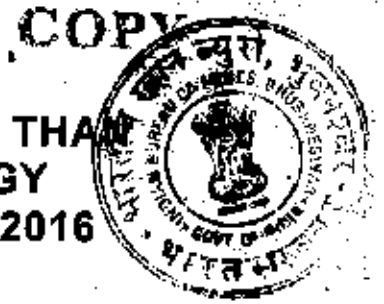


**MODIFIED MINING PLAN  
UNDER RULE 17(3) OF MINERALS (OTHER THAN  
ATOMIC AND HYDRO CARBONS ENERGY  
MINERALS) CONCESSION RULES (MCR), 2016**



**FOR**

**SIJIMALI BAUXITE DEPOSIT (CATEGORY "A")  
IN KALAHANDI AND RAYAGADA DISTRICTS  
(LEASE AREA 1560.400 HA [1549.086 HA AS PER  
DGPS SURVEY] IN WHICH FOREST LAND IS  
648.13 HA), ODISHA**

**ON BEHALF OF**

**LARSEN & TOUBRO LIMITED, MUMBAI**

**VOLUME: I  
TEXT**

**SEPTEMBER 2016**

**Prepared by Qualified Person:**

**Tapan Kumar De**



*Approved with  
letter no:  
MMP/PM/12-ORE/BHU/2016-17  
dated. 28.09.2016.*

**M. N. DASTUR & COMPANY (P) LTD  
CONSULTING ENGINEERS**



**TABLE OF CONTENTS**

	<u>Page</u>
<b>INTRODUCTION</b>	1
Requirement of Bauxite	2
Project Background	3
Preparation of Modified Mining Plan	4
Authorisation	5
Acknowledgement	5
<b>1.0 - GENERAL</b>	1-1
<b>2.0 - LOCATION AND ACCESSIBILITY</b>	
Location	2-1
Land Details	2-1
Infrastructure	2-11
<b>3.0 - DETAILS OF APPROVED MINING PLAN</b>	3-1
 <b>PART - A</b>	
<b>A-1.0 - GEOLOGY AND EXPLORATION</b>	
Topography and Drainage	A.1-1
Climate and Rainfall	A.1-1
Geology	A.1-2
Regional Geology	A.1-2
Local Geology/Geology of the Deposit	A.1-2
Name and Address of the Prospecting/Exploration Agency	A.1-3
Details of Exploration already carried out	A.1-3
Details of Exploration carried out by L&T	A.1-4
Geological Exploration proposed to be carried out	A.1-4
Method of Estimation of Reserves/Resources	A.1-4
Considerations and Assumptions for Reserves/Resources Estimation	A.1-6
Resource Assessment by Geostatistical Method	A.1-7
Geological Resources and Mineable Reserves	A.1-9
Classification of Reserves and Resources as per UNFC (United Nations Framework Classification)	A.1-11
Justification in Support of UNFC Codification	A.1-14



**TABLE OF CONTENTS**  
(Continued)

	<u>Page</u>
<b>A-2.0 - MINING</b>	
Development and Production Programme for First Five Years	.. A.2-1
Access Road	.. A.2-2
Pre-Mining Development	.. A.2-2
Calendar Plan	.. A.2-3
Proposed Rate of Production when the Mine is fully Developed	.. A.2-6
Bauxite	.. A.2-6
Overburden/Mineral Reject	.. A.2-7
Working Duration	.. A.2-8
Average Raising Rate	.. A.2-8
Mineable Reserves and Anticipated Life of the Mine	.. A.2-9
Proposed Method of Mining	.. A.2-9
Open Cast Working	.. A.2-9
Mine General Layout	.. A.2-15
Extent of Mechanisation	.. A.2-15
Unit Operations	.. A.2-16
Ripping and Dozing	.. A.2-17
Rippability of Rocks	.. A.2-17
Seismic Refraction Test at Sijimali	.. A.2-18
Observations on Testwork	.. A.2-18
Deployment of Ripper - Techno-Economic Consideration	.. A.2-19
Number of Ripper required for Ripping	.. A.2-20
Drilling	.. A.2-21
Sub-Grade Drilling	.. A.2-21
Inclined Hole Drilling	.. A.2-21
Selection of Drilling Equipment	.. A.2-22
Number of Drilling Machine required	.. A.2-22
Dust Abatement	.. A.2-24
Blasting	.. A.2-24
Charging and Stemming	.. A.2-24
Secondary Blasting	.. A.2-25
Storage and Transportation of Explosives	.. A.2-25
Excavation and Loading	.. A.2-26
Number of Excavator/Loader required	.. A.2-27
Hauling	.. A.2-29
Selection of Hauling Equipment	.. A.2-29
Number of Hauling Equipment	.. A.2-29
Miscellaneous Operation - Deployment of Equipment	.. A.2-31
Possibility of Introduction of Surface Miner	.. A.2-32
Conceptual Mine Planning	.. A.2-33



**TABLE OF CONTENTS**  
(Continued)

	<u>Page</u>
<b>A-3.0 - MINE DRAINAGE</b>	.. A.3-1
<b>A-4.0 - STACKING OF MINERAL REJECT/SUB-GRADE MATERIAL AND DISPOSAL OF WASTE</b>	
Nature and Rate of Generation of Overburden/Mineral Reject	.. A.4-1
Scheme of Disposal	.. A.4-1
Selection of Dumping Site	.. A.4-2
Site Preparation	.. A.4-3
Mode of Overburden/Mineral Reject Disposal, Dump Formation and Configuration	.. A.4-3
Side Slope and Stability	.. A.4-8
<b>A-5.0 - USE OF MINERAL AND MINERAL REJECT</b>	.. A.5-1
<b>A-6.0 - PROCESSING OF ROM AND MINERAL REJECT</b>	
Design Basis	.. A.6-1
Plant Capacity	.. A.6-1
Bauxite Stockpile	.. A.6-2
Characteristics of Feed	.. A.6-3
Product	.. A.6-3
Plant Location and Layout	.. A.6-4
Major Equipment and Facilities	.. A.6-5
R.O.M. Ore Stockyard	.. A.6-6
Crushing Section	.. A.6-7
Receiving Hopper	.. A.6-7
Apron Feeder	.. A.6-7
Vibrating Grizzly	.. A.6-7
Crusher	.. A.6-8
Belt Conveying System	.. A.6-8
Surge Bin	.. A.6-8
Bin Compartment	.. A.6-8
Apron Feeder	.. A.6-9
Other Facilities	.. A.6-9
Crane and Hoist	.. A.6-9
Belt Scale	.. A.6-9
Metal Detector and Magnetic Separator	.. A.6-9
Automatic Sampler	.. A.6-10
Dust Abatement Facilities	.. A.6-10
Bauxite Transportation to Refinery	.. A.6-10



