. **The project proponent shall submit six monthly report on the status of the implementation of the stipulated environmental safeguards to the**

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पुर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
भुवनेश्वर/ Bhubaneswar-751023

Ministry of Environment and Forests, its Regional Office, Bhubaneswar, Central Pollution Control Board and State Pollution Control Board.

Status: Being complied

As per the Regional Office file records, it has been observed that PAs are regular in submission of six monthly compliance report along with all monitored data. In addition to that The Project is uploading six monthly EC Compliance reports on the website bearing address http://www.imfa.in/statutory/statutory-mines.htm on regular basis.

xii. **A copy of clearance letter will be marked to concerned Panchayat/ local NGO, if any, from whom suggestion/ representation, if any, was received while processing the proposal.**

Status: Complied

It has been informed that a copy of clearance letter has been marked to sarapanch of Kaliapani G.P, Chingudipal G.P, Kansa G.P, Ransol G.P and Zilla Parisad Member, Zone 37 on dated 06.06.2012.

xiii. **State Pollution Control Board should display a copy of the clearance letter at the Regional Office, District Industry Centre and Collector's office/ Tahsildar's office for 30 days.**

Status: Complied

It has been informed that the condition has been complied with.

xiv. **The project authorities should advertise at least in two local newspapers widely circulated, one of which shall be in the vernacular language of the locality concerned, within 7 days of the issue of the clearance letter informing that the project has been accorded environmental clearance and a copy of the clearance letter is available with the State Pollution Control Board and also at web site of the Ministry of Environment and Forests at http://envfor.nic.in and a copy of the same should be forwarded to the Regional Office of this Ministry located at Bhubaneswar.**

Status: Complied

It has been observed that the environmental clearance has been advertised in The New Indian express" English daily and "The Pragativadi" odia daily on dated 31.05.2012 and a copy of environmental clearance has been forwarded to the Regional Office, Bhubaneswar.

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
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Additional conditions as per Letter dated 22.05.2012

i. **The Company shall submit within 3 months their policy towards Corporate Environment Responsibility which should inter-alia provide for (i) Standard operating process / process to bring into focus any infringement / deviation / violation of the environemental or forest norms / conditions, (ii) Hierarchical system or Administrative order of the company to deal with the environmental issues and for ensuring compliance with the EC conditions and (iii) System of reporting of non compliances / violations of environmental norms to the Board of Directors of the company and / or shareholders or stake holders.**

Status: Being complied

It has been observed that the condition is being complied with. It has been informed that the PAs have framed Policy towards Corporate Environment Responsibility and submitted to Ministry on 16.08.2012.

Additional conditions as per Letter dated 22.05.2012

i. **Monitoring of dump with reference to safety and stability shall be done on six monthly basis and report submitted to the Regional Office of MOEF.**

Status: Being complied

It has been observed that PAs are regularly conducting monitoring of dump with reference to safety and stability on six monthly basis and report being submitted to the Regional Office, Bhubaneswar on regular basis.

ii. **All precautions as recommended by DGMS should be implemented.**

Status: Being complied

It has been observed that PAs are in process of implementing all precauitions as recommended by DGMS.

iii. **Reclamation plan for dead dump areas should be periodically implemented and report submitted to the Regional Office.**

Status: Being complied

It has observed that the mining operations are in progress and PAs have not yet taken any reclamation activities. It has been informed that the reclamations and rehabilitation shall be carried out as per approved mining scheme.

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/SCIENTIST 'C'
भारत सरकार/Govt. of India
पर्यावरण वन एवं ज.प.मंत्रालय/ Min. of Env. Forest & CC
पूर्वी क्षेत्रीय कार्यालय/ Eastern Regional Office
भुवनेश्वर/ Bhubaneswar-751023

10. Observations:

The PAs have complied or are in process of complying the conditions stipulated by the Ministry. In this context, information/action plans have been sought on following points.

1. It is required to develop plantation in an area of 73.01ha including a 7.5m wide green belt in the safety zone around the mining lease by planting the native species around ML area, OB dump, roads etc. in consultation with the local DFO/Agriculture Departments.
2. During the day of monitoring, it has been observed that the settling ponds were filled with silt. It is required to desilt the settling ponds on regular basis.

11. Recommendations:

This project can be put up in the following tick-marked category of compliance status.

- Compliance status could not be judged as the project was shut down / not in operational during the site visit.
- No non-compliances detected. No any further action is required.
- ✓ ***Minor non-compliances detected (not of immediate danger to health & safety of the people). Letter issued to project authorities for taking corrective measures.***
- Serious non-compliances detected. Recommended to issue a Show-Cause Notice to Project Authorities

06/12/19.

(डॉ। पी। सुरेश बाबू / Dr. P. Suresh Babu)
वैज्ञानिक-सी / Scientist-C

(डॉ. सुरेश बाबु पासुपुलेती)
(Dr. SURESH BABU PASUPULETI)
वैज्ञानिक 'सी'/ SCIENTIST 'C'
भारत सरकार/ Govt. of India
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Annexure 2b- Letter of RO observation on Certified Compliance

Government of India/ भारत सरकार
Ministry of Environment, Forest & Climate Change/ पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
Eastern Regional Office/ पूर्वी क्षेत्रीय कार्यालय
A/3, Chandrasekharpur/ ए/३, चन्द्रशेखरपुर
Bhubaneswar - 751 023/ भुवनेश्वर - ७५१ ०२३

सत्यमेव जयते

Telephone: 0674-2301213, 2301248, 2302452, 2302453. Fax: 0674-2302432. E-mail: roez.bsr-mef@nic.in

संख्या 101-409/08/ई.पी.ई/1772 स्पीड पोस्ट 10.12.2019

सेवा में,

निदेशक,
मेसर्स इंडियन मेटल्स एंड फेरो अलॉयज़ लिमिटेड,
गाँव कालीपानी, तहसील सुकिंडा, जिला जाजपुर, उड़ीसा.
ई-मेल: debaparija@imfa.in

विषय: मैसर्स IMFA लिमिटेड की सुकिन्दा क्रोमाइट माइन्स के निरीक्षण के संबंध में |

संदर्भ: मंत्रालय का पत्र संख्या- J-11015/346/2007-IA.II(M) दिनांक 18.06.2008, 22.05.2012 एवं 11.08.2014.

महोदय,

मुझे यह सूचित करने का निर्देश हुआ है कि यह परियोजना दिनांक 09.11.2019 में अधोहस्ताक्षरी दवारा निरीक्षण किया गया | पर्यावरण मंजूरी सम्बंधित निर्धारित शर्तों को प्रभावी रूप से अनुपालन करने के लिए प्रति पृष्ठ पत्र के अनुसार निर्धारित सूचना/अनुपालन रिपोर्ट यह पत्र जारी के 30 दिन के अन्दर अवश्य भेजने का कष्ट करें |

भवदीय,

संग्लनक : उपरोक्त

10/12/19
(डॉ0 पी0 सुरेश बाबु)
वैज्ञानिक-सी

प्रतिलिपि : **निदेशक (आई. ए. डिवीज़न),** मॉनिटरिंग सेल, पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय, इंदिरा पर्यावरण भवन, जोरबाग रोड, अली गंज,नई दिल्ली - 110 003 |

वैज्ञानिक-सी

Speed Post

सत्यमेव जयते

Government of India/ भारत सरकार
Ministry of Environment, Forest & Climate Change/ पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
Eastern Regional Office/ पूर्वी क्षेत्रीय कार्यालय
A/3, Chandrasekharpur/ ए/३, चन्द्रशेखरपुर
Bhubaneswar - 751 023/ भुवनेश्वर - ७५१ ०२३

Telephone: 0674-2301213, 2301248, 2302452, 2302453. Fax: 0674-2302432. E-mail: roez.bsr-mef@nic.in

File No. 101-409/08/EPE Date: 10.12.2019

To

The Director,
M/s Indian Metals and Ferro Alloys Ltd.
village Kaliapani, Tehsil Sukinda,
District Jajpur, Orissa.
E-mail: debaparija@imfa.in

Sub: Expansion of Sukinda Chromite Mining Project of M/s Indian Metals and Ferro Alloys Ltd. Located in village Kaliapani, Tehsil Sukinda, District Jajpur, Orissa. -reg.

Ref: Ministry's Environmental Clearance Letter No. J-11015/346/2007-IA.II(M) dated 18.06.2008, 22.05.2012 and 11.08.2014 (Extension).

Sir,

I am directed to state that the above project was monitored by this Office on 09.11.2019 to review the status of implementation of environmental safeguard stipulated in the Environmental Clearance letters as referred above. The discussion was held with concerned officer on implementation of stipulated environmental condition. It was observed that the effective measures are required to taken for following issues to ensure satisfactory compliance status:

1. It is required to develop plantation in an area of 73.01ha including a 7.5m wide green belt in the safety zone around the mining lease by planting the native species around ML area, OB dump, roads etc. in consultation with the local DFO/Agriculture Departments.
2. During the day of monitoring, it has been observed that the settling ponds were filled with silt. It is required to desilt the settling ponds on regular basis.

In view of above, you are requested to submit action taken report to this office within 30 days of receipt of this letter for taking further action, failing which it will be treated as violation under the E(P) Act, 1986.

Yours faithfully,

10/12/19

(Dr. P. Suresh Babu)
Scientist 'C'

Copy to: **The Director (S)**, Monitoring Cell, Ministry of Environment, Forest and Climate Change, Indira Paryavaran Bhawan, Jor Bagh, Aliganj, New Delhi-110 003. Email ID: shruti.rai@nic.in for kind information and further necessary action.

Scientist 'C'

Annexure 2c- Reply of queries on Certified Compliance dated 16.12.2019

INDIAN METALS & FERRO ALLOYS LIMITED

IMFA/MPC/SMC/2019/92
Date: 16 .12. 2019

IMFA Building
Bhubaneswar -751010
Odisha, India

Corporate Identity No.
L27101OR1961PLC000428

TEL +91 674 2611000
+91 674 2580100
FAX +91 674 2580020
+91 674 2580145

mail@imfa.in

www.imfa.in

To
Dr. P. Suresh Babu
Scientist-C
MoEF& CC, Govt of India,
Eastern Regional Office,
A/3, Chandrasekharpur,
Bhubaneswar-751023

Sub:-Action Taken Report in compliance to observations raised by MoEF&CC(ERO), BBSR as per Certified Compliance Report in respect of Environmental Clearance of Sukinda Mines (Chromite) of M/s. Indian Metals & Ferro Alloys Limited.

Ref:-(1)Certified Compliance Report issued by MoEF&CC(ERO), Govt. of India, Bhubaneswar vide letter no. 101-409/08/EPE dated 06.12.2019.

(2)Observation raised by MoEF&CC(ERO), Govt.of India, Bhubaneswar vide letter no. 101-409/08/EPE dated 10.12.2019

Dear Sir,

With reference to the subject and references mentioned above, we are submitting here with the Action Taken Report (ATR) in compliance to the observations raised by MoEF&CC(ERO) as follows:

Observation-1

It is required to develop plantation in an area of 73.01 ha. including a 7.5 m wide green belt in the safety zone around the mining lease by planting the native species around ML area , OB dump, roads etc in consultation with local DFO/ Agriculture departments.

Compliance Status/Action taken

Plantation over an area of 23.66 ha. has been done till the FY-2018-19 **as per approved mining plan** in consultation with local DFO/ Agriculture Department. **As per approved mining plan, plantation over an area of 73.01 ha. needs to be achieved only by the end of conceptual period of the mining lease (i.e. after completion of mining operation).**

Cont'd-P/2

GOVT OF INDIA
MoEF&CC, Eastern R.O.
Bhubaneswar-751023
17 DEC 2019
RECEIVED

IMFA Building
Bhubaneswar -751010
Odisha, India

Corporate Identity No.
L27101OR1961PLC000428

TEL +91 674 2611000
+91 674 2580100
FAX +91 674 2580020
+91 674 2580145

mail@imfa.in

www.imfa.in

Observation-2

During the day of monitoring, it has been observed that the settling pond were filled with silt, it is required to de-silt the settling ponds on regular basis.

Compliance Status/Action taken

Settling ponds are being regularly de-silted on yearly basis by the Lessee before monsoon after the pond becomes dry. The same has been done during the month of April for the F.Y. 2018-19. De-siltation for the F.Y. 2019-20 shall be done after the silt became dry. As soon as the silt removal completed, the same shall be intimated to your good office.

For your kind information please.

Thanking you,

Yours faithfully,
For: **M/s. Indian Metals & Ferro Alloys Limited**

(Sanjeev Das)
Sr. Vice President
Head- Mining Business Unit.

Annexure 3- Cumulative effect of mining & beneficiation plant & techno-economic benefit of beneficiation plant

CUMULATIVE EFFECT OF MINING AND BENEFICIATION ON THE ENVIRONMENT AND TECHNO-ECONOMIC BENEFIT OF BENEFICIATION PLANT

1. CUMULATIVE EFFECT OF MINING AND BENEFICIATION

1.1 INTRODUCTION: The Indian Metals & Ferro Alloys Limited (IMFA) has been working in the field of chromite mining in the country since the last two decades and has emerged as a Private Sector Company in the country with expertise for exploration and exploitation of chromite ore. IMFA is operating an opencast Chromite mine in the name of Sukinda Mine (Chromite) over an area of 116.76 Ha. granted by Orissa, State Government on 04.09.1999. The mine lease is valid up to 04.09.2049 as per MMDR(amended) Act 2015. The project has obtained EC for production of 3.51 Lakh TPA from MoEF&CC vide letter No. J-11015/346/2007-IA.II (M) Dated 18th June 2008 and extension vide letter dated 22.05.2012 and 11.08.2014 for continuation of production of 3.51 LTPA of Chrome Ore by Opencast Method for Captive Use valid up to 03.09.2029.

Now IMFA has proposed expansion in production capacity of ore from 3.51 LTPA to 6.0 LTPA, change of technology from opencast to opencast & underground mining, establishing a Chrome Ore Beneficiation (COB) plant of 40 TPH feed capacity. The mining lease area is located at Village: Kaliapani, Tehsil: Sukinda, District-Jajpur, Orissa. The mine lease is located between latitude $21^0 01' 45.51''$ N to $21^0 02' 33.81''$ N, and longitude $85^0 45' 35.91''$ E to $85^0 46' 42.03''$ E. The area falls in the Survey of India Topo sheet 73-G/16 (OSM Sheet no.F45N16).

The area comprises of hilly and undulating terrain. The highest elevation in the area is 185 mRL and the minimum is 110 mRL. Overall regional slope is from south to north. Regional chromite band no. I&II of Sukinda Chromite belt is lying in the lease area have a general trend of ENE-WSW dipping 75 to 80 degree towards NNW. The proved mineable reserve as per the approved mining plan vide letter no. MS/FM/27-ORI/BHU/2018-19 dated 31.10. 2018 in opencast working of Band I under the UNFC 111 category as on 01.07.2018 is 12.79 Lakh Tonnes considering ultimate pit limit up to (-) 2 mRL and of Band -II is 16.52 Lakh Tonnes considering ultimate pit limit up to 46 mRL..

PROPOSED EXCAVATION OF ORE AND OVERBURDEN AFTER EXPANSION:

After the proposed expansion the production of chromite ore will be 6 lakh Ton per year equivalent to about 1.56 Lakh Cum per year. Total maximum excavation will be 12.11 Lakh Cum in any one year which will include ore, overburden, mineral rejects/subgrade mineral. However, after the start of

production from underground mining from the year 2027-28 the quantum of overburden per year will drastically reduce. There will be no additional excavation for feeding the proposed COB plant which will require a feed of 100000 Ton per year. About 6.12 lakhs subgrade ore having grade from >10% to <30% Cr2O3 is stacked on the dump yard within the lease area which will be fed to COB plant for beneficiation to achieve higher grade concentrate.

ADVERSE EFFECT ON THE ENVIRONMENT DUE TO MINING AND BENEFICIATION PLANT OPERATION:

The mining and allied activities in the proposed project area have an influence on the environment. These activities include:

- Development of quarry at mine site for both opencast and underground mining
- Excavation
- Drilling & Blasting
- Operation of machineries & equipments
- Loading, unloading and Transportation
- Dumping of OB/subgrade material within the lease area
- Development of road
- COB plant installation and operation
- Daily activity of mineworkers

1.2 AIR ENVIRONMENT

1.2.1 Impact on Air Environment due to mining

- Dust emission due to mining operation leads to an increase in PM level causing respiratory problems to workers and to nearby populations and a decrease in the transpiration rate due to deposition on leaves of flora and also affect the aesthetic look of the area..
- Emission of gases from the operation of machineries and equipments will deteriorate the ambient air quality of the area and will affect the respiratory health of workers and nearby population.
- Leakage of petrol/Diesel may result in the emission of VOCs in the air environment which will cause irritation in eyes, nose, and throat, difficulty breathing and nausea.

1.2.2 Impact on Air Environment due to beneficiation plant

- Air Emission due to crushing and screening of ore lead to dust emission which will cause respiratory problem to the workers at the site and nearby population.
- Pollutants emitted from the stack will increase the Ground Level Concentration of pollutants which will affect the respiratory health of people in the nearby areas.

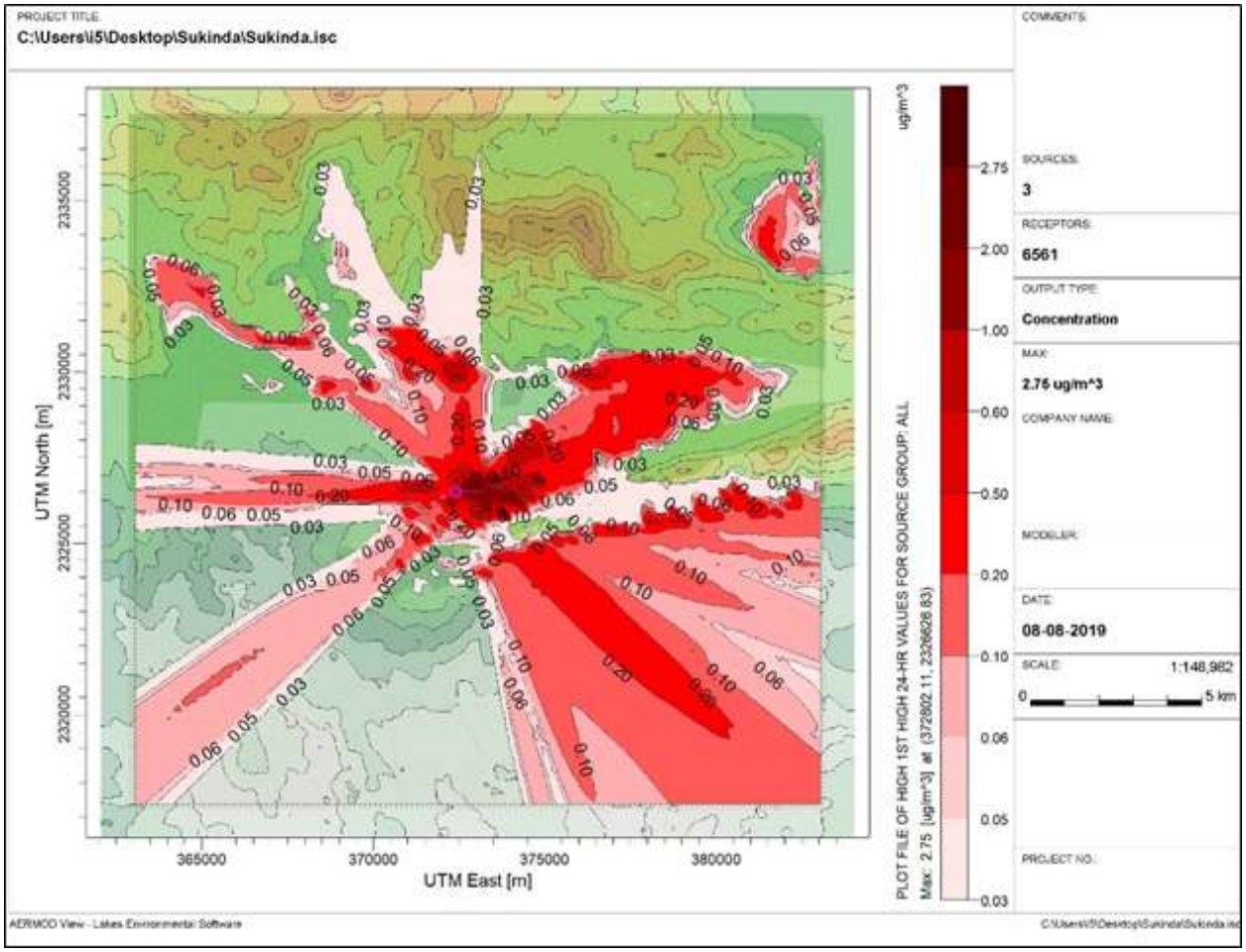
1.2.3 Mitigation Measures

To mitigate the adverse impact of mining and beneficiation, requisite measures have been incorporated in the EIA/EMP report. Accordingly, Air quality reports have been prepared considering all the activities associated with mining as well as COB plant. The details of predicted air quality impact is given below:

1.2.4 Predicted Air quality impact due to combined mining and COB plant operation is given below:

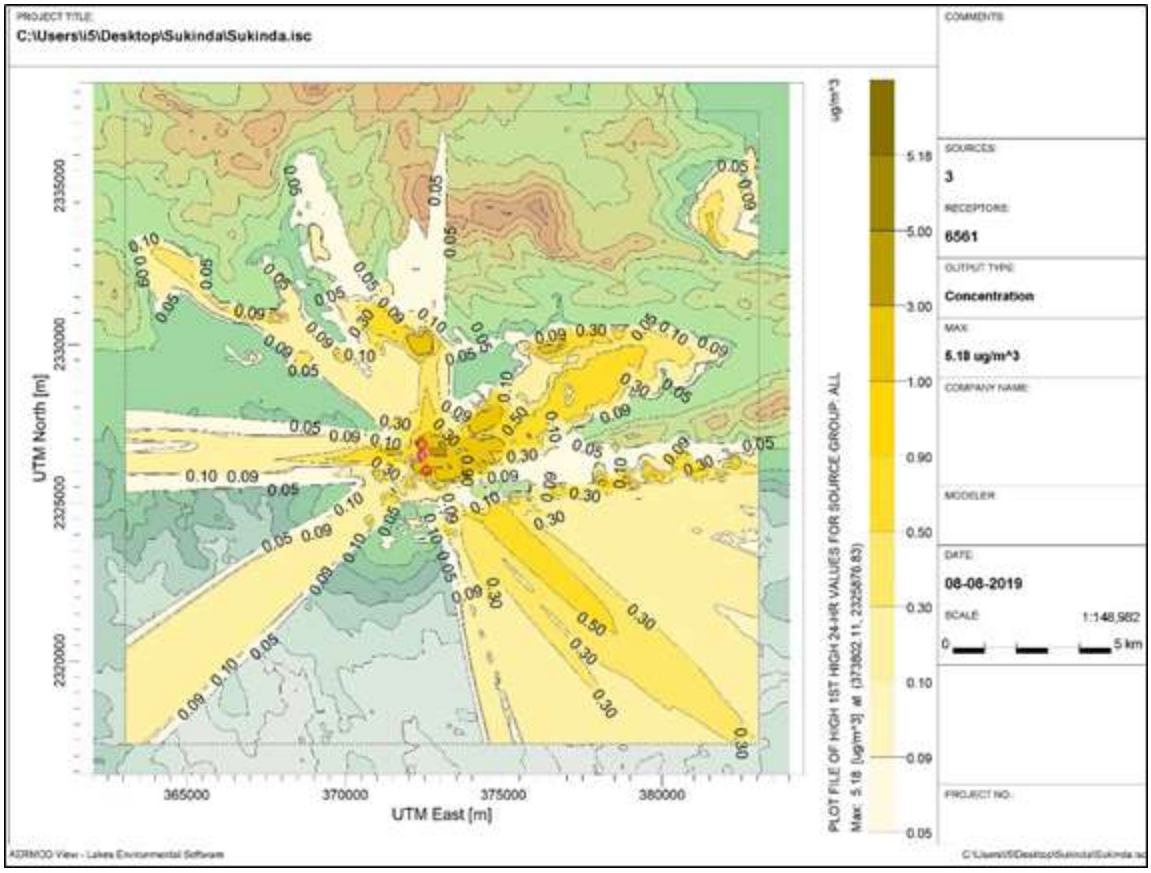
1.2.4.1 Predicted ambient air quality for the impact of PM2.5

With available ambient air quality data and incremental concentrations computed through mathematical modelling the following post project ambient air quality has been predicted. The maximum GLC for $PM_{2.5}$ modelling will be 2.75 mg/m^3.



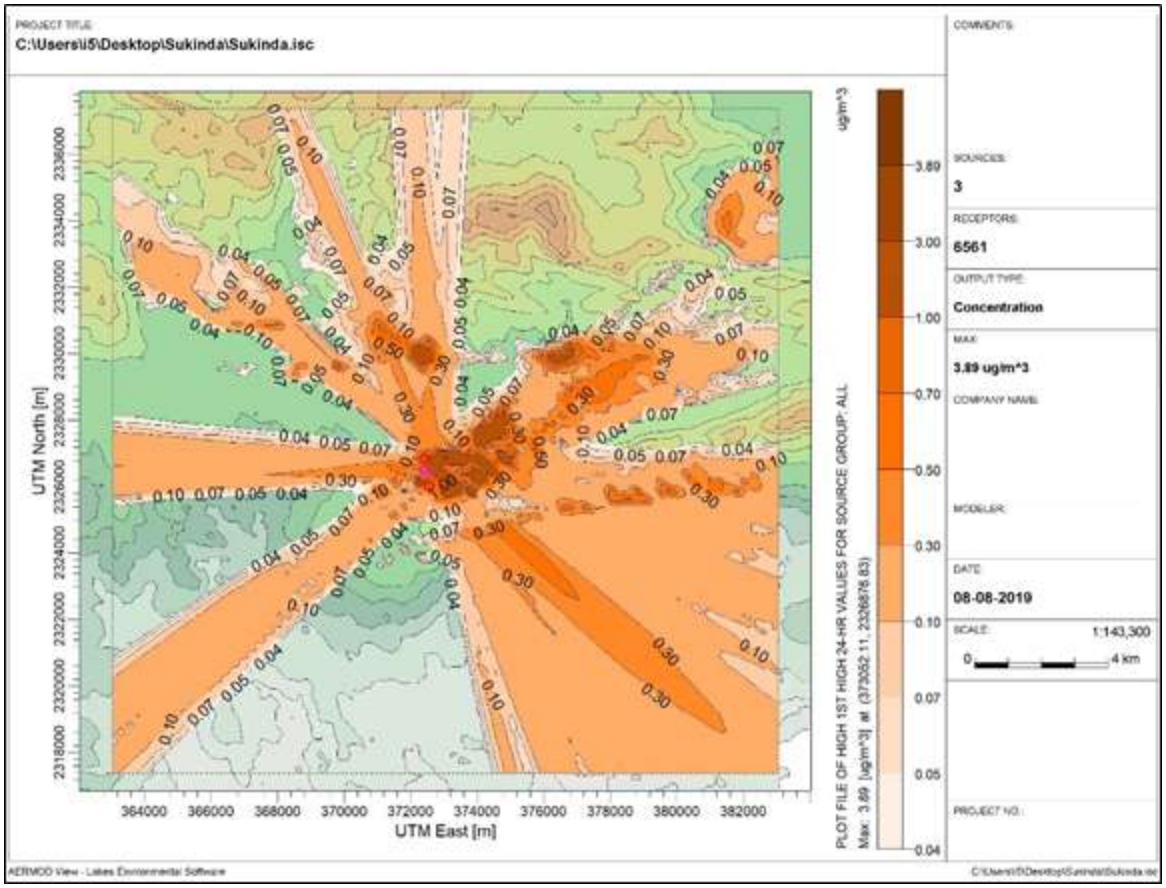
1.2.4.2 Predicted ambient air quality for the impact of PM10

With available ambient air quality data and incremental concentrations computed through mathematical modelling the following post project ambient air quality has been predicted. The maximum GLC for PM_{10} modelling will be 5.18 mg/m^3**.**



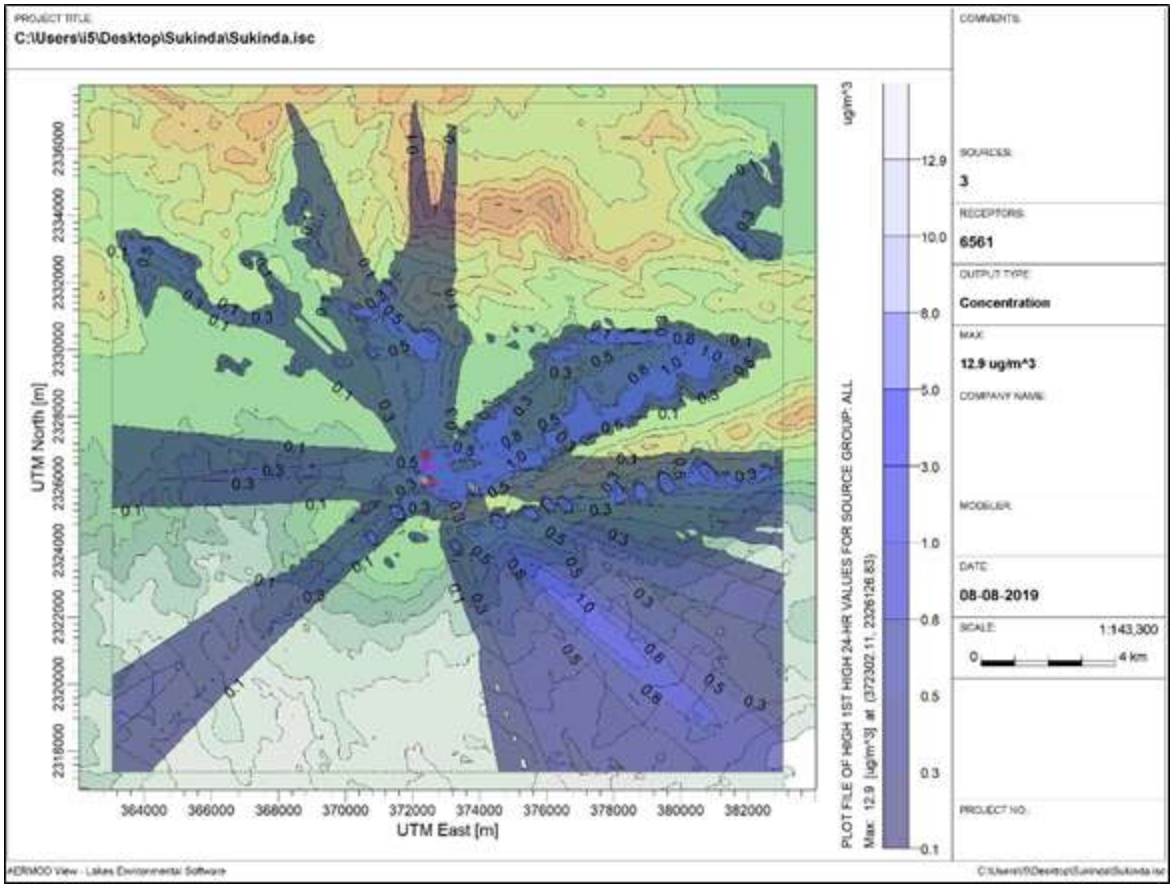
1.2.4.3 Predicted ambient air quality for the impact of SO2

With available ambient air quality data and incremental concentrations computed through mathematical modelling (Gaussian Plume) the following post project ambient air quality has been predicted. The maximum GLC for SO_2 modelling will be 3.89 mg/m^3**.**



1.2.4.4 Predicted ambient air quality for the impact of NOx

With available ambient air quality data and incremental concentrations computed through mathematical modelling (Gaussian Plume) the following post project ambient air quality has been predicted. The maximum GLC for NOx modelling will be 12.9 g/m3 which would be on road.



1.2.5 Conclusion

From the results generated by AERMOD in form of Isopleth and results of the same show that maximum GLC of PM10/ PM2.5/SO2/NOX after commencement of project expansion involving both mining and COB plant do not have significant impact on environment/ ambient air quality on sensitive receptors of the project.

1.3 NOISE ENVIRONMENT

The proposed mining will be both opencast and underground mechanized working with drilling and blasting. In the expansion of the mining project, there will be various sources of noise & vibration due to drilling, blasting, operation of compressor, loading and haulage, COB plant operation and vehicular traffic as described below:

1.3.1 Impact due to mining Operation

- Noise generated due to, Excavation, operation of machineries & equipments (including DG sets, Heavy Earthmoving machineries, ETP etc) from both opencast and underground mining

operations causing physiological & psychological effects on nearby people like annoyance, headache, Auditory impact, increase in heartbeat of patients and elderly people.

- Drilling & Blasting Intermittently Increases noise level & vibration causing physiological and psychological effects like annoyance, deafness, heart issues, headache etc in mine workers and nearby population. Vibration may also cause the development of cracks in the nearby and existing structures of the lease area.
- Noise Generation due to transportation may cause an increase in heartbeat and blood pressure in elderly people and patients within the area.

1.3.2 Impact due to Beneficiation Plant

- Noise will be generated due to crushing and screening units which may result in physiological & psychological effects on labors like annoyance, problems like sleep interference, headache, Auditory impact, increase in heartbeat of patients and elderly people in existing hospitals.
- Running of DG sets will cause vibration generation in immediate surrounding of DG set area

1.3.2.1 Mitigation Measures:

To mitigate the adverse impact of noise and vibration measures have been suggested in the EIA/EMP report. Most of the measures are common and if implemented properly the adverse impact will be minimized. The effect of noise and vibration due to the COB plant will be minimal.

1.4 WATER ENVIRONMENT

The mining operations may produce an impact on the water regime. The important impacts on water regime include change in surface run-off and base flow relationship and possible contamination of surface run-off with excavated overburden as given below:

1.4.1 Impact due to Mining

- Due to change in topography may result in a change of surface run-off and base flow relationship
- Groundwater may get contaminated as the mining has already touched the water table and groundwater may also get polluted due to the seepage of water from the settling pond.
- Pumping of Groundwater from mine pit may deplete the water in aquifer.
- Dust emission deposition over the Surface-water body may deteriorate its quality by increase the pathogen in the water body and thereby affecting the aquatic life and making water unfit for consumption.
- Spillage of Oil & chemicals from transportation, if in any case comes in contact with water body can deteriorate the groundwater & surface water body which in turn may affect the aquatic life also.

1.4.2 Impact due to beneficiation

Wastewater from the beneficiation plant will contaminate the surface water and groundwater if not properly disposed of.

- Due to the open defecation, nearby water bodies may get affected.

1.4.3 Mitigation Measures

- Total generation of mine water due to working below the water table is estimated at 3260 KLD and water from surface runoff entering into the mine area during the peak day of the rainy season is estimated at 6380 KLD. Besides this 240 KLD groundwater will be drawn for domestic consumption. Thus total water generation during the mining operation is estimated at 8880 KLD. Out of this 1000 KLD will be utilized in sprinkling, plantation, wheel washing, mine process and COB. 240 KLD water will be utilized for domestic use. Balance 6380 KLD(only on heavy rainy day) will be sent to existing ETP of 8640 KLD capacity. After the treatment of water in the ETP the treated water will be discharged in Damsal Nala at 0.74 km NW from mining lease. Thus No untreated water will be allowed outside the mine area without any treatment.
- Proper drainage (Garland drain) for stormwater has been constructed at the mine site the same shall be maintained which leads to a settling pond.
- No water from the COB plant will be discharged outside the plant.

1.5 LAND AND SOIL ENVIRONMENT

1.5.1 Impact due to mining

- It is an existing mine. However, in the area of Band II where mining is proposed, insignificant vegetation is present which will be cleared when the mining will be commenced in Band II.
- Benches in the quarry may collapse if proper bench slope is not maintained. Similarly, there may be caving effect in underground stoping if unscientific mining is done.
- Impact on soil due disposal of municipal solid waste and effect on flora from spillage of ROM/ waste on soil.

1.5.2 Impact due to Beneficiation Plant

- Few trees may have to be cut down for site clearance for the establishment of COB Plant may cause generation of topsoil.
- Disposal of tailing may cause degradation of soil.

1.5.3 Mitigation Measures

- Plantation will be done during the conceptual stage on the mined-out backfilled area of Band II.
- Mining is done as per approved mine plan and an adequate slope of bench is maintained. Same shall be followed during expansion also. In underground mining pillar between two stopes will

be left as per scientific analysis and DGMS requirement and backfilling of stopes will be done to avoid caving.

- Land use will be changed in the Band II. To maintain the overall green area at site, the plantation will be done in the safety zone and on the slope of the dump.
- Temporary toilets are provided for the disposal of municipal solid waste.
- Covered tippers/ trucks are deployed for transportation of chrome ore to avoid spillage. The same shall be done during expansion also.
- Topsoil will be stacked separately within the lease area and will be used for plantation.
- Tailings generated in the form of cake from the COB plant will be properly stacked near the subgrade dump yard within the mine lease.

1.6 BIOLOGICAL ENVIRONMENT

1.6.1 Impact due to mining

- Increased PM Level due to mining activity will result in deposition of dust on leaves which may cause a decrease in Transpiration rate of flora
- Increased dust emission can lead to climate change which eventually will result in a decrease in plant/tree cover.
- Increased noise will cause disturbance of existing avifauna, however, avifauna is not restricted to one place for a long time, thus it will not result in their displacement

1.6.2 Impact due to Beneficiation Plant

- Few trees and bushes are present in the area where the establishment of the COB plant is proposed which will be cleared. There will be no impact on fauna.
- Increased dust emission can lead to climate change which eventually will result in a decrease in plant/tree cover.
- Increased noise will cause disturbance of existing avifauna, however, avifauna is not restricted to one place for a long time, thus it will not result in their displacement

1.6.3 Mitigation Measures

- Regular water sprinkling is being done to reduce dust generation.
- Dust suppression systems (fog system) has been installed at the site to abate dust generation. Same practice shall be followed during expansion too.
- Acoustically enclosed DG sets have been provided along with vibration pads.
- All the machineries used will be provided with vibration isolators in accordance to their vibration generation
- Vehicular movement for transportation of raw material will be carried out only in the day-time and will try to avoid unnecessary honking with the help of signboards.

1.7 SOLID WASTE MANAGEMENT

1.7.1 Impact due to mining

- Generation of OB waste if not properly dispose will contaminate the soil

- ETP Sludge if not properly disposed of will contaminate the soil and groundwater through seepage.

1.7.2 Impact due to Beneficiation Plant

- Tailing from COB if not properly disposed of will result in adversely affecting the land and also malfunctioning of COB plant.

1.7.3 Mitigation Measures

- OB/ waste generated from the mine are stacked in the existing dump yard and mineral rejects are stacked in the existing subgrade dump. Coir matting has been done on the existing OB dump for its stabilization followed by plantation. Same shall be followed during expansion too. Mineral rejects generated in the plan period and during the conceptual period will be processed in the proposed COB plant.
- Presently, approx 150 Tonnes of sludge is generated from ETP which is first stored in the impervious sludge pit constructed within the lease area and further given to authorized SPCB agency as per agreement, further the sludge is disposed off to the landfill site by SPCB agency. During expansion, the same procedure will be followed.
- It is expected that approx. 25000 Tonnes of tailing shall be generated per annum which will be stored in a designated place near subgrade dump.

1.8 SOCIO-ECONOMIC ENVIRONMENT

Expansion of project including underground mining & COB plant installation will result in employment to local workers. There will have a positive impact on the socio-economic condition of the area. Regular medical examinations, schooling, better infrastructure, etc. shall benefit employees as well as the locals in the area.

1.8.1 Occupational Health

Workers in chromite mines are at risk of developing interstitial lung disease if the dust levels are above the threshold limit value. Some illnesses, such as chronic bronchitis, bronchial asthma, tuberculosis and the collagen vascular diseases that affect the lung, maybe more severe because of the inhalation of dust are common to mine workers. The most difficult problem is to differentiate asymptomatic sarcoidosis from pneumoconiosis. Exposure of mine workers to hexavalent chromium a known carcinogen, generated during chromite mining may cause different types of cancer, gastrointestinal bleeding, infertility, birth defects and stillbirths.

Miners may also suffer from occupational respiratory ailments, skin allergies etc, but the same are preventable if exposure is minimized. Further, regular health check-up of the miners is required to prevent any negative impact on their health.

1.7.2 Preventive measures:

- Exposure to chromium occurs through the three major routes via absorption through the skin, by direct ingestion and by inhalation of chromium-containing particles.

- Personal Protective Equipment has been provided to the mineworkers especially to those who are working at high noise & dust generation points.
- They are guided and informed about the health hazards and the measures to cope up with them by conducting informative sessions.
- HEMM (Heavy Earth Moving Machinery) operator's cabin are inbuilt with acoustic enclosures which are fully noise proof.

2. TECHNO-ECONOMIC BENEFIT OF BENEFICIATION PLANT:

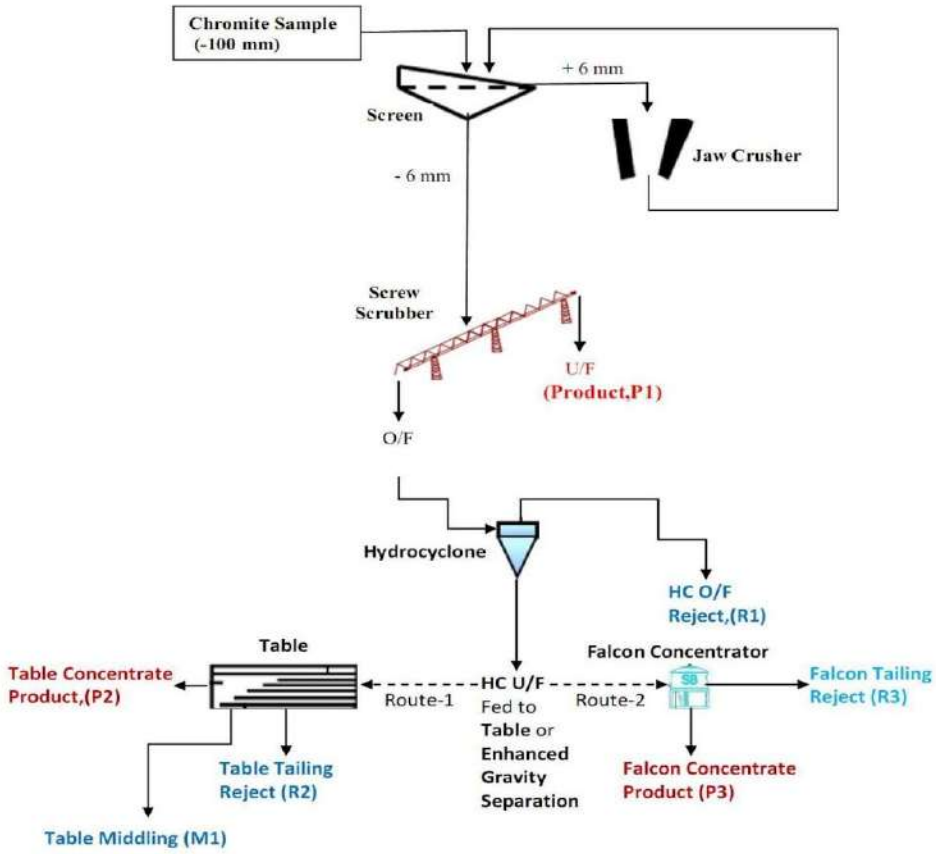
During the course of mining of saleable chrome ore from the mining lease area, a quantity of approx. 6.12 lakh tonnes of chrome ore having (+) 10 to (-) 30%Cr2O3 has been generated which has been stacked separately within leasehold area at an earmarked location. Now in the changed situation beneficiation of low-grade ore has become viable. In view of this, a chrome ore beneficiation (COB) plant has been proposed to beneficiate not only stacked subgrade ore but also sub grade ore (having 10 to 30% Cr2O3) that may be generated from opencast mining of Band I & II during this plan period. The company has proposed to set up the COB plant within the leasehold area which is designed to process 40 tonnes of chrome ore (having 10-30% Cr2O3) per hour.