**TABLE OF CONTENTS**  
(Continued)

	<u>Page</u>
<b>A-7.0 - SITE SERVICE FACILITIES</b>	
Power System	A.7-1
Power Requirements	A.7-1
Characteristics of Loads	A.7-1
Source of Power	A.7-2
Power Distribution Scheme	A.7-2
Selection of Electrical Equipment	A.7-4
Motors and Controls	A.7-5
Auxiliary Power Distribution	A.7-7
Power and Control Cables	A.7-7
Earthing and Lightning Protection System	A.7-8
Plant Illumination System	A.7-8
Instrumentation and Level-1 Automation System	A.7-9
Communication System	A.7-11
Fire Detection and Alarm (FDA) System	A.7-12
Water System	A.7-13
Source of Water	A.7-13
Water Supply System	A.7-15
Water Storage and Distribution System	A.7-15
Distribution Pipe Work	A.7-16
Utilities and Auxiliaries	A.7-17
Compressed Air	A.7-17
Fuel System	A.7-18
Air Conditioning System	A.7-18
Ventilation	A.7-18
Fire Fighting System	A.7-19
Other Facilities	A.7-20
Quality Control Centre	A.7-20
Repair and Maintenance Shop	A.7-21
Stores	A.7-22
Administrative Building	A.7-22
Gate House and Check Posts	A.7-23
Time Office	A.7-23
First Aid Station	A.7-23
Training Centre	A.7-23
Canteen	A.7-23
Rest Shelter and Ablution Block	A.7-24
Transport	A.7-24
Employment Potential	A.7-24
Organisation Structure	A.7-24
Manpower Requirement	A.7-25



**TABLE OF CONTENTS**  
(Continued)

	<u>Page</u>
<b>A-8.0 - PROGRESSIVE MINE CLOSURE PLAN</b>	
<b>UNDER RULE 23 OF MCDR' 1988</b>	
Environment Base Line Information	.. A.8-1
Existing Land Use Pattern	.. A.8-1
Drainage Pattern of the Sijimali Bauxite Mine	.. A.8-1
Ambient Air Quality	.. A.8-2
Water Quality	.. A.8-2
Ambient Noise Level	.. A.8-4
Ecology and Biodiversity	.. A.8-4
Vegetation Structure and Composition	.. A.8-4
Endangered Plants	.. A.8-5
National Park/Sanctuary	.. A.8-5
Avifauna	.. A.8-5
Rare, Endangered and Threatened Fauna in the Study Area	.. A.8-5
Climatic Conditions	.. A.8-6
Meteorological Data Generated at Site	.. A.8-6
Wind Speed/Direction	.. A.8-6
Demography	.. A.8-6
Distribution of Population	.. A.8-6
Potential Impact and Mitigation Measures	.. A.8-8
Land Area Degradation	.. A.8-8
Air Quality	.. A.8-8
Water Quality	.. A.8-9
Noise Levels	.. A.8-9
Vibration Levels (Due to Blasting)	.. A.8-9
Water Regime	.. A.8-10
Acid Mine Drainage	.. A.8-10
Socio-Economic Impact	.. A.8-10
Historical Monuments etc	.. A.8-11
Progressive Reclamation Plan	.. A.8-11
Mined Out Land	.. A.8-11
Top Soil Management	.. A.8-13
Tailings Dam Management	.. A.8-13
Acid Mine Drainage	.. A.8-13
Year-wise Proposal for Progressive Reclamation Plan	.. A.8-13
Disaster Management and Risk Assessment	.. A.8-13
Care and Maintenance during Temporary Discontinuance	.. A.8-17
Financial Assurance	.. A.8-17



**TABLE OF CONTENTS**  
(Continued)

	<u>Page</u>
<b>PART - B</b>	
<b>B-9.0 - CERTIFICATES/UNDERTAKINGS/CONSENTS</b>	
Consent Letter/Undertaking/Certificate from the Applicant	.. B.9-1
Certification from Qualified Person	.. B.9-1
<b>B-10.0 - LIST OF PLANS AND SECTIONS</b>	
	.. B.10-1
<b>B-11.0 - LIST OF DOCUMENTS ANNEXED</b>	
	.. B.11-1

**TABLES**

Table 2-1	- DGPS co-ordinates of the mining lease boundary pillars for Kalahandi district	.. 2-2
Table 2-2	- DGPS co-ordinates of the mining lease boundary pillars for Rayagada district	.. 2-6
Table 2-3	- Abstract of land schedule and land use (area in Hectare)	.. 2-11
Table A.1-1	- Summary of the detailed investigations carried out by L&T in Sijimali deposit	.. A.1-5
Table A.1-2	- Exploration programme for the first five years	.. A.1-6
Table A.1-3	- Semi-variograms parameters and other parameters considered for estimation of resources	.. A.1-9
Table A.1-4	- Block-wise geological and mineable reserves as on 01.08.2016	.. A.1-10
Table A.1-5	- Section-wise geological resources as per level of exploration	.. A.1-12
Table A.1-6	- Details of exploration carried out in the lease area as per UNFC norms	.. A.1-13
Table A.1-7	- Reserves/resources as per UNFC	.. A.1-13
Table A.1-8	- Justification of UNFC coding	.. A.1-14
Table A.2-1	- In-situ tentative excavation for first five years at Sijimali	.. A.2-4
Table A.2-2	- Level-wise removal of topsoil, ore and overburden/mineral reject	.. A.2-5
Table A.2-3	- List of major equipment - Mining	.. A.2-16
Table A.2-4	- Details of drilling	.. A.2-23
Table A.2-5	- Broad blasting parameters	.. A.2-25



**TABLE OF CONTENTS**  
(Continued)

	<u>Page</u>
Table A.2-6 - Requirement of hydraulic excavators	.. A.2-27
Table A.2-7 - Requirement of front-end loader	.. A.2-28
Table A.2-8 - Requirement of rear-dump trucks	.. A.2-30
Table A.2-9 - Miscellaneous equipment	.. A.2-31
Table A.4-1 - First five years top soil and mineral rejects/laterite management plan	.. A.4-2
Table A.6-1 - Characteristics of r.o.m ore considered for design	.. A.6-3
Table A.6-2 - List of major equipment - Crushing Plant	.. A.6-6
Table A.6-3 - Features of belt conveyor system	.. A.6-11
Table A.7-1 - Ratings of step-down transformers	.. A.7-4
Table A.7-2 - Details of high voltage circuit breakers	.. A.7-5
Table A.7-3 - List of equipment for electrical	.. A.7-6
Table A.7-4 - List of major items for instrumentation and Level-1 automation system	.. A.7-11
Table A.7-5 - Water requirement for Sijimali bauxite mining area	.. A.7-14
Table A.7-6 - List of equipment for water supply	.. A.7-17
Table A.7-7 - Details of the air conditioning system	.. A.7-19
Table A.7-8 - Details of fire fighting system	.. A.7-20
Table A.7-9 - Details of manpower	.. A.7-26
Table A.8-1 - Land use pattern of the study area	.. A.8-1
Table A.8-2 - Land use pattern of the proposed ML area	.. A.8-2
Table A.8-3 - Surface water quality	.. A.8-3
Table A.8-4 - Noise levels [(db(A)] in the study area	.. A.8-4
Table A.8-5 - Summary of the meteorological data monitored at site	.. A.8-6
Table A.8-6 - Distribution of population	.. A.8-7
Table A.8-7 - Summary of year-wise proposal for progressive reclamation plan	.. A.8-14
Table A.8-8 - Break-up of areas in the mining lease for calculation of financial assurance	.. A.8-18

**FIGURES**

Fig. A.1-1 - Typical borehole sections	.. A.1-8
Fig. A.4-1 - Formation of mineral reject dump at different stages	.. A.4-5
Fig. A.4-2 - Formation of overburden dump at different stages	.. A.4-6
Fig. A.4-1 - Formation of top soil dump at different stages	.. A.4-7



---

**TABLE OF CONTENTS**  
(Continued)

**Page**

**ENCLOSURE**

Enclosure-1 - Feasibility Report

Enclosure-2 - Prospecting Report



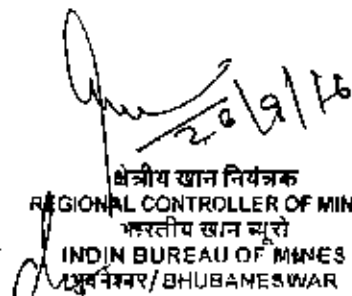
## INTRODUCTION

Larsen & Toubro Limited (L&T) is India's largest engineering, construction and manufacturing conglomerate with additional interests in electrical, electronics and information technology. L&T meets vital requirements in diverse fields of human interest, with a product range that stretches from engineering and construction of complex chemical/mineral/petro-chemical projects to nuclear power reactors, from earth moving equipment to rocket motor casings, just to name a few. During 2015-16, the consolidated revenue was in excess of Rs. 1 Lakh Crores. It operates in over 40 countries worldwide.

L&T has diversified from the traditional construction business and has taken up a number of developmental initiatives in the areas of power and infrastructure. In furtherance of its development initiatives in the field of mines and metals, L&T has proposed to set up a green-field Alumina Refinery of capacity 3 million tonnes per year (MTPY) in the state of Odisha.

The proposed Alumina Refinery will be located near Kusumasila village in Rayagada district and shall be based on bauxite from Kutrumali and Sijimali Bauxite Deposits in Odisha. L&T has engaged M/s. M. N. Dastur & Company (P) Ltd. for preparation of this modified mining plan in accordance with "Indian Bureau of Mines' (IBM) Manual on Appraisal of Mining Plan 2014" and other applicable statutory requirements and guidelines.

मुद्रांकित  
APPROVED

  
20/9/16  
क्षेत्रीय खान नियंत्रक  
REGIONAL CONTROLLER OF MINES  
भारतीय खान ब्यूरो  
INDIAN BUREAU OF MINES  
भुवनेश्वर/BHUBANESWAR



Introduction (cont'd)

### **REQUIREMENT OF BAUXITE**

More than 90 per cent of world's alumina production is through adoption of Bayer's process comprising dissolution of  $Al_2O_3$  content of bauxite in caustic soda liquor, its precipitation from purified pregnant solution in the form of hydrates followed by calcinations to obtain alumina.

The requirement of bauxite for production of 1 MTPY of alumina has been estimated at about 3 MTPY, considering the process requirement of 3 tonnes of bauxite for 1 tonnes of alumina. Hence, the requirement of bauxite for 3 MTPY capacity of the envisaged alumina refinery will be 9 MTPY. It is necessary to ensure a sizeable reserve base of bauxite to sustain the 3 MTPY capacity alumina refinery for considerable number of years so as to ensure viability of the project.

In order to ensure the bauxite supply of stipulated quality and quantity to the proposed alumina plant, L&T has identified two bauxite sources, one at Kutrumali in Kalahandi and Rayagada districts, and other at Sijimali in Rayagada and Kalahandi districts in Odisha. The prospecting licences (PL) for both these deposits were obtained by L&T and subsequently substantial exploration was carried out by them. The copies of the PL deeds executed between Government of Odisha and L&T for Sijimali have been appended in Appendix-1. L&T applied for mining lease (ML) for Sijimali bauxite deposit in April 1994, which is entirely within the PL area. The ML applications are currently under active consideration by Government of India after being recommended by Government of Odisha.

L&T has carried out geological exploration comprising geological mapping, contour surveying, drilling at 200 m grid intervals, metrewise chemical analyses of samples etc to prove the quality and reserves of



D

Introduction (cont'd)

bauxite in Sijimali deposit. The details of the geology and exploration so far carried out on Sijimali bauxite deposit have been described in Part-A - Chapter 1.0.

Based on the drilling at 200 m grid intervals at Sijimali and 400 m grid intervals at Kutrumali, the estimated mineable reserves of bauxite in Sijimali and Kutrumali amount to about 299 million tonnes (MT) as given below:

Deposit	Mineable reserves, MT	Average grade	
		Al <sub>2</sub> O <sub>3</sub> , %	SiO <sub>2</sub> , %
Sijimali	220.39	46.10	2.03
Kutrumali	78.50	40.38	1.64
<b>Total</b>	<b>298.89</b>		

It can be seen from the above that the combined reserves of Kutrumali and Sijimali may support the proposed alumina refinery for about 34 years considering the present requirement of bauxite at the proposed alumina refinery plant of 9 MTPY.

**PROJECT BACKGROUND**

Alumina is produced by Bayer process by refining bauxite ore. The refined Alumina (Aluminium Oxide) is used further as feed material in a smelter to produce Aluminium metal. As per CRU analysis of July 2015, global alumina capacity which is presently at about 138 MTPY is forecasted to grow consistently over the next ten years, reaching to about 180 MT by 2024.



Introduction (cont'd)

In view of this, it is prudent to exploit this market opportunity in India where good quality bauxite is in abundance. L&T has proposed to set up a green-field Alumina Refinery of capacity 3 MTPY in the state of Odisha, based on the bauxite deposits of Kutrumali and Sijimali in Kalahandi and Rayagada districts.

**PREPARATION OF MODIFIED MINING PLAN**

Earlier, in 1993, L&T were contemplating installation of 1 MTPY alumina refinery with a provision of increasing its capacity to 3 MTPY. In view of that, L&T had submitted mining plans for production of 3 MT of bauxite per annum each from Kutrumali and Sijimali bauxite deposits which were approved by IBM in the year 1995 and 1997 respectively.