The bench-scale study was conducted by lessee on chromite ore (10-30% Cr2O3) in the laboratory of IBM, Nagpur during 2002. The bench-scale study as conducted by IBM indicates that the sample is amenable to beneficiation. Further study was carried out at the Institute of Mineral & Material Technology (IMMT), Bhubaneshwar to develop a flow sheet for enriching chromite ore (10-30% Cr2O3) to usable grade and restricting Cr2O3% in tailing below the threshold value (10%). During April 2016, Institute of Mineral & Material Technology (IMMT), Bhubaneshwar submitted their final report. The report of IMMT is attached as Annexure to this report.

Flowsheet/schematic diagram of the processing procedure indicating material balance chart, feed, product, recovery, and its grade at each stage of processing.

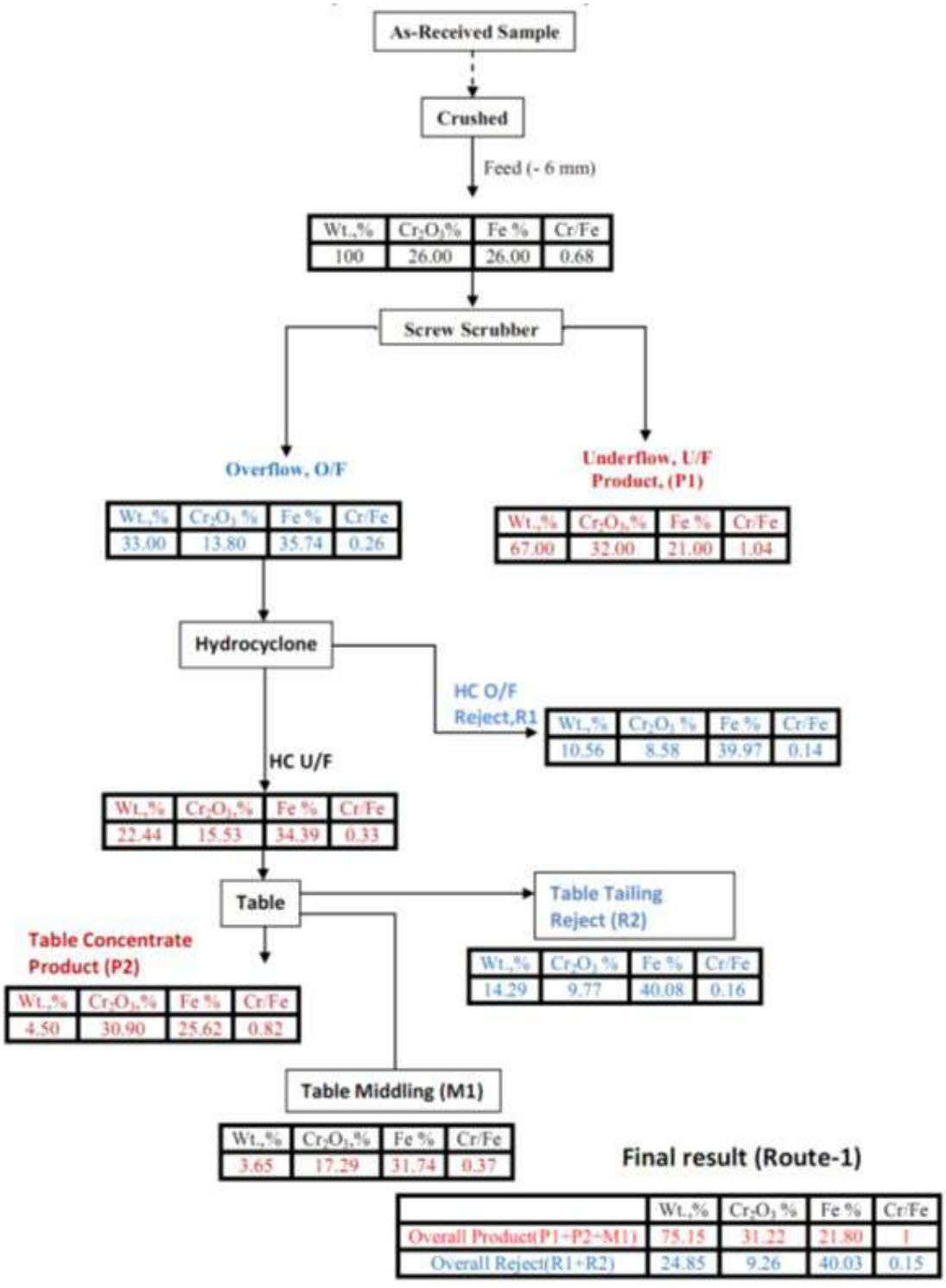
The **IMMT Bhubaneswar** developed five flow sheets using various techniques finally concluded that Flow sheet- I which has scrubbing, desliming with tabling and falcon concentration to recover chromite values from hydrocyclone underflow as most appropriate. With both tabling as well as falcon concentration, the concentrate generated had Cr2O3% of around 32% with the yield around 75% by weight. The tailing generated contained **< 10% Cr2O3**, with around 25% by weight and can be rejected. The Flowsheet that has been considered is given below:

The tentative flow sheet of COB plant:



HC reject(R1), table reject(R2), Falcon reject(R3) will be sent to thickner followed by drum filter/belt press.

Beneficiation results of Flowsheet


As-Received Sample
Crushed
Feed (- 6 mm)
Wt.,% | Cr2O3% | Fe % | Cr/Fe
100 | 26.00 | 26.00 | 0.68
Screw Scrubber
Overflow, O/F
Wt.,% | Cr2O3 % | Fe % | Cr/Fe
33.00 | 13.80 | 35.74 | 0.26
Underflow, U/F
Product, (P1)
Wt.,% | Cr2O3,% | Fe % | Cr/Fe
67.00 | 32.00 | 21.00 | 1.04
Hydrocyclone
HC O/F
Reject,R1
Wt.,% | Cr2O3 % | Fe % | Cr/Fe
10.56 | 8.58 | 39.97 | 0.14
HC U/F
Wt.,% | Cr2O3,% | Fe % | Cr/Fe
22.44 | 15.53 | 34.39 | 0.33
Table
Table Tailing
Reject (R2)
Wt.,% | Cr2O3 % | Fe % | Cr/Fe
14.29 | 9.77 | 40.08 | 0.16
Table Concentrate
Product (P2)
Wt.,% | Cr2O3,% | Fe % | Cr/Fe
4.50 | 30.90 | 25.62 | 0.82
Table Middling (M1)
Wt.,% | Cr2O3,% | Fe % | Cr/Fe
3.65 | 17.29 | 31.74 | 0.37
Final result (Route-1)
Wt.,% | Cr2O3 % | Fe % | Cr/Fe
Overall Product(P1+P2+M1) | 75.15 | 31.22 | 21.80 | 1
Overall Reject(R1+R2) | 24.85 | 9.26 | 40.03 | 0.15

Salient features of the COB:

Input grade	10-30% Cr2O3
Output grade:	Above 30% Cr2O3
Feed rate:	40T/Hr
Yield:	75% by weight concentrate
Concentrate Grade:	>30% Cr2O3%
Tailing	25% by weight
Tailing grade	<10% Cr2O3

The production from the COB will commence from 2023-20124 only after obtaining environmental clearance & installing the COBP with a feed of 100,000 Tons to produce 75000 Tons concentrate. There will be a generation of around 25000 Tons of tailing. It will take about 18 months to complete the installation and commissioning of the plant from zero date.

Disposal of reject from the processing plant:

As per IMMT, Bhubaneshwar study report (Flowsheet-I) scrubbing, desliming along with hydro-cyclone and table /falcon concentrator will be beneficiation technique. After the beneficiation of low-grade chrome ore, the tailing generated will contain around 9.26% Cr2O3, with around 25% by weight which will be rejected. The tailing collected from the pressure filter/Drum filter in the form of cake shall be stored in a designated place near subgrade dump.

It is estimated that approx. 25000 tons of tailing shall be generated per annum. No water from the COB plant shall be discharged outside the COB Plant. Chrome Ore tailing of below 10% Cr2O3 is treated as waste. Entire wastewater after beneficiation will be passed through a thickener specifically designed for the purpose. The thickener water flow will be collected in the collection tank and will be recycled in the system for processing. Use of suitable flocculant will be made for early settlement of solids in the tailing. IMMT has recommended maganafloc 1011 anionic as one of the flocculant. The tailing collected from the thickener as underflow will be subjected to filtration through a drum filter/ pressure filter. The cake obtained after the filtration shall be stored in a designated place near subgrade dump.

Process and make up water requirement:

COB plant shall require 1760 KLD water for processing the low-grade ore. Out of this makeup water requirement will be only 160 KLD which will be sourced from the ETP outlet or filtered mine water. Thus nearly about 90 percent of water will be re-circulated in the system. No water will be allowed to go outside the COB plant. Only the evaporated water loss will be made up from the ETP outlet.

Availability of ROM for the beneficiation plant as feed:

Presently about 6.12 lakh Ton low-grade ore having >10% to < 30% Cr_2O_3 is available on the subgrade stock within the mining lease. In addition, a certain quantity of low-grade Chromite ore will be generated in the future during the mining operation. Thus subgrade ore available on the present dump and the low-grade ore likely to be generated in the future will be the main feed to the proposed COB plant.

Plant machinery and equipment:

The proposed plant will broadly require following equipments:

a. Vibratory screen to separate 6 mm material.
b. Jaw crusher for crushing oversized material
c. Screw scrubber
d. Hydrocyclone
e. Falcon/Table concentrator
f. Thickener
g. Drum/filter press
h. Pumps
i. Conveyors
j. Silos

Power requirement:

The power requirement for the COB is estimated at about 800 KVA to 1000 KVA which will be sourced from Orissa Electricity Board.

Manpower requirement:

Total direct manpower requirement for the said plant is estimated at 30 including engineers, skilled, semi-skilled and unskilled. The breakup of manpower will be as under;

Plant in charge	1
Process engineer	1
Mechanical engineer	1
Electrical engineer	1
Foremen	2
Operators	6
Lab technician	1
Electrician	1
Wheel loader operator	2
General clerks	2
Skilled employees	6
Unskilled labor	6
Total	**30**

Capital cost estimate:

The total estimated capital cost for setting up the COB is estimated as Rs 2270 lakhs. The break up is given below:

Particulars	Rs lakhs
Site development	50
Non-plant buildings	50
Plant buildings	500
Plant and machinery	1300
Electricity supply	50
Water supply	50
Pollution control equipments	100
Pre-operative expenses	100
Miscellaneous	100
Total Capital cost:	**2370**

Owning and Operating cost:

The owning and operating cost of the COB is estimated to be about Rs 870/T of beneficiated product which in this case will be 75000 T per annum with debt of about 75% of total capital cost and assuming depreciation at straight-line method.

a.	Financing cost considering Debt of about 75% and 11% interest rate:	Rs 260/T
b.	Depreciation at straight-line method @ 10 %	Rs 310/ T
c.	Operating cost including administrative overheads	Rs 300/T
d.	Total operating cost/T	Rs 870/T

Economic Viability of the COB plant:

1. **Mineral conservation point of view: Presently there is no market for the subgrade material stacked on the dump having quality of >10% to <30%. If this material is not upgraded then this low-grade mineral will be wasted. Hence by upgrading the low-grade mineral to useable grade, we will convert noneconomic mineral to economic mineral and thus conserve the mineral which is a scarce mineral in the country.**
2. **Economic point of view: As the subgrade mineral has already been mined out and kept on the dump, thus there is no additional mining cost which will be feed to COB plant. The maximum owning an operating cost for the beneficiation is estimated at Rs 870/T. Since beneficiated product is estimated to fetch many times higher sale price than the cost of operation; hence the viability of the project is assured. Further, the entire beneficiated product will be either sold directly or utilized for blending with higher grade chromite ore.**

Report No: 1039/MP/SSP-287/APR/2016

Project Report on

Development of Commercial Process Flowsheet for Beneficiation of Low Grade Chromite Ore

Submitted to:
M/s Indian Metals & Ferro Alloys Ltd., Bhubaneswar

CSIR-Institute of Minerals & Materials Technology
(Council of Scientific & Industrial Research)
Bhubaneswar, 751 013

Executive Summary

M/s Indian Metals & Ferro Alloys Ltd., Bhubaneswar was interested in characterization and beneficiation of low grade chromite samples from its mines at Sukinda. In this background, two different samples from Sukinda was collected after proper identification and sampling. One sample (Lot 1 having low Cr_2O_3 of 10-30%) was from the low grade dumps of approximately 6 lakh tonnes. Another sample (Lot 2 having high phosphorus content) was from the mines. The overall objective of the project was to find out suitable process flowsheet to upgrade the Cr_2O_3 in the product in Lot 1 sample with a rejectable tailing having less than 10% Cr_2O_3 and finding out the possibility of reducing phosphorus in Lot 2 through study on its mineralogical characterization.

The bulk sample analysis, size distribution and the chemical analysis shows that the bulk sample (Lot 1) contains around 25.69% Cr_2O_3 and 25.79% Fe with Cr/Fe ratio of around 0.68. In addition, the other major constituents present are silica (11.92%), alumina (9.35%) and magnesia (4.77%). The size distribution of the as-received sample (Lot-1) indicates that the top size fraction is -100+65 mm with 6.65% weight and the bottom size fraction exists in the size below 20 micron with 12.45% weight.The Cr_2O_3 % is evenly distributed in all the size fraction above 10 mm with around 22-27%. The size fraction -10+2 mm which constitutes around 13% by weight, contain lower concentration of chromium content with around 14-17% Cr_2O_3. The size fraction -300+45 micron (around 15% by weight) contains the enriched concentration with around Cr_2O_3% (36-43%).It is the ultrafine fraction (-20 mm size fraction) which contains around 9.37% Cr_2O_3% and can be rejected as tailing by simple classification and scrubbing. The mineralogical study indicates that the sample predominantly consists of chromite , quartz, goethite and hematite with subordinate amounts of kaolinite , gibbsite , spinel , tremolite , magnetite and anatase. The liberation study indicate that the combined mass of chromite liberated is around 40 % for all size classes from -500 micron. Optimum liberation size for the sample is -125 micron.

For subsequent beneficiation study, the sample was reduced to below 6 mm by screening and crushing in order to meet the size specification for briquetting of the final product. As the size analysis shows the presence of ultrafines in the bulk sample due to friable nature of the ore and also the presence of clay minerals like Kaolinite, these ultrafine particles were removed from the feed sample in the first stage of beneficiation through scrubbing. Different combination of beneficiation techniques were applied to develop five different flowsheets for upgrading low grade chromite ore. In Flowsheet I, the -6 mm size feed was beneficiated through a combination of scrubbing, deslimiming and gravity separation i.e. tabling and enhanced gravity separator i.e. falcon concentrator. It shows that in Flowsheet-I with tabling, it can give a concentrate with 31.22% Cr_2O_3 with an yield of 75.15% and a reject of 9.26% Cr_2O_3 with 24.85% weight. The flowsheet with Falcon concentration generated a concentrate with 31.61% Cr_2O_3 with 74.41% yield and a reject containing 9.59% Cr_2O_3 with 25.59% weight. This flowsheet is more economical process in respect to yield. The capital cost of the equipment for this process is low. In Flowsheet-II, techniques like scrubbing followed by spiral concentration were applied. The overall product was a concentrate with 36.55% Cr_2O_3 and 52.2 % yield. The overall tailing contains 14.48% Cr_2O_3 with 47.8% weight. Compared to flowsheet-I the grade is better but the yield is less in flowsheet-II. In Flowsheet-III, attempt was made to recover valuables out of screwscrubber overflow and spiral tailings by extending Flowsheet-III through flotation. It shows that in flowsheet-III, it is possible to get chromite concentrate of 37% Cr_2O_3 with 56.20% yield and a tailing of 12.42% Cr_2O_3 with 43.80% weight which was a marginal improvement. In Flowsheet-IV, the screw scrubber underflow was reduced to below -1 mm and put through spiral concentration after desliming. It shows that in flowsheet-IV, it is possible to get a chromite concentrate with 42% Cr_2O_3 at 40% yield and an overall tailing of 15.34% Cr_2O_3 with 60% weight. Compared to flowsheet-III, the grade was relatively more here. In the last flowsheet i.e. Flowsheet-V, attempt was made to recover chromite values from Screw Scrubber overflow, hydrocyclone overflow and spiral tailing by passing through double stage flotation. It shows that in flowsheet-V, it is possible to get

a final overall product with a grade of 41.50% Cr_2O_3 with 46% yield and a overall tailing of 12.80% Cr_2O_3 with 54% weight.

The **Lot-II sample** contains 38.51% Cr_2O_3 and 0.029% Phosphorus (P). The 'P' distribution is concentrated more in coarser size fraction than in the finer size fraction. From the mineralogy study of Lot-II sample, it indicates that phosphorous is associated with goethite phase only and was intrinsically associated with the matrix. Beneficiation study was made for Lot-II to assess the reduction in phosphorus content by size reduction below 1 mm and then through scrubbing and classification. It showed that Screw scrubber underflow with 45.10% Cr2O3 and 68.23% yield contains 'P' content of 0.018% which is only a marginal reduction in 'P' content.

Table of Contents

Chapter 1
Introduction

1.1 Introduction:

For the production of special steel and ferrochrome alloys chromium is a important raw material. Based on certain physical and chemical properties, the ore is classified for different users. As per statistics, approximately 90% of mined chromite ore is converted into different grades of ferrochrome by the metallurgical industry. The balance is utilised in chemical, refractory an foundry units.Approximately 80% of ferrochrome produced is consumed by stainless steel industry. Chromite varies widely in composition according to the chemical formula (Mg, Fe^{+2}) $(Cr, Al, Fe^{+3})_2O_4$. Chromium occurs as chromium spinel, a complex mineral containing magnesium, iron, aluminium and chromium in varying proportions depending upon the deposit. Chromium ore occurs exclusively in ultramafic igneous rocks. Based on silica and iron content, chromite ore deposit can be categorised as siliceous type (silica rich) and ferruginous type (iron rich). Major associated gangue minerals are talc, quartz, hematite, goethite, limonite, gabbro, serpentine, anorthosite, dunite, and pyroxinite. Most of the chromite reserves in the world are concentrated in Africa and Asia followed by Europe, Australia and Brazil. India is the world's third largest producer of chromite ore and produces about 3.5–4 MTPA. The estimated reserve of chromite deposit in India is about 187 MT distributed mainly in states like Odisha, Goa, Tamilnadu, Maharastra and Tamilnadu. About 98% of the reserves are from the Sukinda valley and Boula-Nuasahi belt of of Odisha, which is noted for its complex mineralogy. The Sukinda valley ore is typically characterized with soft and friable and powdery material with less quantity of hard lumpy ore and are of high chromite content. The Odisha chromite ore can also be lumpy and hard, banded and disseminated type.

1.2 Challenges:

Chromite ore is little suitable for industrial purpose in its pure form due to the requirement of chromium to iron ratio. Large and massive quantity of chromite ore is being mined and beneficiated at different mines and beneficiation plant to meet the end requirement of different industries. During mining and subsequent processing, huge quantities of fines are generated. This creates problems of space constraint and environmental issues. Also large quantities of ore chrome values are lost as slimes and fines containing enriched chromite content. Due to the increased demand and dwindling stock of good grade chromite ore, and strict environmental rules, it has become binding on the part of industries to utilise the sub-grade dumps,slimes/fines and low grade tailing disposals.

The above challenges open up the scope for research and development for most effective and economic usages of chromite ore resources. The objective target can be of manifold. The first target is at the mines site wherein the optimum care should be taken to ensure minimisation of fines due to mechanised mining. The next focus should be on its value addition during physical beneficiation. Here care should be taken to ensure minimum chromite loss in the tailing disposals in form of fines and slimes. The optimized beneficiation flowsheet should be developed keeping in view the customers requirement.

2.1 The present investigation:

a. Background:

Indian Metals & Ferroalloys Ltd., Bhubaneswar has taken interest to set up the beneficiation plant to recover the chromite values from chromite ore dumps (Lot-1 dumps) available at their mines site. The chromite value in this Lot-1 ore dumps varies from 10-30%. It also contains phosphorus around 0.025%. It needs detail mineralogical characterization to identify the mineral phases present in this ore. The main objective of this project is to enhance the chromite value of this Lot-1 dumps to

more than 40% and simultaneously to reduce the chromite value to less than 10% in the tailings.

IMFA also has another chromite dumps (Lot-2 dumps) with its chromite values varying from 30-40%. IMFA requires IMMT to take up the evaluation jobs on this dump to find out the possibility of reduction in phosphorous after suitable process as suggested by IMMT by carrying out mineralogical characterization and suggesting further action based on the findings after mutual discussion with IMFA.

In this regard, the team of IMFA officials visited CSIR-IMMT, Bhubaneswar and discussed this matter. CSIR-IMMT has agreed to take the responsibility of conducting the above studies on Lot-1 and Lot-2.

b. Objective:

The objective of the project is to develop the process flow-sheet for beneficiation of Lot -1 chromite ore to achieve the desired quality product with maximum recovery and also to find out the possibility of phosphorous reduction in Lot-2 dumps through mineralogical characterization.

c. Scope of work:

The scopes of the work involved in this study are

i) Mineralogical characterization of Lot-1 and Lot-2 chromite ore samples.
ii) Size and chemical analysis of as received samples of Lot-1 and Lot-2 samples
iii) Liberation study of Lot-1 sample
iv) Determination of Bond work index of Lot-1 sample
v) Beneficiation study of Lot-1 sample in different routes at both coarse and fine size depending on its liberation size using spiral, Wilfely table, magnetic separator, flotation etc. Determination of chemical composition

before and after beneficiation

vi) Optimization of the process flow-sheet for Lot-1 sample in pilot scale

vii) Settling study of concentrate and tailings for Lot-1 sample

viii) Filtration study for Lot-1 sample

ix) Material balance for Lot-1 sample

x) Report preparation

2.2 Materials and methods:

Around 10 tons of chromite sample (Lot-1) was received from Sukinda after proper selective identification and blending and mixing of sample at the mines site in the presence of research team of CSIR-IMMT. Representative sample was drawn from the as-received sample for detailed physical, chemical and mineralogical characterization by standard coning and quartering method. Similarly standard sample was also prepared from around 200 kg of Lot-2 sample containing high phosphorus content for detailed characterization study.

After sampling through proper sampling technique, both physical and chemical and mineralogical characterizations were carried out to understand the chemical constituents, particle size distribution and mineralogical constituents of the ore sample. Different techniques like wet chemical method, X-ray diffraction and scanning electron microscope were utilised for this purpose. The samples were studied under scanning electron microscope (SEM) attached with energy dispersive spectroscopy (EDS) system to decipher the distribution of phosphorus in the different phases of the chromite sample. The liberation study of chromite sample (Lot 1) in different size classes was studied under Mineral Liberation Analyser, MLA (Qemscan, Zeiss, Model EVO 50). The characterization of the samples is of importance to understand and modulate the subsequent beneficiation process. Liberation study gives the idea of relative size at which optimum liberation of chromite can be obtained.

Subsequently, different physical beneficiation techniques like scrubbing, classification, spiral concentration, tabling, enhanced gravity separation (Falcon) and flotation were carried to study the amenability of feed sample to beneficiation. Different combinations of these techniques were tried out to develop five different optimised flowsheets to give concentrate and tailings with maximum yield with corresponding grade. Finally techniques like settling and filtration studies were carried out to know the dewatering characteristics of concentrates and tailings.

Annexure 4- Free Silica Analysis report

Issue Date : 29/01/2020

TEST REPORT

Soil/Sediments Analysis

ULR No. : TC699320000000404P

Test Report No. : PRPL/SS/130120-001

Name of the Customer	:	Indian Metals & Ferro Alloys Limited
Name & Address of the project		"Sukinda Mines (Chromite)" at Village: Kaliapani, Tehsil: Sukinda, District: Jajpur, State: Odisha
Location of Sampling & GPS detail	:	Mine Site
Sampling Plan & Procedure	:	PRPL/WP/SS/030
Date of Monitoring/ Date of collection	:	06/01/2020
Date of Receipt of Sample at lab	:	13/01/2020
Sample Description	:	Mineral Sample
Sample Quantity	:	100 gm
Sample Collected by	:	By the Party
Tests started on	:	13/01/2020
Tests Completed on	:	27/01/2020

RESULTS

S.No.	PARAMETER	Unit	Test Method	Results	Range Of Detection
1	Free Silica, by mass	%	IS: I760 (part-6)2001 RA 2017	0.4	-

*Note-The Sample testing has been sub contracted to Shriram Institute for Industrial Research (New Delhi)

Remarks:

1. The results mentioned above relate only to the Sample received and Tested by us.
2. The test report shall not be reproduced either in full or part without the written approval of the Laboratory.
3. Samples received shall be disposed off after one month from the date of issue of Test Report unless specified otherwise.

End of Report

Authorized Signatory

Perfact Researchers Pvt. Ltd. DELHI

Authorized Signatory

Rachna Dogra

CIN: U73200DL2009PTC191202
Registered Office : 506, 5th Floor, NN Mall Sector 3, Rohini, New Delhi-110085
info@perfactgroup.com | www.perfactgroup.com
Phone : 011-49281360

SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH

(A unit of Shriram Scientific and Industrial Research Foundation)

19, University Road, Delhi – 110007 (India)
An ISO - 9001, 14001 & OHSAS 18001 Certified Institute

Website : www.shriraminstitute.org
E-mail id : customercare@shriraminstitute.org

TEST CERTIFICATE NO. : C1/0000206441

Issued To:
Client Code : P0968
PERFACT RESEARCHERS PVT. LTD
506, 5TH FLOOR, NN MALL, MANGALAM PLACE, SECTOR-3, ROHINI
NEW DELHI
DELHI-110085
Kind Attn: MRS. RACHNA DOGRA

Date	27/01/2020
Job No.	2001-1-MIN-1951
Booking No.	RG1920/1/12005
Booking Date	13/01/2020
Customer Ref No.	-
Customer Ref Date	13/01/2020

Sample Description :
ONE UNKNOWN SAMPLE MARKED AS MINERAL SAMPLE WAS RECEIVED.
The sampling has not been carried out by Shriram institute for industrial research.The sample particulars provided in the test certificate are based on declaration by the party.

RESULTS

S.No	Test Carried Out	Test Value	Protocol Used
1.	Free Silica, % by mass	0.4	IS:1760 (part-6)2001 RA 2017

******

D.O.R: 13.01.2020
D.O.C: 27.01.2020

AUTHORISED SIGNATORY
EMPLOYEE CODE : ( )

Phone : 91-11-27667267, 27667983, 27667860 Fax : 91-11-27667676, 27667207

Annexure 5- Plantation details

Sukinda Mines (Chromite)

Plantation Details

EC COMPLIANCE CONDITION:

Plantation shall be raised in an area of 73.01ha including a 7.5m wide green belt in the safety zone around the mining lease by planting the native species around ML area, OB dump, roads etc. in consultation with the local DFO/Agriculture Department. The tree density should be two thousands trees per hectare. At least 1500 trees per year shall be planted.

STATUS:

Plantation for an area of 73.01 hectares will be carried out during the conceptual period as per the approved Mining Plan under Indian Bureau of Mines. The same details submitted to MoEF & CC regional office against the short comings of certified compliance reply.

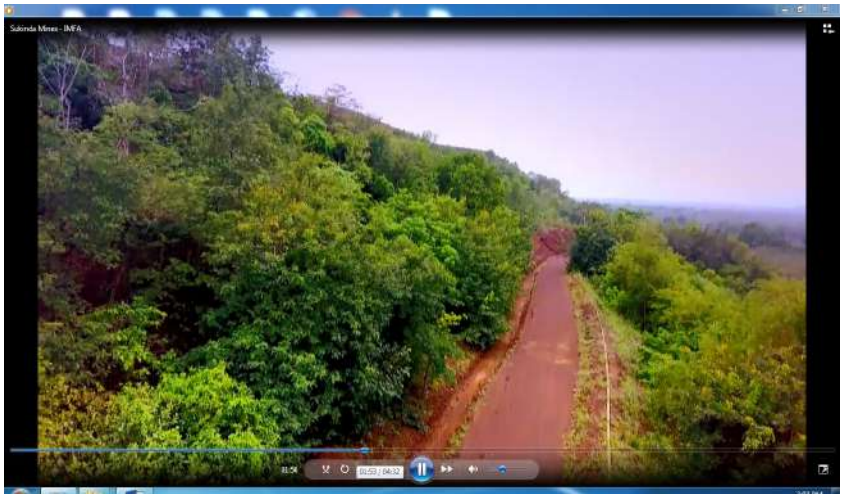
However, in consultation with the local DFO / Agriculture Department, the project is planting at multiple locations including the safety zone and achieved minimum 1,500 saplings per year as per condition.

Regarding Safety zone plantation, plantation has been carried out in the earmarked two patches under FC i.e. the northern & southern side of lease boundary over an area of 4.138 Ha with due approval of State Govt. approval.

The details of coordinates of the plantation areas over dump area, safety zone area and other areas given seperately. KML file showing the plantation area over the above 3 areas along plan showing the attached.

Year	Area Planted in Ha.				No of trees Planted				No .of trees Survived				Survival in %
	Dump Slope	Safety Zone	Other Area	Total	Dump Slope	Safety Zone	Other Area	Total	Dump Slope	Safety Zone	Other Area	Total	
1999-00	0.492	0.150	0	0.642	2214	560	0	2774	1847	490	0	0	0
2000-01	0.680	0.000	0.530	1.210	2617	0	1737	4354	2237	0	1554	3791	87
2001-02	0.631	0.000	0.620	1.251	2817	0	1902	4719	2451	0	1749	4200	89
2002-03	0.586	0.000	0.590	1.176	3268	0	2293	5561	3150	0	1789	4939	89
2003-04	0.560	0.000	0.680	1.240	2577	0	2723	5300	2286	0	2421	4707	89
2004-05	0.615	0.000	0.650	1.265	2806	0	2224	5030	2433	0	1842	4275	85
2005-06	0.640	0.000	0.830	1.470	2224	0	1618	3842	1912	0	1392	3304	86
2006-07	0.880	0.000	0.000	0.880	4006	0	0	4006	3484	0	0	3484	87
2007-08	0.910	0.00	0	0.910	2169	0	0	2169	1962	0	0	1962	90
2008-09	0.960	0.00	0	0.960	2439	0	0	2439	2344	0	0	2344	96
2009-10	1.180	1.00	0.000	2.180	3200	2870	0	6070	3145	2825	0	5970	98
2010-11	1.500	1.00	0.000	2.500	2080	602	0	2682	2046	582	0	2628	98
2011-12	1.500	0.822	0.818	3.140	5430	1256	554	7240	4683	1100	518	6301	87
2012-13	0.230	0.5	0.100	0.830	3235	1500	200	4935	2919	1298	170	4387	89
2013-14	0.500	0.55	0.100	1.150	1565	1695	270	3530	1417	1539	240	3196	90
2014-15	0.000	0.046	0.000	0.046	0	190	0	190	0	174	0	174	92
2015-16	0.540	0.07	0.000	0.610	2860	185	0	3045	2669	148	0	2817	93
2016-17	0.730	0	0.000	0.730	2175	0	0	2175	2035	0	0	2035	94
2017-18	0.550	0	0.000	0.550	1650	0	0	1650	1562	0	0	1562	95
2018-19	0.920	0	0.000	0.920	2765	0	0	2765	2615	0	0	2615	95
2019-20	0.500	0	0.000	0.500	1570	0	0	1570	1570	0	0	1570	100
Total	15.104	4.138	4.918	24.160	53667	8858	13521	76046	48767	8156	11675	66261	87

Note : During the year 2014-15 the mine workings are temporarily discontinued for want of EC & CtO from 01-04-2014 to 30-09-2014 . Hence the proposed plantation of 1500 per annum could not be done for non availability of dead dumping area as per plan.



Plantation in 7.5 m boundary

Plantation on OB dump

Plantation on OB dump

Plantation in 7.5 m boundary

Plantation in 7.5 m boundary

Plantation on OB dump

Plantation in other area

Plantation in 7.5 m boundary

Plantation in 7.5 m boundary

Plantation in other area

PLANTATION AREA OF SUKINDA MINES CHROMITE

85°45'45"E | 85°46'E | 85°46'15"E | 85°46'30"E | 85°46'45"E

21°2'30"N

21°2'15"N

21°2'N

N

W E

S

Scale: 1:2,000

0 0.02 0.04 0.09 0.14 0.18 Kilometers

Other Area Plantation

Other Area Plantation

Other Area Plantation

Safety Zone Plantation

Dump Plantation

Other Area Plantation

ML AREA OF SMC

PLANTATION AREA CO-ORDINATE OF SUKINDA MINES (CHROMITE)										
POINT_ID	LAT_DD	LONG_DD	LAT_DMS			LONG_DMS			GROUP	REMARKS
			D	M	S	D	M	S		
1	21.0340640	85.7613060	21	2	2.63	85	45	40.7	1	Dump Plantation
2	21.0353170	85.7619190	21	2	7.14	85	45	42.91	1	-DO-
3	21.0364970	85.7638920	21	2	11.39	85	45	50.01	1	-DO-
4	21.0365110	85.7645780	21	2	11.44	85	45	52.48	1	-DO-
5	21.0369530	85.7654860	21	2	13.03	85	45	55.75	1	-DO-
6	21.0373720	85.7652530	21	2	14.54	85	45	54.91	1	-DO-
7	21.0375810	85.7659060	21	2	15.29	85	45	57.26	1	-DO-
8	21.0380810	85.7671640	21	2	17.09	85	46	1.79	1	-DO-
9	21.0382810	85.7675080	21	2	17.81	85	46	3.03	1	-DO-
10	21.0387420	85.7678640	21	2	19.47	85	46	4.31	1	-DO-
11	21.0391170	85.7680720	21	2	20.82	85	46	5.06	1	-DO-
12	21.0395610	85.7687780	21	2	22.42	85	46	7.6	1	-DO-
13	21.0398530	85.7686610	21	2	23.47	85	46	7.18	1	-DO-
14	21.0401940	85.7692310	21	2	24.7	85	46	9.23	1	-DO-
15	21.0402750	85.7704060	21	2	24.99	85	46	13.46	1	-DO-
16	21.0399080	85.7705860	21	2	23.67	85	46	14.11	1	-DO-
17	21.0396060	85.7705720	21	2	22.58	85	46	14.06	1	-DO-
18	21.0392920	85.7703140	21	2	21.45	85	46	13.13	1	-DO-
19	21.0389000	85.7699500	21	2	20.04	85	46	11.82	1	-DO-
20	21.0386640	85.7698000	21	2	19.19	85	46	11.28	1	-DO-
21	21.0384970	85.7698140	21	2	18.59	85	46	11.33	1	-DO-
22	21.0385110	85.7700390	21	2	18.64	85	46	12.14	1	-DO-
23	21.0391250	85.7706890	21	2	20.85	85	46	14.48	1	-DO-
24	21.0395190	85.7709360	21	2	22.27	85	46	15.37	1	-DO-
25	21.0400670	85.7709110	21	2	24.24	85	46	15.28	1	-DO-
26	21.0406470	85.7706030	21	2	26.33	85	46	14.17	1	-DO-
27	21.0406420	85.7694330	21	2	26.31	85	46	9.96	1	-DO-
28	21.0406940	85.7688940	21	2	26.5	85	46	8.02	1	-DO-
29	21.0400060	85.7677250	21	2	24.02	85	46	3.81	1	-DO-
30	21.0395670	85.7672500	21	2	22.44	85	46	2.1	1	-DO-
31	21.0391470	85.7668140	21	2	20.93	85	46	0.53	1	-DO-
32	21.0386030	85.7656920	21	2	18.97	85	45	56.49	1	-DO-
33	21.0380190	85.7644330	21	2	16.87	85	45	51.96	1	-DO-
34	21.0378780	85.7638640	21	2	16.36	85	45	49.91	1	-DO-
35	21.0376560	85.7633750	21	2	15.56	85	45	48.15	1	-DO-
36	21.0370780	85.7625420	21	2	13.48	85	45	45.15	1	-DO-
37	21.0368560	85.7621310	21	2	12.68	85	45	43.67	1	-DO-
38	21.0359080	85.7606110	21	2	9.27	85	45	38.2	1	-DO-
39	21.0356780	85.7604780	21	2	8.44	85	45	37.72	1	-DO-
40	21.0354330	85.7605440	21	2	7.56	85	45	37.96	1	-DO-
41	21.0352060	85.7606860	21	2	6.74	85	45	38.47	1	-DO-
42	21.0350080	85.7606830	21	2	6.03	85	45	38.46	1	-DO-
43	21.0369080	85.7684610	21	2	12.87	85	46	6.46	1	-DO-
44	21.0382170	85.7690940	21	2	17.58	85	46	8.74	1	-DO-
45	21.0380860	85.7693580	21	2	17.11	85	46	9.69	1	-DO-
46	21.0367640	85.7688220	21	2	12.35	85	46	7.76	1	-DO-
47	21.0293970	85.7736920	21	1	45.83	85	46	25.29	1	-DO-
48	21.0294560	85.7736610	21	1	46.04	85	46	25.18	1	-DO-
49	21.0299720	85.7742780	21	1	47.9	85	46	27.4	1	-DO-
50	21.0310720	85.7756030	21	1	51.86	85	46	32.17	1	-DO-
51	21.0314170	85.7765280	21	1	53.1	85	46	35.5	1	-DO-
52	21.0316670	85.7772500	21	1	54	85	46	38.1	1	-DO-
53	21.0316330	85.7773220	21	1	53.88	85	46	38.36	1	Dump Plantation
1	21.0410720	85.7686390	21	2	27.86	85	46	7.1	2	Safety Zone Plantation
2	21.0407890	85.7687530	21	2	26.84	85	46	7.51	2	-DO-
3	21.0401310	85.7677640	21	2	24.47	85	46	3.95	2	-DO-
4	21.0400720	85.7678220	21	2	24.26	85	46	4.16	2	-DO-
5	21.0380780	85.7643610	21	2	17.08	85	45	51.7	2	-DO-
6	21.0381170	85.7639670	21	2	17.22	85	45	50.28	2	-DO-
7	21.0366780	85.7617690	21	2	12.04	85	45	42.37	2	-DO-
8	21.0369310	85.7615360	21	2	12.95	85	45	41.53	2	-DO-
1	21.0296190	85.7733810	21	1	46.63	85	46	24.17	2	-DO-
2	21.0296530	85.7734440	21	1	46.75	85	46	24.4	2	-DO-
3	21.0293580	85.7736390	21	1	45.69	85	46	25.1	2	-DO-
4	21.0293080	85.7735940	21	1	45.51	85	46	24.94	2	-DO-
1	21.0293970	85.7736920	21	1	45.83	85	46	25.29	2	-DO-