However, now L&T intends to modify the earlier approved mining plans on the Kutrumali and Sijimali bauxite deposits for the following reasons:

- a) Changes in the bauxite production capacities for the Kutrumali (3 MTPY) and Sijimali (6 MTPY) bauxite deposits considering installation of a 3 MTPY alumina refinery so as to achieve economy of scale.
- b) Changed threshold values/cut-off grades for estimation of bauxite resources as stipulated by IBM vide notification dated 16th October 2009 and circular dated 14th July 2010.
- c) Advancement in the technology for scientific and environment friendly mining.
- d) Change in area of the leasehold from earlier approved mining plan. Earlier, the mining plan was approved for 1551.013 Ha as per the then land schedule which was available in 1995. However, as per the present record of the revenue authorities and certified by the relevant authorities, the land schedule area is 1560.40 Ha. Moreover, DGPS survey was conducted recently and the area as per the DGPS measurement is 1549.086 Ha.

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



Introduction (cont'd)

Considering the above, it is the statutory obligation on part of the prospective lessee to submit the duly approved modified mining plan for each of these deposits as required under Section 5(B)(ii) of Mines and Minerals (Development and Regulations) Amendment Act, 2015 and Rule 17(3) of Minerals (Other than Atomic and Hydro Carbons Energy Minerals) Concession Rules, 2016 for obtaining the mining leases as well as for developing the mines.

**AUTHORISATION**

In pursuance of the above objectives, L&T appointed M. N. Dastur & Company (P) Ltd., Kolkata as CONSULTING ENGINEERS for preparation of modified mining plan for production of 6 MTPY of metallurgical grade bauxite per year from Sijimali bauxite deposit covering both Kalahandi and Rayagada districts, vide its letter no. L&T/BMP/MP/2015-16/18 dated 16th March 2016.

**ACKNOWLEDGEMENT**

The CONSULTING ENGINEERS express their sincere thanks to the concerned officials of L&T for the co-operation and help extended to them for preparation of the modified mining plan for Sijimali bauxite deposit.

A handwritten signature or set of initials in black ink, located at the bottom right of the page.



**1.0 - GENERAL**

- a) Name of the applicant with complete address .. LARSEN & TOUBRO LIMITED  
Landmark Building,  
'A' Wing, 2nd Floor,  
Suren Road,  
Off Andheri Kurla Road  
Chakala, Andheri (East)  
Mumbai, Maharashtra,  
India  
Pin Code - 400 093
- Fax No. .. +91-22-66965345
- Contact 1 .. Mr. Ajit Samal  
Chief Executive - Special  
Projects  
Telephone: +91-22-66965243  
Email:  
ajit.samal@larsentoubro.com
- Contact 2 .. Mr. S. Ekambaram  
Jt. General Manager  
Telephone: +91-22-66965210  
Email:  
s.ekambaram@larsentoubro.com
- b) Status of the applicant .. A Public Limited Company
- c) Mineral(s) which is/are included in the prospecting license (For Fresh grant) .. Bauxite
- d) Mineral(s) which is/are included in the letter of intent .. Bauxite
- e) Mineral(s) which is the applicant intends to mine .. Bauxite

A handwritten signature in black ink, appearing to be 'd' or a similar stylized name, located at the bottom right of the page.

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



1.0 - General (cont'd)

f) Name and address of the qualified person(s) who prepared the mining plan as per Rule 15 of Minerals (Other than Atomic and Hydro Carbons Energy Minerals) Concession Rules (MCR), 2016

Qualified person:

Tapan Kumar De

M. N. Dastur & Company (P)  
Ltd.

P-17, Mission Row Extension  
Kolkata - 700013

Tel: +91 33 2225 0500 / 5420

Fax: +91 33 2225 1422 / 7101

E-mail: [info@dastur.com](mailto:info@dastur.com)



## **2.0 - LOCATION AND ACCESSIBILITY**

### **LOCATION**

The proposed Mining Lease (ML) area of Sijimali deposit covering 1560.400 Ha (1549.086 Ha as per DGPS Survey) is located partly in Thuamularampur Tahasil of Kalahandi and partly in Kasipur Tahasil of Rayagada districts, Odisha and is shown in Maps FDC-220/1 and FDC-220/2. The district boundary passes through the plateau, dividing the deposit into almost two halves. The deposit is approachable from Sunger through a 9 km fair weather village/hilly road. Sunger is at a distance of 85 km from Rayagada town and is approachable by a State Highway via Kasipur, a Tahasil headquarter. The location plan is shown in Drawing 11420-97C-000-PRM-0001. The Sijimali plateau is bounded by latitudes 19°28'40" N - 19°32'05" N and longitudes 83°06'04" E - 83°09'50" E and is covered by parts of Survey of India Toposheet Nos. E44F2 (65 M/2) and E44F3 (65 M/3) on a scale 1:50,000. The area showing the boundary of Sijimali mining lease area and all the features lying within 5 km of the mining lease area has been shown in the key plan Drawing 11420-97C-000-PRM-0002.

### **LAND DETAILS**

L&T submitted the ML application with the then land schedule in April 1994 (Refer Appendix 2-1) which was subsequently revised based on new land schedule. The revised plan of the ML area and revised land schedule were submitted in January 1995 to the Government of Odisha (Refer Appendix 2-2). On the basis of the above new land schedule, the total area applied for ML works out to 1551.013 Ha. L&T has recently conducted a DGPS survey in accordance with the Ministry of Mines guidelines dated 31.10.2014 and the maps prepared through this survey were approved by Orissa Space Applications Centre, Bhubaneswar on 7th September 2015 (Survey Map FDC-220/1 for

A handwritten signature or set of initials in dark ink, located at the bottom right of the page.



2.0 - Location and Accessibility (cont'd)

Kalahandi and Survey Map FDC-220/2 for Rayagada are appended along with this report). As per approved DGPS survey maps, the measured area of the ML works out to 1549.086 Ha. This minor difference is due to technological change in survey method as the land schedule has not changed.

The DGPS co-ordinates of the mining lease boundary pillars for Kalahandi and Rayagada districts are indicated below in Table A.2-1 and Table A.2-2 respectively:

**TABLE 2-1 - DGPS CO-ORDINATES OF THE MINING LEASE BOUNDARY PILLARS FOR KALAHANDI DISTRICT**

Point Id	UTM-CO-ORDINATES		GEO-GRAPHIC CO-ORDINATES	
	Easting	Northing	Latitude	Longitude
A	721208.398	2158452.853	N19°30'30.60559"	E83°06'28.29329"
B	721288.159	2158535.479	N19°30'33.26004"	E83°06'31.06286"
B1	721544.056	2158352.832	N19°30'27.21952"	E83°06'39.75962"
B2	721793.806	2158157.879	N19°30'20.78129"	E83°06'48.24022"
B3	722038.271	2157966.010	N19°30'14.44532"	E83°06'56.54077"
B4	722284.818	2157773.750	N19°30'08.09573"	E83°07'04.91234"
C	722526.498	2157583.366	N19°30'01.80901"	E83°07'13.11766"
D	722865.396	2157364.084	N19°29'54.54355"	E83°07'24.64358"
D1	722813.559	2157678.913	N19°30'04.79995"	E83°07'22.99995"
E	722773.466	2157947.631	N19°30'13.55250"	E83°07'21.73937"
F	722662.645	2157972.977	N19°30'14.42108"	E83°07'17.95059"
G	722680.362	2158309.540	N19°30'25.35613"	E83°07'18.70080"
H	722314.345	2158184.632	N19°30'21.44229"	E83°07'06.09867"
H1	722202.280	2158465.128	N19°30'30.60662"	E83°07'02.37516"
I	722080.316	2158774.015	N19°30'40.69795"	E83°06'58.32416"
J	722484.976	2158837.295	N19°30'42.59278"	E83°07'12.22550"
J1	722602.548	2158709.774	N19°30'38.39962"	E83°07'16.20259"
K	722760.502	2158538.242	N19°30'32.75932"	E83°07'21.54550"
K1	722954.418	2158677.329	N19°30'37.20316"	E83°07'28.25325"
L	723068.161	2158760.462	N19°30'39.86007"	E83°07'32.18844"
M	723286.642	2158714.889	N19°30'38.29036"	E83°07'39.66004"

**LARSEN & TOUBRO LIMITED**  
**Sijimall Bauxite Deposit**  
**Modified Mining Plan**



2.0 - Location and Accessibility (cont'd)

Point Id	UTM-CO-ORDINATES		GEO-GRAPHIC CO-ORDINATES	
	Easting	Northing	Latitude	Longitude
N	723421.542	2159006.577	N19°30'47.71907"	E83°07'44.40948"
O	723595.079	2159243.729	N19°30'55.35909"	E83°07'50.46061"
P	723715.957	2159155.964	N19°30'52.45688"	E83°07'54.56778"
P1	723727.309	2159245.549	19° 30' 55.3648176"	83° 7' 54.9952104"
P2	723748.231	2159245.738	19° 30' 55.362492"	83° 7' 55.71264"
P3	723745.052	2159385.523	19° 30' 59.9083704"	83° 7' 55.6632696"
Q	723763.558	2159532.614	N19°31'04.68299"	E83°07'56.36054"
Q1	724036.599	2159399.387	19° 31' 0.2411292"	83° 8' 5.6656428"
R	724251.618	2159297.384	N19°30'56.83779"	E83°08'12.99454"
R1	724307.353	2159251.445	N19°30'55.32168"	E83°08'14.88592"
S	724581.272	2158999.999	N19°30'47.03582"	E83°08'24.17023"
S1	724655.844	2159249.962	N19°30'55.13210"	E83°08'26.83411"
T	724717.805	2159457.617	N19°31'01.85800"	E83°08'29.04750"
T1	724813.007	2159559.665	N19°31'05.13701"	E83°08'32.35549"
T1A	724908.896	2159640.440	N19°31'07.72410"	E83°08'35.67794"
U	725149.390	2159851.428	N19°31'14.48568"	E83°08'44.01453"
V	725190.396	2160135.310	N19°31'23.69825"	E83°08'45.54244"
W	724931.604	2160260.174	N19°31'27.86299"	E83°08'36.72234"
W1	724966.107	2160564.089	N19°31'37.72952"	E83°08'38.03578"
X	724984.971	2160711.428	N19°31'42.51199"	E83°08'38.74585"
Y	725222.520	2160781.587	19° 31' 44.69619"	83° 8' 46.9215348"
Z	725010.896	2160896.536	N19°31'48.51945"	E83°08'39.71427"
Z1	724864.733	2161007.914	N19°31'52.19990"	E83°08'34.75007"
Z2	724915.996	2161320.895	N19°32'02.35433"	E83°08'36.64223"
Z2A	725218.980	2161273.596	N19°32'00.69325"	E83°08'47.01154"
Z2B	725519.000	2161226.602	19° 31' 59.0431404"	83° 8' 57.2792964"
Z2C	725696.417	2161198.310	19° 31' 58.05093"	83° 9' 3.3508656"
Z3	725898.000	2161161.766	19° 31' 56.7805152"	83° 9' 10.2475368"
Z4	725862.635	2160890.041	19° 31' 47.9610084"	83° 9' 8.9177508"
Z5	726028.613	2160738.759	19° 31' 42.9749004"	83° 9' 14.5439172"
Z6	725833.164	2160435.006	19° 31' 33.1795154"	83° 9' 7.7111784"
Z6A	725891.517	2160238.138	19° 31' 26.755374"	83° 9' 9.6272496"
Z7	725956.943	2160021.230	19° 31' 19.6768128"	83° 9' 11.7771768"
Z8	725694.649	2159926.333	19° 31' 16.6987092"	83° 9' 2.7427032"
Z8A	725669.304	2159688.795	19° 31' 8.9865048"	83° 9' 1.7714628"
Z9	725645.727	2159428.859	19° 31' 0.545394"	83° 9' 0.851256"
Z10	725831.766	2159477.309	19° 31' 2.0446572"	83° 9' 7.2508896"

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



2.0 - Location and Accessibility (cont'd)