2	21.0294560	85.7736610	21	1	46.04	85	46	25.18	2	-DO-
3	21.0299720	85.7742780	21	1	47.9	85	46	27.4	2	-DO-
4	21.0310720	85.7756030	21	1	51.86	85	46	32.17	2	-DO-
5	21.0314170	85.7765280	21	1	53.1	85	46	35.5	2	-DO-
6	21.0316670	85.7772500	21	1	54	85	46	38.1	2	-DO-
7	21.0316330	85.7773220	21	1	53.88	85	46	38.36	2	-DO-
1	21.0316640	85.7774170	21	1	53.99	85	46	38.7	2	-DO-
2	21.0317080	85.7773670	21	1	54.15	85	46	38.52	2	-DO-
3	21.0318330	85.7777780	21	1	54.6	85	46	40	2	-DO-
4	21.0319420	85.7780390	21	1	54.99	85	46	40.94	2	-DO-
5	21.0320470	85.7780890	21	1	55.37	85	46	41.12	2	-DO-
6	21.0320220	85.7781280	21	1	55.28	85	46	41.26	2	-DO-
7	21.0318940	85.7780720	21	1	54.82	85	46	41.06	2	Safety Zone Plantation
1	21.0351060	85.7606140	21	2	6.38	85	45	38.21	3	Other Area Plantation
2	21.0352060	85.7606860	21	2	6.74	85	45	38.47	3	-DO-
3	21.0354330	85.7605440	21	2	7.56	85	45	37.96	3	-DO-
4	21.0356780	85.7604780	21	2	8.44	85	45	37.72	3	-DO-
5	21.0359080	85.7606110	21	2	9.27	85	45	38.2	3	-DO-
6	21.0366420	85.7617890	21	2	11.91	85	45	42.44	3	-DO-
7	21.0369310	85.7615360	21	2	12.95	85	45	41.53	3	-DO-
8	21.0360500	85.7599920	21	2	9.78	85	45	35.97	3	-DO-
1	21.0410720	85.7686390	21	2	27.86	85	46	7.1	3	-DO-
2	21.0407890	85.7687530	21	2	26.84	85	46	7.51	3	-DO-
3	21.0407250	85.7695190	21	2	26.61	85	46	10.27	3	-DO-
4	21.0407420	85.7702530	21	2	26.67	85	46	12.91	3	-DO-
5	21.0406610	85.7706420	21	2	26.38	85	46	14.31	3	-DO-
6	21.0403500	85.7708170	21	2	25.26	85	46	14.94	3	-DO-
7	21.0400580	85.7709310	21	2	24.21	85	46	15.35	3	-DO-
8	21.0394970	85.7709170	21	2	22.19	85	46	15.3	3	-DO-
9	21.0390080	85.7705750	21	2	20.43	85	46	14.07	3	-DO-
10	21.0385060	85.7700810	21	2	18.62	85	46	12.29	3	-DO-
11	21.0381580	85.7701110	21	2	17.37	85	46	12.4	3	-DO-
12	21.0379670	85.7710250	21	2	16.68	85	46	15.69	3	-DO-
13	21.0373580	85.7713030	21	2	14.49	85	46	16.69	3	-DO-
14	21.0374220	85.7714190	21	2	14.72	85	46	17.11	3	-DO-
15	21.0382690	85.7710530	21	2	17.77	85	46	15.79	3	-DO-
16	21.0383170	85.7704560	21	2	17.94	85	46	13.64	3	-DO-
17	21.0386110	85.7703670	21	2	19	85	46	13.32	3	-DO-
18	21.0387830	85.7705500	21	2	19.62	85	46	13.98	3	-DO-
19	21.0386830	85.7709220	21	2	19.26	85	46	15.32	3	-DO-
20	21.0392560	85.7711280	21	2	21.32	85	46	16.06	3	-DO-
21	21.0399690	85.7711810	21	2	23.89	85	46	16.25	3	-DO-
22	21.0407690	85.7709940	21	2	26.77	85	46	15.58	3	-DO-
23	21.0413440	85.7697720	21	2	28.84	85	46	11.18	3	-DO-
1	21.0421440	85.7717360	21	2	31.72	85	46	18.25	3	-DO-
2	21.0418280	85.7713000	21	2	30.58	85	46	16.68	3	-DO-
3	21.0415000	85.7714920	21	2	29.4	85	46	17.37	3	-DO-
4	21.0410860	85.7709190	21	2	27.91	85	46	15.31	3	-DO-
5	21.0405780	85.7712000	21	2	26.08	85	46	16.32	3	-DO-
6	21.0396720	85.7712830	21	2	22.82	85	46	16.62	3	-DO-
7	21.0392080	85.7712640	21	2	21.15	85	46	16.55	3	-DO-
8	21.0380190	85.7714500	21	2	16.87	85	46	17.22	3	-DO-
9	21.0381970	85.7717530	21	2	17.51	85	46	18.31	3	-DO-
10	21.0388190	85.7715810	21	2	19.75	85	46	17.69	3	-DO-
11	21.0395940	85.7715810	21	2	22.54	85	46	17.69	3	-DO-
12	21.0397690	85.7718860	21	2	23.17	85	46	18.79	3	-DO-
13	21.0402970	85.7718170	21	2	25.07	85	46	18.54	3	-DO-
14	21.0405670	85.7721640	21	2	26.04	85	46	19.79	3	-DO-
15	21.0406750	85.7727500	21	2	26.43	85	46	21.9	3	-DO-
1	21.0394000	85.7736360	21	2	21.84	85	46	25.09	3	-DO-
2	21.0389750	85.7735580	21	2	20.31	85	46	24.81	3	-DO-
3	21.0384690	85.7725970	21	2	18.49	85	46	21.35	3	-DO-
4	21.0379830	85.7716190	21	2	16.74	85	46	17.83	3	-DO-
5	21.0376440	85.7719500	21	2	15.52	85	46	19.02	3	-DO-
6	21.0381580	85.7728360	21	2	17.37	85	46	22.21	3	-DO-
7	21.0383190	85.7734830	21	2	17.95	85	46	24.54	3	-DO-
8	21.0388250	85.7740170	21	2	19.77	85	46	26.46	3	-DO-
1	21.0349720	85.7662750	21	2	5.9	85	45	58.59	3	-DO-
2	21.0350530	85.7662060	21	2	6.19	85	45	58.34	3	-DO-
3	21.0366000	85.7688690	21	2	11.76	85	46	7.93	3	-DO-

4	21.0330190	85.7713360	21	1	58.87	85	46	16.81	3	-DO-
5	21.0329470	85.7711690	21	1	58.61	85	46	16.21	3	-DO-
6	21.0364330	85.7688500	21	2	11.16	85	46	7.86	3	-DO-
1	21.0359390	85.7759830	21	2	9.38	85	46	33.54	3	-DO-
2	21.0359000	85.7758580	21	2	9.24	85	46	33.09	3	-DO-
3	21.0325500	85.7781670	21	1	57.18	85	46	41.4	3	-DO-
4	21.0325860	85.7782530	21	1	57.31	85	46	41.71	3	-DO-
1	21.0314360	85.7758940	21	1	53.17	85	46	33.22	3	-DO-
2	21.0309220	85.7747970	21	1	51.32	85	46	29.27	3	-DO-
3	21.0314670	85.7746530	21	1	53.28	85	46	28.75	3	-DO-
1	21.0315030	85.7742280	21	1	53.41	85	46	27.22	3	-DO-
2	21.0306080	85.7731310	21	1	50.19	85	46	23.27	3	-DO-
3	21.0300310	85.7734580	21	1	48.11	85	46	24.45	3	-DO-
4	21.0304860	85.7741030	21	1	49.75	85	46	26.77	3	-DO-
1	21.0295330	85.7737580	21	1	46.32	85	46	25.53	3	-DO-
2	21.0298780	85.7735250	21	1	47.56	85	46	24.69	3	-DO-
3	21.0302310	85.7739780	21	1	48.83	85	46	26.32	3	-DO-
1	21.0299440	85.7742000	21	1	47.8	85	46	27.12	3	-DO-
2	21.0301560	85.7740530	21	1	48.56	85	46	26.59	3	-DO-
3	21.0307360	85.7747000	21	1	50.65	85	46	28.92	3	-DO-
4	21.0305110	85.7748920	21	1	49.84	85	46	29.61	3	-DO-
5	21.0302560	85.7745860	21	1	48.92	85	46	28.51	3	-DO-
6	21.0304250	85.7744030	21	1	49.53	85	46	27.85	3	-DO-
1	21.0307080	85.7726560	21	1	50.55	85	46	21.56	3	-DO-
2	21.0307560	85.7727670	21	1	50.72	85	46	21.96	3	-DO-
3	21.0296560	85.7734420	21	1	46.76	85	46	24.39	3	-DO-
4	21.0296360	85.7733690	21	1	46.69	85	46	24.13	3	Other Area Plantation

Annexure 6- Compliance status of Site-specific wildlife conservation Plan

OFFICE OF THE DIVISIONAL FOREST OFFICER: CUTTACK FOREST DIVISION
AT:- GHATAKULA, NUAPADA, CUTTAK 753010
Tel:- 0671-2340443 FAX:- 0671-2347611 Email:- dfo.cuttackforest division@yahoo.com

No 751 /5F(Misc) /2017
Dated, Cuttack the 29 th January, 2020.

To

Sanjeev Das, Sr. Vice President,
Head-Mining Business Unit, IMFA Ltd.

Sub:- Issue of certified compliance status against the conditions prescribed in the Site Specific Wildlife Conservation Plan implemented by Project Proponent in respect of Sukinda Mines (Chromite) of M/s IMFA Ltd.

Ref:- Your Letter No. IMFA/MPC/SMC/2019/94 dt. 02.01.2020.

Sir,

In response to your letter cited above on the captioned subject, the certificate is hereby issued regarding compliance status against the conditions prescribed in the Site Specific Wildlife Conservation Plan.

Encl: As above.

Yours faithfully

29/01/2020

Divisional Forest Officer
Cuttack Forest Division

CERTIFICATE

This is to certify that the Site Specific Wildlife Conservation Plan submitted by the Project proponent i.e. M/s IMFA Ltd. for Sukinda Mines (Chromite) has been approved by the Principal Chief Conservator of Forests (WL) & Chief Wildlife Warden, Odisha vide his letter No. 10061/IWL-SSP-181/2015 dt. 18.11.2015. The activities approved in Site Specific Wildlife Conservation Plan is being implemented by the DFO, Cuttack Forest Division. The approved activities which are to be taken up by the project proponent are also being implemented by the Project Proponent.

29/02/2020

Divisional Forest Officer
Cuttack Forest Division

Divisional Forest Officer
Cuttack Forest Division

Annexure 7- Details of ETP performance & sludge management Plan

Introduction

IMFA operates one of the chromite mines in India at the Sukinda Valley in Odisha. The chrome ore produced is subsequently converted into Ferro Chrome and sold to customers across the world. A large quantity of water, generated during mining and due to rainfall, needs to be handled during the mining operations. Chrome Ore mainly contains trivalent chromium oxide and a very small fraction of hexavalent di-chromate. Water coming in contact with chromium ore preferentially leaches out soluble hexavalent chromium from the ore body, as a result, water from the mine contains 0.63 mg/l of hexavalent chromium requiring all water to be treated before its release from the mines. Thus, IMFA has set up an Effluent Treatment Plant at Sukinda with a capacity of 8640 KLD.

Describing Sukinda and its importance to India

Sukinda Valley, known for its high grade chromite deposits, is located in eastern state of Odisha, India. This valley contains 99% of India's chromite deposit. The ultramafic mass occurs sporadically over an area of 420 sq.km around Sukinda. IMFA's Sukinda Chromite Mines, with a mine extending over 116.76 ha., is one of the largest chrome mines in India.

Chrome Ore

Chrome ore occurs as Chromite, which is chromium oxide (Cr_2O_3), and is essentially in the form of unweathered, hard, compact, fine grained dark grey lumpy ore or as a weathered, and loosely bonded, brown-black, friable ore in ultra-basic host rock. Chromite contains mainly stable trivalent oxide of Chromium with a small fraction in the unstable hexavalent state.

Hexavalent Chromium

While trivalent compounds of chromium ore are not soluble in water, hexavalent chromium compounds are. Water coming in contact with chromium ore leaches out soluble hexavalent chromium from ore body.
Hexavalent Chromium (Cr^{+6}) is considered a human carcinogen with geno-toxic properties.
Hexavalent chromium can cause the following diseases:

- Ingestion of hexavalent chromium contaminated water causes irritation and ulcers in the stomach and the intestines.
- Contact with hexavalent chromium (in the form of dust or dissolved in water) with soft mucous tissues of the eyes and the nose can lead to irritation and ulceration.
- Exposure to liquids/water contaminated with hexavalent chromium causes allergic skin reactions.

There is no evidence of elevated levels of these diseases (compared to the national and the state average) in the valley. Another study, by Utkal Polyclinic, has also showed a lower incidence of skin diseases in the Sukinda Valley, which, due to the allergic effects of Cr^{+6} on skin, is contrary to expectations. This is probably due to the low levels of Cr^{+6} found naturally (and in Sukinda).

Water Management at Sukinda Mines

The Sukinda Valley experiences about 110 cm to 180 cm of rainfall annually, of which eighty percent (80%) occurs during the monsoon season i.e. between June and September. Owing to this highly uneven distribution of rain, the weather in the Sukinda Valley ranges from extremely dry to extremely wet.

The major portion of the rain goes as surface runoff and flows through the garland drains, that have been made around the quarries and dumps. The flow carries silt and dry vegetation with it, apart from picking up hexavalent chromium as it trickles down the chrome rich quarries and dumps. These drains also channel the water pumped out during mining operations.

Source & Quantity of water

The CGWA NOC has been obtained for i.e. 3500 Cu.m/day includes freshwater requirement for domestic use of 240 Cu.m and 3260 Cu.m for dewatering mines seepage. The dewatered seepage water will be used for sprinkling on haulage roads, drilling, wheel washing and plantation after treatment through ETP plant.

Total water requirement for the project is 1240 Cu.m / Day (During peak summer season), in which 240 Cu.m / day for domestic uses and 1000 Cu.m for industrial uses. **The freshwater requirement is only 240 Cu.m/day which is only for the domestic uses** and water requirement for industrial uses i.e. 1000 Cu.m will meet from mine seepage water after treatment. The process-wise water requirement is given below.

During Peak Summer Period:

Water for Drinking & Domestic	:	240	KLD
Water for Sprinkling	:	710	KLD
Water for Green belt	:	100	KLD
COB plant makeup water	:	160	KLD
Wheel Washing	:	020	KLD
Mines drilling purpose	:	010	KLD
Total	:	1240	KLD

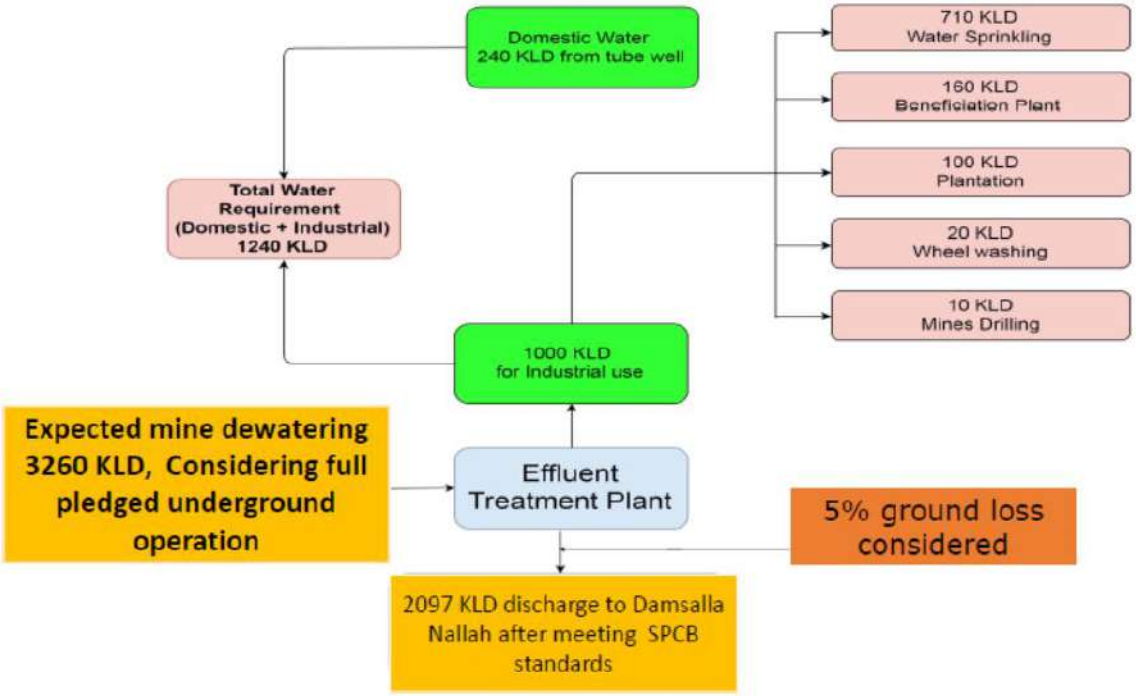


Figure 1. Water balance during peak summer period

During Monsoon Period:

Water for Drinking & Domestic	:	240	KLD
Water for Sprinkling	:	000	KLD
Water for Green belt	:	000	KLD
COB plant makeup water	:	160	KLD
Wheel Washing	:	20	KLD
Mines drilling purpose	:	10	KLD
Total	:	430	KLD

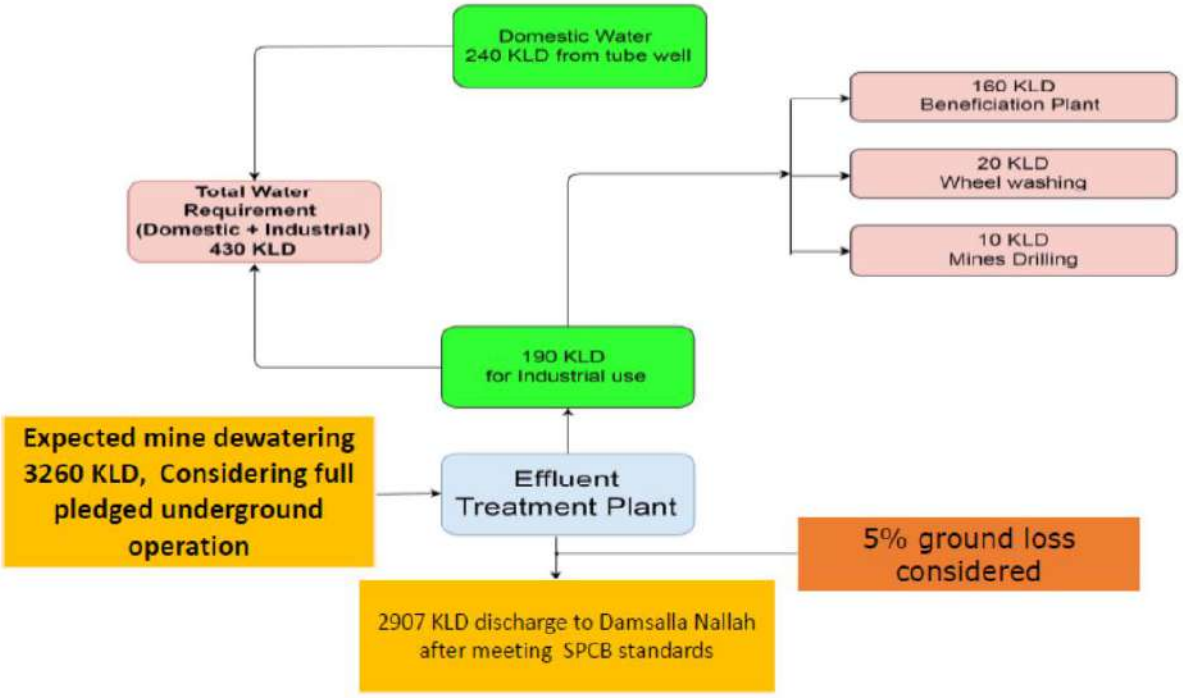


Figure 2. Water balance during monsoon period

Quantity & source of water to be treated in ETP

From the above table & figure it is reiterated that mine seepage water i.e. 3260 KLD and Surface run off water will be treated in ETP.
The quantity of surface runoff water to be treated in ETP is given below:

Run off Details:

Table 1. Run off details

Maximum Runoff Calculation For Day							
Heads	**Unit**		**Area**	**Maximum Rainfall in 24 Hrs in m**	**Coefficient of Runoff**	**Volume in Cu.m**	**Available Reservoir /Settling tank**
Total Lease Area	Ha.		116.76				
Catchment 1	Ha.	QC LAB,WORKSHOP,WESTERN SIDE OF THE BAND	6.88	0.206	0.35	4960.48	4140

		II,MINERAL STORAGE YARD					
Catchment 2	Ha.	MINERAL STORAGE AND ETP AREA	12.15	0.206	0.35	8760.15	2304
Catchment 3	Ha.	Central Ore PLot and subgrade dump	25.54	0.206	0.35	18414.34	5520
Catchment 4	Ha.	OB dump northern part	11.5	0.206	0.35	8291.5	1200
Catchment 5	Ha.	Opencast quarry and southern part of OB dump	60.69	0.206	0.35	43757.49	MINE BOTTOM
Total						**84183.96**	
Maximum Runoff Calculation For Monthly Average							
Heads	**Unit**		**Area**	**Daily average Rainfall in m**	**Coefficient of Runoff**	**Volume in Cu.m**	**Available Reservoir /Settling tank**
Total Lease Area	Ha.		116.76				
Catchment 1	Ha.	QC LAB,WORKSHOP,WESTERN SIDE OF THE BAND II,MINERAL STORAGE YARD	6.88	0.02	0.35	481.6	4140
Catchment 2	Ha.	MINERAL STORAGE AND ETP AREA	12.15	0.02	0.35	850.5	2304
Catchme	Ha.	Central Ore	25.54	0.02	0.35	1787.8	5520

nt 3		PLot and subgrade dump					
Catchment 4	Ha.	OB dump northern part	11.5	0.02	0.35	805	1200
Catchment 5	Ha.	Opencast quarry and southern part of OB dump	60.69	0.02	0.35	4248.3	MINE BOTTOM
Total						**8173.2**	

Runoff Management Structures

Table 2. Runoff Management Structures

A	**Settling Ponds Sukinda Mines (Chromite)**		
	Description	**Dimension in m**	**Volume in Cu.m**
a.	Settling pit no. 1 (Near Magazine)	92 x 15 x 3.0 (MTR) & 48 x 12 x 4.0 (MTR)	4140 2304
Total			**6444**
b.	Settling pit No -2 (Intermediate Sump)	60 x 17 x 4 (MTR) 60 x 08 x 3 (MTR)	4080 1440
Total			**5520**
c.	Settling Pit No -3 (Near ETP 2)	34 x 15 x 2.5 (MTR)	1275
B.	**Collection Sump of the Sukinda Mines Open quarry**		
	Bottom two benches of the opencast quarry are being used as sump during the rainy season. The dimensions of present bottom two benches are as follows:		
a.	1st bench bottom	175 x 20 x 5 (MTR)	17500
b.	2nd bench bottom	290 x 40 x 8 (MTR)	92800
Total			**110300**

TREATMENT TECHNOLOGY & CAPACITY OF ETP

1. Evaluation of various techniques to treat Cr^{+6} and why $FeSO_4$ technology has been selected

There are many solutions to eliminate hexavalent chromium from water. Some technologies are well established and in use commercially for specific situations. There are also some innovative solutions that have been proved experimentally. A summary of the available technologies, and the reasons for the selection of the $FeSO_4$ technology is summarized in the table below:

Table 3. Comparison of technology

S.No.	Technology	Process Details	Advantages	Disadvantages	Suitability to treatment of mine water
1.	Physical adsorption of soluble chromium ions (Cr+6)	Use of absorbents like activated charcoal, zeolites etc.	Fast Kinetics-able to deal with large volume of water Low Cost	Narrow pH range, Fouled by suspended solids, tolerance	Unsuitable due to TSS & pH
2.	Electrochemical treatment	Electro-coagulation by electrolytic oxidation of the sacrificial electrode.	Wide pH range tolerant to suspended solids	Cost (sacrificial electrode & electricity) High sludge, moderate kinetics in low concentration	Unsuitable due to cost, moderate speed of treatment in low concentration.
3.	Osmosis/Membrane separation	Using Ultrafiltration membrane to remove Cr+6 ions based on size exclusion	High removal efficiency (>85%) Low solid generation, Low chemical consumption	Narrow pH range, Fouled by suspended solids, High cost of membrane	Unsuitable due to high cost., low speed of treatment.
4	Bioremediation	Using Microbes, especially bacteria capable of Chromium (VI) reduction	Eco-friendly Highly selective operational flexibility (can be grown in existing drains)	Narrow pH & temperature range, Fouled by suspended solids, oil & other contaminants, effect of bacteria on animals & humans not known fully	Unsuitable due to intolerance to variations in pH, temperature, contaminants & possible ill effects of bacteria.

5.	Phyto-remediation	Using plants which accumulate toxic compounds i.e. Chromium (VI)	Very cost effective has aesthetic advantages & long term applicability Eco-friendly tolerant to pH & suspended solids	Very slow process, Phytotoxic at high concentration. High space requirement, Plant waste needs to be buried.	Unsuitable due to the very low process kinetics, Large space requirements & possible ill effects of plant bio-mass.
6	Chemical Precipitation	Chemical Reduction of soluble Cr^{+6} to insoluble Cr^{+3}	Fast reaction Time tested Tolerant to variations in pH and to high TSS Medium Capex Simple well understood operation	High Sludge generation, Extra operational cost for sludge disposal	Method chosen due to prior experience, fast reaction time, low space requirement. Tolerance to TSS, pH, temperature variations, very well understood process.

**Ref: IFA/ABP/389/2013- Dr Y Rama Murthy et al, Jun-14 (ref.1)*

Treatment Process Description:

The treatment process include:

1. Flash mixer
2. Clarifloculator
3. Chemical dozing
4. Supernatant sump
5. Multigrade Pressure sand filter (MPSF)
6. Sludge sump
7. Filter press
8. Sludge container

For getting efficient treatment in less time, the following things were considered while selecting chemical precipitation procedure:

a) Highly efficient and fast reaction for the reduction of hexavalent chromium Cr^{+6} to Cr^{+3}.
b) Rapid flocculation of precipitated Cr^{+3} compounds to reduce residence time in the Clariflocculator, while enabling control of TSS within statutory limits.

Both the above are necessary to increase the throughput of the ETP and enable treatment of a large volume of water in a short time.

- Mined seepage water is pumped out and surface runoff water through graland drain etc is passed through pipeline into ETP for treatment. At the ETP water is passed through the flash mixture where the chemical dozing is done.
- Acid Dozing of raw effluent in a flash mixer is done to bring down the pH before reaction with $FeSO_4$ since the $FeSO_4$ reaction is most efficient at a low pH. Also, because of the efficient reaction at low pH, the consumption of $FeSO_4$, and the amount of sludge generated can be substantially reduced.
- Stirring arrangements are made in the flash mixer and a reaction channel to allow for complete reduction of hexavalent chromium.
- pH correction using an alkali before dozing with a polyelectrolyte, to ensure complete reaction, as polyelectrolyte reaction needs a neutral pH, along with a stirring arrangement. The alkali recommended for pH reduction is NaOH.

Principle of Reduction

Hexavalent Chromium is a strong oxidizing agent and can readily be reduced to trivalent chromium by adding Ferrous Sulphate ($FeSO_4$). After proper mixing with Ferrous Sulphate the hexavalent Chromium (Cr^{6+}) is reduced to trivalent chromium (Cr^{3+}) while Ferrous ion (Fe^{2+}) is oxidized to Ferric Ion (Fe^{3+}).

Further by adding alkali reagent i.e. Sodium Hydroxide (NaOH), the ferric ion is precipitated as Ferric Hydroxide ($Fe(OH)_3$). Both the precipitates Chromium hydroxide ($Cr(OH)_3$) & Ferric Hydroxide ($Fe(OH)_3$) get coagulated along with other suspended solids and ultimately settle down in a settling tank.

A. If water contains Chromates (CrO_4^{2-})
   $2NaCrO_4 + 6FeSO_4 + 6H_2O = 2Na_2O + Cr_2O_3 + 3Fe_2O_3 + 6H_2SO_4$

B. If water contains Dichromates ($Cr_2O_7^{2-}$)
   $Na_2Cr_2O_7 + 6FeSO_4 + 6H_2O = Na_2O + Cr_2O_3 + 3Fe_2O_3 + 6H_2SO_4$

C. Ferric ion and Cr^{3+} removal
   $Cr_2O_3 + 6NaOH = 2Cr(OH)_3 + 3Na_2O$
   $Fe_2O_3 + 6NaOH = 2Fe(OH)_3 + 3Na_2O$

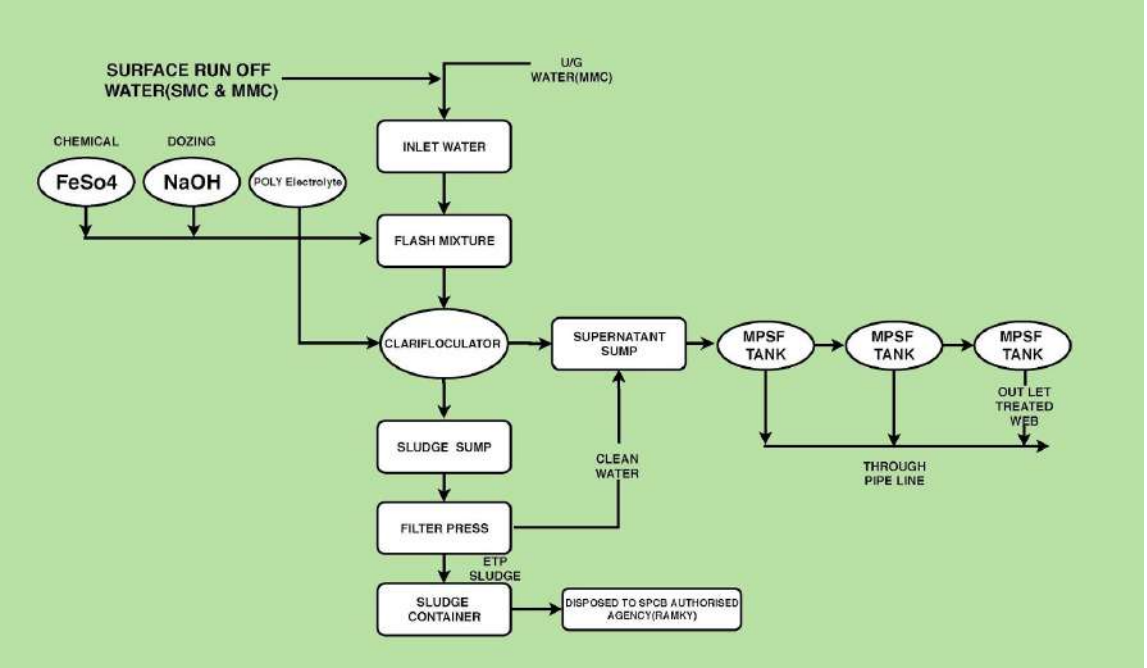


Figure 3. Schematic Flow Diagram of ETP

Characteristics of Raw & Treated Sewage:

Table 4. Inlet Characteristics (Design Parameters)

Parameters	Unit	Concentration
pH		6.5-9.5
TSS	mg/l	200-300
TDS	mg/l	300-500
Total Chromium	mg/l	5-10

Table 5. Treated Effluent Characteristics (Design Parameters)

Parameters	Unit	Standards
pH		6.5-8.5
TSS	mg/l	10

TDS	mg/l	500
Total Chromium	mg/l	0.02

ETP Structures Dimensions

Table 6. ETP Capacity

Plant Capacity Per Day in Cu. m	8640
Plant Capacity in Hour in Cu.m	360
Plant Capacity per minutes in Cu.m	6
Treatment Concept	Clarifloculation followed by Polishing treatment

Table 7. Dimensions of ETP Structures

	Dimension	**Length in m**	**Breadth in m**	**Depth in m**	**Volume in Cu.m**	**Retention time in minutes**	**Standard Retention time in minutes**
Flash mixing tank	(1.6 x 1.6 x 1.25 SWD) m + 0.4m FB	1.6	1.6	1.25	3.2	0.53	0.5
Clariflocculator Tank	(26 ⌀ x 3.5 + 0.50 FB) meter	26 dia		3.5	1857.31	309.55	180
Supernatant Tank	(20.5x 5.3 x 4.0 SWD) m + 0.50 FB	20.5 dia		4	1319.585	219.93	180
Sludge Sump	(5.3 x 2x 4.0 SWD) m + 0.50 FB	5.3	2	4	42.4	141.33	180
$FeSO_4$ Dosing Tank					4		
Poly Dosing					1		

Tank							
NaOH Dosing Tank					1		

ETP Chemical Dozing Rate

Table 8. ETP Chemical Dozing Rate

$FeSO_4$	60 to 80 gm/Cu.m
NaOH	2 to 2.5 gm/Cu.m
Polyelectrolyte	1 to 1.5 gm/Cu.m

Performance evaluation of ETP:

The surface runoff water and the quarry water are pumped to ETP for treatment. Total Chromium & Hexavalent chromium quantity in ETP inlet outlet is given below:

Sample Code	-	Standard (Effluent discharge), as per EPA notification	ETP Inlet	ETP Clarifier Tank	Settling Pond	ETP Outlet
pH Value		**5.5-9**	7.23	8.57	7.89	7.06
Total Dissolved Solids	mg/l	-	189.3	224	94.65	231.2
Total Chromium	mg/l	2	4.2	0.85	0.32	0.19
Hexavalent Chromium	mg/l	0.1	0.63	0.033	0.027	0.014
BOD	mg/l	30	45	20	11	8
COD	mg/l	250	240	72	32	24
TSS	mg/l	100	225	32	26	9
Oil & Grease	mg/l	10	22	11	12	4

From above it can be seen that outlet water from ETP is 0.014 mg/l which is below the standard effluent discharge norms.

Sludge handling:

Details of Sludge Generation & Its Management

Table 9. Sludge generation

Sludge generation per hour	18
Sludge generation per minute	0.3
Sludge generation per day in Cum	432
Solid Content in sludge gm/cum	84
Solid content in a day in kg	725.76
Solid content in kg per year	264902.4
Solid Sludge per year in Tons	2649024
Sludge generation	200 MT/annum

The sludge generated is lifted by the authorised vendor (Ramky) and is disposed of at the TSDF site. Same will be followed after expansion.

UNIQUE FEATURES OF THE EFFLUENT TREATMENT PLANT

The Effluent treatment plant constructed at Sukinda Mines (Chromite) has many unique features (Table-10)

a. 24/7 real-time monitoring of the input raw effluent and output treated water for Cr^{+6}, pH and TSS through online monitors installed at both input (raw effluent) and output (treated water). This prevents any inadequately treated effluent from leaving the mine and give warning signals if the treated output water quality is not up to the mark.
b. The ETP is highly automated, with a feedback mechanism. Thus the dozing of chemicals (acid, $FeSO_4$, alkali and flocculants) is automated through a system of PLC based controllers, based on the input raw effluent and the output water quality.
c. Automated backwash arrangements for the pressure sand filters to ensure that the filters do not choke.

Table 10. Unique Features of the Effluent Treatment Plant at Sukinda Mines (Chromite)

ETP Technology	**Additional Facilities**
Technology chosen is- - Highly efficient & rapidly reduces hexavalent chromium to trivalent chromium - Causes rapid flocculation of precipitated Cr^{+3} compounds - Reduces residence time in the Clariflocculator, while enabling control of TSS within statutory limits *This has increased the throughput of the ETP and enables treatment of a large*	I. Acid Dozing of the raw effluent in a flash mixer to bring down the pH before reaction with $FeSO_4$ since the $FeSO_4$ reaction is most efficient at a low pH. Also, because of the efficient reception at low pH, the consumption of $FeSO_4$ and the amount of sludge generated is substantially reduced. Ii. Stirring arrangement in the flash mixer and a reaction channel to allow for complete reduction of hexavalent chromium. iii. pH correction using an alkali before

volume of water in a short time.	dozing with a polyelectrolyte, to ensure complete reaction, as polyelectrolyte reaction needs a neutral pH, along with a stirring arrangement.
Design Elements	**Online Monitoring & Automation**
The Effluent Treatment Plant is so designed that: - The output not only meets current specifications for treated effluents in non-urbanized areas, but in order to be future ready, meet the specifications for treated effluents in both urban areas and the likely stricter norms for treated effluents that are likely to be imposed in the future. - The plant has been designed such that the output has less than 0.01 mg/l of Cr+6 against a norm of 0.05 mg/l and meets the stricter TSS standard of <10 mg/l (drinking water specifications) against a norm of <100 mg/l (norms for treated effluents in non-urbanized areas) - Treat both Surface runoff water and mine water in the same way.	The ETP has state of art online monitoring & automation systems: a. 24/7 real-time monitoring of the input raw effluent and output treated water for Cr^{+6}, pH & TSS through online monitors installed at both input (raw effluent) and output (treated water) to prevent any inadequately treated effluent from leaving the mine and give warning signals if the treated output water quality is not up to the mark. b. The ETP is highly automated, with a feedback mechanism. Thus the dosing of chemicals (acd, $FeSO_4$, alkali and flocculants) is automated through a system of PLC based controllers, based on the input raw effluent and the output water quality. c. Automated backwash arrangements for the pressure sand filters to ensure that the filters do not choke.

Real Time Monitoring of Data

For real-time monitoring of data, we have set up a data communication system that captures real-time information from the analysers for Cr^{+6}, TSS and pH installed at the outlet in a server and transmit the data thus captured automatically to OPCB/CPCB server on real basis. The schematic of data transmission is shown in Fig-4.

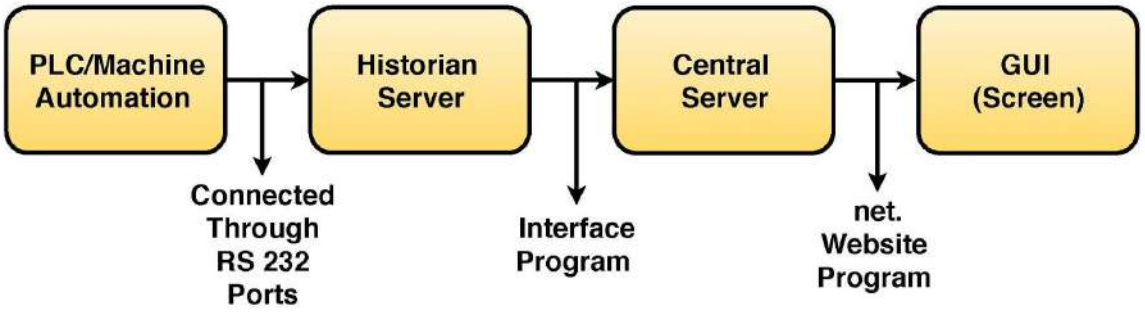


Figure 4. Fig. showing capturing & Transmitting data for real time monitoring

Thus the output water quality data are available both internally through a dedicated web page and can be transmitted to the Pollution Control Board on a real time basis.

Conclusions

The output water quality post treatment at the Effluent Treatment Plant is better than the water available in the local Nullah, giving us the opportunity to use in various places, like dust suppression, gardening etc.. The benefits of this are:

a. **Good Quality Water:** During the monsoon season water flowing through Damsal river has very high TSS. The output water from the ETP is already treated and thus a better input to the WTP than the water from the Nallah.
b. **Cost Saving:** Apart from substantial cost saving in pumping from the Nallah which is 0.75 km away the chemical consumption at the WTP will substantially reduce, due to the consistent and better input water quality, reducing the cost of treatment as well.
c. **Towards Zero Discharge:** As per the Pollution Control Act, an industry should ideally have ZERO discharge. Thus reusing the water from the ETP is one step toward achieving zero discharge.

PHOTOGRAPHS OF ETP INSTALLED

Automatic Dozing & Monitoring System

Multiple Pressure Sand Filter

Clariflocculator

Flash Mixing Tank

Photographs for runoff management Structures apart from ETP

Settling Pond

Opencast Quarry

Smc/05

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SERVICE AGREEMENT

F 250147

This Service Agreement ('Agreement') is made at Sukinda on this 2nd May 2017 BY AND BETWEEN

M/s INDIAN METALS & FERRO ALLOYS LIMITED, having its registered office at Bomikhal, Rasulgarh, Bhubaneswar -10, represented by its Mines Manager (hereinafter collectively referred to as "GENERATOR/USER" which expression shall unless repugnant to the subject or context include its administrators, successors and assigns) of the party of the first part.

AND

M/s RAMKY ENVIRO ENGINEERS LIMITED, Company registered under the Companies Act, 1956 and having its registered office at 6-3-1089/G/16, Gulmohar Avenue, Rajbhavan Road, Somajiguda, Hyderabad – 500082 represented by its Project Head, Odisha Waste Management Project, A Division of Ramky Enviro Engineers Limited, (hereinafter referred as "REEL / Operator" which expression shall unless repugnant to the subject or context include its administrators, successors and assigns) as Second Part.

The GENERATOR/USER and REEL/Operator hereinafter individually referred as 'Party' and collectively as 'Parties'.

WHEREAS;

A. REEL is engaged in the business of Waste Management and presently operating 'Integrated Common Hazardous Waste Treatment Storage Disposal Facility' Plot No. 420/648/1, Near Village Kanchichuan, PO: Mangalpur, Via: Sukinda in the district of Jajpur, Odisha -755018 under its control (hereinafter called "TSDF"), as per the guidelines under Hazardous and Other Wastes (Management &Transboundary Movement) Rules, 2016 and amendments thereof, and as per the authorization of State Pollution Control Board (SPCB),Odisha.

B. AND WHEREAS The GENERATOR being desirous of availing the services of collection, transport, treatment, storage and disposal of hazardous wastes (hereinafter referred to as "Waste")

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Authorised Signatory

generated at their premises, has entered in to an agreement dated 1st April, 2012 for a period of 5-years, as per the terms and condition mentioned therein, which gets terminated on 31st March , 2017 and both the parties agreed to enter into this agreement on the terms and conditions set out herein read with the provisions of Hazardous and Other Wastes (Management &Transboundary Movement) Rules, 2016, as amended from time to time and supervision of the State Pollution Control Board (SPCB), Odisha.

NOW THEREFORE in consideration of the above-mentioned premises and the mutual promises contained herein, the GENERATOR/USER and REEL/Operator have agreed to enter into this Agreement under the terms and conditions set forth hereinafter.

NOW IT IS HEREBY AGREED BY AND BETWEEN THE PARTIES HERE TO AS FOLLOWS:

1. DEFINITIONS AND INTERPRETATION

1.1 **Definitions**: In this Agreement, including in the recitals hereof, the following words, expressions and abbreviations shall have the following meanings, unless the context otherwise requires:

"Agreement" means this agreement including all attachments, annexure or Schedules annexed thereto.

"CPCB" means Central Pollution Control Board.

"Hazardous Rules" means Hazardous and Other Wastes (Management &Transboundary Movement) Rules, 2016 as amended from time to time.

"MoEF&CC" means Ministry of Environment, Forest and Climate Change.

"SPCB" means State Pollution Control Board, Odisha in the state in which the TSDF operated by REEL is situated.

"TSDF" means the Integrated Common Hazardous Waste Treatment Storage Disposal Facility by name "ODISHA WASTE MANAGEMENT PROJECT" (OWMP) operated by REEL and located at Plot No. 420/648/1, Near Village Kanchichuan, PO: Mangalpur, Via: Sukinda, Jajpur district, Odisha, pursuant to the Consent for Operation No. 01/11 dated 16/11/2011 under Section 25/26 of the Water (Prevention and Control of Pollution) Act, 1974, under Section 21 of Air (Prevention and Control of Pollution) Act, 1981 and Authorization under the Provisions of Hazardous and Other Wastes (Management &Transboundary Movement) Rules, 2016.

"Waste" means Hazardous waste generated in the premises of the GENERATOR/USER.
"TREM" card means Transportation Emergency Card.
"CHWTSDF" means Common Hazardous Waste Treatment Storage and Disposal Facilities.

1.2 **Interpretation**: In this Agreement, unless the subject or context otherwise requires:

a. reference to the singular number shall include references to the plural number and vice-versa;

b. references to a "person" shall include references to natural persons, partnership firms, companies, bodies corporate and associations, whether incorporated or not or any other organization or entity including any governmental or political sub-division, ministry, department or agency thereof;

Ramky Enviro Engineers Ltd.

2

Authorised Signatory

c. references to recitals, clauses and schedules / annexure are to recitals, clauses and schedules to this Agreement;

d. Any reference herein to a statutory provision shall include such provision, as is in force for the time being and as may be from and from time to time, amended or re-enacted in so far as such amendment or re-enactment is capable of applying to any transactions covered by this Agreement.

e. Clause headings used herein are only for ease of reference and shall not affect the interpretation of this Agreement.

1.3 The Schedules / Annexure shall form an integral part of this Agreement.

1.4 All capitalized terms used in this agreement which have not been specifically defined in this Agreement shall, unless inconsistent with the context have the meanings assigned to them under the Agreement.

2 SCOPE OF SERVICES

2.1 The scope of services to be provided by Operator under this Agreement shall be collection, transportation, treatment, storage and disposal of Waste generated at the premises of the GENERATOR located at 1. Sukinda Mines (Chromite), Sukinda, 2. Mahagiri Mines (Chromite), Kaliapani, Sukinda, jajpur, Odisha.