Point id	UTM-CO-ORDINATES		GEO-GRAPHIC CO-ORDINATES	
	Easting	Northing	Latitude	Longitude
Z11	725833.310	2159190.079	19° 30' 52.7059656"	83° 9' 7.1802072"
Z11A	725978.667	2159085.808	19° 30' 49.2566868"	83° 9' 12.1191228"
Z12	726141.920	2158968.698	19° 30' 45.3826728"	83° 9' 17.6660712"
Z12A	726086.026	2158709.761	19° 30' 36.987282"	83° 9' 15.6381264"
Z12B	725994.979	2158306.419	19° 30' 23.9115096"	83° 9' 12.342816"
Z13	725970.652	2158200.645	19° 30' 20.4826536"	83° 9' 11.4632568"
Z13A	725781.225	2158127.702	19° 30' 18.1884816"	83° 9' 4.9373928"
Z13B	725577.350	2158051.952	N19°30'15.80890"	E83°08'57.91502"
Z14	725378.128	2157976.517	19° 30' 13.4375652"	83° 8' 51.0523584"
Z15	725593.857	2157931.132	19° 30' 11.8741896"	83° 8' 58.4290536"
Z16	725734.730	2157790.259	19° 30' 7.2369"	83° 9' 3.1982328"
Z17	725886.212	2157824.446	19° 30' 8.2865628"	83° 9' 8.4063744"
Z17A	726044.177	2157626.399	19° 30' 1.783458"	83° 9' 13.7368584"
Z17B	726199.785	2157420.101	19° 29' 55.0130064"	83° 9' 18.9828396"
Z17C	726334.763	2157230.306	19° 29' 48.7875048"	83° 9' 23.5285632"
Z17D	726470.920	2157028.723	19° 29' 42.1782432"	83° 9' 28.1095272"
Z17E	726617.098	2156833.624	19° 29' 35.7756504"	83° 9' 33.0367032"
Z17F	726763.275	2156633.220	19° 29' 29.2005636"	83° 9' 37.9614852"
Z18	726950.122	2156389.198	19° 29' 21.1907688"	83° 9' 44.2615536"
Z18A	726971.342	2156149.892	19° 29' 13.4020788"	83° 9' 44.8856316"
Z19	726991.382	2155858.716	19° 29' 3.9275664"	83° 9' 45.4468968"
Z19A	727055.040	2155660.080	19° 28' 57.4437144"	83° 9' 47.5433136"
Z20	727124.002	2155448.477	19° 28' 50.5361064"	83° 9' 49.815936"
Z21	726968.984	2155355.348	19° 28' 47.5719024"	83° 9' 44.4617856"
Z22	726741.624	2155454.838	N19°28'50.89942"	E83°09'36.71095"
Z22A	726699.279	2155497.619	19° 28' 52.3075548"	83° 9' 35.2778112"
Z23	726645.754	2155543.194	N19°28'53.81112"	E83°09'33.46264"
Z23A	726608.908	2155627.598	N19°28'56.57022"	E83°09'32.23595"
Z23B	726575.300	2155725.962	N19°28'59.78187"	E83°09'31.12628"
Z24	726545.969	2155854.355	N19°29'03.96798"	E83°09'30.17613"
Z24A	726439.018	2156033.564	N19°29'09.83791"	E83°09'26.58703"
Z25	726402.549	2156088.991	N19°29'11.65478"	E83°09'25.36072"
Z26	726238.624	2156144.357	N19°29'13.52172"	E83°09'19.76506"
Z26A	726174.074	2156237.465	N19°29'16.57508"	E83°09'17.59229"
Z26B	726133.380	2156299.208	N19°29'18.59901"	E83°09'16.22381"
Z26C	726074.423	2156382.956	N19°29'21.34579"	E83°09'14.23870"
Z26D	726011.226	2156465.269	N19°29'24.04761"	E83°09'12.10764"

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



**2.0 - Location and Accessibility (cont'd)**

Point id	UTM-CO-ORDINATES		GEO-GRAPHIC CO-ORDINATES	
	Easting	Northing	Latitude	Longitude
Z26E	725935.052	2156555.412	N19°29'27.00930"	E83°09'09.53500"
Z26F	725840.962	2156656.952	N19°29'30.34880"	E83°09'06.35309"
Z26G	725786.679	2156701.273	N19°29'31.81186"	E83°09'04.51120"
Z26H	725724.876	2156750.580	N19°29'33.44003"	E83°09'02.41364"
Z26I	725660.862	2156798.395	N19°29'35.02062"	E83°09'00.23961"
Z26J	725602.793	2156832.952	N19°29'36.16776"	E83°08'58.26374"
Z27	725545.559	2156869.433	N19°29'37.37709"	E83°08'56.31727"
Z27A	725521.232	2156909.859	N19°29'38.70129"	E83°08'55.50061"
Z28	725323.077	2157223.890	N19°29'48.99137"	E83°08'48.84204"
Z29	725205.185	2157327.988	N19°29'52.42363"	E83°08'44.84496"
Z29A	725096.049	2157463.993	19° 29' 56.8896576"	83° 8' 41.1616824"
Z30	725015.715	2157578.275	N19°30'00.63770"	E83°08'38.45648"
Z31	724893.152	2157718.624	N19°30'05.25038"	E83°08'34.31463"
Z31A	724807.982	2157808.466	N19°30'08.20582"	E83°08'31.43310"
Z32	724532.911	2158068.098	N19°30'16.75833"	E83°08'22.11346"
Z32A	724561.589	2158145.254	N19°30'19.25514"	E83°08'23.12969"
Z32B	724600.736	2158244.940	N19°30'22.48014"	E83°08'24.51449"
Z33	724716.305	2158468.559	N19°30'29.70333"	E83°08'28.57255"
Z33A	724603.099	2158607.518	N19°30'34.26698"	E83°08'24.75066"
Z33B	724572.658	2158711.384	N19°30'37.65613"	E83°08'23.75140"
Z33C	724564.085	2158748.148	N19°30'38.85484"	E83°08'23.47320"
Z34	724560.177	2158840.731	N19°30'41.86638"	E83°08'23.37882"
Z34A	724446.754	2158916.157	N19°30'44.36457"	E83°08'19.52218"
Z34B	724278.253	2159008.516	N19°30'47.43559"	E83°08'13.78433"
Z35	724181.391	2159048.035	N19°30'48.75963"	E83°08'10.48010"
Z35A	724108.778	2159035.163	N19°30'48.37055"	E83°08'07.99494"
Z35B	723956.048	2158968.636	N19°30'46.26951"	E83°08'02.71991"
Z36	723872.362	2158920.334	N19°30'44.73301"	E83°07'59.82995"
Z36A	723727.858	2158799.450	N19°30'40.86139"	E83°07'54.82383"
Z37	723585.858	2158682.479	N19°30'37.11588"	E83°07'49.90531"
Z37A	723502.169	2158594.135	N19°30'34.27751"	E83°07'46.99829"
Z37B	723465.328	2158548.006	N19°30'32.79266"	E83°07'45.71552"
Z37C	723387.348	2158430.684	N19°30'29.00985"	E83°07'42.99196"
Z37D	723337.637	2158352.730	N19°30'26.49551"	E83°07'41.25438"
Z37E	723258.496	2158203.262	19° 30' 21.6680436"	83° 7' 38.4773952"
Z38	723134.101	2157938.892	N19°30'13.12317"	E83°07'34.10010"
Z39	723117.433	2157767.212	N19°30'07.54834"	E83°07'33.45570"

**LARSEN & TOUBRO LIMITED**  
**Sijmali Bauxite Deposit**  
**Modified Mining Plan**



2.0 - Location and Accessibility (cont'd)

Point Id	UTM-CO-ORDINATES		GEO-GRAPHIC CO-ORDINATES	
	Easting	Northing	Latitude	Longitude
Z40	723001.980	2157542.538	N19°30'00.29035"	E83°07'29.40201"
Z40A	722923.977	2157450.781	N19°29'57.33863"	E83°07'26.68877"
Z41	722814.357	2157270.403	N19°29'51.51837"	E83°07'22.85400"
Z41A	722607.976	2157364.464	N19°29'54.65942"	E83°07'15.81833"
Z42	722393.734	2157432.409	N19°29'56.95448"	E83°07'08.50197"
Z43	722260.322	2157548.296	N19°30'00.77570"	E83°07'03.97706"
Z43A	722208.802	2157577.642	N19°30'01.75047"	E83°07'02.22316"
Z43B	722033.908	2157673.484	N19°30'04.93660"	E83°06'56.26750"
Z44	721905.856	2157752.905	N19°30'07.57001"	E83°06'51.91079"
Z45	721724.159	2157940.302	N19°30'13.78539"	E83°06'45.76044"
Z45A	721596.834	2158028.297	N19°30'16.64721"	E83°06'41.43218"
Z46	721527.452	2158074.109	N19°30'18.16442"	E83°06'39.07272"
Z46A	721468.786	2158130.601	N19°30'20.02451"	E83°06'37.08514"
Z46B	721392.247	2158204.994	N19°30'22.47379"	E83°06'34.49230"
Z47	721306.759	2158282.615	N19°30'25.03156"	E83°06'31.59398"
Z47A	721242.742	2158368.810	N19°30'27.85950"	E83°06'29.43542"

**TABLE 2-2 - DGPS CO-ORDINATES OF THE MINING LEASE BOUNDARY PILLARS FOR RAYAGADA DISTRICT**

Point Id	UTM-CO-ORDINATES		GEO-GRAPHIC CO-ORDINATES	
	Easting	Northing	Latitude	Longitude
A	721208.398	2158452.853	E83°06'28.29329"	N19°30'30.60559"
B	721288.159	2158535.479	E83°06'31.06286"	N19°30'33.26004"
B1	721207.296	2158609.499	83° 6' 28.3215204"	19° 30' 35.69886"
C	721204.975	2158849.256	83° 6' 28.3430052"	19° 30' 43.494696"
C1	720962.107	2158667.861	E83°06'19.93934"	N19°30'37.69424"
D	720862.175	2158593.787	E83°06'16.48178"	N19°30'35.32586"
E	720666.314	2158448.671	E83°06'09.70531"	N19°30'30.68599"
F	720520.615	2158340.724	E83°06'04.66443"	N19°30'27.23450"
F1	720675.366	2158234.596	E83°06'09.92569"	N19°30'23.72240"
G	720837.597	2158124.805	E83°06'15.44181"	N19°30'20.08823"
G1	720994.929	2157976.266	E83°06'20.77354"	N19°30'15.19619"
H	721127.709	2157850.154	E83°06'25.27289"	N19°30'11.04302"
I	721192.145	2157535.628	E83°06'27.34963"	N19°30'00.79151"

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



**2.0 - Location and Accessibility (cont'd)**

Point id	UTM-CO-ORDINATES		GEO-GRAPHIC CO-ORDINATES	
	Easting	Northing	Latitude	Longitude
I1	721335.714	2157301.601	E83°06'32.17324"	N19°29'53.12552"
I2	721480.400	2157066.932	E83°06'37.03473"	N19°29'45.43817"
I3	721625.878	2156831.074	83° 6' 41.9227848"	19° 29' 37.7118528"
J	721807.532	2156547.749	E83°06'48.03088"	N19°29'28.42778"
K	722018.411	2156801.736	E83°06'55.36770"	N19°29'36.60088"
L	722197.516	2156569.564	E83°07'01.40982"	N19°29'28.98077"
M	722441.532	2156724.346	E83°07'09.84089"	N19°29'33.91508"
M1	722656.257	2156697.540	E83°07'17.19094"	N19°29'32.95732"
M2	722870.929	2156675.043	E83°07'24.54093"	N19°29'32.13959"
N	723112.462	2156648.220	E83°07'32.80995"	N19°29'31.17033"
NI	723181.062	2156847.285	E83°07'35.24630"	N19°29'37.61460"
O	723243.479	2157034.515	E83°07'37.46572"	N19°29'43.67655"
P	723523.731	2157100.056	83° 7' 47.1015876"	19° 29' 45.6943632"
Q	723588.637	2157374.031	83° 7' 49.4433804"	19° 29' 54.575448"
R	723773.367	2157427.079	83° 7' 55.799256"	19° 29' 56.2254864"
S	723895.064	2157115.658	83° 7' 59.8387764"	19° 29' 46.0516488"
S1	724203.988	2157123.147	83° 8' 10.4329104"	19° 29' 46.1701824"
T	724489.196	2157130.636	83° 8' 20.2139916"	19° 29' 46.2981516"
U	724625.872	2157035.151	83° 8' 24.858834"	19° 29' 43.1384064"
U1	724713.868	2156837.939	83° 8' 27.791268"	19° 29' 36.6911448"
V	724804.361	2156639.479	83° 8' 30.8086908"	19° 29' 30.2022816"
W	724670.806	2156447.884	83° 8' 26.14821"	19° 29' 24.0274788"
W1	724396.207	2156427.289	83° 8' 16.7256276"	19° 29' 23.46918"
X	724123.481	2156409.814	83° 8' 7.3685652"	19° 29' 23.0114364"
Y	723852.002	2156519.030	83° 7' 58.1082636"	19° 29' 26.6719056"
Y1	723611.728	2156475.343	83° 7' 49.8525312"	19° 29' 25.3486248"
Y2	723370.830	2156432.281	83° 7' 41.5756992"	19° 29' 24.0457776"
Z	723123.067	2156384.227	83° 7' 33.0614256"	19° 29' 22.5832632"
Z1	723307.173	2156153.314	83° 7' 39.27486"	19° 29' 15.0018108"
Z2	723312.790	2156026.000	83° 7' 39.4133232"	19° 29' 10.8603888"
Z3	722801.661	2155969.208	83° 7' 21.8670024"	19° 29' 9.2196996"
Z4	722737.380	2155756.393	83° 7' 19.5731796"	19° 29' 2.3266248"
Z5	722948.946	2155662.156	83° 7' 26.7859164"	19° 28' 59.1777732"
Z6	722961.428	2155446.221	83° 7' 27.1222284"	19° 28' 52.1523984"
Z6A	723194.213	2155467.440	83° 7' 35.1111972"	19° 28' 52.7485944"
Z7	723433.239	2155489.908	83° 7' 43.3146432"	19° 28' 53.3827524"
Z8	723535.589	2155350.112	83° 7' 46.7638248"	19° 28' 48.7965396"

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



2.0 - Location and Accessibility (cont'd)