2.2 It is agreed between the Parties that REEL/Operator shall provide the above services to the GENERATOR through the TSDF operated by Operator and located at Plot No. 420/648/1, Near Village Kanchichuan, PO: Mangalpur, Via: Sukinda in the district of Jajpur, Odisha - 755018

2.3 Operator shall dispose the Waste as per the mandate of the SPCB, Odisha read with the provisions of Hazardous Waste Rules.

2.4 Operator also agrees to accept even non-hazardous wastes from the GENERATOR provided that the SPCB, Odisha issues 'no objection'.

3 GENERAL CONDITIONS

3.1 The GENERATOR shall immediately upon execution of this agreement, become a registered member of REEL by paying a Membership Fees per the criteria mentioned under Annexure item no. 1. The lifetime membership/security deposit shall be adjustable against user charges in the event either party decides to terminate this Agreement. No financial charges are applicable to such membership / security deposit.

3.2 The GENERATOR shall provide to REEL/Operator, a sample of the waste and inform the entire process details which leads to generation of such Waste, for the purpose of determining the Waste characteristics and to decide parameters for comprehensive analysis, as well as its final pathway of treatment, storage and disposal of the Waste.

3.3 REEL/Operator shall carry on the comprehensive analysis of the Waste in its laboratory at the cost of the GENERATOR, as per the parameters identified under Annexure item no. 7 (A). The comprehensive analysis report shall be used by Operator to determine the disposal pathway based on the waste characteristics & as per Ministry of Environment, Forest& Climate Change (MoEF & CC), CPCB (Central Pollution Control Board) and the concerned SPCB, Odisha rules and guidelines issued from time to time. Disposal pathway shall be

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mutually agreed based on comprehensive analysis report between the GENERATOR & Operator and shall form basis for disposal and user charges.

3.4 Upon receipt of information from the Generator, REEL/Operator shall plan and schedule for collection of the waste from the Generator and the safety during transportation is the collective responsibility of the Generator and the Transporter.

3.5 The GENERATOR shall provide the details of Waste to Operator as mentioned below:

i) Complete details of the Waste and its characteristics regarding presence of explosive/ ignitable/ corrosive/ toxic/ odorous compounds in the manifest provided to the OPERATOR for safe transportation and disposal.

ii) Safety information in 'Form 8', 'Waste transportation manifest' in 'Form 10' and TREM Card in 'Form 9' for every Waste type as per Hazardous Waste Rules.

3.6 REEL/Operator shall analyze the Waste received though finger print analysis as per the parameters identified at Annexure item no. 7 (B) as prescribed by the concerned SPCB, Odisha.

3.7 In the event there are any differences in the analysis results of comprehensive analysis and finger print analysis, the GENERATOR may either accept the results of REEL/Operator or send their samples to a mutually agreed third party analysis at their own cost. Any discrepancy in relation thereto shall be informed to the SPCB, Odisha.

3.8 The GENERATOR shall provide a fresh comprehensive analysis report when there is a change in the waste characteristics, manufacturing processes, changes in product mix.

3.9 In the event of any false information or withholding information, all liabilities whether directly or indirectly arising there from, during transportation, handling, treatment & disposal shall be the responsibility of the Generator/User.

3.10 The GENERATOR shall provide an advance declaration every year in the month of April assuring quantity of Waste they would be sending to REEL/Operator till next March 31, and declare the approximate Waste quantities on an annual and/or quarterly and/or monthly basis as per Hazardous and Other Wastes (Management &Transboundary Movement) Rules, 2016 as per the declaration format provided in Annexure.

3.11 REEL/Operator agrees to provide its containers available at its TSDF to the GENERATOR provided the GENERATOR pays the container maintenance charges to REEL/Operator as per Annexure item no. 4.

3.12 The Waste supplied by the GENERATOR shall not contain any kind of nuclear and/or radio-active and/or any other prohibited material.

3.13 REEL/Operator shall also supply specially designed containers to help segregate the Waste and arrange the transportation of such containers containing such waste from the GENERATOR premises.

3.14 The Generator/User shall pay a fixed amount to REEL as minimum annual service commitment charges every year for the purpose of utilization of REEL services. This amount shall be adjusted against user charges in calendar period of one year. In the event, for whatsoever reason, the Generator/User is unable to utilize the facility services for a particular year/period. The Generator shall forfeit the amount that is utilized in that in that calendar year, the charges are mentioned in Annexure item no. 5.

Ramky Enviro Engineers Ltd.

Authorised Signatory

3.15 The OPERATOR shall liable for compliance of safety, Health and Environment Guidelines of the GENERATOR enclosed herewith as Annexure-IV while operating inside the premises of the GENERATOR and also liable for penalty for non compliance of such guidelines as per Annexure V.

4 USER CHARGES & TERMS OF PAYMENT:

4.1 The GENERATOR shall pay user charges to REEL/Operator for its services as per the slab mentioned under Annexure item no. 2 & 3. which shall be based upon the Declaration given by the GENERATOR as provided under Annexure. In addition the Generator shall also be liable for payment of applicable taxes, levies etc., if any, on the user charges. The user charges are subject to revision from time to time based on change in Consumer Price Index.

4.2 5% escrow deposit would be charged for land filling after waste treatment overand above the disposal charges as may become applicable from time to time.

4.3 REEL/Operator will communicate the Comprehensive Analysis Report to the GENERATOR and on the basis of which the disposal cost/estimate will be finalised at the prevailing rate and a Work Order will be issued by the GENERATOR against the same prior to collection of waste from Generator's Premises.

5 TERM OF AGREEMENT

This Agreement shall be valid for a period of three (3) years effective from 2nd May **2017** subject to earlier termination by either party in accordance with this Agreement.

6 FORCE MAJEURE

a) Force Majeure means any event or circumstance that is beyond the reasonable control, either directly or indirectly, of either party and which event cannot, by exercise of reasonable diligence, be prevented or caused to be prevented; cannot despite the adoption of reasonable precaution and reasonable alternative measures (where sufficient time to adopt such precautions or alternative measures before occurrence of such events or circumstances is available) be prevented; and which adversely affects such party's performance of its duties and obligation or enjoyment of its rights under the contract.

b) The aforesaid force majeure conditions should be such as : Acts of God, war, riot, flood, sabotage, compliance with Governmental requests, orders or action, change in laws & regulations, National Defence requirements or any labour trouble, lock out or court order or any other event which is beyond the reasonable control of such Party.

c) In case of occurrence of a force majeure event, the party whose performance is affected by such an event, shall, promptly notify in writing to the other party the existence and cessation of such event. The party shall take all reasonable steps within their power to recompense the performance of the Agreement within such days as mutually agreed following the cessation of an event of force majeure.

d) Neither party shall be considered to be in default or in breach of its obligation under this Agreement to the extent that the performance of such obligation by such party is prevented by any circumstances of force majeure event which arise during the term of this Agreement.

e) In the event, any or all of the above mentioned circumstances/ reasons totally prevent(s) either party from fulfilling its obligation under this Agreement for a continuous period of thirty days, the either party shall have the option of terminating this Agreement with immediate effect

f) Notwithstanding anything else contained herein, neither Party hereto shall be liable for damages or to have this agreement terminated for any delay or default in the performance of such Party hereunder if such delay or default in performance derives from conditions beyond the reasonable control of such Party, including but not limited to, acts of god, strikes, fires, floods, extreme drought, shortage of supply, riots, work stoppages, embargoes, governmental actions or damage to the plant or facility or any cause unavoidable or beyond the control of either party including any arbitrary ruling by the Government prohibiting the handling of the Waste or continuing domestic or international problems such as wars or insurrections.

7 INDEMNITY

The GENERATOR do hereby indemnify, keep indemnified and hold harmless the REEL, its representatives, nominees and officers (including without limitation, reimbursement of any loss suffered by Operator and / or its officers, directors, employees, agents or affiliates and their legal costs), awards, damages, losses and / or expenses, either pecuniary or non-pecuniary in nature, arising directly or indirectly, whether during collection or transportation or treatment or storage or disposal, as a result of:

a) the Waste supplied by or collected from the GENERATOR in case of any mismatch of waste from TREM card or finger prints; and any non-disclosure or wrong disclosure of any information as to the characteristic of waste, or

b) Any civil or criminal proceedings or liability under any law for any unlawful dumping of untreated wastes by the REEL either at the project site of REEL or anywhere else.

c) any violation or non-compliance by the GENERATOR of the provisions of Hazardous Rules, Water (Prevention and Control of Pollution) Act, 1974 and Air (Prevention and Control of Pollution) Act, 1981 including any modifications, amendments made thereto and any new acts and rules legislated and promulgated governing the activity under this Agreement during the term of this Agreement or any extension thereof.

8 EVENTS OF DEFAULT

Gross violation of terms of this Agreement by any Party shall constitute events of default.

a) In case of any event of default by any Party, the other Party shall give 30 days notice in writing of such default to the other Party. for corrective measures or remedifying the defect. In case no corrective measure is taken or such defect is not remidifyed within the notice period of 30 days, The other Party shall have the right to terminate the Agreement forthwith.

b) If the GENERATOR fails / refuses to pay its bills / dues for the user charges payable under this Agreement.

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6

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9 TERMINATION

9.1 Subject to provisions of Clause 7 (Event of Default), the other Party/ Party suffering from the defect shall terminate this Agreement in writing forthwith. After such termination, OPERATOR shall refund the lifetime membership deposit as per Clause 3.1 (General Conditions) of this Agreement.

9.2 Either party shall have the right to terminate this Agreement in the event of violation of any of the terms and conditions as agreed upon in this Agreement or otherwise, upon giving thirty (30) days written notice to the other party.

10 ENTIRE AGREEMEENT

This Agreement shall be deemed to represent the entire Agreement between the parties hereto regarding the subject matter hereof and shall supersede, cancel and replace any and all prior agreements or arrangements, if any, in this behalf, by and between the Parties hereto.

11 RELATIONSHIP OF THE PARTIES

Nothing contained herein shall be deemed to constitute a partnership, joint venture or agency by and between the Parties hereto.

12 VARIATIONS

This Agreement may be modified or amended only by writing, duly executed by or on behalf of the Parties hereto in non-judicial stamp paper of approximate value.

13 INVALIDITY

In the event that any provisions of this Agreement is held to be illegal, invalid or unenforceable under any present or future laws of the Republic of India such provisions shall be deemed terminable and the remaining parts & provisions of this Agreement shall remain in full force & effect.

14 NOTICES

14.1 Any notice, request, demand or other communication given or made under or in connection with the matters contemplated by this Agreement shall be in writing and shall be delivered personally or sent by registered post acknowledgement due or by facsimile or by courier or by E-mail·

*In case of **GENERATOR** to:*

Attn: Mines Manager Sukinda Mines (Chromite) IMFA
At/Po. – Kaliapani; Sukinda; Odisha.

*In case of **OPERATOR** to:*

Ramky Enviro Engineers Ltd.

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and shall be deemed to have been duly given or made as follows:-

(a) if personally delivered, upon delivery at the address of the relevant Party;

(b) if sent by registered post-acknowledgement due seven (7) days after the posting;

(c) if sent by facsimile upon receipt of confirmation by sender, from the receiver, that the facsimile has been received;

(d) if sent by courier four (4) days after the date of dispatch.

14.2 A Party may notify the other Party of a change to its name, relevant addressee or address number for the purposes of Cause 14.1 as provided herein.

15 SURVIVAL

Notwithstanding any contained in this Agreement, the provisions of clause 7 and 8 of this Agreement shall survive for 5 years after termination or completion of term of this agreement whichever is later.

16 DISPUTE RESOLUTION

Any dispute arising on any clause or clauses of this Agreement and the contents of the Annexure, hereto between the GENERATOR and Operator shall be referred to sole arbitrator to be appointed by the Generator and the said arbitration will be in accordance with the provisions of the Arbitration and Conciliation Act, 1996. The arbitration proceedings shall be conducted in English and the seat of arbitration shall be at Bhubaneswar. The arbitral award shall be final and binding upon both the Parties.

17 APPLICABLE LAW

Operator and the GENERATOR mutually agree that the courts of law at Bhubaneswar shall have the exclusive jurisdiction over all the disputes arising out of this Agreement.

The OPERATOR and the GENERATOR mutually agreed that only the courts of law at Bhubaneswar shall have the exclusive jurisdiction over all the disputes arising out of this Agreement.

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Authorised Signatory

For **Indian Metals & Ferro Alloys Ltd.**

Name: Sudhanshu Patni
Designation: Sr. G. M. & Head COMO IMFA

In the Presence of

Name: M. MANIKANDAN
Designation: Mgr. ENVIRONMENT

Name: A. C. Ojha.
Designation: Mgr (QC)

For **Ramky Enviro Engineers Ltd.,**

Name: ChtittaranjanRatha
Designation: Project Head

In the Presence of

Name: PRADIPTA KUMAR DHAL
Designation: Head - Operation

Name: SOUMYA RANJAN JENA.
Designation: Sr. EXECUTIVE (MBD)

Ramky Enviro Engineers Ltd.

Authorised Signatory

ANNEXURE

Membership/Security Deposit, USER Charges Details: to avail CHW-TSDF, Sukinda services for Disposal of Hazardous Waste

1)Membership Deposit/ Security Deposit:

A lifetime initial registration amount has to be paid by the GENERATOR.
The following matrix shall help GENERATOR determine the payable amount as applicable.

Capital Investment [Rs.]	Membership Deposit (in Rs.)	
	RED	ORANGE
0 – 2 Lakhs	5, 000/-	
2 – 5 Lakhs	7, 500/-	
5 – 25 Lakhs	15, 000/-	
25 - 60 Lakhs	25, 000/-	
60 Lakhs – 1 Crore	50, 000/-	25,000/-
1- 5 Crores	1, 00, 000/-	50,000/-
5 – 10 Crores	1, 50,000/-	75,000/-
10 – 50 Crores	2, 00,000/-	1, 00,000/-
50 – 100 Crores	3, 00,000/-	1, 50,000/-
100 – 200 Crores	5, 00,000/-	2, 50,000/-
> 200 Crores	10, 00,000/-	5, 00,000/-

Note: This deposit is refundable / adjustable only against waste disposal charges in the event, members desire to withdraw membership.

2) User Charges:

The GENERATOR shall pay the following applicable User Charges based on the Waste Types.

a) **Direct Landfill: per MT**

Direct disposal into Landfill : Rs. 1820/- per MT (The user charges are subject to revision from time to time based on change in Consumer Price Index)

Note: ***Biodegradable Organics value should be less than 5%***
Non- Biodegradable Organics valueshould be less than 20%
Calorific Value should be less than 2500 Kcal/Kg
Absence of Metal Parts.

b) **Stabilization Charges: per MT**

Cost of Direct Land filling (1+Bulking Factor) + Cost of Stabilization Reagents + Rs.350/- per MT for re-handling expenses.

Note: ***Biodegradable Organics value should be less than 5%***
Non- Biodegradable Organics value should be less than 20%
Calorific Value should be less than 2500 Kcal/Kg
Presence of Metal Parts.

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c) **Incineration Charges: per MT or KL (also depends on Material Density)**
Rs. 8000/- (Base Cost) + Cost of Chemicals, Additives + Cost of Fuel + Cost of Power + Cost of Pollutant Scrubbing + Cost of throughput time + residual landfill

Note: Biodegradable Organics value should be more than 5%
Non- Biodegradable Organics value should be more than 20%
Calorific Value should be more than 2500 Kcal/Kg

3) Transportation Charges: [Optional, applicable when Operator Services are utilized]

a) **Waste Transport Charges:**

Rs. 6.00 per Km per Ton (MT), on distance calculated both-ways (Minimum for 20 km i.e. minimum distance used for calculation is 10 Km each way. Minimum Charges shall be Rs. 1500/- per trip). The charges shall be calculated by taking into consideration minimum 90% of the container loading capacity. **Since the diesel rate is fluctuating frequently the transportation charges/rate is calculated every month based on the average diesel rate during the month.**

b) **Diesel escalation clause:-**

Diesel escalation clause is applicable as below:

Base price / Old diesel price*Current diesel price.

Rs. 4.35/44.16*63.24=Rs. 6.22

The base price is Rs. 4.35 when diesel price was Rs. 44.16 paisa per liter, when diesel price is Rs. 63.24, the cost of transportation is Rs. 6.22.

c) **Truck Detention Charges:**

Maximum time of Two hours is allowed for the truck to be detained at the GENERATOR premises from the time of reporting to their Security Gate. In the event this period is exceeded then Rs. 700/- per hour shall be charged as detention charges unless it is mutually agreed and accepted between both parties in writing.

4) Container Maintenance Charges: [Optional, applicable when Operator Services are utilized]

The GENERATOR has to pay the following charges as mentioned below towards the services of the Container, if opted for by the GENERATOR.

a) **Container Maintenance charges:** The Container deposits are: -

- 10.0 MT Hook Loaders Rs.3,00,000/- per Container

Note: Since these containers will be replaced after three years, above container maintenance charges will be valid for three years only

b) **Container Handling Charges:**

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The GENERATOR shall pay for Container Handling Charges to Operator as follows for utilizing the Material Handling Equipment.

Unloading Charges: Rs 100/- per MT

5) Minimum Yearly Service Charges:

The GENERATOR has to pay a minimum service charge of **Rs. 3000/-** per Month i.e, **(Rs. 36,000/** per Annum). This amount shall be adjusted against User Charges invoices in a financial period of one year. In the event, for whatsoever reason, the GENERATOR is unable to utilize the facility services for a particular year /period, the GENERATOR shall forfeit the amount that is unutilized in that calendar year. (This is applicable in case if **the generator doesn't provide any waste during the financial period).**

6) Lab Analysis Charges:

The lab analysis charges for Comprehensive analysis per sample will be **Rs.17, 000/- excluding service tax and handling charges**, which has to be paid by the GENERATOR.

Note: Comprehensive analysis has to be carried out once again if there is any change in the manufacturing process, product mix or any change in the process which will have impact on waste characteristics or every TWO (02) years whichever is earlier Prior intimation has to be given by the GENEARATOR to the OPERATOR/REEL.

7 (A) Parameters to be analyzed for Comprehensive analysis of WASTE:

a. Physical State: (Liquid/ Slurry/ Sludge/ Semi-solid/Solid: Inorganic, Organic, Metallic)
b. Different Phases: (in cases of Solid / Slurries / Sludge) contained in aqueous liquids/solutions
c. Colour and Texture
d. Specific Gravity
e. Viscosity
f. Calorific Value
g. Flash Point
h. % Moisture content (Loss on ignition at 105oC)
i. % Organic Content (Loss on ignition at 550oC)
j. Paint Filter Liquid Test (PFLT)
k. PH
l. Sulphur (elemental)
m. 24 hour Leaching Procedure
n. Reactive Cyanide (PPM)
o. Total Cyanide
p. Reactive Sulphide (ppm)
q. Sulphur elemental
r. Concentration of individual inorganics (Metals), both total and leachable, specific parameters to be determined based on source of waste
s. Oil and Grease
t. Extractable Organics
u. % Carbon, % Nitrogen, % Sulphur, % Hydrogen
v. Concentration of Individual Organics
w. TCLP for identified parameters

7 (B) Parameters to be analyzed for Finger Print Analysis:

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a. Physical State of the WASTE
b. Identification of different phases of WASTE
c. Colour and Texture
d. Specific Gravity
e. Viscosity
f. Flash Point
g. % Moisture content (Loss on ignition at 105°C)
h. % Organic Content (Loss on ignition at 550°C)
i. Paint Filter Liquid Test (PFLT)
j. Liquid Release test
k. pH
l. Reactive Cyanide (PPM)
m. Reactive Sulphide (ppm)

Taxes / Levies:- All Government / Municipal / Panchayat Taxes / Duties/ Levies/ Octroi / Tolls etc, as applicable from time to time, will be payable by GENERATOR/USER.

Terms & Conditions:

a. This membership is valid as long as the user industry is in good standing with the CHWTSDF and has continued valid authorization from SPCB-Odisha.
b. The membership deposit is one time refundable deposit with benefits for full of tenure CHW-TSDF. The deposit will be refunded / adjustable against waste disposable charges, when desired to discontinue membership, before the end of life of TSDF, otherwise it lapses.
c. This CHW-TSDF shall accept only hazardous wastes as classified in HW Rules for disposal and shall not accept radioactive wastes, Municipal wastes, Bio-Medical waste.
d. Acceptance of wastes is dependent on the fulfillment of regulatory and statutory guidelines for operations of CHWTSDF issued from time to time.
e. Pathway of disposal of wastes and its price shall be decided based on the guidelines issued from time to time by the appropriate regulatory authorities.
f. From the date of signing of agreement you have to submit your sample for comprehensive analysis within 15 days. The analysis report generated by REEL will form the basis of disposal pathway along with disposal charges (as Annexure IV) which will be annexed after analysis of the sample and will form the part of agreement.

For **Indian Metals & Ferro Alloys Ltd.**

Name: SUDHANSHU PATNI
Designation: Sr G.M. & Head COMO

For **RAMKY ENVIRO ENGINEERS LIMITED**

Ramky Enviro Engineers Ltd.
Authorised Signatory

Name: Chittaranjan Ratha
Designation: Project Head

ANNEXURE

DECLARATION

We M/s Sukinda Mines Chromite & Mahagiri Mines (Chromite) (IMFA) hereby declare that based on our industry production and our annual projections we shall be disposing the following Hazardous Waste types to OPERATOR. (Additional sheets could be used for multiple waste types)

The Avg. Yearly generation of Hazardous Waste is expected as follows.

1) Avg.4.0 MT per year of Waste / Residue Containing oil (Schedule – I / Stream 5.2) type of hazardous waste.
2) Avg. 4.00 MT per year of filter and Filter Materials (Schedule – I / Stream 5.2) type of hazardous waste.
3) Avg. 200 MT per year of Chemical sludge from waster water treatment (Schedule – I / Stream 3.5.3)_ype of hazardous waste.
4) Avg. 20 MT per year of oil & Grease Skimming residues (Schedule – I / Stream 35.4) type of Hazardous Waste.
5) Avg. 14.0 MT per year of liners contaminated with Hazardous wastes / chemicals (Schedule – I / Stream 33.1) type of Hazardous Waste.

The Avg. quarterly generation of Hazardous Waste is expected as follows.

1. Avg. 1.00 MT per year of Waste / Residue Containing oil (Schedule – I / Stream 5.2) type of hazardous waste.
2. Avg. 1.00 MT per year of filter and Filter Materials (Schedule – I / Stream 5.2) type of hazardous waste.
3. Avg. 50.00 MT per year of Chemical sludge from waster water treatment (Schedule – I / Stream 3.5.3)_type of hazardous waste.
4. Avg. 5.00 MT per year of oil & Grease Skimming residues (Schedule – I / Stream 35.4) type of Hazardous Waste.
5. Avg. 4.00 MT per year of liners contaminated with Hazardous wastes / chemicals (Schedule – I / Stream 33.1) type of Hazardous Waste.

- The Total accumulated/stored/buried in pits Hazardous Waste from the period of .....'20..... is approximately as follows which is being sent to disposal at RAMKY - OWMP.

1. Avg. _____ MT per year of _____ type of hazardous waste
2. Avg. _____ MT per year of _____ type of hazardous waste
3. Avg. _____ MT per year of _____ type of hazardous waste

FOR Indian Metals & Ferro Alloys Ltd.

Authorized Signatory
GENERATOR, The Second Part

Witness : Name : M. Manikandan Sign:
Company/Occupation: IMFA
Designation : Mgr.

Witness : Name : Mr. A. C. Ojha.
Company/Occupation: ~~Mgr~~ IMFA
Designation : Mgr

Annexure 8- Management of Surface runoff

MANAGEMENT OF SURFACE RUNOFF AND MITIGATIVE MEASURES

The Sukinda Valley experiences about 110 cm to 180 cm of rainfall annually, of which eighty percent (80%) occurs during the monsoon season i.e. between June and September. Owing to this highly uneven distribution of rain, the weather in the Sukinda Valley ranges from extremely dry to extremely wet.

The major portion of the rain goes as surface runoff and flows through the garland drains, that have been made around the quarries and dumps. The flow carries silt and dry vegetation with it, apart from picking up hexavalent chromium as it trickles down the chrome rich quarries and dumps. These drains also channel the water pumped out during mining operations.

Run off Details:

Maximum Runoff Calculation For Day							
Heads	**Unit**		**Area**	**Maximum Rainfall in 24 Hrs in m**	**Coefficient of Runoff**	**Volume in Cu.m**	**Available Reservoir/Settling tank**
Total Lease Area	Ha.		116.76				
Catchment 1	Ha.	QC LAB,WORKSHOP,WESTERN SIDE OF THE BAND II,MINERAL STORAGE YARD	6.88	0.206	0.35	4960.48	4140
Catchment 2	Ha.	MINERAL STORAGE AND ETP AREA	12.15	0.206	0.35	8760.15	2304
Catchment 3	Ha.	Central Ore PLot and subgrade dump	25.54	0.206	0.35	18414.34	5520
Catchment 4	Ha.	OB dump northern part	11.5	0.206	0.35	8291.5	1200
Catchment 5	Ha.	Opencast quarry and southern part of OB dump	60.69	0.206	0.35	43757.49	MINE BOTTOM
Total						**84183.96**	
Maximum Runoff Calculation For Monthly Average							
Heads	**Unit**		**Area**	**Daily average**	**Coefficient of Runoff**	**Volume in Cu.m**	**Available Reservoir/Settling tank**

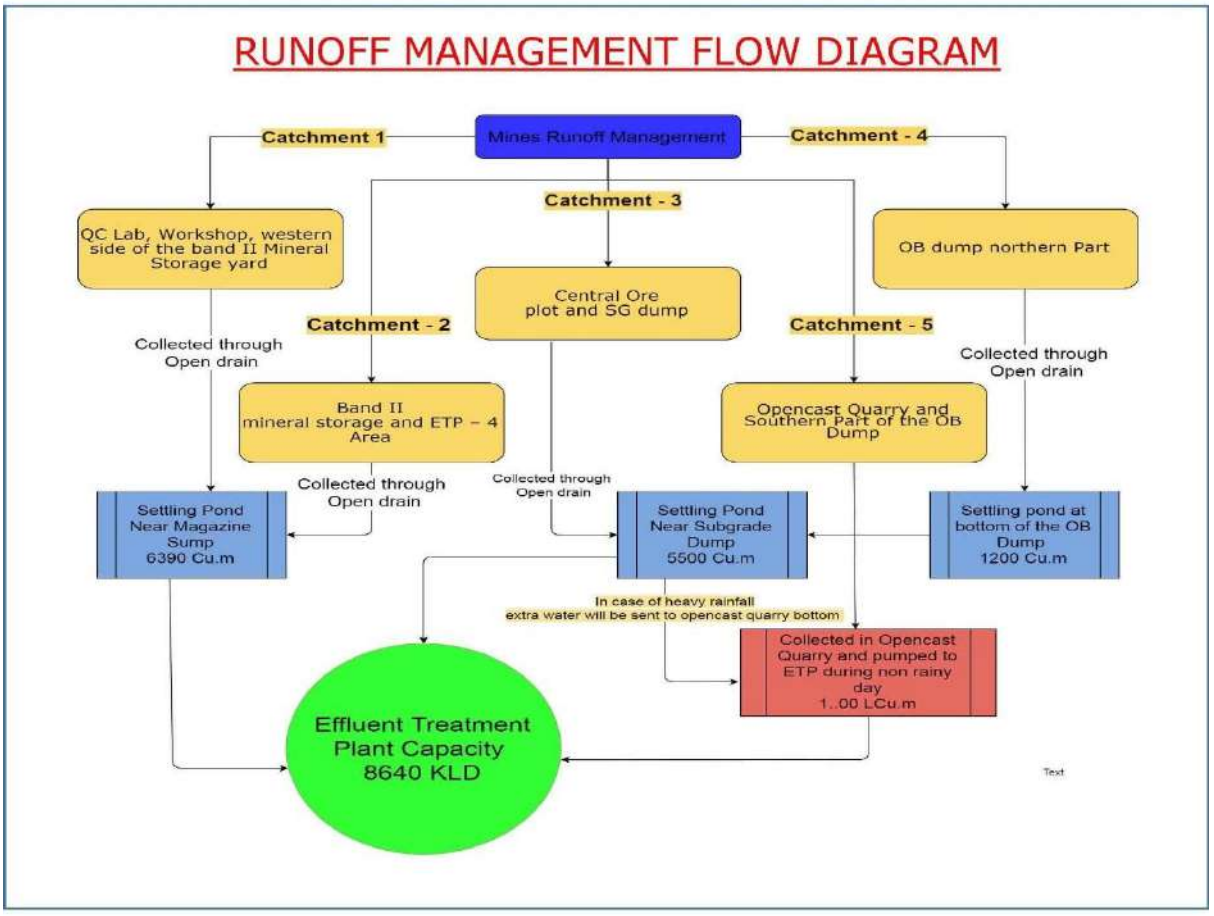
				Rainfall in m			
Total Lease Area	Ha.		116.76				
Catchment 1	Ha.	QC LAB,WORKSHOP,WESTERN SIDE OF THE BAND II,MINERAL STORAGE YARD	6.88	0.02	0.35	481.6	4140
Catchment 2	Ha.	MINERAL STORAGE AND ETP AREA	12.15	0.02	0.35	850.5	2304
Catchment 3	Ha.	Central Ore PLot and subgrade dump	25.54	0.02	0.35	1787.8	5520
Catchment 4	Ha.	OB dump northern part	11.5	0.02	0.35	805	1200
Catchment 5	Ha.	Opencast quarry and southern part of OB dump	60.69	0.02	0.35	4248.3	MINE BOTTOM
Total						**8173.2**	

Runoff Management Structures

A	**Settling Ponds Sukinda Mines (Chromite)**		
	Description	**Dimension in m**	**Volume in Cu.m**
a.	Settling pit no. 1 (Near Magazine)	92 x 15 x 3.0 (MTR) & 48 x 12 x 4.0 (MTR)	4140 2304
Total			**6444**
b.	Settling pit No -2 (Intermediate Sump)	60 x 17 x 4 (MTR) 60 x 08 x 3 (MTR)	4080 1440
Total			**5520**
c.	Settling Pit No -3 (Near ETP 2)	34 x 15 x 2.5 (MTR)	1275
B.	**Collection Sump of the Sukinda Mines Open quarry**		
	Bottom two benches of the opencast quarry are being used as sump during the rainy season. The dimensions of present bottom two benches are as follows:		
a.	1st bench bottom	175 x 20 x 5 (MTR)	17500

b.	2nd bench bottom	290 x 40 x 8 (MTR)	92800
Total			**110300**

From the above tables it is concluded that to avoid contamination of groundwater and surface water there is proper management of Run-off from the mine which will be treated in the Common Effluent treatment Plant and part of treated water will be used for sprinkling and Plantation. Excess water will be discharged to damsal nala after meeting SPCB standards. Schematic diagram of surface runoff management is given below:



Mitigation Measures

The settling pond and retaining walls have been built along OB dump and Sub-grade dump. There is an existing retaining wall of 2020 Running Meter long and garland drain of 2852m long along the dump. Runoff Water is stopped by retaining wall and water is collected and overflow is diverted by garland drains through 6 nos. of check dams which finally settles into 2nos of settling tanks. As per proposal the retaining wall, garland drain and check dams will be constructed and maintained during this review of plan period. The water collected from mines open cast operation seepage

and runoff water collected during monsoon is being stored at existing settling ponds and followed to effluent treatment plant and treated water is being used for the said dust suppression activities and plantation.

The collected water is being treated in existing common effluent treatment plants and the treated water is being used for green belt development and sprinkling to suppress dust generation from ML. area, encase of excess water it is discharged to the land outside the lease area after confirming the prescribed standards in approved Consent to Operate.

As per proposal the retaining wall, garland drain and check dams has been constructed and maintained during this review of plan period. The dead ends of the dump have been stabilized by plantation and will be further planted as per approved mining plan by time to time.

The water collected from mines open cast operation seepage and runoff water collected during monsoon is being stored at existing settling ponds and followed to effluent treatment plant and treated water is being used for the said dust suppression activities.

There will be no contamination of groundwater as the water in the mine pit is being pumped and treated in the Effluent treatment plant installed within the mine lease. Also, to protect the contamination of surface water, garland drain along with check dams has been provided at the slope of both OB and subgrade dump, runoff water is channelized to impervious (lined with Geo-textile) settling pond and then to Effluent treatment plant where after treatment the water is reused in sprinkling and gardening after expansion same will also be used in COB plant.

The process water from the beneficiation plant will be recovered in thickener and from the tailing pond it will be re-circulated for use in the beneficiation process. The effluent from the workshop will be treated in oil and grease trapping unit installed within the mine site and will be reused. Domestic sewage effluent will be discharged in septic tanks and soak pit systems. Thus, there will not be any effluent discharge from the mining and beneficiation activities in the proposed project.

Annexure 9- Water details & approach on decreasing the water requirement

WATER BUDGET AND FUTURISTIC APPROACH ON DECREASING THE WATER REQUIREMENT AS WELL AS RAINWATER HARVESTING

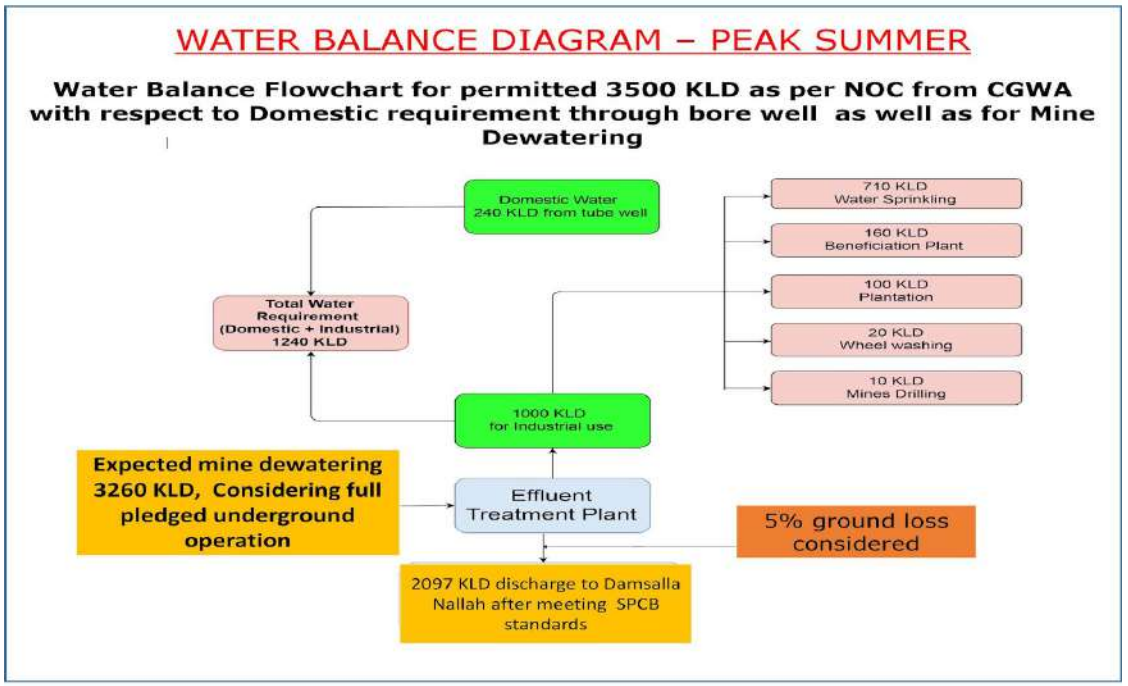
Water Budget:

That NOC qty 3500 Cu.m/day includes freshwater requirement for domestic use of 240 Cu.m and 3260 Cu.m for dewatering mines seepage. The dewatered seepage water will be used for sprinkling on haulage roads, drilling, wheel washing and plantation after treatment through ETP plant.

Total water requirement for the project is 1240 Cu.m / Day (During peak summer season), in which 240 Cu.m / day for domestic uses and 1000 Cu.m for industrial uses. **The freshwater requirement is only 240 Cu.m/day which is only for the domestic uses** and water requirement for industrial uses i.e. 1000 Cu.m will be meet from mine seepage water after treatment. The process-wise water requirement is given below.

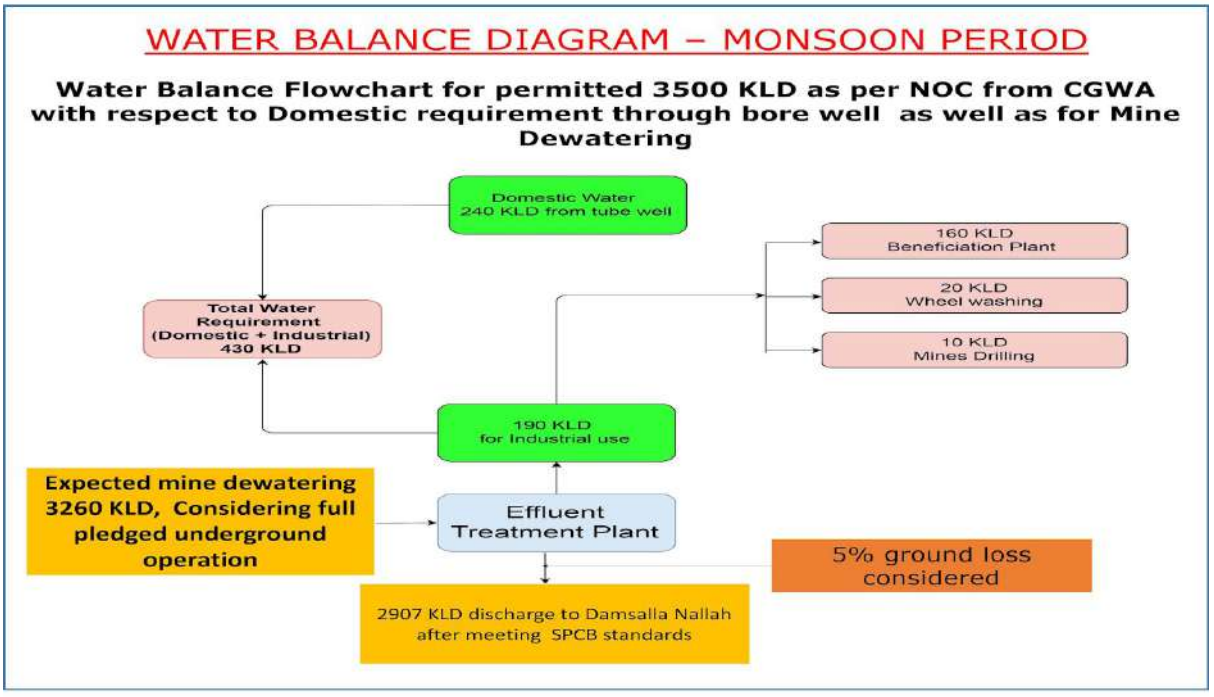
During Peak Summer Period:

Water for Drinking & Domestic	:	240	KLD
Water for Sprinkling	:	710	KLD
Water for Green belt	:	100	KLD
COB plant makeup water	:	160	KLD
Wheel Washing	:	020	KLD
Mines drilling purpose	:	010	KLD
Total	:	1240	KLD



During Monsoon Summer Period:

Water for Drinking & Domestic	:	240	KLD
Water for Sprinkling	:	000	KLD
Water for Green belt	:	000	KLD
COB plant makeup water	:	160	KLD
Wheel Washing	:	020	KLD
Mines drilling purpose	:	010	KLD
Total	:	0430	KLD



FUTURISTIC APPROACH ON DECREASING THE WATER REQUIREMENT AS WELL AS RAINWATER HARVESTING

Once underground operation starts, the water requirement will be reduced by 50 percent for industrial uses. Once full pledge underground operation started there will be very less water requirement for sprinkling (dust suppression) to the OB dump, mines haulage roads and mine benches.

Rainwater Harvesting implementation:

The project has implemented various rainwater harvesting systems in the project surrounded area, an around 62,000 Cu.m / year of rainwater is being recharged to the ground through these implementations. The details follow.

1. **Surface water harvesting:** Surface water harvesting system has been implemented at Mahagiri Enclave i.e. a residential colony for the project in consultation with the Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar. An average 50400 Cu.m / Year of rainwater is being recharged through this implementation.

2. **Rooftop Water Harvesting within ML area:** Rooftop rainwater harvesting system has been implemented at mines administrative building in consultation with the Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar. An average of 600 Cu.m / Annum is being recharged through this implementation.

3. **Rooftop Water harvesting at buffer zone:** Rooftop rainwater harvesting system has been implemented at Chandimata UP School, village Kaliapani by project proponent. An average 1410 Cu.m (Avg) / Annum is being recharged through this implementation.

4. **Water Harvesting Ponds:** 6 number of the village pons is adopted by the project underwater harvesting management plan. An average 9500 Cu.m (Avg) / Annum is being recharged through this implementation @ average 1800 mm rainfall by considering 0.8 is coefficient factor. The village wise pond details follow.

-	Kakudia (Purna Panasia)	-	1200 Sqr. Mtr
-	Jharanasahi	-	0750 Sqr. Mtr
-	Karadagadia	-	2000 Sqr. Mtr
-	Karadagadia (II)	-	0450 Sqr. Mtr
-	Giringamali	-	0450 Sqr. Mtr
-	Bamnagar	-	1050 Sqr. Mtr
	Total	-	5900 Sqr. Mtr

Annexure 10- Revised TOR Compliance

A.COMPLIANCE OF STANDARD TERMS OF REFERENCE		
Terms of Reference		**Compliance**
1	Year-wise production details since 1994 should be given, clearly stating the highest production achieved in any one year prior to 1994. It may also be categorically informed whether there had been any increase in production after the EIA Notification 1994 came into force, w.r.t. the highest production achieved prior to 1994.	Year-wise production details since the inception of mine are given at heading 2.8.2 of Chapter 2 of EIA report. There was an excess production during 2000-01 to 2007-08 for which State Gov has raised the demand. Since as per the project proponent the demand made by Government authorities is not admissible demand hence project proponent has filed a revision application challenging the demand notice issued by the State Government. After hearing Revisionary Authority has stayed the same with a notice to State Govt. to furnish reply within 3 months. Details are given in the chapter 2 at heading 2.1. An affidavit has been submitted to MoEF&CC in compliance of OM dated 30.05.2018.
2	A copy of the document in support of the fact that the Proponent is the rightful lessee of the mine should be given.	Mining lease of 116.76 Ha for the project was granted by Govt. of Orissa for 30 years which was executed on 04.09.1999. Copy of the lease deed is given at **Annexure 1** of the EIA report.
3	All documents including approved mine plan, EIA and public hearing should be compatible with one another in terms of the mine lease area, production levels, waste generation and its management and mining technology and should be in the name of the lessee.	The EIA report and public hearing is compatible with the mining plan in all respects including production levels, waste generation and its management and mining technology etc.
4	All corner coordinates of the mine lease area, superimposed on a High-Resolution imagery/ topo-sheet, topographic sheet, geomorphology and geology of the area should be provided. Such an Imagery of the proposed area should clearly show the land use and other ecological features of the study area (core and buffer zone).	The mine lease area duly superimposed on topographical Map is given at **Plate-2**, Land Use map showing various details is given at **Plate-12** of the EIA report

5	Information should be provided in Survey of India Toposheet in 1:50000 scale indicating geological map of the area, geomorphology of landforms of the area existing minerals and mining history of the area, important water bodies, streams and rivers and soil characteristics.	The requisite details regarding geomorphology of landforms of the area, important water bodies, streams and rivers have been shown in the topographical Map given at **Plate-2**, Land Use map is given at **Plate-12** of the EIA report. Regional geology of the area has been covered in Chapter 2.
6	Details about the land proposed for mining activities should be given with information as to whether mining conforms to the land use policy of the State; land diversion for mining should have approval from State land use board of the concerned authority.	The project is already under active mining operation and all the statutory clearances are already obtained for the project. Out of total mining lease area of 116.76 Ha, the land falling within forest is 115.05 ha for which approval from forest department has already been obtained. Now this proposal is for Change in technology from opencast mining to opencast and underground mining with enhancement in production from 3.51 LTPA to 6.0 LTPA along with COB plant of 40 TPH.
7	It should be clearly stated whether the proponent Company has a well laid down Environment Policy approved by its Board of Directors? If so, it may be spelt out in the EIA report with description of the prescribed operating process/procedures to bring into focus any infringement/deviation/violation of the environmental or forest norms/ conditions? The hierarchical system or administrative order of the company to deal with the environmental issues and for ensuring compliance with the EC conditions may also be given. The system of reporting of non-compliance/violations of environmental norms to the Board of Directors of the company and/or stakeholders or shareholders at large may also be detailed in the EIA Report.	The company has a well laid down environment policy approved by the management. The Environment cell is headed by an officer of the rank of Sr. Vice President(Head-Mining) and has four other members in the cell comprising of V.P., Mine Manager, Manager Environment and one senior officer. The Details regarding organization is given in the EIA report and details of Environmental policy is given in Annexure 12 of the EIA Report.
8	Issues relating to Mine Safety, including subsidence study in case of underground mining and slope study in case of open cast mining, blasting study etc should be	Issues relating to mine safety are addressed at Chapter 7 of the EIA Report. The National Institute of Rock Mechanics (NIRM) has prepared detailed report for underground mining after carrying out

	detailed. The proposed safeguard in each case should be provided.	various studies. NIRM report is given at Annexure 20.
9	The study area will comprise of 10 km zone around the mine lease from lease periphery and the data contained in the EIA such as waste generation etc. should before the life of the mine / lease period.	The topographical Map of 10 Km radius around the lease periphery has been prepared which is given at **Plate-2**, Land Use map is given at **Plate-12** of the EIA report. Total SB/IB waste generation for the life of mine is given at Chapter 2 of EIA report.
10	Land use of the study area delineating forest area, agricultural land, grazing land, wildlife sanctuary, national park, migratory routes of fauna, water bodies, human settlements and other ecological features should be indicated. Land use plan of the mine lease area should be prepared to encompass preoperational, operational and post operational phases and submitted. Impact, if any, of change of land use should be given.	Land Use map showing forest area, agricultural land, grazing land, water bodies, human settlements, ecological features etc has been prepared and is given at **Plate 12** of the EIA report.
11	Details of the land for any Over Burden Dumps outside the mine lease, such as extent of land area, distance from mine lease, its land use, R&R issues, if any, should be given.	No outside OB Dump has been planned. .
12	A Certificate from the Competent Authority in the State Forest Department should be provided, confirming the involvement of forest land, if any, in the project area. In the event of any contrary claim by the Project Proponent regarding the status of forests, the site may be inspected by the State Forest Department along with the Regional Office of the Ministry to ascertain the status of forests, based on which, the Certificate in this regard as mentioned above be issued. In all such cases, it would be desirable for a representative of the State Forest Department to assist the Expert Appraisal Committees.	As per Sabik records the land schedule of the ML area consists of 115.05 Ha of Forest Land and 1.71 Ha of Non-Forest Land. Lessee has obtained forest clearance (stage II) from MoEF&CC, over 115.05 ha of forest land, vide letter no: 8-16/2016-FC, dated 22.06.2018. Forest Clearance letter has been attached at Annexure 7 of EIA report.
13	Status of forestry clearance for the broken-up area and virgin forestland involved in the Project including deposition	As per Sabik records the land schedule of the ML area consists of 115.05 Ha of Forest Land and 1.71 Ha of Non-Forest Land. Lessee has obtained forest

	of net present value (NPV) and compensatory afforestation (CA) should be indicated. A copy of the forestry clearance should also be furnished.	clearance (stage II) from MoEF&CC, over 115.05 ha of forest land, vide letter no: 8-16/2016-FC, dated 22.06.2018. The NPV of Rs 8,39,86,500 as demanded by Forest Department vide letter no 4655/5F(Misc)/2015 dated 16.052015 has been deposited through SBI vide UTR no SBINR520150520115201024 on 20.05.2015. Forest Clearance letter has been attached at Annexure 7 of EIA report.
14	Implementation status of recognition of forest rights under the Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 should be indicated.	Not Applicable. There are no forest dwellers in the Mine lease area.
15	The vegetation in the RF / PF areas in the study area, with necessary details, should be given.	EB report is a part of **Chapter 3 heading 3.12 Biodiversity.**
16	A study shall be got done to ascertain the impact of the Mining Project on wildlife of the study area and details furnished. Impact of the project on the wildlife in the surrounding and any other protected area and accordingly, detailed mitigative measures required, should be worked out with cost implications and submitted.	The study has been done for ascertaining the impact of the mining project on wildlife of the study area with suggested mitigative measures have been incorporated in the EIA report in **chapter 4 Para 4.10 Biological Environment.** There are no National Parks, Sanctuaries, Biosphere Reserves, Wildlife Corridors, Ramsar site Tiger/Elephant Reserves existing within the study area. The study of flora fauna within study area have been carried out and detailed under heading **3.12 Ecology & Biodiversity** in **chapter-3 Baseline study.**
17	Location of National Parks, Sanctuaries, Biosphere Reserves, Wildlife Corridors, Ramsar site Tiger/Elephant Reserves/(existing as well as proposed), if any, within 10km of the mine lease should be clearly indicated, supported by a location map duly authenticated by Chief Wildlife Warden. Necessary clearance, as may be applicable to such projects due to proximity of the ecologically sensitive areas as mentioned above, should be obtained from the Standing Committee of National Board of Wildlife and copy furnished.	There are no National Parks, Sanctuaries, Biosphere Reserves, Wildlife Corridors, Ramsar site Tiger/Elephant Reserves.

18	A detailed biological study of the study area [core zone and buffer zone (10 km radius of the periphery of the mine lease)] shall be carried out. Details of flora and fauna, endangered, endemic and RET Species duly authenticated, separately for core and buffer zone should be furnished based on such primary field survey, clearly indicating the Schedule of the fauna present. In case of any scheduled-I fauna found in the study area, the necessary plan along with budgetary provisions for their conservation should be prepared in consultation with State Forest and Wildlife Department and details furnished. Necessary allocation of funds for implementing the same should be made as part of the project cost.	Details of fauna existing within the study area are given in **Heading 3.12 Ecology & Biodiversity** in **chapter-3 Baseline study.** Necessary Conservation plan along with budgetary provisions for their conservation has been approved by the Chief Wildlife warden. The approval letter is given at **Annexure-9.** It is duly implemented and measures have been taken to ensure the protection of the species and help it thrive in the area.
19	Proximity to Areas declared as 'Critically Polluted' or the Project areas likely to come under the 'Aravali Range', (attracting court restrictions for mining operations), should also be indicated and where so required, clearance certifications from the prescribed Authorities, such as the SPCB or State Mining Dept. should be secured and furnished to the effect that the proposed mining activities could be considered.	The proposed project does not fall within 10 Km radius of any "Critically polluted" area and also it does not come under the "Aravali Range".
20	Similarly, for coastal Projects a CRZ map duly authenticated by one of the authorized agencies demarcating LTL. HTL, CRZ area, location of the mine lease w.r.t CRZ, coastal features such as mangroves,if any, should be furnished. (Note: The Mining Projects falling under CRZ would also need to obtain approval of the concerned Coastal Zone Management Authority).	Not Applicable
21	R&R Plan/compensation details for the Project Affected People (PAP) should be furnished. While preparing the R&R Plan, the relevant State/National Rehabilitation & Resettlement Policy should be kept in view.	This is an expansion project without addition of any land and there is no habitation within the lease area hence no R&R is applicable. Surface rights for entire lease area has already been obtained by PP as given at **Annexure-3** of

	In respect of SCs /STs and other weaker sections of the society in the study area, a need based sample survey, family-wise, should be undertaken to assess their requirements, and action programmes prepared and submitted accordingly, integrating the sectoral programmes of line departments of the State Government. It may be clearly brought out whether the village(s) located in the mine lease area will be shifted or not. The issues relating to shifting of village(s) including their R&R and socio-economic aspects should be discussed in the Report.	the EIA report
22	One season (non-monsoon) [i.e. March – May(Summer Season); October – December(post monsoon season); December - February (winter season)] primary baseline data on ambient air quality as per CPCB Notification of 2009, water quality, noise level, soil and flora and fauna shall be collected and the AAQ and other data so compiled presented date-wise in the EIA and EMP Report. Site-specific meteorological data should also be collected. The location of the monitoring stations should be such as to represent the whole of the study area and justified keeping in view the predominant downwind direction and location of sensitive receptors. There should be at least one monitoring station within 500 m of the mine lease in the predominant downwind direction. The mineralogical composition of PM10, particularly for free silica, should be given.	The baseline data of one Season (Pre–monsoon) was collected from **October 2015 to December 2015** and has been revalidated in October 2018**.** Please refer **Chapter-3.** Further as per Direction of MoEF&CC an additional one month baseline in the month of Nov 2019 has been collected and details are given at Annexure 1 of ADS letter.
23	Air quality modeling should be carried out for prediction of impact of the project on the air quality of the area. It should also take into account the impact of movement of vehicles for transportation of mineral. The details of the model used and input parameters used for modeling should be	The combined study on Air quality modelling for mining as well as COB plant with respect to PM2.5, PM10, SO2, and NOx has been done and it has been observed that there is no significant impact is envisaged. The covered in chapter-4. The AQ report is attached at Annexure 25

	provided. The air quality contours may be shown on a location map clearly indicating the location of the site, location of sensitive receptors, if any, and the habitation. The wind roses showing pre-dominant wind direction may also be indicated on the map.	
24	The water requirement for the Project, its availability and source should be furnished. A detailed water balance should also be provided. Fresh water requirement for the Project should be indicated.	Total water requirement for various uses is estimated at 1240 KLD comprising of 240 KLD drinking and domestic use, Water for sprinkling & dust suppression will be 710 KLD, Plantation 100 KLD, Chrome Ore Beneficiation plant make up water will be 160 KLD and others 30 KLD. Water demand will be fulfilled by existing bore well and ETP treated water within the mine lease area. Water drawl permission for withdrawing of 3500 m3/day (240 m3/day from borewell and 3260 m3/day through mine seepage) has been obtained from Central Ground Water Authority dated 07.04.2016 and attached at Annexure 8 of EIA report. Water balance has been given at Chapter 10 of EIA report.
25	Necessary clearance from the Competent Authority for drawl of requisite quantity of water for the Project should be provided.	Permission letter from CGWB for drawing water is attached as **Annexure-8.**
26	Description of water conservation measures proposed to be adopted in the Project should be given. Details of rainwater harvesting proposed in the Project, if any, should be provided.	The rain water accumulated in the pit and quarry water after treatment in ETP is being used for sprinkling and green belt development as a water conservation measure. Rain water harvesting pits are installed which helps in recharging the groundwater. Water conservation measures are detailed in EIA report at EMP given in **Chapter-9.**
27	Impact of the project on the water quality, both surface and groundwater should be assessed and necessary safeguard measures, if any required, should be provided.	Mining shall not adversely impact surface or groundwater. Mining shall be done keeping all the safety procedures in mind. Anticipated impact on the water quality both surface and groundwater have been assessed and mitigation measures are suggested & provided in **Chapter-4 Para 4.5 Water Environment.** To avoid contamination of downstream water body and ETP of 8640 KLD has been installed for treatment of effluent before discharging the

		water into the Damsal Nala. There is proper management of Run-off from the mine by constructing settling pond, retaining walls built along OB dump, Sub-grade dump and fines dump.
28	Based on actual monitored data, it may clearly be shown whether working will intersect groundwater. Necessary data and documentation in this regard may be provided. In case the working will intersect groundwater table, a detailed Hydro Geological Study should be undertaken and Report furnished. The Report inter-alia, shall include details of the aquifers present and impact of mining activities on these aquifers. Necessary permission from Central Ground Water Authority for working below ground water and for pumping of ground water should also be obtained and copy furnished.	The leasehold area displays an undulating topography; however as per CGWB brochure it ranges from pre monsoon 5-10 mbgl to post monsoon season rises upto 2-5 mbgl. Mining has already intersected water table, permission from CGWA for pumping water has been enclosed at Annexure 8 of EIA report. Detailed Hydro geological report is given at **Annexure-16.**
29	Details of any stream, seasonal or otherwise, passing through the lease area and modification / diversion proposed, if any, and the impact of the same on the hydrology should be brought out.	There is no river or water body flowing across the mine site.
30	Information on site elevation, working depth, groundwater table etc. Should be provided both in AMSL and bgl. A schematic diagram may also be provided for the same.	The leasehold area displays an undulating topography. The ultimate mining depth in the band I deposit will be (-)2 mRL and in the band II deposit 46 mRL. As per CGWB brochure the depth of water level ranges from pre monsoon 5-10 mbgl to post monsoon season rises upto 2-5 mbgl. Detailed Hydro-geological report is given at **Annexure-17**
31	A time bound Progressive Greenbelt Development Plan shall be prepared in a tabular form (indicating the linear and quantitative coverage, plant species and time frame)and submitted, keeping in mind, the same will have to be executed up front on commencement of the Project. Phase-wise plan of plantation and compensatory afforestation should be	Progressive Green Belt plan is provided in Chapter 9 of the EIA report. Detail of Existing plantation done by PP from 1999 to till date are given at **Annexure no. 14.** Existing Plantation details have been covered in brief and proposed plantation during plan period are given in EIA Chapter 4 under heading **4.12 Plantation/Afforestation Programme.**

	charted clearly indicating the area to be covered under plantation and the species to be planted. The details of plantation already done should be given. The plant species selected for green belt should have greater ecological value and should be of good utility value to the local population with emphasis on local and native species and the species which are tolerant to pollution.	
32	Impact on local transport infrastructure due to the Project should be indicated. Projected increase in truck traffic as a result of the Project in the present road network (including those outside the Project area) should be worked out, indicating whether it is capable of handling the incremental load. Arrangement for improving the infrastructure, if contemplated (including action to be taken by other agencies such as State Government) should be covered. Project Proponent shall conduct Impact of Transportation study as per Indian Road Congress Guidelines.	Projected increase in truck traffic as a result of the Project in the present road network has been studied and capability of existing road w.r.t. Incremental load has been worked out. It has been found that the existing road network is sufficient to handle the increased transportation of mineral ore produced after expansion of mine. Impact of transportation after the expansion will be minimal. Detail is given in **Ch-4 heading 4.9 Transportation**
33	Details of the onsite shelter and facilities to be provided to the mine workers should be included in the EIA report.	A mine office, rest shelter and first aid center have already been constructed at the site of mining. Details are given in **2.11.3. in Chapter 2 Proposed Transportation and Infrastructure**
34	Conceptual post mining land use and Reclamation and Restoration of mined out areas (with plans and with adequate number of sections) should be given in the EIA report.	Conceptual post mining landuse is given in Chapter 9 of EIA report.
35	Occupational Health impacts of the Project should be anticipated and the proposed preventive measures spelt out in detail. Details of pre-placement medical examination and periodical medical examination schedules should be incorporated in the EMP. The project specific occupational health mitigation measures with required facilities proposed in the mining area may be detailed.	Existing and proposed measures towards Occupational health and safety to maintain safe and healthy work environment have been detailed with budget estimation. Rs 8 Lakh per annum has been provided as a recurring expenditure for dealing with occupational health impact. Details are given in EIA report in **Chapter 7 under heading 7.8 Occupational Health**

36	Public health implications of the Project and related activities for the population in the impact zone should be systematically evaluated and the proposed remedial measures should be detailed along with budgetary allocations.	Public health implications of the Project has been studied and the Detail is given in EIA **Chapter-7 para 7.8.8 Public Health and safety** with budget allocations.
37	Measures of socio-economic significance and influence to the local community proposed to be provided by the Project Proponent should be indicated. As far as possible, quantitative dimensions may be given with time frames for implementation.	The CER budget has been provided as per the provision of OM dated 01.05.2018. The head wise expenditure is given with the ADS reply of point no 12 and attached as Annexure 11 of ADS. The Details of significant Welfare Activities to be taken up by the Company under Corporate Environmental Responsibility are given in **EIA report Chapter 7 heading 7.7 Corporate Environmental Responsibility**
38	Detailed environmental management plan (EMP) to mitigate the environmental impacts which, should inter-alia include the impacts of change of land use, loss of agricultural and grazing land, if any, occupational health impacts besides other impacts specific to the proposed project.	Please refer to Chapter **9** of the EIA report having detailed Environmental Management Plan and budget allocations. Capital Amount of Rs 73.5 Lakhs and Recurring expenditure of Rs 87 Lakhs per annum have been provided under the various heads of Environment management plan.
39	Public hearing points raised and commitment of the Project proponent on the same along with time bound action plan with budgetary provisions to implement the same should be provided and also incorporated in the final EIA/EMP Report of the Project.	The public hearing minutes and the compliance of same is given at **Annexure-no. 18**
40	Details of litigation pending against the project, if any, with direction /order passed by any Court of Law against the project should be given.	Revision application No.22/46/2018/RC-1, challenging the demand issued on excess production by the State Govt, heared on 10-05-2018 by Revision Authority and has stayed the same with a notice to State Govt.
41	The cost of the project (capital cost & recurring cost) as well as the cost towards implementation of EMP should be clearly spelt out.	The project cost is Rs.394.45 Crore and EMP cost is given in Chapter 9 of EIA report. Capital Amount of Rs 73.5 Lakhs and Recurring expenditure of Rs 87 Lakhs per annum have been provided under the various heads of Environment management plan.
42	A Disaster Management plan shall be prepared and included in the EIA/EMP	The DMP is give in Chapter 7 and detailed plan is given at **Annexure no-17**

	Report.	
ADDITIONAL TERMS OF REFERENCE		
1.	Department of Mining & Geology, State Government shall ensure that mining operation shall not commence till the entire compensation levied, for illegal mining paid by the Project Proponent through their respective Department of Mining & Geology in strict compliance of judgement of Hon'ble Supreme Court dated the 2nd August 2017 in Writ Petition (Civil) No. 114 of 2014 in the matter of Common Cause versus Union of India and Ors	Noted
2	The activities and budget earmarked for Corporate Environmental responsibility (CER) shall be as per Ministry's OM No. 22-65/2017-IA.II(M) dated 01.05.2018 and the action plan on the activities proposed under CER shall be submitted at the time of appraisal of the project included in the EIA/EMP report.	The activities and budget earmarked for Corporate Environmental responsibility as per Ministry's OM No. 2-65/2-17-IA.II(M) dated 01.05.2018 and the action plan on the activities proposed under CER have been covered under heading no. **7.7 Corporate Environmental Responsibility given in Chapter 7** of the EIA report. This is also provided in the annexure 11 of ADS reply.
3	The Action Plan on the compliance of the recommendations of the CAG as per Ministry's Circular No. J-11013/71/2016-IA.I(M) dated 25.10.2017 needs to be submitted at the time of appraisal of the Project and included in the EIA/EMP report	See Reply below (point wise)
	a) Revalidation of data with respect of grant of ToR /EC to be carried out on regular basis with NIC.	Noted. Being Complied as directed.
	b) While scrutinizing the EIA reports, may ensure that they are as per the ToR, comply with generic structure, baseline data is accurate and concerns raised during the public hearing are adequately addressed.	Has been complied with.
	c) The EIA Reports/EC letters should clearly mention cost of the activities under EMP and ESR along with the timelines for their implementation.	Cost of the activities proposed under EMP and ESR/CER have been covered in **Chapter-9** of the EIA report.

	d) The EMP/EC conditions should be more specific for the area to be developed under Green belt and species planted in consultation with Forest/ Agriculture Department along with post EC third Party Evaluation.	It will be complied with and the detail has been incorporated in **Chapter-4 and Chapter-9** of the EIA report.
	e) Copy of EC letter to these projects should be endorsed to CGWA to ensure monitoring of ground water extraction.	Noted. Will be Complied as directed.
	f) While appraising the EC application, the name and number of posts to be engaged by the project proponent for implementation and monitoring of environmental parameters be specified.	This has been incorporated in **Chapter-6 and Chapter 9** of the EIA report. This is to be noted
	g) While prescribing the conditions of EC please mention installation of monitoring stations and frequency of monitoring of various environment parameters in respect of air, surface water, ground water, noise etc.	This has been incorporated in **Chapter-6** of the EIA report.
	h) While scrutinizing the EC application, should ensure that the EIA reports is prepared by accredited consultant having no conflict of interest with any Committee processing the case.	Noted.
	i) The conditions of EC should be compatible with the nature and type of project in order to avoid non- uniformity in similar kinds of projects.	Noted. Will be Complied as directed.
	j) The EIA report should clearly mention activity wise EMP and ESC cost details and should depict clear break up of the capital and incurring the capital cost. The basis of allocation of EMP & ESCcost should be detailed in the EIA report to enable the comparison of compliance with the commitment by the central and State Monitoring agencies. The capital and revenue expenditure amount to be spent on EMP and CSR Cost should be distinctly specified in the EC letter. It should be ensured that there is a time bound action	Noted. The cost-break up and expenditure to be incurred has been detailed in **Chapter-7 and Chapter-9** of the EIA report.

	plan for fulfilling the EMP commitment mentioned in the EIA report to the EC letter.	
	k) On maintenance of separate accounts for EMP and ESC, EC conditions should be more specific like opening a separate bank account and accounting format with specific heads of accounts in order to provide financial accountability by PP. This should be made compulsory part of the Annual Environment Statement.	Noted will be complied with.
4	Compliance of the Ministry's office Memorandum No. F.3-50/2017-IA.III(Pt.) dated 30.05.2018 on the judgment of Hon'ble Supreme Court, dated 02nd August 2017 in Writ Petition (Civil) No.114 of 2014 in the matter of Common Cause versus Union of India needs to be submitted and included in the EIA/EMP report.	Affidavit in Compliance of the Ministry's office Memorandum No. F.3-50/2017-IA.III(Pt.) dated 30.05.2018 was submitted to MoEF&CC on 08.04.2019. Copy of the document is given at **Annexure-26**
5	PP should submit the quantity of surface or ground water to be used for this project. The complete water balance cycle needs to be submitted. In addition to this PP should submit a detailed plan for rain water harvesting measures to be taken. The PP should submit the year wise target for reduction in consumption of ground water by developing alternative source of water through rain water harvesting measures. The capital and recurring expenditure to be incurred needs to be submitted.	Detail has been given in Chapter 9 of EIA report.
6	The PP should clearly bring out the details of the manpower to be engaged for this project with their roles/responsibilities/designations. In addition to this PP should mention the number and designation of person to be engaged for implementation of environmental management plan (EMP).	Detail has been given in chapter 2 of EIA report. And Chapter 9 of EIA report.
7	The PP should submit the year-wise, activity wise and time bound budget earmarked for EMP, occupational health survelliance & Corporate Environmental Responsibility	Detail has been given in Chapter 9 of EIA report.

	needs to be submitted.	
8	PP should submit the measures to be adopted for the prevention of illegal mining and pilferage of mineral needs to be submitted.	Detail given in Chapter 9 of EIA report.
9	PP should submit the detailed mineralogical and chemical composition of the mineral and percentage of free silica from a NABL/MoEF&CC accredited laboratory.	Report showing mineralogical and chemical composition of the mineral and percentage of free silica is given at **Annexure 27** of EIA report.
10	PP should clearly bring out that what is the specific diesel consumption and steps to be taken for reduction of the same. Year-wise target for reduction in the specific diesel consumption needs to be submitted.	Detail has been given in Chapter 2 of EIA report.
General Points of ToR		
a)	All documents to be properly referenced with index and continuous page numbering.	Complied with
b)	Where data are presented in the Report especially in Tables, the period in which the data were collected and the sources should be indicated.	Complied with
c)	Project Proponent shall enclose all the analysis/testing reports of water, air, soil, noise etc. using the MoEF&CC/NABL accredited laboratories. All the original analysis/testing reports should be available during appraisal of the Project.	Complied with
d)	Where the documents provided are in a language other than English, an English translation should be provided.	Complied with
e)	The Questionnaire for environmental appraisal of mining projects as devised earlier by the Ministry shall also be filled and submitted.	Noted
f)	While preparing the EIA report, the instructions for the Proponents and instructions for the Consultants issued by MoEF vide O.M. No. J-11013/41/2006-IA.II (I) dated4th August, 2009, which are available on the website of this Ministry, should be followed.	Noted

g)	Changes, if any made in the basic scope and project parameters (as submitted in Form-I and the PFR for securing the TOR) should be brought to the attention of MoEF&CC with reasons for such changes and permission should be sought, as the TOR may also have to be altered. Post Public Hearing changes in structure and content of the draft EIA/EMP (other than modifications arising out of the P.H. process) will entail conducting the PH again with the revised documentation.	Noted
h)	As per the circular no. J-11011/618/2010-IA. II (I)dated 30.5.2012, certified report of the status of compliance of the conditions stipulated in the environment clearance for the existing operations of the project, should be obtained from the Regional Office of Ministry of Environment, Forest and Climate Change, as may be applicable.	It is given at **Annexure-3** along with previous EC letter.
i)	The EIA report should also include (i) surface plan of the area indicating contours of main topographic features, drainage and mining area, (ii) geological maps and sections and (iii) Sections of the mine pit and external dumps, ifany, clearly showing the land features of the adjoining area.	Complied with

Annexure 11- Revised CER budget

Sr. No.	Activities	Provisions	Areas	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total (Lakhs)
1	Drinking water supply	Construction of water storage tank and water will be made available through tanker supply or providing tubewell in different villages.	Ransol, Gandhapal, Kankadpal, Kaliapani & Chingudipal	12	15	18	15	20	80
2	Sanitation facility	Construction of 10 community's toilet with water tank facilities and distribution of coloured dustbins for collection, segregation and proper disposal of waste generated from different villages.	Ransol, Gandhapal, Kankadpal, Kaliapani & Chingudipal	5	7	8	6	5	31
3	Infrastructure development	Construction and maintenence of village roads under peripheral development programmes of the company in nearby villages	Ransol, Gandhapal, Kankadpal, Kaliapani & Chingudipal	8	11	12	9	12	52
4	Health support	Organizing free health checkup camp in village nearby the project site at an interval of every six months and distribution of free medicines to the needy one	kaliapani	8	5	9	8	9	39
4	Education support	Development of smart class room in village government primary school to improve education system and will	Ransol, Gandhapal, Kankadpal, Kaliapan	12	18	21	23	24	98

		provide ammenities like blackboards, table, & benches in different villages	i & Chingudi pal						
TOTAL (LAKHS)				45	56	68	61	70	300

The project is for expansion hence as per the MoEF&CC OM No. F.No.22-65/2017-IA-III dated 01.05.2018, 0.75% of the project cost i.e. Rs 394.45 Crores which amounts to Rs 295.8375 Crores has to be spent under CER. However Rs 3 Crores has been allocated towards CER.

Annexure 12 a- CGWA approvals

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES

Ph.3325079/3325686
Fax. 3325063
E-mail: cgwa@vsnl.com

Central Ground Water Authority
A-2, W-3, Curzon Road Barracks
New Delhi-110001

No. 21-8/CGWA/Sukinda/02- 411 Dated- 13/3/02

To,

The Regional Director
Central Ground Water Board
South Eastern Region
Bhubaneswar

Sub:-Approval of Central Ground Water Authority in respect of Sukinda Chromite Mines, Sukinda Block, Jajpur District, Orissa of M/s Indian Metals & Ferro Alloys Ltd., Bomikhal, Rasulgarh, Bhubaneswar

Sir,

Please find enclosed herewith the Letter of Approval (in original), in respect of Sukinda Chromite Mines, Sukinda Block, Jajpur District, Orissa of M/s Indian Metals & Ferro Alloys Ltd., Bomikhal, Rasulgarh, Bhubaneswar. It is requested that the same may be forwarded to the concerned firm under intimation to this office.

Encl: as above

Yours faithfully

(Dr. A. N. BHOWMICK)
Member Secretary

Copy to-

The Vice President (Mines), M/s Indian Metals & Ferro Alloys Ltd., IMFA Building, Bomikhal, Rasulgarh, Bhubaneswar-751010 (Orissa)

(Dr. A. N. BHOWMICK)
Member Secretary

CGWA/IND/Proj/2002-07

Central Ground Water Authority
Ministry of Water Resources, Govt. of India
(Constituted under Section 3(3) of Environment Protection Act, 1986)

Sub- Ground Water Clearance in respect of Sukinda Chromite Mines, Sukinda Block, Jajpur District, Orissa of M/s Indian Metals & Ferro Alloys Ltd., Bomikhal, Rasulgarh, Bhubaneswar

Application of M/s Indian Metals & Ferro Alloys Ltd., Bomikhal, Rasulgarh Bhubaneswar has been examined critically from ground water angle. The concurrence of Central Ground Water Authority is hereby accorded for the withdrawal of 13.5 m^3/day of ground water for drinking purpose for its proposed mining activity at [redacted] Chromite Mines, Sukinda Block, Jajpur District, Orissa of M/s Indian Metals & Ferro Alloys Ltd., Bomikhal, Rasulgarh, Bhubaneswar

The approval is however, subject to the following stipulated conditions:-

1. The firm may abstract 131 m^3/day of ground water through construction of proposed number of three ground water abstraction structures. No enhanced withdrawal of ground water is permitted without approval of the Authority and no additional tubewells/ground water abstraction structures shall be constructed without prior consent of the Authority.
2. The project authorities shall, in consultation with Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar shall plan and implement suitable conservation measures to augment ground water resources in the area.
3. Ground water either in form of mine discharge or the withdrawals from the proposed ground water abstraction structures shall be properly treated before use as per norms of Orissa State Pollution Control Board.
4. Mine seepage water/waste water generated shall be properly re-cycled and re-use to the maximum possible extent.
5. The project authorities at its own cost shall install piezometers, at suitable locations in consultation with Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar and execute ground water regime monitoring system in and around the project area. The ground water data generated by project authorities during pre and post project periods shall be submitted to Central Ground Water Board, South Eastern Region, Bhubaneswar periodically on annual basis.

Dated- 14/2/02

Dr. A.N. Bhowmick
Member Secretary

भारत सरकार
केन्द्रीय भूमि जल प्राधिकरण
जल संसाधन, नदी विकास
और गंगा संरक्षण मंत्रालय

Government of India
Central Ground Water Authority
Ministry of Water Resources,
River Development & Ganga Rejuvenation

File No:- 21-4/838/OR/MIN/2016 - 727

NOC No:- CGWA/NOC/MIN/ORIG/2016/2166

Dated :- 07/04/2016
06 MAY 2016

To,

M/s Indian Metals and Ferro Alloys Limited,
IMFA House, Bamikhal, Rasulgarh,
Bhubaneswar, District Khordha,
Odisha – 751010

Sub:- NOC for ground water withdrawal to Sukinda Chromite Mines of M/s Indian Metals And Ferro Alloys Limited located at Village Kaliapani, Block Sukinda, Village Kaliapani, Block Sukinda, District Jajapur, Odisha – reg.

Refer to your application on the above cited subject. Based on recommendations of Regional Director, Central Ground Water Board South Eastern Region, Bhubaneswar vide their recommendations dated 17/03/2016 and further deliberations on the subject, the NOC of Central Ground Water Authority is hereby accorded to **Sukinda Chromite Mines of M/s Indian Metals and Ferro Alloys Limited located at Village Kaliapani, Block Sukinda, Village Kaliapani, Block Sukinda, District Jajapur, Odisha .** The NOC is, however subject to the following conditions:-

1. The firm may abstract **240 cu.m/day** of ground water through proposed **one (1)** borewell The firm at its own cost shall install piezometers at suitable locations both in core and buffer zone and execute ground water regime monitoring programme in and around the project area on regular basis in consultation with the and **3260 cu.m/day** through dewatering the mine seepage on account of mining intersecting the water table. The total withdrawal should not exceed **3500 cu.m/day (not exceeding 12,77,500 cu.m/year)**. No additional dewatering and no additional ground water abstraction structures to be constructed for this purpose without prior approval of the CGWA. Firm to submit computation of mine seepage and utilization of mine dewatering after requisite treatment as the mine water **may contain hexavalent chromium**.
2. The dewatering structure as well borewell to be fitted with water meter by the firm at its own cost and monitoring of ground water abstraction to be under taken accordingly on regular basis, at least once in a month. The ground water quality to be monitored twice in a year during pre- monsoon and post- monsoon periods.
3. **M/s Indian Metals and Ferro Alloys Limited,** shall, in consultation with the Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar, implement ground water recharge measures atleast to the tune of **47,717 cu.m/year** as proposed, for augmenting the ground water resources of the area within six months from the date of issue of this letter. No part of the dewatered mine water should be used in any way to recharge the aquifer or even allowed to seep back to the aquifer

system. Because of the presence of Hexavalent Chromium the firm should take adequate measures and utmost care and protection against any chances of contamination to the aquifers.

4. The photographs of the recharge structures after completion of the same are to be furnished immediately to the Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar for verification and under intimation to this office.

5. The firm at its own cost shall install 8 to 10 piezometers fitted with automatic water level recorders at suitable locations both in core and buffer zone and execute ground water regime monitoring programme in and around the project area on regular basis in consultation with the Central Ground Water Board, South Eastern Region, Bhubaneswar. The monitoring report to be submitted within six months of the issuance of this letter.

6. The ground water monitoring data in respect of S. No. 2 & 5 to be submitted to Central Ground Water Board, South Eastern Region, Bhubaneswar on regular basis at least once in a year. Ground water monitoring in core and buffer zones

7. The firm shall ensure proper recycling and reuse of waste water after adequate treatment.

8. Action taken report in respect of S. No. 1 to 7 may be submitted to CGWA within one year period.

9. The permission is liable to be cancelled in case of non-compliance of any of the conditions as mentioned in S. No. 1 to 8.

10. This NOC is subject to prevailing Central/State Government rules/laws or Court orders related to construction of tubewell/ ground water withdrawal/ construction of recharge or conservation structures/ discharge of effluents or any such matter as applicable.

11. This NOC does not absolve the applicant / proponent of his obligation / requirement to obtain other statutory and administrative clearances from other statutory and administrative authorities.

12. The NOC does not imply that other statutory / administrative clearances shall be granted to the project by the concerned authorities. Such authorities would consider the project on merits and be taking decisions independently of the NOC.

13. This NOC is valid till 06/04/2018.

Member Secretary

Copy to:

1. The Director, Ministry of Environment and Forests (I. A. Division), Paryavaran Bhawan, CGO Complex, Lodhi Road, New Delhi-110003.
2. The Member Secretary, Orissa State Pollution Control Board, Odisha, A/118, Nilakantha Nagar, Unit-VIII, Bhubaneswar-751012, Odisha.
3. The District Collector, District Jajapur, Odisha
4. The Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar. This has reference to your recommendation dated 17/03/2016.
5. TS to the Chairman, Central Ground Water Board, Bhujal Bhawan, Faridabad, Haryana.
6. Guard File 2016-17.

Member Secretary

CC - M.M. - SMC

D/c Env.

17/5/16

ATTACHMENT-6

Member (CGWA)

सत्यमेव जयते

भारत सरकार
केन्द्रीय भूमि जल प्राधिकरण
जल संसाधन, नदी विकास
और गंगा संरक्षण मंत्रालय

Government of India
Central Ground Water Authority
Ministry of Water Resources,
River Development & Ganga Rejuvenation

File No: - 21-4/838/OR/MIN/2016 -2303

NOC No: - CGWA/NOC/MIN/REN/1/2018/5556

Date:- 14 DEC 2018

To

M/s Indian Metals and Ferro Alloys Ltd.
(Sukinda Chromite Mines), IMFA Building,
Bomikhal, Rasulgarh, Block Bhubaneswar,
District Khordha, Odisha – 751010

Sub: - Renewal of NOC for ground water withdrawal to M/s Indian Metals and Ferro Alloys Ltd. in respect of their existing "Sukinda Chromite Mines" located at Village Kaliapani (CT), Block – Sukinda, District Jajapur, Odisha – reg.

Refer to your application dated 05/04/2018 for grant of NOC for ground water withdrawal. Based on recommendations of Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar vide his letter dated 18/07/2018 and further deliberations on the subject, the renewal of NOC of Central Ground Water Authority for ground water withdrawal is hereby accorded to **M/s Indian Metals and Ferro Alloys Ltd. in respect of their existing "Sukinda Chromite Mines" located at Village Kaliapani (CT), Block – Sukinda, District Jajapur, Odisha.** The renewal of NOC is valid from 07/04/2018 to 06/04/2021 however subject to the following conditions:-

1. The firm may abstract **240 cu.m/day** of ground water (and **87,600 cu.m/year)** through two (2) existing bore wells and **3,260 cu.m/day** (not exceeding **11,89,900 cu.m/year**) through dewatering mine seepage from mine pit on account of mining intersecting the water table. The total withdrawal should not exceed **3500 cu.m/day** (not exceeding **12, 77,500 cu.m/year**). No additional dewatering and ground water abstraction structure shall be constructed for this purpose without prior approval of the CGWA. Any unexpected variation in inflow of ground water into the mine pit should be reported to the concerned Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar.
2. Both the wells as well as dewatering structures shall remain fitted with digital water flow meters and monthly ground water abstraction data of each structure shall continue to be recorded in a log book.
3. **M/s Indian Metals and Ferro Alloys Ltd. (Sukinda Chromite Mines)** shall continue to implement ground water recharge measures to the tune of **51,370 cu.m/year** for augmenting the ground water resources of the area. Firm shall also undertake periodic maintenance of recharge structures at its own cost.
4. The firm shall continue to execute monthly ground water level monitoring in the project area through eight (8) no. of existing piezometers. Further, the firm shall continue to execute ground water level monitoring four (4) times a year (January, May,

18/11, Jamnagar House, Mansingh Road, New Delhi-110011
Phone : (011) 23383561 Fax : 23382051, 23386743
Website: www.cgwa.noc.gov.in

August and November) in core and buffer zone through existing key wells. Firm shall install telemetry system in one of the piezometers and shall share the user ID and password of the telemetry system with the Regional Director, Central Ground Water Board, North Central Region, Bhubaneswar.

5. The ground water quality shall be monitored twice in a year during pre monsoon period.

6. The ground water monitoring data in respect of S. No. 2, 4 & 5 shall be submitted to Central Ground Water Board, South Eastern Region, Bhubaneswar on regular basis at least once in a year.

7. The firm shall ensure proper recycling and reuse of waste water after adequate treatment.

8. Action taken report in respect of S. No. 1 to 7 may be submitted to CGWA within one year period.

9. The permission is liable to be cancelled in case of non-compliance of any of the conditions as mentioned in S. No. 1 to 8.

10. This NOC is subject to prevailing Central/State Government rules/laws or Court orders related to construction of tubewell/ ground water withdrawal/ construction of recharge or conservation structures/ discharge of effluents or any such matter as applicable.

11. The firm shall report self-compliance online in the website (www.cgwa-noc.gov.in) within one year from the date of issue of this NOC.

12. This NOC does not absolve the applicant / proponent of his obligation / requirement to obtain other statutory and administrative clearances from other statutory and administrative authorities.

13. The NOC does not imply that other statutory / administrative clearances shall be granted to the project by the concerned authorities. Such authorities would consider the project on merits and be taking decisions independently of the NOC

Member (CGWA)

Copy to:

1. The Member Secretary, Odisha Pollution Control Board, Paribesh Bhawan, A/118, Nilakantha Nagar, Unit- VIII, Bhubaneswar- 751012, Odisha.
2. The District Collector & Magistrate, District Jajapur, Odisha for necessary action.
3. The Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar. This has reference to your recommendation dated 18/07/2018.
4. Guard File 2018-19.

Member (CGWA)

Annexure 12 b- Compliance status of conditions in installation of piezometer

Reference	Location	latitude	longitude	RL
Piezometers- 1/8	In front of Mahagiri mines decline	21°1'39.50"N	85°46'39.70"E	159.0
Piezometers- 2/8	Near weighbridge- II	21° 2'16.33"N	85°46'15.95"E	126.0
Piezometers- 3/8	Near Mahagiri Enclave	21° 2'18.39"N	85°45'43.09"E	108.0
Piezometers- 4/8	At herbal garden	21° 2'16.61"N	85°45'49.73"E	113.5
Piezometers- 5/8	Near administrative building	21° 2'30.02"N	85°46'17.16"E	120.5
Piezometers- 6/8	At near Chandimata school	21° 2'12.29"N	85°45'41.69"E	113.5
Piezometers- 7/8	Near magazine sump	21° 1'58.56"N	85°46'38.13"E	133.5
Piezometers- 8/8	Near etp-4	21° 1'52.14"N	85°46'32.74"E	140.0

Photo showing piezometer no. 1/8 installed in front of Mahagiri mines decline in respect of Sukinda mines (chromite)

Photo showing Piezometer no. 2/8 installed at near weighbridge of Sukinda mines (Chromite)

Photo showing Piezometer no. 3/8 installed near Mahagiri enclave in respect of Sukinda mines (chromite)

Photo showing Piezometer no.4/8 installed at herbal garden of Sukinda mines (Chromite)

Photo showing piezometer no. 5/8 installed near administrative building of Sukinda mines (chromite)

Photo showing piezometer no.6/8 installed at near chandimata school of Sukinda mines (chromite)

Photo showing piezometer no. 7/8 installed near magazine sump of Sukinda mines (Chromite)

Photo showing piezometer no 8/8 installed near etp-4 of Sukinda mines (Chromite)

INDIAN METALS & FERRO ALLOYS LIMITED

IMFA Building
Bhubaneswar-751010
Odisha, India

Corporate Identity No.
L27101OR1961PLC000428

TEL +91 674 2611000
+91 674 2580100
FAX +91 674 2580020
+91 674 2580145

mail@imfa.in

www.imfa.in

Ref. No: IMFA/MPC/SMC/2019/19
Date: 05.03.2019

Member Secretary
Central Ground Water Authority
Ministry of Water Resources
18/11, Jamnagar House
Mansingh Road,
New Delhi-110011

Sub:-Submission of Action Taken Report (ATR) in compliance to the conditions stipulated in the NOC approved vide Letter No.CGWA/NOC/MIN/REN/1/ 2018/5556 Dated 14.12.2018 in respect of Sukinda Mines(Chromite) of M/s. Indian Metals & Ferro Alloys Limited.

Ref:- NOC granted vide letter No. CGWA/NOC/MIN/REN/1/2018/5556 Dated 14th December,2018.

Dear Sir,

With reference to the above cited subject and as per the directive of condition no.8 of NOC (under reference), we are submitting here with the Action Taken Report (attached as Annexure-I) in compliance to the NOC condition no. 1 to 7 for abstraction of ground water and de-watering of mine seepage water in respect of Sukinda Mines(Chromite) of M/s. Indian Metals & Ferro Alloys Limited located in village Kaliapani under Sukinda Block of Jajpur District, Odisha.

This is for your kind information and record.

Thanking you,
yours faithfully,
For: **M/s. Indian Metals & Ferro Alloys Limited.**

(Sanjeev Das)
Sr. Vice President
Head-Mining Business Unit

Enclosed : ATR as Annexure-I

CC: The Regional Director, Central Ground Water Board,South Eestern Region, Bhujal Bhawan, Khandagiri, Bhubaneswar-751030- for kind information

CENTRAL GROUND WATER BOARD RECEIPT Date 6/3/19 Sig. Contains not Verified S.E.R., BHUBANESWAR

CENTRAL GROUND WATER BOARD RECEIPT Date 6/3/19 Sig. Contains not Verified S.E.R., BHUBANESWAR

IMFA Building
Bhubaneswar-751010
Odisha, India

Corporate Identity No.
L27101OR1961PLC000428

TEL +91 674 2611000
+91 674 2580100
FAX +91 674 2580020
+91 674 2580145

mail@imfa.in

www.imfa.in

ANNEXURE-I

Action Taken Report in compliance to the condition no.1 to 7 stipulated in the NOC vide letter no. CGWA/NOC/MIN/REN/1/2018/5556 dated 14th December, 2018 in respect of Sukinda Mines(Chromite) of M/s. Indian Metals & Ferro Alloys Limited.

Condition No – 1:

The firm may abstract 240 cu.m/day of ground water and (87,600 cu.m./year) through two (2) existing bore wells and 3,260 cu.m/day (not exceeding 11,89,900 cu.m./year)through dewatering the mine seepage from mine pit on account of mining intersecting the water table. The total withdrawal should not exceed 3500 cu.m/day (not exceeding 12,77,500 cu.m/year). No additional dewatering and ground water abstraction structure shall be constructed for this purpose without prior approval of the CGWA. Any unexpected variation in inflow of ground water into the mine pit should be reported to the concerned Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar.

Action Taken:

Abiding the said condition. However, Daily water withdrawal does not exceed the permissible limit of 3500 m3/day. The average intraday withdrawal of ground water from existing two (2) bore-wells does not exceed the permissible limit of 240 m3/day and the average intraday withdrawal of de-watering mine seepage water does not exceed the permissible limit of 3260 m3/day. No additional ground water abstraction structures have been constructed following the CGWA directive. In case of any unexpected variation in inflow of ground water in the mine pit, will be reported to Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar.

Condition No – 2:

Both the wells as well as de-watering structures shall remain flitted with digital water flow meters and monthly ground water abstraction data of each structure shall continue to be recorded in a log book.

Action Taken:

Both the wells as well as de-watering structures have been fitted with digital flow meters and monthly ground water abstraction data is being recorded in the log book and the same is being submitted to Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar during quarterly compliance report. The latest quarterly compliance report submitted 30.01.2019 vide our letter no IMFA/SMC/19/4074 Dtd 23.01.2019.

IMFA Building
Bhubaneswar-751010
Odisha, India

Corporate Identity No.
L27101OR1961PLC000428

TEL +91 674 2611000
+91 674 2580100
FAX +91 674 2580020
+91 674 2580145

mail@imfa.in

www.imfa.in

Condition No – 3:

M/s Indian Metals and Ferro Alloys Ltd. (Sukinda Mines Chromite) shall continue to implement ground water recharge measures to the tune of 51,370 cu.m/year for augmenting the ground water resources of the area. Firm shall also undertake periodic maintenance of recharge structures at its own cost.

Action Taken:

M/s Indian Metals and Ferro Alloys Ltd (Sukinda Mines Chromite) is continuing to implement and maintain the existing rain water harvesting structures for augmenting the ground water resources to the tune of 51,370 cu.m/year. The periodic maintenance of existing rain water harvesting structures are being carried out during pre-monsoon and post-monsoon at our own cost..

Condition No – 4

The firm shall continue to execute monthly ground water level monitoring in the project area through eight (8) no. of existing piezometers. Further, the firm shall continue to execute ground water level monitoring four (4) times a year (January, May, August and November) in core and buffer zone through existing key wells.
Firm shall install telemetry system in one of the piezometers and shall share the user ID and password of the telemetry system with the Regional Director, Central Ground Water Board, North Central Region, Bhubaneswar.

Action Taken:

M/s Indian Metals and Ferro Alloys Ltd (Sukinda Mines Chromite) is being continued of ground water level monitoring through eight (8) no. of existing water level piezometers. Further, ground water level monitoring for the key wells in core and buffer zone also monitored (4) times in year i.e. in the month of January, May, August and November and the report is being submitted to Regional Director, Central Ground Water Board, South -Eastern Region, Bhubaneswar during Quarterly compliance report. The latest quarterly compliance report submitted on 30.01.2019 vide our letter no IMFA/SMC/19/4074 Dtd 23.01.2019.

Regarding telemetry system, M/s Indian Metals and Ferro Alloys Ltd (Sukinda Mines Chromite) has installed telemetry system in all the existing eight (8) no. of piezometers and the user ID & Password has been shared to Regional Director, Central Ground Water Board, South-Eastern Region, Bhubaneswar vide our letter no IMFA/MOC/SMC/2019-15 dated 26.02.2019.

Condition No – 5.

The ground water quality shall be monitored twice in a year during pre-monsoon and post monsoon.

IMFA Building
Bhubaneswar -751010
Odisha, India

Corporate Identity No.
L27101OR1961PLC000428

TEL +91 674 2611000
+91 674 2580100
FAX +91 674 2580020
+91 674 2580145

mail@imfa.in

www.imfa.in

Action Taken:

The ground water quality is being monitored 4 times in a year i.e. pre-monsoon, monsoon, post-monsoon and winter. In this regard M/s Indian Metals and Ferro Alloys Ltd (Sukinda Mines Chromite) has engaged a qualified laboratory who has accredited by NABL & MoEF & CC. The report is being submitted to Regional Director, Central Ground Water Board,South-Eastern Region, Bhubaneswar during Quarterly compliance report. The latest quarterly compliance report submitted on 30.01.2019 vide our letter No. IMFA/SMC/19/4074 Dtd 23.01.2019.

Condition No – 6.

The ground water monitoring data in respect of Sl.No 2, 4 & 5 shall be submitted to Central Ground Water Board, South Eastern Region, Bhubaneshwar on regular basis at least once in a year.

Action Taken:

The ground water monitoring data in respect of Sl.No 2, 4 & 5 is being submitted to Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneshwar on quarterly basis. The latest quarterly compliance report submitted on 30.01.2019 vide our letter No. IMFA/SMC/19/4074 Dtd 23.01.2019.

Condition No – 7.

The firm shall ensure proper recycling and reuse of waste water after adequate treatment.

Action Taken:

The mines seepage water is being treated in the existing 360 cu.m/hr Effluent Treatment Plant (ETP) and treated water is being used for water sprinkling, dust suppression, plantation and other allied activities at our mines. The excess treated water if any, is being disposed to outside the lease area after confirming the prescribed standards recommended by OSPCB. Waste water generated from the workshop service centre is being recycled through oil trapping system followed with Corrugated Plate Interceptor (CPI) Unit and used for the same vehicle washing.

Authorized Signotory.
For: **M/s. Indian Metals & Ferro Alloys Limited.**

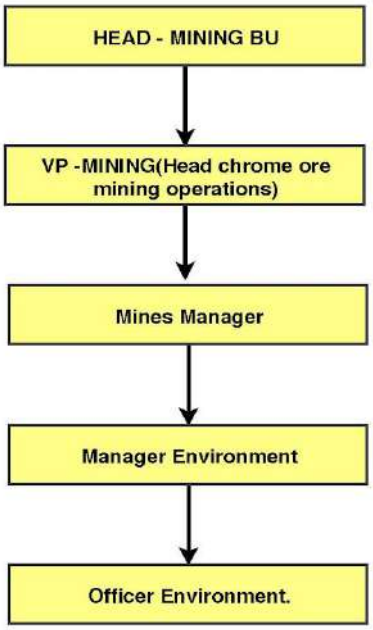
(Sanjeev Das)
Sr. vice President
Head-Mining Business Unit

Annexure 13- Details of Environmental Management Cell

Environment Management Cell

The environmental management cell is being headed by Sr. V.P.- Head Mining BU of M/s IMFA Ltd. with qualified persons. The details of the cell with their qualification & experience has been submitted to the MoEF&CC vide letter no. IMFA/CHQ/18/124 dated 17.11.2018.

Organizational Chart of Environmental Management Cell is given below:



The monitoring cell responsibilities of the cell members are following.

1. Planning and execution of environmental management plan as proposed in the EIA & EMP.
    a. Air Pollution Control Measures
    b. Water Pollution Control Measures
    c. Noise Control Measures
    d. Ecological preservation and up gradation
    e. Improvement of Socio-Economic Aspects
    f. Solid Waste Management
    g. Green Belt Development
    h. Rainwater Harvesting structures implementations
2. Monitoring environmental parameters
    a. Air Quality and Meteorological Instruments
    b. Water and Waste water quality
    c. Noise Levels monitoring
    d. Soil Characteristics
3. Ensuring pollution controlling equipment operations.
4. Submission of the Environmental compliance report to different Govt. bodies as per requirement.

5. Conduct environmental awareness program to the workers, supervisory staff and contract labourers.
6. Statutory Requirements and Implementation

The management cell duties and responsibilities in connection to the compliance requirement in respect of approved environmental clearance and other guidelines are being reviewed by chairman of the Environmental management cell by every month in Business review meeting monthly Health, Safety and Environmental meeting head by Sr. VP Head Mining BU specifically to review of HSE issues and quarterly MRM review meeting under ISO 14001 (Environmental Management System).

INDIAN METALS & FERRO ALLOYS LIMITED

IMFA Building
Bhubaneswar -751010
Odisha, India

Corporate Identity No.
L27101OR1961PLC000428

TEL +91 674 3051000
+91 674 2580100
FAX +91 674 2580020
+91 674 2580145

mail@imfa.in

www.imfa.in

Reference No: IMFA/CHQ/18/124
17.11.2018

To,

Dy. Director (S)
Ministry of Environment, Forest & Climate Change,
Eastern Regional Office
A/3, Chandrasekharpur
Bhubaneswar-751023

Subject: Information regarding constitution of Environmental Management Cell (EMC) –Reg

Reference: Your good office letter No. 101-335/EPE/3525 dated 16.11.2018.

Sir,

With reference to the captioned subject and reference, hereby submitting the information on constitution of the Environmental Management Cell as Annexure - I & II respectively Sukinda Mines (Chromite) and Mahagiri Mines (Chromite) of Indian Metals and Ferro Alloys Limited.

This is for your kind information.

Thanking You
Yours Faithfully
For: Indian Metals and Ferro Alloys Limited

(Sanjeev Das)
Sr. Vice President
Head Mining Business Unit, M/s IMFA

GOVT. OF INDIA
MoEF & CC, Eastern R.O.
Bhubaneswar-751023
19 NOV 2018
RECEIVED

Enclosed: Annexure I and II

Annexure - 1

Sukinda Mines (Chromite)
M/s Indian Metals and Ferro Alloys Limited

Hierarchical wise Environmental Management Cell Details

1.	Name	:	Mr. Sanjeev Das
	Designation	:	Sr. VP (Head Mining Business Unit – M/s IMFA)
	Qualification	:	MBA, Master in International Trade
	Experience	:	27 Years
	Contact No	:	993700221
	Email	:	sanjeevdas@imfa.in
2.	Name	:	Mr. Sudhanshu Patni
	Designation	:	VP (Head Chrome Ore Mining Operation – M/s IMFA
	Qualification	:	Mining Engineer
	Experience	:	29 Years
	Contact No	:	9937299495
	Email	:	sudhanshupatni@imfa.in
3.	Name	:	Mr. Manoj Samal
	Designation	:	Mines Manager, Sukinda Mines (Chromite), M/s IMFA
	Qualification	:	Mining Engineer
	Experience	:	20 years
	Contact No	:	9937297129
	Email	:	manojsaml@imfa.in
4.	Name	:	Manikandan
	Designation	:	Manager Environment, M/s IMFA
	Qualification	:	M.Sc. Environmental Science
	Experience	:	10 years
	Contact No	:	9777441769 & 8895035775
	Email	:	mmanikandan@imfa.in
5.	Name	:	Dr. Manisha Mohanty
	Designation	:	Officer - Environment, M/s IMFA
	Qualification	:	Phd fisheries
	Experience	:	8 years
	Contact No	:	9777444142
	Email	:	manishamohanty@imfa.in

Annexure 14- Details of Underground Mining

DETAIL OF UNDERGROUND MINING AND SAFETY ALONG WITH PRECAUTIONARY MEASURES AS PER GOVERNMENT GUIDELINES

Scientific study for feasibility of underground mining was done by NIRM in Band -I at Sukinda Mines (Chromite). For that it was awarded to NIRM for the study and design of underground openings and support system.

Based on the field investigations, laboratory testing and numerical modelling, NIRM has recommended to adopt the 'Blast hole stoping' method of extraction of the ore, with post filling. The underground mining is feasible below -200mRL considering the rock strength parameters.The size of the stopes have been designed by NIRM considering the self sustainability of rocks below -200mRL.Accordingly the first block of mining will be between -250mRL and -300mRL.

NIRM has recommended maximum stope height is 50m, the stope width shall be within 20m below -250mRL and the length of stope shall be maximum 20m and recommended rib pillar thikness is 6 m and the crown pillar thickness is 15 m.

For development of drives & cross cut, NIRM has recommended support system is 1.8m long, 20mm diameter, full column grouted roof bolts made of tor steel. For the 4m wide drives below -250m depth, three bolts in a row are suggested, with 1.2m row spacing. This is applicable for the waste drives and cross cuts in the footwall and hangwall, and also for the raises and the shaft. In all the ore drives and ore cross cuts, and also in the drives in the country rock above -250m depth, there shall be 4 bolts in a row, with a row spacing of 1 m.

As per the above recommendations of NIRM, underground mining proposal has been incorporated in the Review of Mining Plan and the same has been approved by Indian Bureau of Mines. The safety procedures are planned as per DGMS guidelines.

Copy of the NIRM study report is attached for perusal. In brief the support system and other safety measures are briefly stated as under:

1. As per NIRM recommendation the underground mining will be undertaken from -250 mRL and below as the rock below -200mRL is competent.
2. **Support System:** As per recommendation of NIRM for underground support system below

-250 mRL, in all the waste drive and x-cuts there shall be three roof bolts in a row with row spacing of 1.2 m. In ore drives and x-cuts there shall be four roof bolts in a row spacing of 1m. the support system have been designed considering a bolt capacity of 8 tonnes for the 1.8 m long, 20 mm dia., full column cement grouted bolts.

3. **Stoping and Subsidence Management:**

The underground development has been planned as per recommendations of scientific study carried out by NIRM. Moreover, the stopes will be backfilled by cemented fill material. Therefore, subsidence is not expected. However, the stability of void shall be monitored regularly by strata monitoring instruments. Also, subsidence survey shall be carried out at regular interval.

The backfilling of the stopes will eliminate caving of roof and simultaneously enhance the working efficiency of the stopes. The salient features of sequence of stoping is given below:

	Stope parameters:	
1.	Number of working stopes	Presently Stopes are in proposal stage
2.	Size of the panel	L= 20m & Width= Ore Body Width
3.	Level interval	50 m
4.	Thickness of crown pillar	188 m (Parting between surface & UG working)
5.	Thickness of Sill pillar	15 m
6.	Thickness of Rib pillar	6 m
7.	Method of stowing/ back filling	Hydraulic Filling
8.	Method of drainage of stowed water	Decantation & Percolation

4. **Safety precautions during transportation of Men and Material**

The ore shall be hoisted by skip through main shaft which shall be circular one having minimum 6m in dia. The service shaft shall be rectangular one & having a dimension of minimum 5.5 m x 5.1 m. The service shaft shall hoist men & material from underground. All the safety measures will be adopted not only at the time of sinking of the shaft but also during the transportation through these shafts as per Mine regulation and direction of DGMS from time to time.

5. PRECAUTIONARY STEP AND OTHER SAFETY MEASURES AS PER GOV GUIDELINES

Standard procedures as per mine regulation and recommendation of DGMS in respect to underground mining that includes stoping, transportation, support system, backfilling, ventilation, and avoidance of inundation will be followed to control accident in the mine. The company will formulate Standard operating Procedure(SoP) with instructions for different categories of staff who would take action in the manner indicated in the SoP. The instructions will be kept up-to-date

at all times and be made available to the mine officials concerned and to the local rescue station. It will also be necessary to have mock rehearsal of the SoP at regular intervals of say three to six months. The underground mining will be carried out by following all the directions and guidelines of DGMS and other relevant Government Authorities for safe underground mining.

Project No. GC-12-04 **January, 2013**

Report No. GC-12-04

Final Report

on

Design of Underground Openings and Support System at Sukinda Mines (Chromite) of IMFA in Sukinda Valley, Dist. Jajpur, Odisha

by

Sripad R Naik, Scientist V,

Roshan Nair, Scientist II,

Rabi Bhushan, Scientist I

and

V Venkateswarlu, Scientist V

NUMERICAL MODELLING DEPARTMENT

National Institute of Rock Mechanics
CHAMPION REEFS - 563 117
(Kolar Gold Fields, Karnataka, India)
Ph : 08153 - 275000, 275006, 275008; Fax : 08153 - 275002
e-mail : nirm@snirm.in; www. nirm.in

Executive Summary

The Indian Metals and Ferro Alloys Limited (IMFA) are in the process of starting underground mining operations at Sukinda Mines (Chromite) in Odisha. For this, NIRM has taken up the study for design of underground openings and support system.

The mine lease consists of two minable chromite bands and the country rock is mostly serpentinite and serpentinite-dunite-peridotite. Based on the borehole logs, the Geological Strength Index (GSI) for these rocks has been estimated as given below :

Level	RMR		Q	
	Serpentinite	Chromite Ore	Serpentinite	Chromite Ore
-200 to -250	**40 – 50**	**45 - 65**	**0.3 – 2.2**	**0.8 – 38.3**
-250 to -450	**45 – 55**		**0.8 – 5.6**	
	55 – 70		**5.6 – 100**	

Rock samples from different depths and boreholes were tested to determine their physico mechanical properties. The wall rocks are generally weak till -150 mRL, and the ore body is also weak till -200 mRL.

Detailed numerical modelling was carried out for different stoping conditions, using the software 3DEC. The stresses and deformations were analyzed with different parameters. Parametric analysis was conducted for ascertaining the optimum unsupported stope dimensions and other parameters required for the safe extraction of the ore. The stability of the openings was evaluated using rock mass yield criteria. The extraction sequence was simulated by developing three dimensional numerical models. Output in the form of displacement and factor of safety was obtained from the models and results of geometrical parametric study were compared.

Based on these studies, the recommended method of extraction for the ground conditions prevailing at Sukinda Mine (Chromite) is ‘Sub-Level Stoping’ or ‘Blasthole Stoping’ with post filling. For operational efficiency of the blasthole stoping method, a level interval of 50 m is suggested, but in view of the “Fair” to “Good” rock mass, two sub-levels are recommended at 15 to 20 m vertical distance. Since the hangwall rocks are strong enough, the slot can also be opened towards the hangwall side, and the stope can sustain without collapse.

The recommended maximum stope height is 50 m. the stope width shall be within 20 m (or the maximum ore body width) below -250 mRL. The length of the stope (along the strike) shall be maximum 20 m. The extraction may start at -250 mRL. With these dimensions, each stope may last for about two months. For producing the required ore, two to three stopes may be worked at a time. The recommended rib pillar thickness (within the ore body) is 6 m, and the recommended crown pillar thickness is 15 m.

The recommended support system is 1.8 m long, 20 mm diameter, full-column grouted roof bolts. For the 4 m wide drives in serpentinite below -250 m depth, three bolts in a row are suggested, with 1.2 m row spacing. This is applicable for the waste drives and cross cuts in the footwall and hangwall, and also for the raises and the shaft. In all the ore drives and ore cross cuts, and also in the drives in the country rock above -250 m depth, there shall be 4 bolts in a row, with a row spacing of 1 m.

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Final Report

Design of Underground Openings and Support System at Sukinda Mines (Chromite) of IMFA in Sukinda Valley, Dist. Jajpur, Odisha

The Indian Metals and Ferro Alloys Limited (IMFA) are in the process of starting underground mining operations at a maximum depth at -400 mRL for extracting Chromite ore at Sukinda Mines (Chromite) in Sukinda Valley (Dist. Jajpur, Odisha). For this, the mine management requested NIRM to carry out scientific study for the design of underground openings and support system [vide letter no. MDO/SGM(M) /12/4655, dt. 09-02-2012 from the Sr. General Manager (Mines), IMFA].

The objective of the study is to carry out scientific study for the design of underground openings and support system in Sukinda Mines (Chromite) of IMFA in Sukinda Valley, Dist. Jajpur, Odisha.

To fulfil this objective a study was conducted for design of underground openings and support system for extracting chromite ore below -200 mRL based on the extraction method to be adopted by M/s IMFA. This report includes the details of field investigations and rock mass characterization of the ore and host rock, followed by determination of physico-mechanical properties of the rock mass and design of the optimum underground openings and support designs for cross cuts and ore drives based on empirical and numerical modelling results. The study included design of optimum stope dimensions, thickness of rib pillars and crown pillars for sub-level open stoping as well as filled stopes.

1. INTRODUCTION

Odisha accounts for about 98% of the total proved chromite (chromium ore) reserves in the country, and the third largest reserves in the world. The state has rich potential for chromite over an area covering approximately 200 sq.km in Jajpur

District. There are two major deposits in the area, namely, Sukinda Ultramafic Belt and Boula Nuasahi Igneous Complex, holding around 98% of the total Indian reserve. Presently there are 14 chromite mines operating in the Sukinda valley. Out of these, M/s Indian Metals & Ferro Alloys Limited (IMFA) has a mining lease of over 116.76 Ha in the Sukinda valley complex. The mine shares common boundary with M/s Balasore Alloys Ltd, M/s OMC Ltd and M/s ICCL. The lease consists of two minable chromite bands (Figure 1.1). Both the chromite bands are of soft, friable type in the upper levels and hard, lumpy greyish–brown in the lower levels. In the open pit, weathered, friable chromite has been observed in the weathered ultramafic host rock. The weathered host rock consists of dunite, peridotite and pyroxenite with serpentinite schist.

Both bands are showing vertical to sub vertical trend with greyish–brown and massive to friable mineralisation in layer form. A few bands are spotted and laminated in the contact zone with serpentinite. Currently, the chromite ore from open cast benches of Band I are being extracted by M/s IMFA. The proved reserves in the lease extend upto -475 mRL, while the approved open cast pit limit is 30 m. In the open pit, the brown ore has alteration from grey chromite to brown chromite ore. The ore body is showing distinguished texture variation. Band-I contact margin has shearing effects. The sheared serpentinite has slickenslides with greasy lustre appearance. M/s IMFA have approached National Institute of Rock Mechanics (NIRM) to carry out scientific study for the design of underground openings and support system for extraction of ore below -100 mRL at Sukinda Mines (Chromite). During the course of study, it was found that the soft zone extended nearly upto -200 mRL and this zone would have difficult rock mass conditions for extraction. Hence, scope of the present study was limited to the design of underground openings and support system for extraction of ore below -200 mRL.

2. LOCATION AND ACCESSIBILITY

Chromite ore deposit of Kaliapani Sector of Sukinda Valley, Jajpur District, located in the eastern state of Odisha was investigated by Geological Survey of India (GSI, 1976). The valley runs in NE-SW direction pinching towards east and fanning

out towards west. The area is bounded by North Latitude 21°01′12″ to 21°02′ 35″ and East Longitude 85°45′42″ and 85°47′16″. The area falls in south–western quadrant of Survey of India Toposheet No. 73 G /16 (Scale 1: 50000). Jajpore-Keonjhar Road Railway station of the South-Eastern Railway is at a distance of 60 km from the mine area. It is flanked by Tomka - Daitari Hill ranges to North and Mahagiri Hill ranges to the East. The Tomka – Mangalpur metalled and black tarred road passes almost in the northern boundary of the lease area.

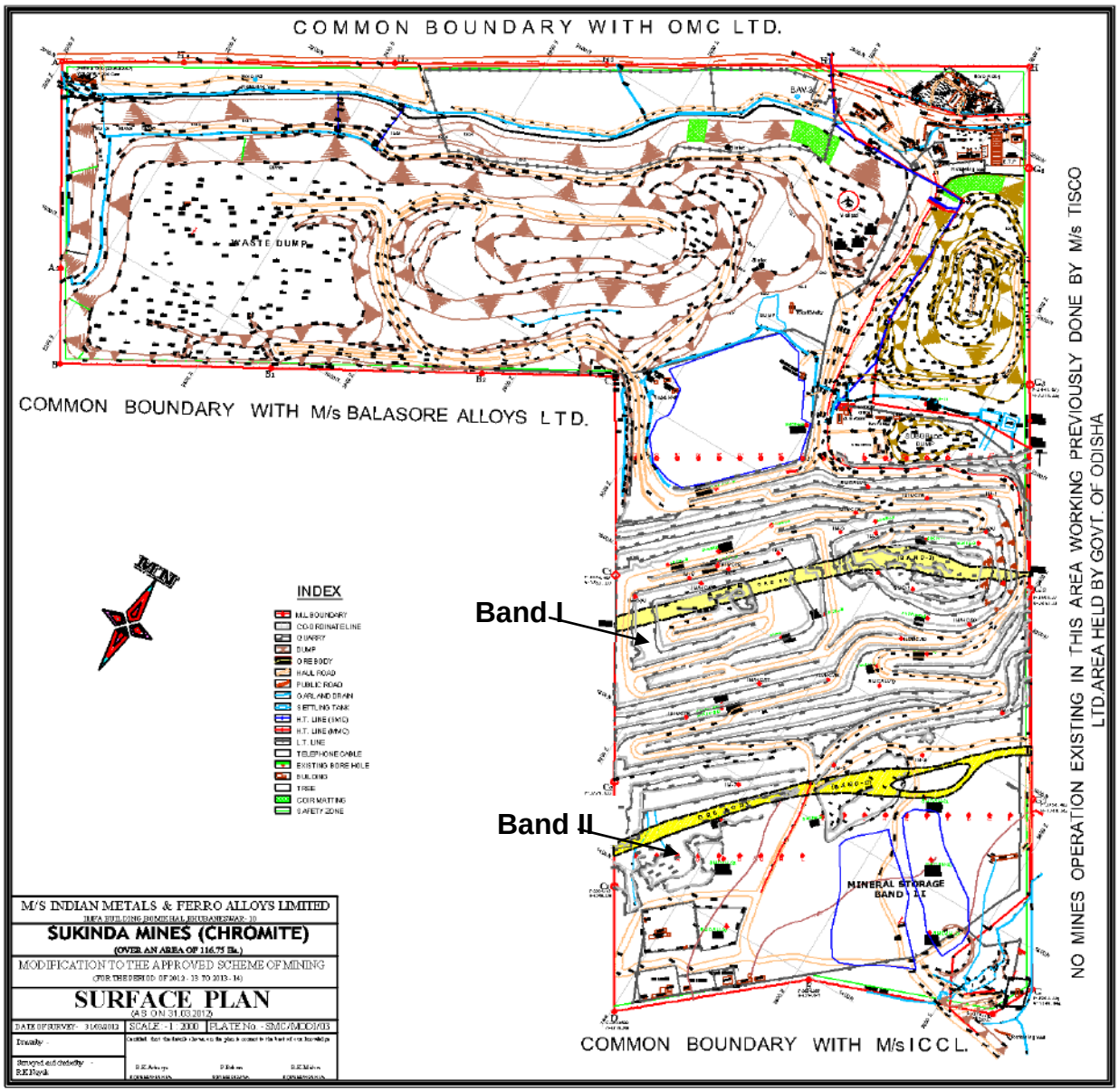

Figure 1.1. Surface plan of the Sukinda Mines (Chromite) of M/s IMFA

3. GEOLOGY AND STRUCTURE

The Geological Survey of India (GSI) first initiated reconnaissance survey work after the discovery of the lode. Based on pressing demand for assessing the chromite reserve, GSI had drilled holes at 200 m intervals. Subsequently the task was taken up through an integrated programme where GSI, Mineral Exploration Corporation of India (MECL) and Odisha Mining Corporation (OMC) took active part. Since 1979 active exploration is going on by the lessees in their respective leasehold areas to prove the strike continuity, depth persistency and grade of chromite lode. In Sukinda Mines (Chromite) leasehold area, IMFA is conducting exploration of the lease area concurrently with mining.

The ultrabasic rocks are all of Precambrian age and have high potential of chromite differentiated layered igneous complexes. Chromite deposits of Odisha region mainly occur as bands, lenses and pockets in serpentinised dunite peridotite. The ultramafic body consists essentially of magnesite-rich dunite-peridotite with chromite bands and subordinate amount of pyroxenite devoid of chromite mineralization. The ultramafic body has a maximum width of about one kilometer in the middle, tapering gradually towards north and south, and mainly consists of a serpentinised dunite peridotite core and a subordinate amount of pyroxinite. The chromite bodies occur in the form of discontinuous bands and lenses, 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 m. The chromite deposit of Sukinda valley is mainly stratiform type and can be classified into categories like lumpy ore, granular ore, friable ore, ferruginous ore, disseminated ore and banded ore. It is characterized by both rhythmic and cryptic layering, thickness of individual layers varying from a few centimetres to meters.

4. FIELD INVESTIGATIONS

NIRM Scientists visited different areas of the open cast pit and collected the surficial and borehole data required for underground mine design.

4.1 Geomorpohology of the Area

Topography of the area is plain with a few rising and falling ridges (rising ~10 to ~ 75 m). The highest elevation in the area is 185 mRL and the minimum is 110 mRL. Overall regional slope is from south to north. The area is covered with highly weathered materials (soil and laterite) in the open pit. The waste dump in the area in the north side acts as a barrier to the natural slope. Perennial drainage of the area is represented by Damsal nala flowing in the southwest direction, and is 1.5 km away from the lease area in north-west direction. It can be classified as a 5^{th} order stream, which is seasonal fed by several streamlets and gullies. The run off water is collected by streamlets, and Damsal nala discharges into river Brahmani at a distance of about 25 km. The overall drainage pattern of the area can be categorized as dendritic which indicates weathered rock mass.

4.2 Lithology

The litho units observed in drill hole at IMFA are as follows: laterite, silicified rock, pyroxenite, limonite (yellowish green in colour), talc-serpentine rock (in sheared bands only), serpentinite, serpentinite-dunite-peridotite with chromite bands (spotted and laminated, friable chromites). Detailed description of the lithology is given in Table 4.1.

Table 4.1. Lithologic description of rocks from drill hole data

Sl. no.	Lithotype	Description
1	Laterite	The studied area shows weathering of serpentinite to a thick lateritic column. The chromiferous dark brown coloured laterite occurs as a capping over a major part of the lease hold. The laterite is dark brown in colour and contains goethite and magnetite. The laterite in general is chromiferous (Figure 4.1).

		It is observed that sheared effects also play a major role for the weathering of the rock mass.
2	Pyroxenite	They are coarse grained and green in colour. Mostly large and tabular crystals of enstatite are found in between ore bands.
3	Dunite and Peridotite	The dunite is completely altered at the surface; it is greenish grey to dark grey in colour, and massive. Pitted appearance has been observed at the surface (Figure 4.2).
4	Serpentinite	It is very fine grained, and greenish grey in colour, showing prominent schistocity at depth. Thin bands of talc-serpentinite schist are altered in nature due to shearing effect. The rock is greenish white in colour, and gives a soapy feel (Figure 4.3). Near the contact of the ore body, shearing of the rock mass has been noticed. However, the sheared rock mass is very competent and hard (Figure 4.3).
5	Limonite	The ultramafic pyroxenite-dunite suite of rock has been completely altered into limonite, as is exposed in the quarry.
6	Chromite ore	The general orientation of the main ore body is NE-SW and dipping 70^{o} to 75^{o} in the south direction. On the basis of physical appearance, two types of chrome ores have been distinguished. The chromite grains are greyish to brown in colour due to weathering. The grain size ranges from fine to coarse. It is also generally observed that the coarse grained ore is more highly friable than the fine grained ore (Figure 4.1).

Figure 4.1. Variation in colour due to weathering in sheared rock

Figure 4.2. Highly weathered rock mass of peridotite and dunite

Figure 4.3. Sheared serpentinite and spotted chromite band

Figure 4.4. Friable chromite ore in the open pit area

4.3 Structural Study

Four prominent joint sets have been identified around chromite Band - I. Joints are rare in the southern benches of the pit. Well developed joints are noticed in weathered rock formations. Both tight joints as well as joints with opening of 0.5 to 10 mm have been observed. The joint sets are J1 (035^0-076^0/10^o-24^o & 30^o-56^o), J2 (120^o-149^o/05^o-19^o & 38^o-57^o), J3 (187^o-215^o/10^o-28^o) and J4 (270^o-355^o/26^o-55^o) with a few random joints. The structural data are given in Table 2. The pole projection and rose diagram of joint data is shown in Figures 4.5 and 4.6.

4.4 Chromite Band-I

This study area comprises of Band–I of the chromite ore. Exploratory works have been carried out in IMFA at 1: 2000 and 1:500 scales with 2 m contour interval for the chromite ore. A length of 749.64 m has been drilled in 8 drill holes by M/s IMFA and samples were collected at every 1 m or less for the mineralized zone.

For estimation of strength of chromite ore and serpentinite, data from borehole nos. 14, 18, 20, 35, 19 and 15B was considered. The boreholes were distributed on both the sides i.e. hangwall and footwall of the ore body. The details are given in Table 4.2.

Table 4.2. Details of joint data of Band-I

Class of Joint	Dip Direction	Dip Amount	Aperture	Ground Water
J1	035^0-076^0	10^o-24^o & 30^o-56^o	Tight or < 3 mm	Dry
J2	120^o-149^o	5^o-19^o & 38^o-57^o	Tight or < 2.5 mm	Dry
J3	187^o-215^o	10^o -28^o	Tight or < 2.5 mm	Dry
J4	270^o-335^o	26^o- 55^o	Tight or < 5 mm	Dry
Roughness : Smooth, slightly rough and slickenlines present **Infilling** : Tight joints (Figure 4.7); a few coated with clay/calcite/chlorite. **Spacing :** In general wide; range 5 cm to 2.5 m. **Aperture :** Mostly tight; a few have an aperture of less than 3 mm, and at a few places the joints are open due to blasting. ***Note :*** *Some joints, a major fault, and sheared zone are observed in core samples and in the open pit area; persistence of the joints is > 5 m.*				

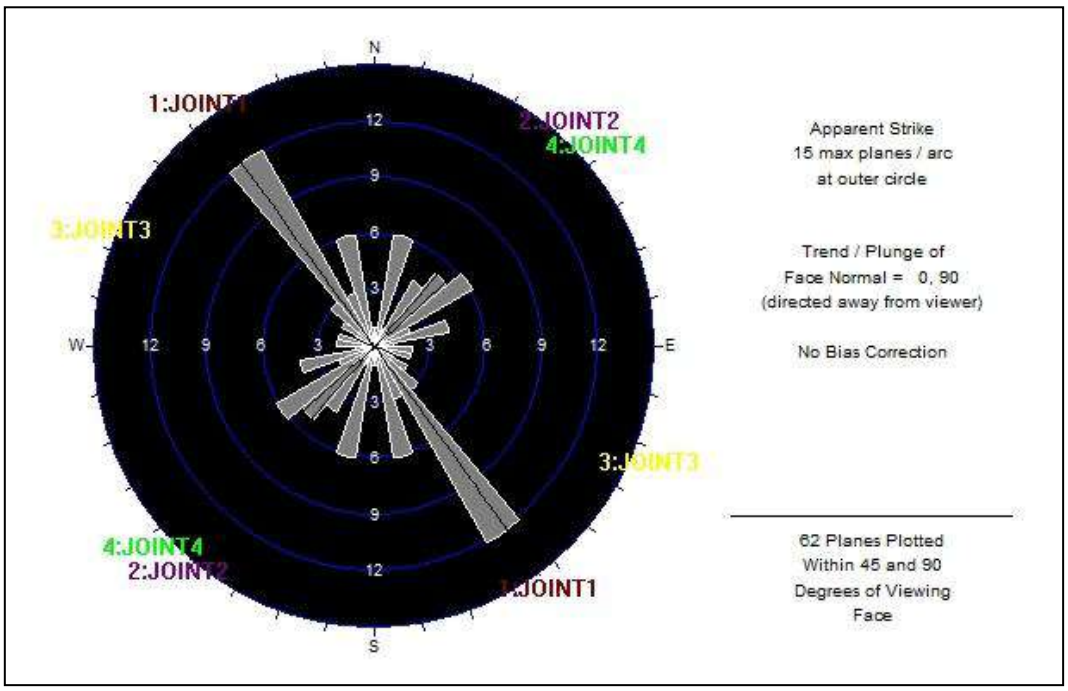

Figure 4.5. Pole diagram of joint sets

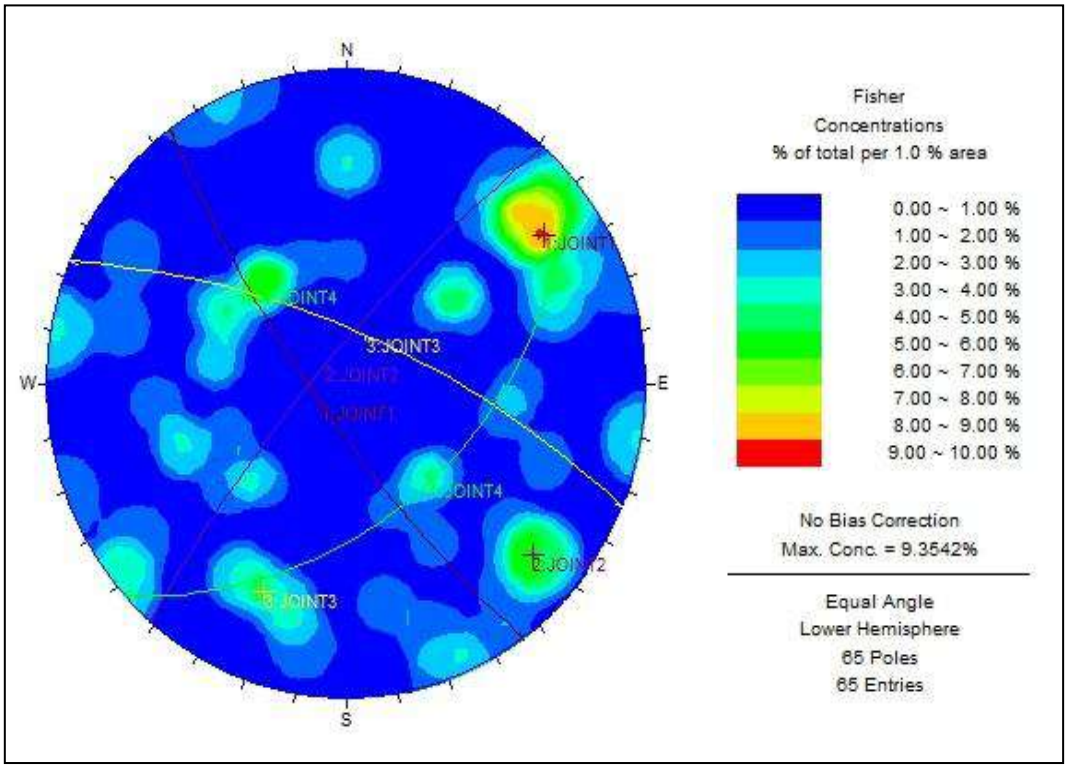

Figure 4.6. Rose diagram of joint data

Figure 4.7. Jointed rock mass with calcite filling

5. PHYSICO-MECHANICAL PROPERTIES OF THE ROCKS

The following samples from Band–I were identified from the boreholes for the laboratory tests. These samples were taken from different depths and boreholes in order to reach to a representative interpretation of the rock mass. The details of the samples collected are given in Table 5.1.

Table 5.1. Details of rock samples collected from the mine

Sl. No.	Sample ID	Lithology
1	18F	Chromite
2	18E	Serpentinite (top)
3	18K	Serpentinite (bottom)
4	20E	Serpentinite (hangwall)
5	15B-D	Serpentinite
6	15B-C	Serpentinite
7	35A	Serpentinite
8	35F	Serpentinite
9	14H	Chromite
10	15B-E	Serpentinite

The tests on samples collected during field investigations were carried out at NIRM laboratory as per ISRM standards. The tests were conducted to determine the geotechnical parameters required as inputs to numerical modelling studies. The various tests conducted on the rock samples were as follows:

1. Density
2. Compressive Strength
3. Young's Modulus
4. Poisson's Ratio
5. Cohesion
6. Friction Angle

Density

Density is a measure of mass per unit of volume. Density of rock material varies, often related to its porosity, the specific gravity of the constituent minerals and the compaction of the minerals.

Compressive Strength

Uniaxial compressive strength (UCS) is the capacity of a material to withstand axially directed compressive forces. The compressive strength is the most quoted geotechnical property in rock engineering practice. It is widely used in analysis and modelling. This test is performed on intact rock core specimens, with a length of at least two times the diameter. The specimen is placed in the testing machine and loaded axially at a constant rate such that failure occurs within 2 to 15 minutes.

Young's Modulus

Young's Modulus or modulus of elasticity measures the stiffness of a rock material. It is defined as the ratio, for small strains, of the rate of change of stress with strain. This can be experimentally determined from the slope of a stress-strain curve obtained during compressional or tensile tests conducted on a rock sample. Similar to strength, Young's Modulus of rock materials varies widely with rock type.

Poisson's Ratio

Poisson's ratio measures the ratio of lateral strain to axial strain, at linearly-elastic region. For most rocks, the Poisson's ratio is between 0.15 and 0.4.

Cohesion & Friction Angle

Shear strength is used to describe the strength of rock materials, to resist deformation due to shear stress. Shear strength of rock material can be determined by direct shear test and by triaxial compression tests. It is generally expressed in terms of cohesion and angle of internal friction.

Cohesion is a measure of internal bonding of the rock material; it is represented by c. Internal friction in rock sample is caused by contact between particles, and is defined by the angle of internal friction, φ.

All the above tests were conducted at NIRM as per ISRM standards. The results of tests for rock samples from Sukinda Mines (Chromite) are given in Table 5.2.

Table 5.2. Physico-mechanical properties of rocks determined at NIRM

Sl. No.	Properties	Serpentinite	Chromite Ore
1	Density, kg/m^3	2826, 2820, 2677 & 2668	3882, 4211 & 4047
2	Uniaxial Compressive Strength, MPa	163 & 128	68 & 72
3	Young's Modulus, GPa	65 & 50	52 & 77
4	Poisson's ratio	0.27 & 0.29	0.31 & 0.22
5	Tensile strength, MPa	17.46 & 12.00	6.28 & 5.95
6	Cohesion, MPa	44.44	31.52
7	Friction angle, degrees	37.04	41.01

6. ROCK MASS CHARACTERIZATION

Based on the field and laboratory investigations and the borehole logs, the Geological Strength Index (GSI) values for the different rock types and at different depths have been estimated, as given in Table 6.1.

Table 6.1. Values of GSI for the rocks of Band-1 at different depths

Level	Borehole No. 14	Borehole No. 18	Borehole No. 20	Borehole No. 35	Borehole No. 19	Borehole No. 15B	GSI for Serpen-tinite	GSI for Chromite ore
175	Sludge	Sludge, weathered rock, with fractured and faulted rock mass	Sludge	Sludge	Weathered limonite with chert, void zone	Sludge, weathered rock with fractured and faulted rock mass	30 - 35	25 - 35
150								
125								
100								
75								
50	Faulted fractured, brecciated, sheared rock, with vein fillings			Weathered and fractured serpentinite				
25								
0								
-25				Weathered magnesite and highly fractured serpentinite				
-50								
-75								
-100								
-125			Friable chromite, rarely with serpentinite bands					
-150		Hard rock faulted, fractured, and sheared						
-175							35 - 45	
-200					Fractured and weathered serpentinite			
-225					Friable Disseminated chromite	Hard serpentinite		
-250								40 - 60
-275	Non coring zone						40 -50	
-300		Disseminated chromite, friable, fine - coarse grained		Friable chromite with alternate bands of serpentinite				
-325								
-350	Hard greenish serpentinite, faulted, and coated with serpentine			Hard serpentinite				
-375							50 - 65	
-400			Hard serpentinite			Disseminated chromite		
-425		Hard serpentinite						
-450								

The chromite and serpentinite host rocks at Sukinda Mine (Chromite) have been evaluated for their competency by converting the GSI values to the Rock Mass Rating, RMR, and Rock Mass Quality, Q, indices (Table 6.2).

Table 6.2. RMR and Q estimated from the values of GSI

Level	**RMR** (taken as GSI + 5)		**Q** [taken as $10^{(RMR-46/12)}$]	
	Serpentinite	**Chromite Ore**	**Serpentinite**	**Chromite Ore**
-200 to -250	**40 – 50**	**45 - 65**	**0.3 – 2.2**	**0.8 to 38.3**
-250 to -450	**45 – 55**		**0.8 – 5.6**	
	55 – 70		**5.6 - 100**	

From the above, the design estimates are made using the following empirical relations :

Maximum unsupported span of a roof (in m) = $2 \times ESR \times Q^{0.4}$

where Q = rock mass quality index, and ESR = Excavation Support Ratio.

Rock load (in t/sq.m) = Wr * B * (100 - RMR) / 100

where Wr = rock density, taken as 2.8 t/cu.m for serpentinite country rock
& 4.2 t/cu.m for the ore body

B = gallery span (m) (here, estimated for 4 m wide drives)

The results of the above estimations are given in Table 6.3.

Table 6.3 Estimation of unsupported span and rock loads

Level	**Maximum Unsupported Span (m)**		**Rock Load (t/sq.m)**	
	Serpentinite	**Chromite Ore**	**Serpentinite**	**Chromite Ore**
-200 to -250	**6.3 – 13.6**	**9 – 43**	**5.6 – 6.7**	**5.9 – 9.2**
-250 to -450	**9 – 20**		**3.8 – 4.6**	
	20 – 63		**3.4 – 5.0**	

7. SUGGESTIONS FOR METHOD OF MINING & STOPE DESIGN

The ore body at Sukinda Mines (Chromite) of IMFA is steeply dipping, and it has a width of 18 to 30 m (average 20 m). The wall rock, namely, serpentinite, which are in contact are weak till -125 to -150 mRL, and the ore body is also weak till -175 to -200 mRL. One of the methods of mining which may be considered for these conditions is cut-and-fill stoping beyond -200 mRL. However, this method is not a very productive method.

The more productive extraction method suitable for these conditions is 'Sub-Level Stoping' or 'Blasthole Stoping' with post filling. It is practiced for steeply dipping ore bodies. In this method, one or two sub-levels are developed along the strike of the ore body. Each sub-level is eventually enlarged into the shape of a trough, and at its end, a raise is driven to the drilling level above. This raise is enlarged by blasting into a vertical slot extending across the width of the ore body. Drill hole diameter is generally 57 mm, and hole length is 15 to 20 m. The drilling is done in a ring pattern from sublevels which are spaced at about 15 m apart, and the holes are charged and blasted. Beginning at the slot, blasting is conducted in successive slices, and the miners retreat down the drilling drift. Trough rings are blasted against drop raise to form trough up to a certain height (12 to 15 m). This will create a funnel shaped opening wherein the blasted ore from the upper levels / sub-levels will be collected and guided to the draw-points. The blasted ore is recovered from the trough bottom, and the stope is filled (Figure 7.1). The extraction level is developed throughout the strike length, and it is accessed by x-cuts from a vertical shaft or a decline. In each extraction level, drives are developed in the footwall.

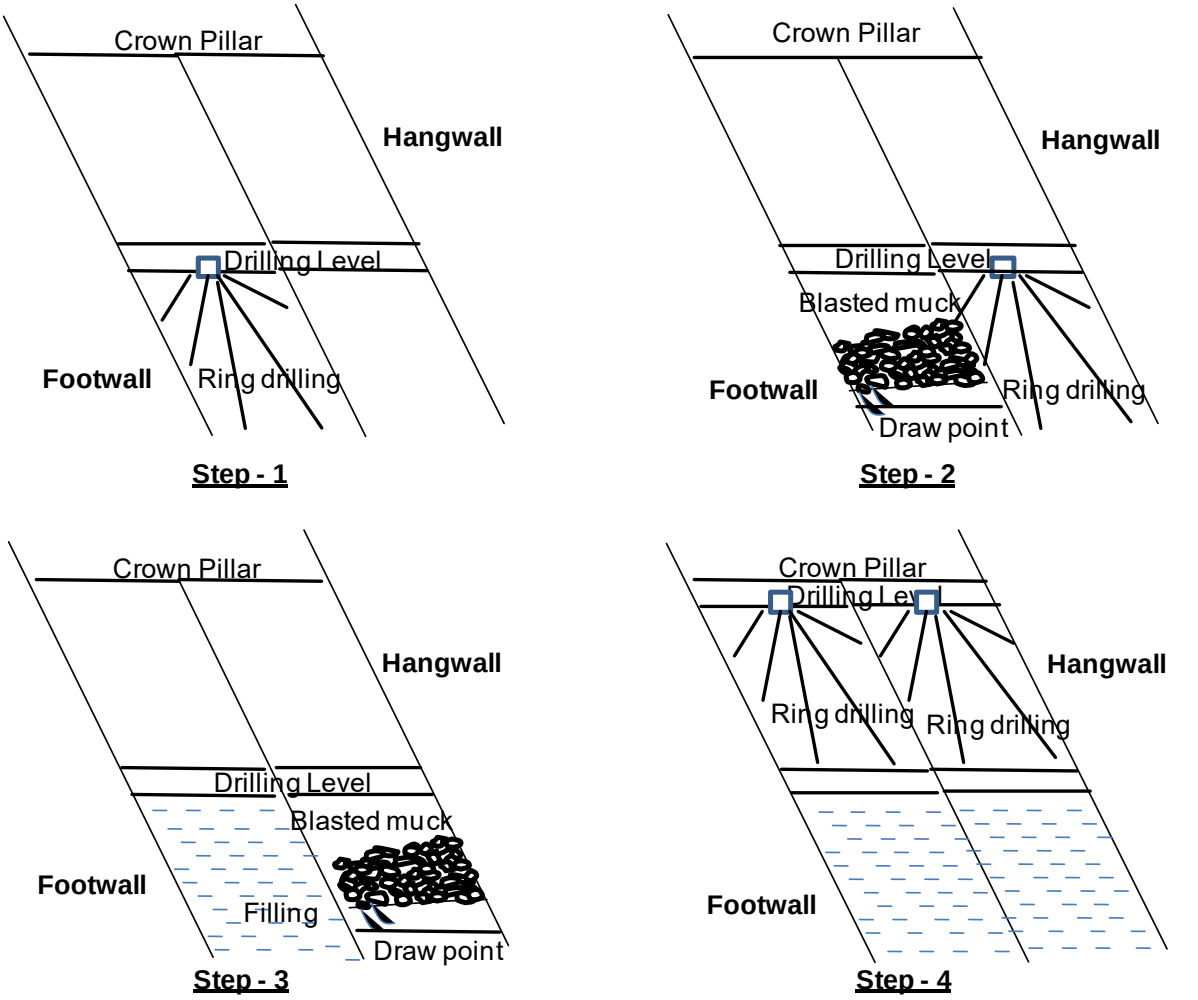

Figure 7.1. Conceptual design of Sub-Level Blasthole Stoping

The advantages with Blasthole Sublevel mining (Post-Filled) method are that individual stope production of more than 1,000 tpd can be achieved, the extraction operations are not necessarily sequential, and there is less waiting time for stoping. There will not be any dilution of the country rock into the ore, The mucking operations are faster. The supporting is minimal.

For operational efficiency of the blasthole stoping method, a level interval of 50 m is suggested, but in view of the “Fair” to “Good” rock mass, two sub-levels are recommended at 15 to 20 m vertical distance. Since the hangwall rocks are strong enough, the slot can also be opened towards the hangwall side, and the stope can sustain without collapse.

7.1 Rib Pillar

As shown above, considering the ESR value as 5 for the temporary mine openings, the unsupported span, or, the stope width (which is also the interval between vertical rib pillars) is estimated to be 6 m up to 250 m depth, and 20 m beyond 250 m. Based on further parametric analysis, the recommended rib pillar thickness (within the ore body) is 6 m. The stress on the pillar, S_p, would be :

$$S_p = S_v (1 + W_o / W_p)$$

where S_v is the maximum vertical stress (= r. g. H), W_o is the span and W_p is the pillar width. Considering a vertical stress gradient of 28 kPa per m (r * g), the maximum vertical stress at 100 m depth would be 2.8 MPa. Therefore,

$$S_p = 2.8 * (1 + 20 / 6) = 12 \text{ MPa}$$

Now, safety factor (SF) is the ratio of the compressive strength of the rock (S_c) and the stress on the rock (S_p). Accordingly, for the above sized pillars in the ore body (compressive strength 68 MPa), the factor of safety would be :

$$SF = S_c / S_p = 68 / 12 = 5.65$$

7.2 Crown Pillar

The two sides of the stopes along the width are supported by hangwall and footwall of the ore body. The other two sides of the stopes along the strike are supported at the edge by the vertical (rib) pillars. Hence it may be considered that the roof of the stope (crown pillar) is clamped on the four sides. The deflection (d) at the centre of such a beam clamped rigidly on all four sides, would be:

$$d \text{ (in mm)} = a. [q. a^4 / E. t^8]$$

where a = a constant = 0.024 when the ratio of the length of the stope to its width is 1.5 or more, and the Poisson's ratio of the rock is 0.3 or less;

q = uniformly distributed load = S_v = 2.8 MPa

a = width of the crown pillar = width of the ore body / stope = 50 m

E = modulus of elasticity of the rock = 50 GPa (minimum)

t = thickness of the crown pillar

Based on iterative analysis using the above relation, a crown pillar thickness of 15 m is suggested. This will ensure that the deflections are less than 1/100 of a mm, and it will not disturb the stability of the horizontal pillars.

8. NUMERICAL MODELLING

At Sukinda mine, it is proposed to extract chromite ore by underground mining method (as described in the previous section) from a depth beyond -200 mRL. The rock mass consists of chromite as the ore body and serpentinite as the host rock. According to the bore log details collected from the field, the ore body is weak from 125 mRL to -200 mRL, beyond which the ore and the host rock both are competent. The design of underground openings and support system for extraction of ore below -175 mRL was conducted using three dimensional numerical modelling techniques. According to the bore log details, the rock mass (both ore and serpentinite) consists of four prominent joint sets with a few random joints. Hence, the behaviour of the rock mass was analysed using discontinuum models. 3DEC is one such three-dimensional distinct element numerical program which is widely used for modelling the rock mass behaviour (Itasca, 2011).

3DEC simulates the response of discontinuous media (such as a jointed rock mass) subjected to either static or dynamic loading. The discontinuous medium is represented as an assemblage of discrete blocks. The discontinuities are treated as boundary conditions between blocks; large displacements along discontinuities and rotations of blocks are allowed. Individual blocks behave as either rigid or deformable material. Deformable blocks are subdivided into a mesh of elements, and each element responds according to a prescribed linear or nonlinear stress-strain law. The relative motion of the discontinuities is also governed by linear or nonlinear force-displacement relations for movement in both the normal and shear directions.

3DEC has several built-in material behaviour models, for both the intact blocks and the discontinuities that permit the simulation of response representative of discontinuous geologic or similar materials. 3DEC is based on a Lagrangian

calculation scheme that is well-suited to model the large movements and deformations of a blocky system.

In this study, the entire rock mass below -100 mRL consisting of both dipping ore body and host serpentinite with varying strength properties was modelled using 3DEC. The geological and geotechnical parameters were incorporated into the model. The stability of underground working with respect to various dimensions of underground openings and pillars at different depths was required to be studied. Hence, a parametric analysis was conducted for ascertaining the optimum unsupported stope dimensions and other parameters required for the safe extraction of the ore.

8.1 The Input Parameters

The geometrical parameters were obtained from the plans and sections provided by M/s IMFA. Site visits were made to obtain various information regarding geological and geometrical parameters. The geological details of rock mass formations were obtained and incorporated into the model. The contacts between ore body and host rock were identified based on the joint conditions. The joint details which were discussed in the previous sections were also used as input for the model. As the study included interaction of different rock mass, the surrounding host rock mass along with sheared band of 5 m on both the sides of ore body was simulated. The boundary of the model was considered to be roller support. The geotechnical parameters were further evaluated to arrive at values for rock mass based on various joint conditions and geological conditions. The rock mass properties for model were estimated based on the procedure outlined by Hoek et al. (2002) and Hoek & Diederiches (2006) using the input parameters (Table 8.1).

Table 8.1. Rock mass properties used in the analysis

Parameter	Chromite		Sepentinite		
	-100 mRL to -200 mRL	-200 mRL to -500 mRL	-100 mRL to -175 mRL	-200 mRL to -300 mRL	-300 mRL to -500 mRL
GSI	35	70	30	50	65
mi	25	30	25	25	25

Parameter	Chromite		Sepentinite		
	-100 mRL to -200 mRL	-200 mRL to -500 mRL	-100 mRL to -175 mRL	-200 mRL to -300 mRL	-300 mRL to -500 mRL
Hoek-Brown parameters					
mb	0.522	5.030	0.892	2.312	4.722
s	0.0001	0.0106	0.0001	0.0013	0.0094
a	0.516	0.501	0.522	0.506	0.502
Cohesion (MPa)	0.467	9	0.724	2.325	7.43
Friction angle (ϕ)	38	50.45	40	50	51

The stability of the openings was evaluated using rock mass yield criteria. The yield criteria are described in three dimensional space of stresses, and encompasses the elastic region of material behaviour. The original Hoek and Brown yield criteria is an empirical criterion developed through curve-fitting of triaxial test data. However, the criterion was revised substantially based on large scale field tests on different types of rock mass. Currently, the criterion is the most widely used failure criterion for estimating the strength of jointed rock masses. In case of mining at deeper depths, it is observed that intermediate stresses also play an important role in influencing the stability of the underground openings. Numerous extensions of modified Hoek and Brown yield criterion to 3D space have been proposed (Pan and Hudson, 1988; Priest and Hunt, 2005; Zhang and Zhu, 2007; Zhang, 2008; Melkoumian, Priest and Hunt, 2008). The three dimensional Hoek and Brown yield criterion proposed by Melkoumian, Priest and Hunt (2008) was used in the analysis of failure state of powerhouse complexes.

Based on the geometric parameters and geological details, the three dimensional model was prepared in 3DEC (Figure 8.1). Various geometric combinations were considered for the analysis. The width of ore body varied from 18 m to 30 m as per the available data from the field. The total ore length was divided into stopes of varying lengths of 12 m to 28 m. The extraction was assumed to commence from -200 mRL till –475 mRL. The width and length of the ore body was varied for different stope heights throughout the extraction zone. The analysis helped

in parametric study to achieve the optimum and safe geometric parameters for extraction based on the actual geological and geotechnical parameters. The output in the form of displacements and factor of safety was analysed to evaluate the stability of underground openings.

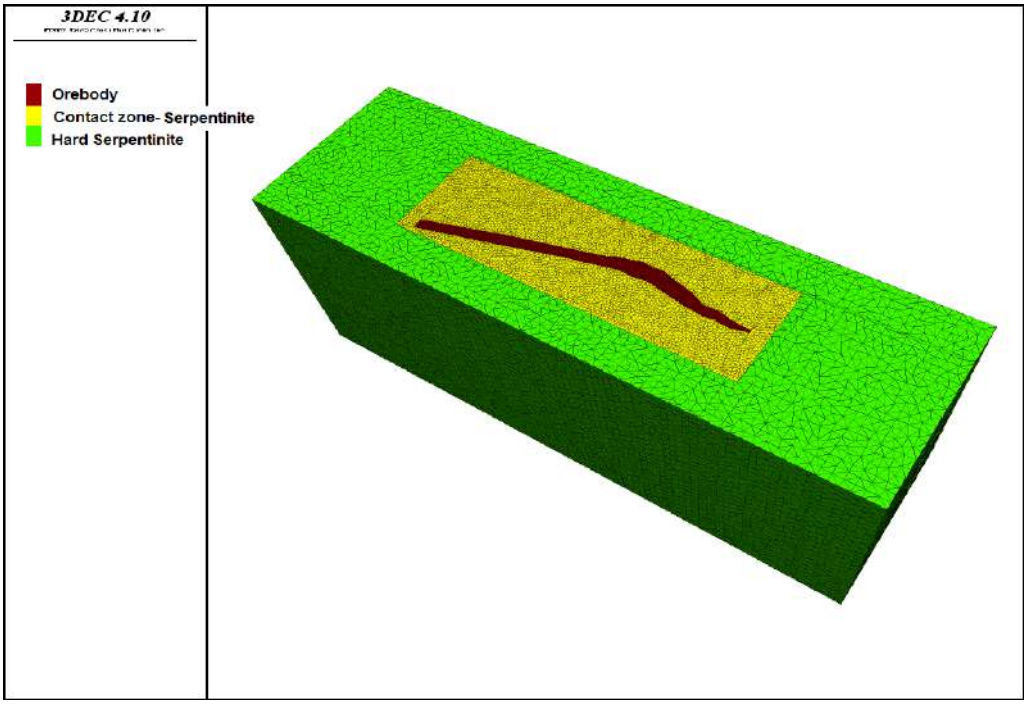

Figure 8.1. Perspective view of the numerical model

9. SUPPORT DESIGN

For the conditions prevailing at Sukinda Mine (Chromite), the recommended support system is full-column grouted roof bolts, using tor steel rods of 1.8 m length and 20 mm diameter. For the 4 m wide drives in serpentinite below -250 m depth, three bolts in a row are suggested, with 1.2 m row spacing (Figure 9.1). This is applicable for the waste drives and cross cuts in the footwall and hangwall, and also for the raises and the shaft. In all the ore drives and ore cross cuts, and also in the drives in the country rock above -250 m depth, there shall be 4 bolts in a row, with a row spacing of 1 m (Figure 9.2).

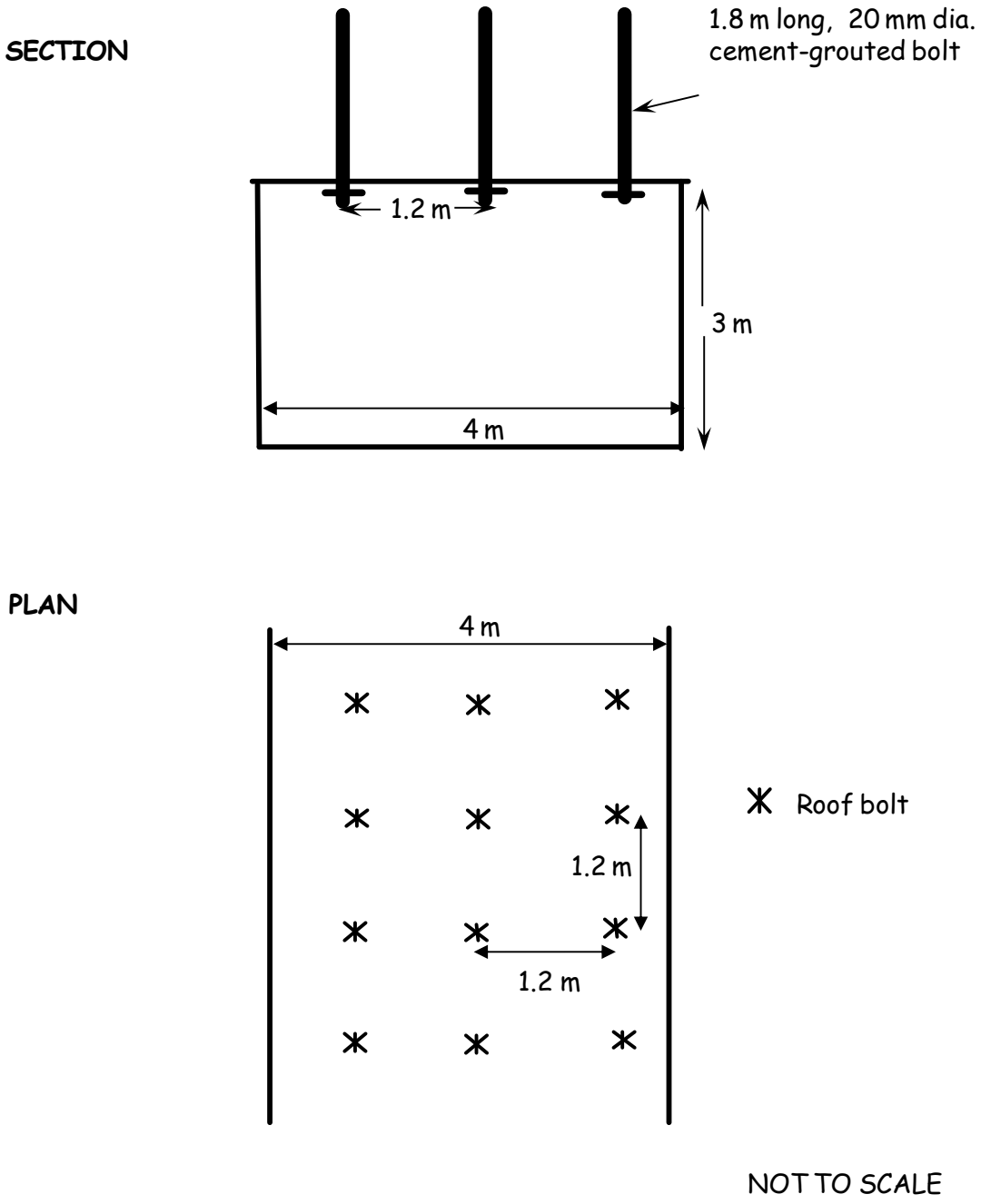

Figure 9.1. Suggested roof support system for the drives in country rock

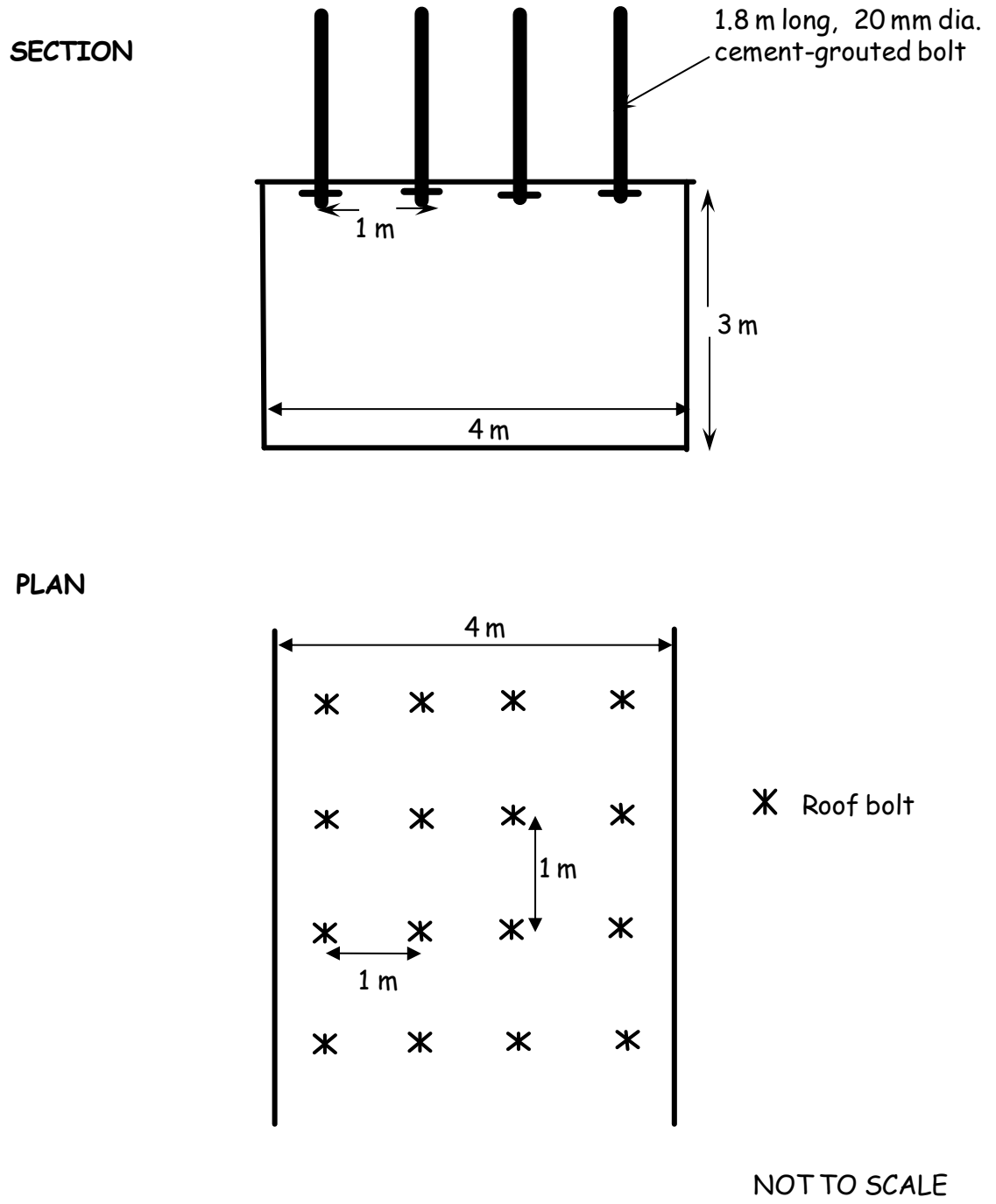

Figure 9.2. Suggested roof support system for the drives in the ore body

Considering a bolt capacity of 8 t for the 1.8 m long 20 mm diameter full-column cement grouted bolts, the support capacity provided and the factor of safety are estimated as given in Table 9.1.

Table 9.1. Support load provided and the factor of safety in different rock types

Minimum Rock Load (t/sq.m)		Support Load Provided (t/sq.m)		Safety Factor	
Serpentinite	Chromite Ore	Serpentinite	Chromite Ore	Serpentinite	Chromite Ore
5.6	5.9	4 bolts at 1 m row spacing = 4 * 8 / (4 * 1) = 8	4 bolts at 1 m row spacing = 4 * 8 / (4 * 1) = 8	1.4	1.4
3.8		3 bolts at 1.2 m row spacing = 3 * 8 / (4 * 1.2) = 5		1.3	
3.4		3 bolts at 1.2 m row spacing = 3 * 8 / (4 * 1.2) = 5		1.5	

10. RESULTS AND DISCUSSION

Based on the details provided in the previous sections, three dimensional numerical models were developed, and the extraction sequence was simulated. Output in the form of displacement and safety factors was obtained from the models, and the results of parametric study were compared. A typical displacement contour is shown in Figure 10.1. It can be observed that the displacements were higher in the elevations between -175 mRL and -225 mRL and reduced significantly beyond -250 mRL. This can be attributed to the fact that the strength of the ore body is less from -100 mRL to -250 mRL (GSI : 25 - 35), and it improved considerably beyond -250 mRL (GSI : 40 - 60). The host rock, i.e. serpentinite, also showed variation in strength; with weaker rock mass of GSI : 25-35 from -100 mRL to -225 mRL, moderately strong rock mass from -250 mRL to -375 mRL (GSI : 40 - 50) and strong rock mass beyond -375 mRL having GSI : 50-65. Hence, it is recommended to have three definite zones of extraction, i.e., (a) -200 mRL to -250 mRL, (b) -250 mRL to -375 mRL and (c) Beyond -375 mRL (Figure 10.1).

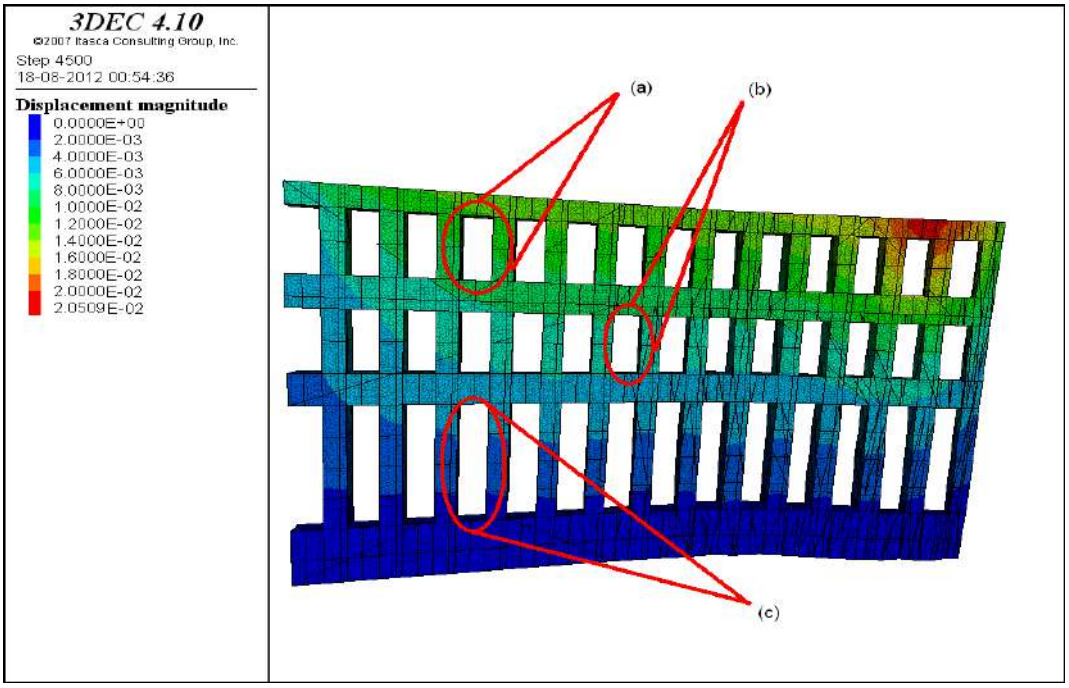

Figure 10.1. Typical displacement contours during extraction

The displacement contours for various stope length in the 20 m wide ore body are shown in Figures 10.2 to 10.5. The results indicate that as the length of stope increases, displacements in the unsupported span as well as the rib also increased. The displacements on the hangwall side were higher than the displacements on the footwall side of the ore body, which may be due to the movement of sheared serpentinite of about 5 m which is in contact of the ore body. The eastern side of the ore body shows higher displacements as compared to the western side, as the rock mass was found to be weaker as well as varying in thickness. This causes weakening of restraints offered by the host rock leading to higher movement. There is a significant reduction of displacements in the ore body at greater depths. However, the results at these depths may vary if in-situ stress is considered (values presently not available). There is no significant block movement at deeper depths beyond -350 mRL which can allow higher stope heights as compared to the upper elevations. The major joint pattern observed from the borehole log does not significantly influence the displacements in the ore body on a global scale. However, there may be detachment of localised blocks at -260 mRL to -280 mRL, -320 mRL to -355 mRL and -390 mRL to 430 mRL based on the current joint profile.

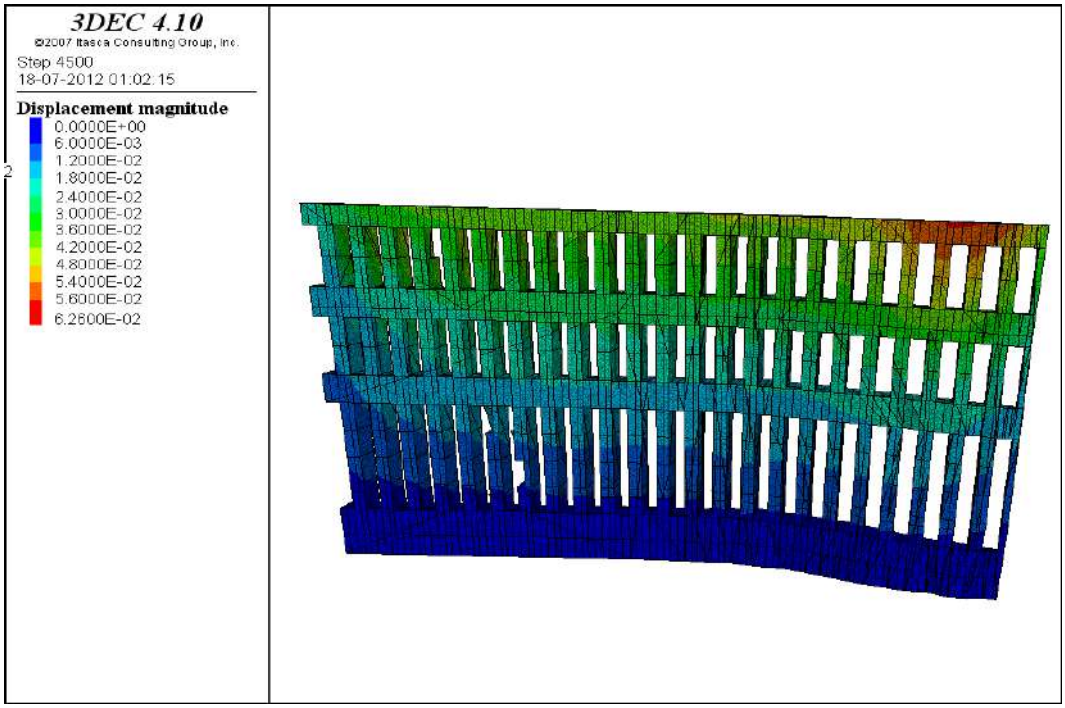

Figure 10.2. Displacement contours during extraction : stope length 16 m, width 30 m, and height 50 m

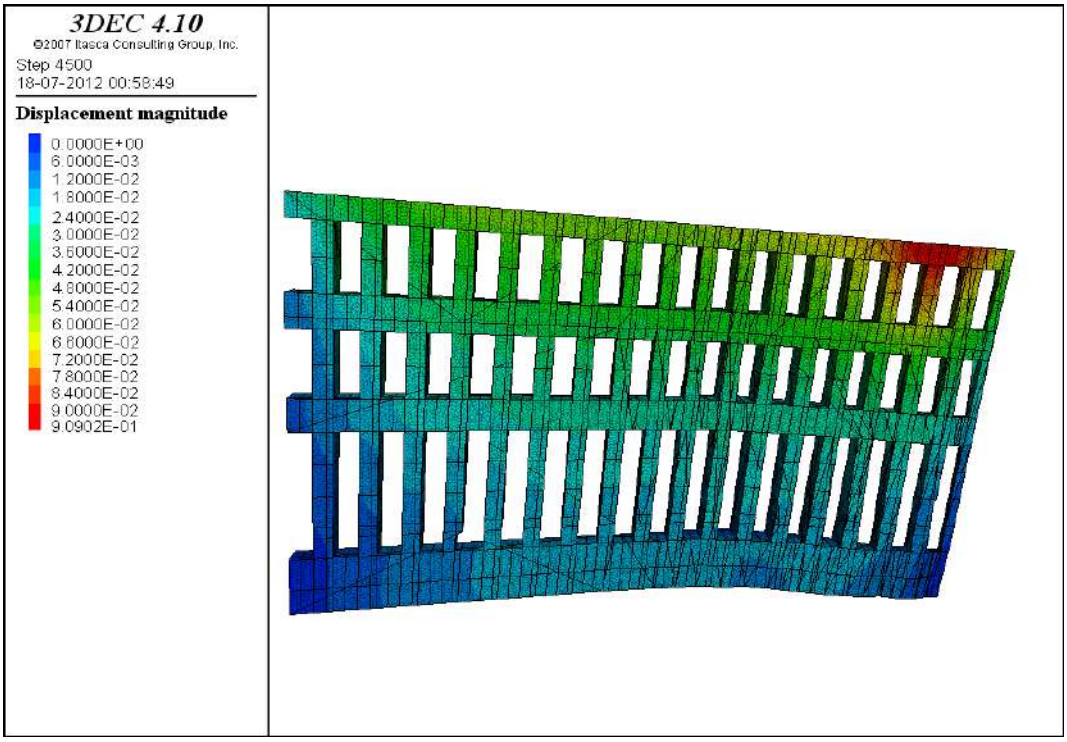

Figure 10.3. Displacement contours during extraction : stope length 20 m, width 30 m, and height 50 m

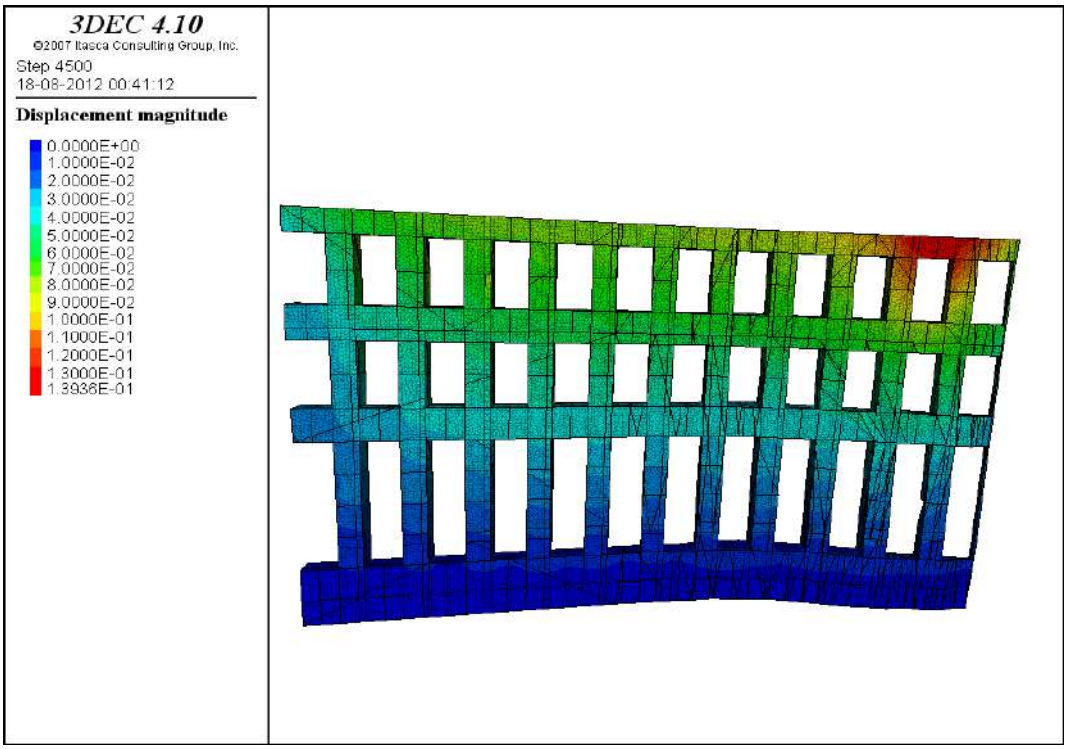

Figure 10.4. Displacement contours during extraction : stope length 24 m, width 30 m, and height 50 m

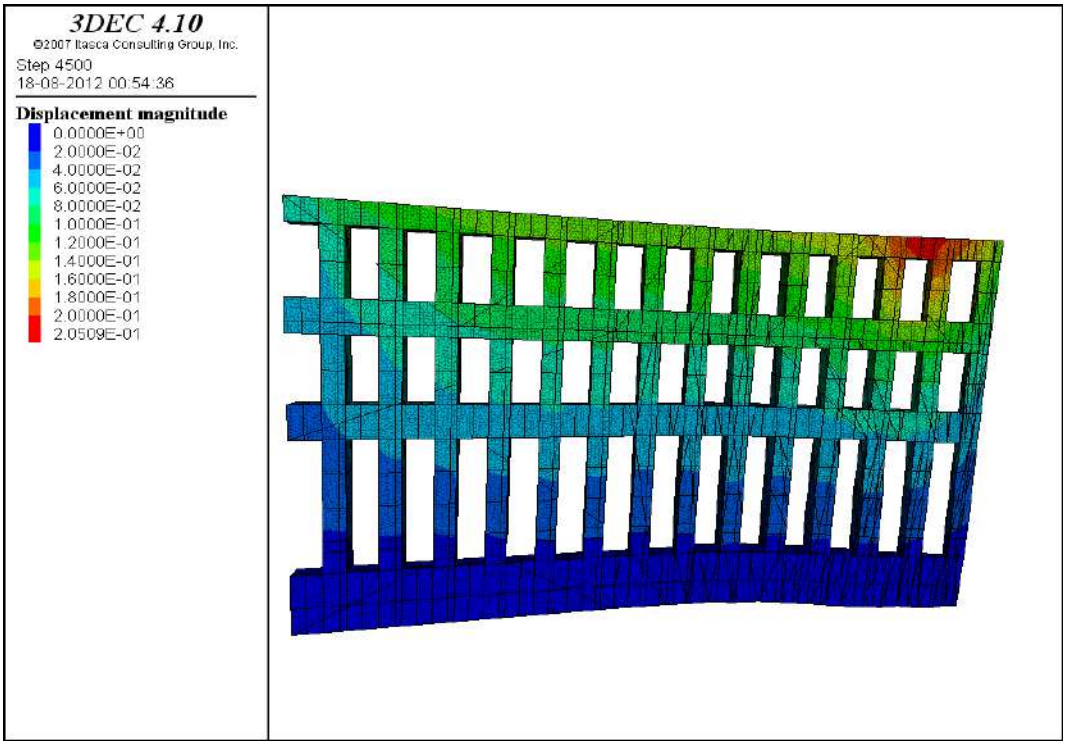

Figure 10.5. Displacement contours during extraction : stope length 28 m, width 30 m, and height 50 m

The stability of ore body during extraction was evaluated using the Factor of Safety (FoS) based on the modified Hoek and Brown yield criteria. The FoS contours were generated for each of the model in parametric analysis and the critical dimensions were determined. Some typical FoS contours are shown in Figures 10.6 to 10.9. It can be observed that FoS in elevations between -175 mRL and -250 mRL was lower than the FoS in the ore body due to the variation in strength of rock mass. FoS on the western side of ore body was lower than the eastern side. The pillars between -175 mRL to -250 mRL are susceptible to failures during extraction. The FoS on both rib and the unsupported roof was significantly low in this region. Based on the displacement contours and FoS profile in the ore body and adjoining areas, the critical dimensions for extraction are arrived at, and are presented in Table 9. The results indicated that stope length of 16 to 22 m can be safely extracted beyond -250 mRL. However, in the region between -200 mRL and -250 mRL, stope length shall be restricted to 12 to 16 m with 50 m of extraction height. The height of stope can be considered as per the recommendations in Table 10.1.

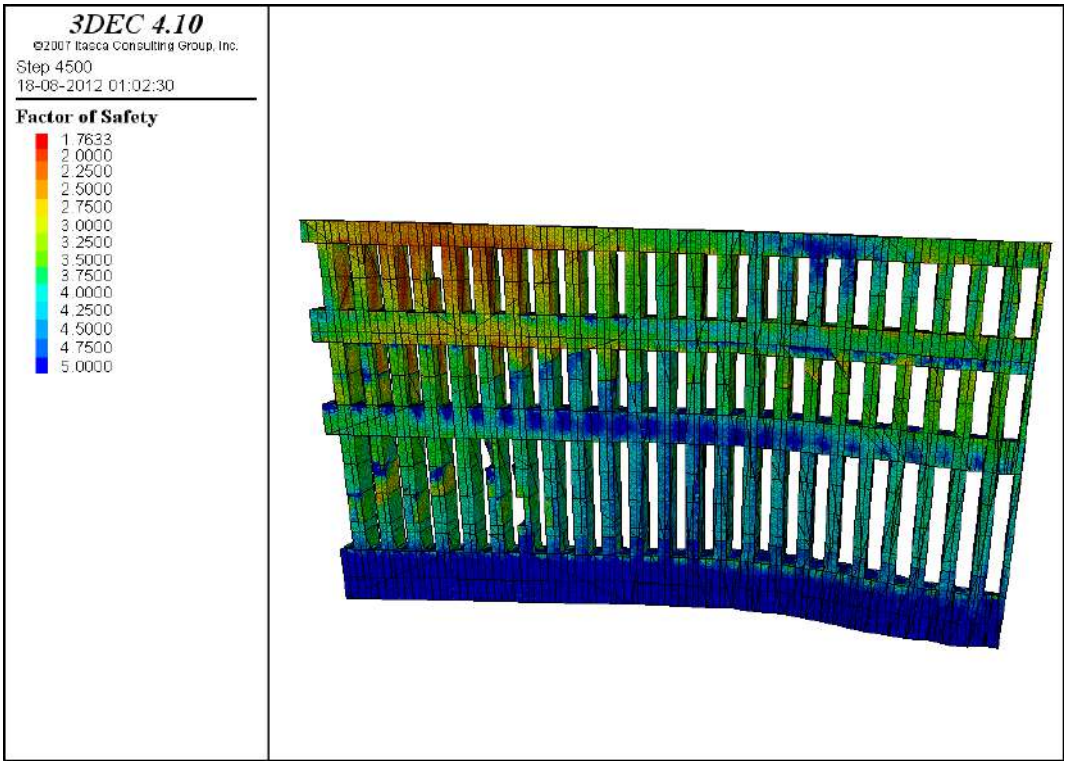

Figure 10.6. FOS contours during extraction : stope length 16 m, width 30 m, and height 50 m

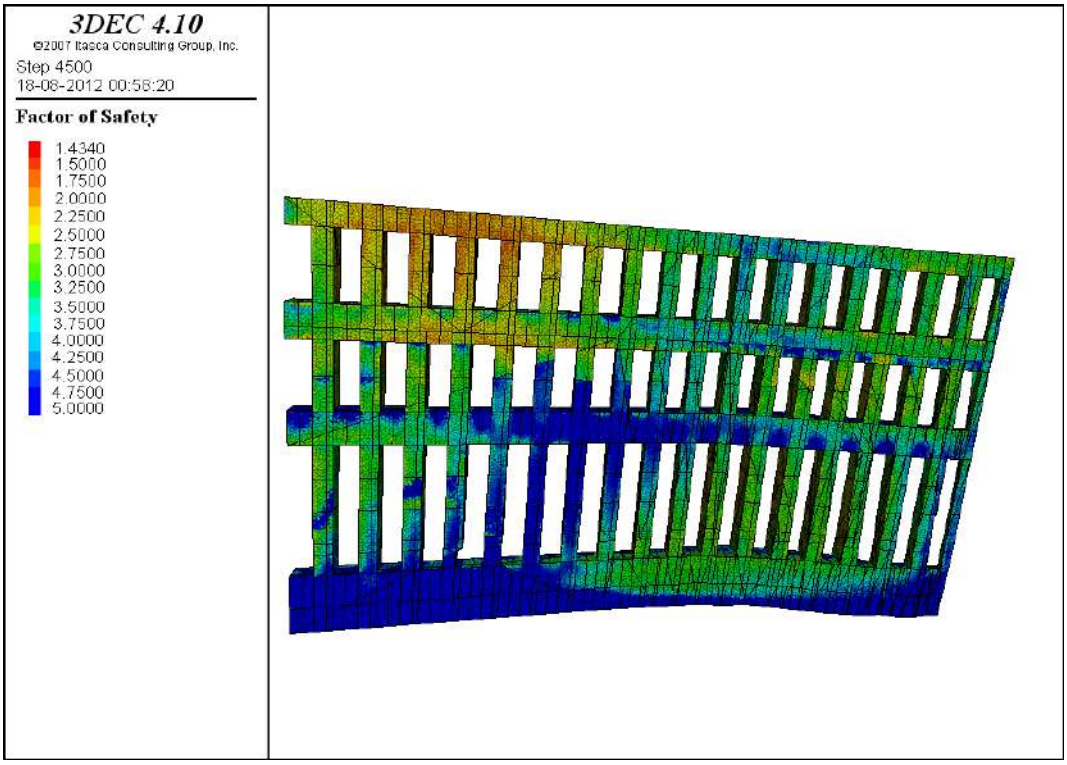

Figure 10.7. FOS contours during extraction : stope length 20 m, width 30 m, and height 50 m

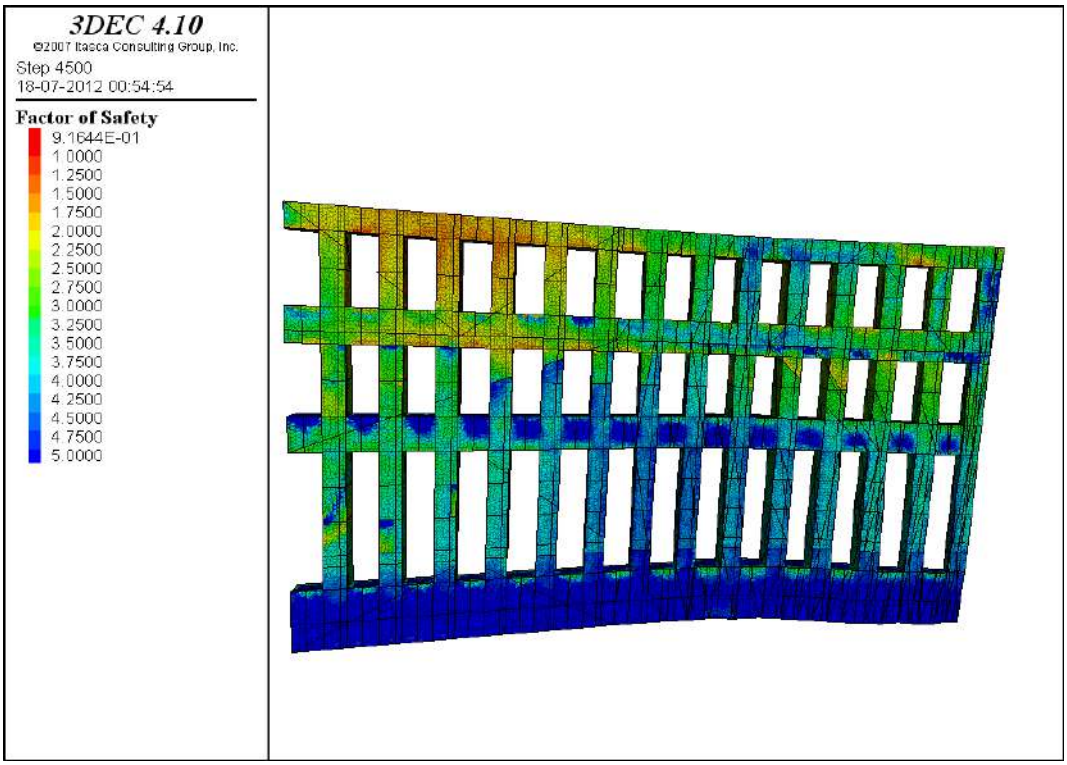

Figure 10.8. FOS contours during extraction : stope length 24 m, width 30 m, and height 50 m

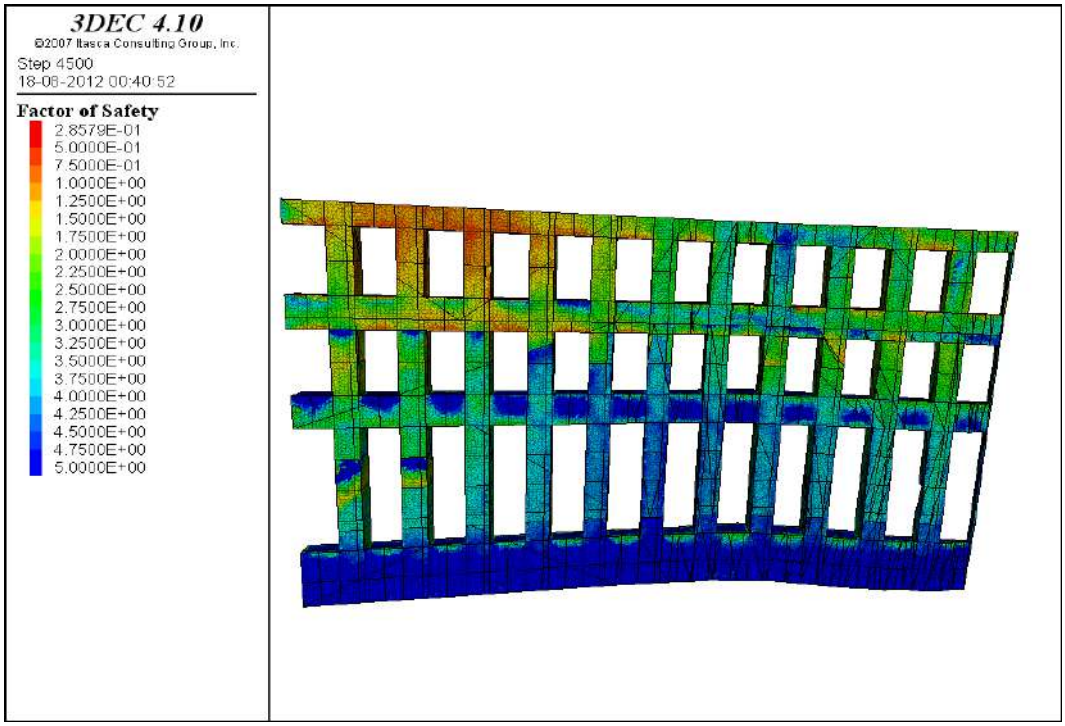

Figure 10.9. FOS contours during extraction : stope length 28 m, width 30 m, and height 50 m

Table 10.1. Critical dimensions for extraction of 16-22 m length of ore body

Elevation at extraction level	For Stope Width				
	12 m	16 m	20 m	24 m	28 m
	Height of the single stope (m)				
-200 mRL to -250 mRL	30 m	22 m	10 m	-	-
-250 mRL to -375 mRL	60 - 70 m	50 - 60 m	40 - 50 m	30 m	25 m
-375 mRL to -500 mRL	-	90 m	60 - 70 m	60 m	50 m

From the above table, it is concluded that the **optimum stope height is 50 m**, while the stope length and width shall be within 20 m (or the maximum ore body width) below -250 mRL.

11. CONCLUSIONS AND RECOMMENDATIONS

Based on the field investigations, laboratory testing and numerical modelling, for the “Fair” to “Good” rock mass ground conditions prevailing at Sukinda Mine (Chromite), it is recommended to adopt the ‘Sub-Level Stoping’ or ‘Blasthole Stoping’ method of extraction of the ore, with post filling. There shall be a level interval of 50 m, with two sub-levels at 15 to 20 m vertical distance. The required drilling slot can be opened either towards the footwall side or the hangwall side.

While the recommended maximum stope height is 50 m, the stope width shall be within 20 m (or the maximum ore body width) below -250 mRL. The length of the stope (along the strike) shall be maximum 20 m. The extraction may start at -250 mRL. Each stope may last for about two months, and two to three stopes may be worked at a time. The recommended rib pillar thickness (within the ore body) is 6 m, and the recommended crown pillar thickness is 15 m.

The recommended support system is 1.8 m long, 20 mm diameter, full-column grouted roof bolts made of tor steel. For the 4 m wide drives in serpentinite below -250 m depth, three bolts in a row are suggested, with 1.2 m row spacing. This is applicable for the waste drives and cross cuts in the footwall and hangwall, and also for the raises and the shaft. In all the ore drives and ore cross cuts, and also in the drives in the country rock above -250 m depth, there shall be 4 bolts in a row, with a row spacing of 1 m.

ACKNOWLEDGEMENTS

The authors acknowledge the support provided by M/s IMFA Ltd and for sponsoring the project. The mining engineers and the officers of Sukinda Mines (Chromite) are thankfully acknowledged for their help and co-operation during the field investigations.

The authors thank the Director, NIRM, for permission to carry out the studies.

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Annexure 15- Reasons for Common Dumping

Sukinda Mines (Chromite)

Reason for common dumping.

The M/s Indian Metals & Ferro Alloys Ltd (M/s IMFA Ltd) and M/s Balasore Alloys Ltd (M/s BAL Ltd) proposed common dumping with a view to utilize the vacant space of 7.5 Meter and its influence, on either side of the common boundary for dumping of overburden, to come out of the space shortage problem for overburden dumping and increasing the mine life considerably for opencast operation. In view of that both M/s IMFA and M/s BAL have a MoU for the dumping along the common boundary i.e. ML boundary line A-B and B-C of IMFA and I-H and HF of BAL respectively by mutually acceptable terms & conditions. Accordingly permission from DGM's under Regulation 111 (3) of the Metal ferrous Mines Regulation, 1961, vide letter BJA/C34-2 & 13/P-111 (3)/2013 DATED February, 2013 , it is being renewed time to time and it is valid up to 14.02.2021.(copy enclosed)

The current common dumping is along the boundary line B-C of M/s IMFA Ltd, the coordinates of the present dumping area is given below. As on date total 13.65 lakhs Cu.m has been filled in the common dumping area along A-B and B-C boundary line.

B-C line dumping is under progress, another 2 lakhs Cu.m of OB will be accommodated in the common dumping area.

The plan & section showing the common dumping area are attached.

Bharat Sarkar/Govt. of India
Shram Mantralaya/Ministry of Labour
Khan Suraksha Mahanideshalaya
Directorate General of Mines Safety
Bhubaneswar Khetra/Bhubaneswar Region

No.BCU/CH-12/R-111/2004/ 1875-76 Dated 17/05/2004

From

The Director of Mines Safety
Bhubaneswar Region,
Plot No.L-1, Nayapalli,
PO: RRL Campus, Near Swosti Plaza Hotel,
Bhubaneswar-751013.

To

(1) Agent — M/s Ispat Alloys Company Ltd.
Owner of Kaliapani Chromite Mine,
Balugopalpur-756 020/Balasore.

(2) Agent M/s IMFA Ltd.
Owner of Sukinda Mines (Chromite)
P.O. Kalrangiatta, Dist: Jajpur

Sub: **Permission under Regulation 111(3) of Metalliferous Mines Regulations, 1961 to work within 7.5 m of the common boundary in band No.1 between Kaliapani Chromite mine of M/s Balasore Alloys Ltd. and Sukinda mines (Chromite) of M/s IMFA.**

Dear Sir,

Please refer to your letter No. Nil dated 20.3.04 and the plan accompanying the application on the above cited subject

By virtue of the powers conferred on the Chief Inspector of Mines (also designated as Director General of Mines Safety) under Regulation 111(3) of the Metalliferous Mines Regulations, 1961, I hereby permit you to work the above two mines within 7.5 m of the common boundary between 184mRL and 134mRL as shown on the plan No.BKCM/10/04 dated 20.3.04, enclosed with the application subject to the following conditions strictly being complied with:

1.0 The boundary of the mines shall be demarcated on the surface by suitable pillars. If any boundary pillar(s) is disturbed while working near the mine boundary, the same shall be re-established on the floor of the quarry so that common boundary between two mines can be demarcated.

2.0 The workings of the mine shall be shown on all the statutory plans of both the mines.

3.0 The sequence of mining, modalities of working near common boundary and code of practice during blasting operation shall be as proposed in the application and as shown on the enclosed plan.

4.0 The quarry on either side of the common boundary shall be worked in such a manner that benches of adequate dimensions are formed in accordance with Reg.106.

5.0 Provisions of Regulation 111(2) of the Metalliferous Mines Regulations, 1961 shall be strictly complied with from 134mRL and below.

6.0 Chrome ore bands in both the mines, shall not be worked by underground method without obtaining prior permission in writing from this directorate.

7.0 The permission may be amended or withdrawn at any time if considered necessary in the interest of safety

8.0 The permission is being issued without any prejudice to any other provisions of law, which may be or may become applicable at any time.

9.0 If at any time, any one of the conditions subject to which this permission has been granted, is violated or not complied with, this permission shall be deemed to have been revoked with immediate effect.

Yours faithfully,

DIRECTOR OF MINES SAFETY
BHUBANESWAR REGION

भारत सरकार
GOVERNMENT OF INDIA
श्रम एवं रोजगार मंत्रालय
MINISTRY OF LABOUR EMPLOYMENT
खान सुरक्षा महानिदेशालय
DIRECTORATE GENERAL OF MINES SAFETY,
भुवनेश्वर क्षेत्र
BHUBANESWAR REGION

L-1, Nayapalli, PO: RRL Campus, Bhubaneswar-751013
(Phone – (+91) 7735277034 ; FAX – (0674) 2301452; e-mail: dgmsbbsr@gmail.com)

संख्या BBR-JA/CH-2&12/P-111(3)/2017/2351-36 भुवनेश्वर, दिनांक 15/02/2017

प्रेषक

खान सुरक्षा निदेशक,
भुवनेश्वर क्षेत्र ।

To

1) The Agent,
Kaliapani Chromite Mine,
M/s Balasore Alloyes Limited,
P.O. Kaliapani, Dist: Jajpur (Odisha).

2) The Agent,
Sukinda Mines(Chromite)
M/s IMFA, Jajpur Road,
Dist: Jajpur (Odisha).

Sub: Extension of validity period of permission granted vide letter no.BJA/CH-2 & 12/P-111(3)/2015/595-96 dated 12.02.2015 under Reg.111(3) of the Metalliferous Mines Regulations, 1961 for dumping of overburden within 7.5 m of common boundary between Kaliapani Chromite Mine of M/s Balasore Alloys Ltd. & Sukinda Mines(Chromite) of M/s IMFA Ltd.

Sir,

Please refer to your letter No.Mines/BAL/160 dated 10.01.2017 and the enclosed plans/sections therewith on the above subject.

The matter has since been examined in the light of what has been stated in the application and the submitted plan/section.

In exercise of the powers conferred on the Chief Inspector of Mines (also designated as Director-General of Mines Safety) under the provisions of Regulations 111(3) of the Metalliferous Mines Regulations, 1961 and by virtue of authorisation granted to me by the Chief Inspector of Mines (also designated as Director-General of Mines Safety) under Section 6(1) of the Mines Act, 1952, I, hereby extend the validity period of the earlier granted permission under Reg.111(3) of the Metalliferous Mines Regulations, 1961 vide this Directorate's letter no. BJA/CH-2&12/P-111(3)/2015/595-96 dated 12.02.2015, for dumping of overburden within 7.5 m of common boundary between Kaliapani Chromite Mine of M/s Balasore Alloys Ltd. & Sukinda Mines(Chromite) of M/s IMFA Ltd, as shown on the enclosed Plan No. BAL/IMFA/02/16 and No.BAL/IMFA/2/16 both dated 10.01.2017, **for a further period of two years i.e. upto 11.02.2019,** subject to the following conditions being complied with:

1.0 The proposed dumping of overburden along the common boundary lines i.e 'AB' & 'BC' of M/s IMFA and 'IH' & 'HG' of M/s BAL, as shown in the enclosed Plan No. BAL/IMFA/02/16 and No.BAL/IMFA/2/16 both dated 10.01.2017, shall be in 3(three) stages of each not exceeding 20 m in height subject to a total common height of not exceeding 60 m from ground level.

2.0 The overall stability aspects of the proposed common overburden dumping of height not exceeding 60 m from the ground level and also the influence of the common overburden dump on stress levels in the surrounding ground surface shall be jointly got studied by a

scientific agency of repute and a report submitted to this Directorate within 6 (six) months of commencement of operations in accordance with this permission.

3.0 All other conditions of the earlier granted permission under Reg.111(3) of the Metalliferous Mines Regulations, 1961 vide this Directorate's letter no. BJA/CH-2&12/P-111(3)/2015/595-96 dated 12.02.2015 shall remain unchanged except validity period.

4.0 In the event of any change in the circumstances connected with this relaxation which is likely to endanger the life of persons employed in the mine or the mine, the mining operations for which this relaxation has been granted shall be stopped forthwith and intimation thereof shall be sent to this Directorate. The said mining operation shall not be resumed without express and fresh permission in writing from this Directorate.

5.0 If at any time any one of the conditions, subject to which this permission has been granted, is violated or not complied with, this relaxation shall be deemed to have been revoked with immediate effect.

6.0 This relaxation may be amended or withdrawn at any time if considered necessary in the interest of safety.

7.0 This relaxation is being granted under Regulation 111(3) of the Metalliferous Mines Regulations, 1961 only without prejudice to any other provisions of law which may be or may become applicable at any time.

8.0 Intimation about completion of the mining operations should also be sent promptly and in any case not later than one month thereof.

भ व दी य,

(आर. सुब्रमणियन)
खान सुरक्षा निदेशक,
भुवनेश्वर क्षेत्र ।

Ref. No.: BAL/18
Date:15/01/2019

To
The Director of Mines Safety
Bhubaneswar

Sub: Extension of Permission under Reg.111 (3) of the Metalliferous Mines regulation 1961 for dumping of overburden within 7.5 m of the common boundary between Kaliapani Chromite Mines of M/s Balasore Alloys ltd. (BAL) and Sukinda Mines (Chromite) of M/s Indian Metals and Ferro Alloys Ltd. (IMFA)

Ref.:- Permission letter for dumping of overburden within 7.5 m of the common boundary between Kaliapani Chromite Mines of M/s Balasore Alloys Ltd. (BAL) and Sukinda Mines (Chromite) of M/s IMFA vide letter no. BBR-JA/CH-2 & 12/P-111(3)/2017/235-36, dt. 15/02/2017.

Dear Sir,

With kind reference to your letter no. BBR-JA/CH-2 & 12/P-111(3)/2017/235-36, dt. 15/02/2017.and the subject cited above it is bring to your kind notice that M/s BAL & M/s IMFA were granted permission for dumping within 7.5 m of common boundary, of the ~~to~~ two leases of M/s BAL and M/s IMFA vide letter under reference is valid for a period of 2 (two) years from the date of issue i.e from 15.02.2017 till 11.02.2019.

Common boundary dumping along line IHG of M/s BAL and along line ABC of M/s IMFA commenced during April 2014, when M/s BAL started dumping of overburden along the common boundary.

Presently, overburden dumping along common boundary of IMFA and BAL (lines AB & BC of IMFA/ lines IH & HG of BAL) is being continued with reference to your good office permission no. BBR-JA/CH-2 & 12/P-111(3)/2017/235-36, dt. 15/02/2017 over a length of 1250 meters for a height of 60 m from ground level in three stages.

In view of this, we request to your good office to extend the period for another two years from dumping along common boundary under same terms & conditions issued vide above reference.

Plan & section showing the current position of the Dump and the proposed dumping area has been enclosed for your kind perusal.

Thank you
Yours faithfully

Agent
Kaliapani Chromite Mines
M/s Balasore Alloys Ltd.

M/s. Balasore Alloys Limited
Dist.- Jajpur
Pin - 755047

Enclosures: As above

Agent
Sukinda Mines (Chromite)
M/s Indian Metals & Ferro Alloys. Ltd.

Sanjeev Das
Senior Vice President
Head-Mining Business Unit

16/1/19

16/01/2019

भारत सरकार/Government of India
श्रम एवं रोजगार मंत्रालय/Ministry of Labour & Employment
खान सुरक्षा महानिदेशालय/Directorate General of Mines Safety
भुवनेश्वर क्षेत्र/Bhubaneswar Region.

संख्या- BBR-JA/CH-2&12/P-111(3)/2019/ 10-11 /भुवनेश्वर दिनांक 23/01/2019.

प्रेषक

खान सुरक्षा निदेशक,
भुवनेश्वर क्षेत्र ।

To

1) The Agent,
Kaliapani Chromite Mine,
M/s. Balasore Alloys Ltd.,
P.O. Kaliapani, Dist: Jajpur(Odisha)

2) The Agent,
Sukinda Mines(Chromite),
M/s. IMFA, Jajpur Road,
Dist: Jajpur(Odisha).

Sub: Dumping of overburden within 7.5m of the common boundary between Kaliapani Chromite Mines of M/s. Balasore Alloys Ltd. and Sunkinda Mines(Chromite) of M/s. Indian Metals and Ferro Alloys Ltd.

Sir,

With reference to your letter No.BAL/18 dated 15.01.2019 on the above subject, your request is hereby **noted** in this Directorate.

You are hereby directed to prepare a Safety Management Plan for dumping overburden and monitoring of overburden dump at common boundary between Kaliapani Chromite Mines of M/s. Balasore Alloys Ltd. and Sunkinda Mines(Chromite) of M/s. Indian Metals and Ferro Alloys Ltd, based on Risk Assessment and ensure strict implementation of the same.

भवदीय,
23/1/19
(शुभ्र बागची)
खान सुरक्षा निदेशक
भुवनेश्वर क्षेत्र ।

CROSS SECTION AT X''-X-X'

CROSS SECTION AT V''-V-V'

INDEX

- 🟥 M.L.BOUNDARY
- ☐ CO-ORDINATE LINE
- ▨ QUARRY
- ▼ DUMP SLOPE
- ▨ HAUL ROAD
- ▨ PUBLIC ROAD
- ▭ GARLAND DRAIN
- ▭ SETTLING TANK
- 🟩 SAFETY ZONE
- ☐ BUILDINGS
- 🟥 M.L.BOUNDARY
- ▼ EXISTING DUMP SLOPE
- ▼ PROPOSED CONCEPTUAL DUMP SLOPE (M/s IMFA)
- ▼ PROPOSED CONCEPTUAL DUMP SLOPE (M/s BAL)
- ▨ HAUL ROAD
- 🟩 SAFETY ZONE

SUKINDA MINES (CHROMITE)

M/s INDIAN METALS & FERRO ALLOYS LIMITED

PLAN & SECTIONS SHOWING THE PROPOSED JOINT DUMPING POSITION ALONG COMMON BOUNDARY BETWEEN KALIAPANI CHROMITE MINES OF M/s BAL & SUKINDA MINES (CHROMITE) OF M/s IMFA LTD.

(SEQUENCE WISE JOINT DUMPING)

SCALE - 1:2000

PLATE NO.- BAL/IMFA/01/16

DUMP POSITION AS ON 30-12-2016

CERTIFIED THAT THE PLAN IS CORRECT TO THE BEST OF OUR KNOWLEDGE

MINES SURVEYOR (M/s BAL)

MINES MANAGER (M/s BAL)

MINES SURVEYOR (M/s IMFA)

MINES MANAGER (M/s IMFA)

JOINT DUMPING OF SUKINDA MINES CHROMITE

85°45'30"E 85°45'45"E 85°46'E 85°46'15"E 85°46'30"E 85°46'45"E

21°2'30"N

21°2'15"N

21°2'N

21°1'45"N

N W E S

Scale: 1:2,000

0 0.02 0.04 0.09 0.14 0.18 Kilometers

Joint Dumping Area of SMC

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

CO-ORDINATE OF JOINT DUMPING AREA OF SUKINDA MINES (CHROMITE)										
Point_ID	LAT_DD	LONG_DD	LAT_DMS			LONG_DMS			GROUP	REMARKS
			D	M	S	D	M	S		
1	21.03512000N	085.76061000E	21	2	06.43200000N	85	45	38.19600000E	1	Common Dumping Area Point
2	21.03571000N	085.76161000E	21	2	08.55600000N	85	45	41.79600000E	1	-DO-
3	21.03419000N	085.76263000E	21	2	03.08400000N	85	45	45.46800000E	1	-DO-
4	21.03739000N	085.76824000E	21	2	14.60400000N	85	46	05.66400000E	1	-DO-
5	21.03644000N	085.76885000E	21	2	11.18400000N	85	46	07.86000000E	1	-DO-
6	21.03267000N	085.76225000E	21	1	57.61200000N	85	45	44.10000000E	1	Common Dumping Area Point

Annexure 16- NPV Payment document

INDIAN METALS & FERRO ALLOYS LIMITED

imfa

IMFA Building
Bhubaneswar -751010
Odisha, India

Corporate Identity No.
L27101OR1961PLC000428

TEL +91 674 3051000
+91 674 2580100
FAX +91 674 2580020
+91 674 2580145

mail@imfa.in

www.imfa.in

22nd May, 2015

The Divisional Forest Officer,
Office of the DFO, Cuttack Forest Division,
Ghatakula, Nuapada,
Cuttack 753 010.

Sub: Payment of NPV for the forest kissam land as on 25.10.1980 and treated as non-forest Hal Settlement records in respect of Sukinda Chromite Mines of M/s.IMFA Ltd..

Ref: i) Your Memo No.4655 dated 16th May, 2015
ii) Memo No.5417 dt. 30.03.2015 of Govt of Odisha, F&E Dept.
iii) F No.8-78/199-FC(pt.), GoI, MoEF & CC
iv) Memo No.7031 dt. 20.04.2015 of the PCCF, Odisha
v) Our letter dated 30.03.2015.

Dear Sir,

As desired in your letter dated 16th May, 2015 we have deposited a sum of Rs.8,39,86,500/- (Rupees eight crore thirty nine lakh eighty six thousand five hundred only) through RTGS in favour of Ad-hoc Body of Compensatory Afforestation Fund Management and Planning Authority (CAMPA) on 20th May, 2015. Certificate to that extent by State Bank of India along with the print out of the computer screen is attached for necessary action at your end.

Thanking you,

Yours faithfully,
for Indian Metals & Ferro Alloys Ltd.,

(Sanjeev Das)
Vice President,
Head-Corporate Affairs & Legal

Received one copy
25/5/15
O/o DFO Cuttack

PRINCIPAL CHIEF CONSERVATOR OF FORESTS
ODISHA, BHUBANESWAR
Received No. 26 MAY 2015

Encl: As above

cc: Addl.Pr.CCF (Forest Diversion & Nodal Officer, FC Act), O/o. PCCF, Odisha, Bhubaneswar.
cc: Regional Chief Conservator of Forests, Angul.

-> By Courier to Angul office.

STATE BANK OF INDIA

Commercial Branch (Code - 06657)
IDCOL House, Ashok Nagar, Unit - II
Bhubaneswar - 751 009, Odisha, India
E-mail: sbi.06657@sbi.co.in, Fax: 0674-2530803/616
IFSC : SBIN0006657, Swift : SBININBB119
Tel : (for Forex) : (91-674) 2532139, 2530412,
Tel : (for Inland LC/BG) : (91-674) 2535415

WHOMSOEVER IT MAY CONCERN

Certified that the following RTGS is made in favour of Ad-hoc Body of Compensatory Afforestation Fund Management and Planning Authority (CAMPA) Corporation Bank A/c No.SB01025222 payable at New Delhi by debiting CC Account **No.10229908780 of Indian Metals & Ferro Alloys Limited.**

Favouring— Ad-hoc Body of Compensatory Afforestation Fund Management And Planning Authority (CAMPA)

Date of payment	UTR No.	Amount (Rs)
20 May 15	SBINR52015052015201024	8,39,86,500/-

(RUPEES EIGHT CRORE THIRTY NINE LAC EIGHTY SIX THOUSAND FIVE HUNDRED ONLY)

State Bank of India
By Chief Manager
Commercial Branch
Bhubaneswar

COMMERCIAL BR. 6657 S.B.I. BHUBANESWAR

\\ SCR:009523 RTGS: Message Type Details

UTR Number	SBINR52015052015201024		
Value Date:	20/05/2015	MessageType	P08
Amount	83986500.000	INR	
Related Ref.No:		Commission	56.000

Beneficiary Details

Dealer Code:

Beneficiary A/C: SB01025222

Benef. Name And Address:

ADHOC BODY OF COMPENSATORY
AFFORESTATION FUND MANAGEMENT
AND PLANNING AUTHORITY WITH
CORPORATION BANK NEW DELHI

Remitting Customer Details

Account Number: 0000001022990878O

Remitter's Name And Address:

INDIAN METALS AND FERRO ALLOYS LTD
WITH SBI COMM BRANCH BBSR

Beneficiary bank/branch

Receiver's IFSC Code: CORP0000371

Sender's IFSC Code: SBIN0006657

Details of Payment:

Sender's To Receiver Information

ATTN//

Error Code:

Error Reason:

Inst. Priority: HIGH

Close

OFFICE OF THE DIVISIONAL FOREST OFFICER, CUTTACK FOREST DIVISION
GHATAKULA, NUAPADA, CUTTACK-753010
Memo No. 4655 / 5F (Misc)/2015
Dated, Cuttack the 16th May, 2015

To

The Vice –President ,
Head Corporate Affairs & Legal
M/S IMFA Ltd., At-IMFA Building,
Bhubaneswar-751010.

Sub: - Guidelines regarding prior approval of Central Government under the Forest (Conservation) Act, 1980 for areas falling in the mining leases which were or are recorded as forest in the Government record on or after the day the FC Act came for use of forest land falling in such mining leases for mining purposes, such areas were treated as non-forest.

X-Sub- Payment of NPV for the forest kissam land as on 25.10.1980 and treated as non-forest Hal Settlement records in respect of Sukinda Chromite Mines of M/S IMFA Ltd. .

Ref: - (i) Memo No.5417 dt.30.03.2015 of Govt. of Odisha, F&E Deptt.
(ii) F No.8-78/199-FC(pt.) , GoI, MoEF & CC.
(iii) Memo No.7031 dt.20.04.2015 of the PCCF, Odisha.
(iv) Your letter dt.30.03.2015.

Sir,

In pursuance to the letters cited above on the captioned subject, you are requested to make arrangement for payment of Net Present Value (NPV) in respect of chromate mining lease of Sukinda Chronmite Mines of M/s IMFA Ltd. in Jajpur District.

i) Total M.L area – 116.76 ha.
ii) Forest area as per Hal Settlement Record which is diverted – Nil and NPV amount paid - Rs. N I L
iii) Forest area as on 25.10.1980 (as per report of the Tehsildar, Sukinda vide his Letter No. 2840 dt. 20.11.2014) 115.050 ha. and amount required for Payment @ Rs.730000/- (Eco-Value Class –I , canopy density below -Rs.08,39,86,500.00

Hence you are requested to make arrangement for payment of the amount of Rs. 08,39,86,500/- (Rupees Eight Crores Thirty Nine Lakhs Eighty Six Thousand Five Hundred) only through RTGS in favour of Ad-hoc Body of Compensatory Afforestation Fund Management and Planning Authority (CAMPA) through RTGS /NEFT mode in Corporation Bank, Lodhi Complex Branch, New Delhi-110003 (RTGS /IFSC No. CORP0000371, S.B Account No.SB01025222) and submit the receipt in original as a token of evidence to this office for the needful.

Yours faithfully,
16/5/2015
Divisional Forest Officer
Cuttack Forest Division

P.T.O

Memo No 4656 Date 16-05-2015

Copy forwarded to the Addl. Pr.CCF (Forest Diversion & Nodal Officer, FC Act), O/o the Principal Chief Conservator of Forests, Odisha, Bhubaneswar with reference to Memo No. 7031 dt.20.04.2015 of the Principal Chief Conservator of Forests, Odisha, Bhubaneswar for favour of kind information and necessary action.

16/5/2015

Divisional Forest Officer
Cuttack Forest Division

Memo No 4657 Date 16-05-2015

Copy forwarded to the Regional Chief Conservator of Forests, Angul with reference to Memo No. 7031 dt.20.04.2015 the Principal Chief Conservator of Forests, Odisha, Bhubaneswar for favour of kind information and necessary action.

Copy to N.P.V File

16/5/2015

Divisional Forest Officer
Cuttack Forest Division

Annexure 17- Affidavit regarding no change in mining plan

SL NO = 14 VOL-1

04 JAN 2020

ଓଡ଼ିଶା ओडिशा ODISHA

NILAMANI BEHERA
NOTARY BHUBANESWAR
GOVT. OF ODISHA (INDIA)
REGD. NO.ON- 39/2003

51AA 101371

NOTARY
N. BEHERA
BHUBANESWAR
REGD. NO.ON
39/2003
GOVT. OF ODISHA (INDIA)

Before Shri N. Behera,
Notary Public, Bhubaneswar

Affidavit

I, Shri Sanjeev Das, aged about 52 Years, S/o. Shri A.K. Das Burma, residing at A/2, HIG Baramunda Colony, Bhubaneswar - 751003, District - Khordha, Odisha, at present working as Senior Vice President, Head - Mining Business Unit of M/s. Indian Metals and Ferro Alloys Limited, having its Registered Office At – IMFA Building, Bomikhal, P.O. - Rasulgarh, Bhubaneswar - 751010, District – Khordha, Odisha (in short "**IMFA**"), do hereby solemnly affirm and state as follows:

1. That Sukinda Mines (Chromite) of IMFA, is situated at Village Kaliapani under Sukinda Tahasil of Jajpur District in the State of Odisha.

2. That the Regional Controller of Mines, Indian Bureau of Mines, vide its letter No. MSM/FM/06-ORI/BHU/2016-17/1697 dated 23.09.2016, had approved the modification to the approved Mining Scheme including Progressive Mine Closure Plan of Sukinda Mines (Chromite) over an area of 116.76 ha in the Jajpur District of Odisha State submitted by said IMFA, under Rule 10 of MCDR, 1988.

For Indian Metals & Ferro Alloys Ltd.
(Sanjeev Das)
Senior Vice President
Head-Mining Business Unit

12089

18/11/19

IMAA Law

18/11/19

Akshaya Kumar Champati
Stamp-Vander
Civil Court, Bhubaneswar

Gopali Surajit Dhal.

3. That the said Mining Plan was further modified and approved by IBM vide letter No. MPM/FM/25-ORI/BHU/2017-18/2815 dated 14.02.2018 for the year 2017-18 to 2018-19 and further reviewed for the period from 2019-20 to 2023-24 and approved by IBM vide letter No. MS/FM/27-ORI/BHU/2018-19/1296 dated 31.10.2018.

4. That there is no change in the area of the Mining Lease (116.76 Ha), production capacity (3.51 LTPA to 6 LTPA), mining technology involving Opencast-cum-Underground Mine, and Mineral Processing Plant (40 TPH) in the IBM approved Review Mine Plan dated 31.10.2018 as submitted to MoEF & CC along with EIA/EMP Report for appraisal and IBM approved Mining Plan dated 23.09.2016 submitted earlier for Public Hearing held on 23.06.2017.

For Indian Metals & Ferro Alloys Ltd.

(Sanjeev Das)
Senior Vice President
Head-Mining Business Unit

Place: Bhubaneswar,
Date:

Deponent

Verification

I, Shri Sanjeev Das, aged about 52 Years. S/o. Shri A.K. Das Burma, residing at A/2, HIG Baramunda Colony, Bhubaneshwar - 751003, District - Khordha, Odisha, at present working as Senior Vice President, Head-Mining Business Unit of M/s. Indian Metals and Ferro Alloys Limited, having its Registered Office At – IMFA Building, Bomikhal, P.O. - Rasulgarh, Bhubaneswar - 751 010, District – Khordha, Odisha, do hereby solemnly affirm and state that the facts stated in this Affidavit are true and correct to my knowledge and best of belief and are based on the records of the Company and no materials have been concealed and omitted therefrom.

For Indian Metals & Ferro Alloys Ltd.

(Sanjeev Das)
Senior Vice President
Head-Mining Business Unit

Verificant

NOTARY N. BEHERA BHUBANESWAR REGD. NO.ON 39/2003 GOVT. OF ODISHA (INDIA)

4/1/2020

NILAMANI BEHERA
NOTARY BHUBANESWAR
GOVT. OF ODISHA (INDIA)
REGD. NO.ON- 39/2003