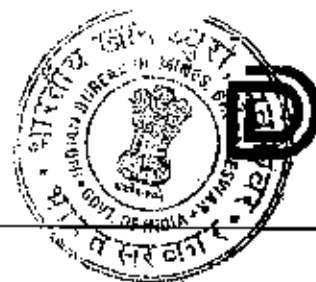
Point id	UTM-CO-ORDINATES		GEO-GRAPHIC CO-ORDINATES	
	Easting	Northing	Latitude	Longitude
Z8A	723752.772	2155471.185	83° 7' 54.2603892"	19° 28' 52.6451844"
Z9	723926.269	2155574.784	83° 8' 0.2520204"	19° 28' 55.9432596"
Z9A	723980.564	2155374.451	83° 8' 2.0279616"	19° 28' 49.4082624"
Z10	724028.619	2155160.389	83° 8' 3.5840832"	19° 28' 42.4294068"
Z10A	724213.349	2155267.732	83° 8' 9.9623292"	19° 28' 45.8446008"
Z11	724371.868	2155358.225	83° 8' 15.434916"	19° 28' 48.7225092"
Z12	724542.244	2155219.677	83° 8' 21.2162352"	19° 28' 44.149188"
Z13	724700.138	2155344.495	83° 8' 26.682126"	19° 28' 48.14319"
Z14	724505.423	2155652.171	83° 8' 20.1386796"	19° 28' 58.2249648"
Z14A	724785.014	2155774.492	83° 8' 29.775498"	19° 29' 2.0884668"
Z14B	725068.351	2155896.813	83° 8' 39.5407932"	19° 29' 5.9502912"
Z14C	725341.701	2156014.766	83° 8' 48.9620256"	19° 29' 9.6739908"
Z14D	725625.038	2156133.967	83° 8' 58.726212"	19° 29' 13.4340576"
Z15	725846.589	2156228.828	83° 9' 6.361992"	19° 29' 16.42785"
Z16	725947.691	2156152.690	83° 9' 9.7951716"	19° 29' 13.9113024"
Z17	726194.206	2156142.080	83° 9' 18.2413872"	19° 29' 13.465824"
Z18	726264.077	2155927.968	83° 9' 20.544444"	19° 29' 6.4763556"
Z18A	726170.789	2155712.328	83° 9' 17.2537056"	19° 28' 59.5037964"
Z19	726073.757	2155488.035	83° 9' 13.8310092"	19° 28' 52.25142"
Z19A	726387.262	2155410.943	83° 9' 24.5446776"	19° 28' 49.617174"
Z19B	726460.956	2155437.223	83° 9' 27.0821808"	19° 28' 50.4414372"
Z19C	726508.461	2155436.973	83° 9' 28.7105148"	19° 28' 50.4139008"
Z20	726629.659	2155395.895	83° 9' 32.8474404"	19° 28' 49.0289196"
Z20A	726663.823	2155412.977	83° 9' 34.025904"	19° 28' 49.5702912"
Z22	726741.615	2155454.844	83° 9' 36.710658"	19° 28' 50.8996236"
Z22	726741.624	2155454.838	E83°09'36.71095"	N19°28'50.89942"
Z22A	726699.279	2155497.619	83° 9' 35.2778112"	19° 28' 52.3075548"
Z23	726645.754	2155543.194	E83°09'33.46264"	N19°28'53.81112"
Z23A	726608.908	2155627.598	E83°09'32.23595"	N19°28'56.57022"
Z23B	726575.300	2155725.962	E83°09'31.12628"	N19°28'59.78187"
Z24	726545.969	2155854.355	E83°09'30.17613"	N19°29'03.96798"
Z24A	726439.018	2156033.564	E83°09'26.58703"	N19°29'09.83791"
Z25	726402.549	2156088.991	E83°09'25.36072"	N19°29'11.65478"
Z26	726238.624	2156144.357	E83°09'19.76506"	N19°29'13.52172"
Z26A	726174.074	2156237.465	E83°09'17.59229"	N19°29'16.57508"
Z26B	726133.380	2156299.208	E83°09'16.22381"	N19°29'18.59901"
Z26C	726074.423	2156382.956	E83°09'14.23870"	N19°29'21.34579"

**LARSEN & TOUBRO LIMITED**  
**Sijimal Bauxite Deposit**  
**Modified Mining Plan**



2.0 - Location and Accessibility (cont'd)

Point id	UTM-CO-ORDINATES		GEO-GRAPHIC CO-ORDINATES	
	Easting	Northing	Latitude	Longitude
Z26D	726011.226	2156465.269	E83°09'12.10764"	N19°29'24.04761"
Z26E	725935.052	2156555.412	E83°09'09.53500"	N19°29'27.00930"
Z26F	725840.962	2156656.952	E83°09'06.35309"	N19°29'30.34880"
Z26G	725786.679	2156701.273	E83°09'04.51120"	N19°29'31.81186"
Z26H	725724.876	2156750.580	E83°09'02.41364"	N19°29'33.44003"
Z26I	725660.862	2156798.395	E83°09'00.23961"	N19°29'35.02062"
Z26J	725602.793	2156832.952	E83°08'58.26374"	N19°29'36.16776"
Z27	725545.559	2156869.433	E83°08'56.31727"	N19°29'37.37709"
Z27A	725521.232	2156909.859	E83°08'55.50061"	N19°29'38.70129"
Z28	725323.077	2157223.890	E83°08'48.84204"	N19°29'48.99137"
Z29	725205.185	2157327.988	E83°08'44.84496"	N19°29'52.42363"
Z29A	725096.049	2157463.993	83° 8' 41.1616824"	19° 29' 56.8896576"
Z2A	723075.636	2156004.781	83° 7' 31.274346"	19° 29' 10.2660288"
Z30	725015.715	2157578.275	E83°08'38.45648"	N19°30'00.63770"
Z31	724893.152	2157718.624	E83°08'34.31463"	N19°30'05.25038"
Z31A	724807.982	2157808.466	E83°08'31.43310"	N19°30'08.20582"
Z32	724532.911	2158068.098	E83°08'22.11346"	N19°30'16.75833"
Z32A	724561.589	2158145.254	E83°08'23.12969"	N19°30'19.25514"
Z32B	724600.736	2158244.940	E83°08'24.51449"	N19°30'22.48014"
Z33	724716.305	2158468.559	E83°08'28.57255"	N19°30'29.70333"
Z33A	724603.099	2158607.518	E83°08'24.75066"	N19°30'34.26698"
Z33B	724572.658	2158711.384	E83°08'23.75140"	N19°30'37.65613"
Z33C	724564.085	2158748.148	E83°08'23.47320"	N19°30'38.85484"
Z34	724560.177	2158840.731	E83°08'23.37882"	N19°30'41.86638"
Z34A	724446.754	2158916.157	E83°08'19.52218"	N19°30'44.36457"
Z34B	724278.253	2159008.516	E83°08'13.78433"	N19°30'47.43559"
Z35	724181.391	2159048.035	E83°08'10.48010"	N19°30'48.75963"
Z35A	724108.778	2159035.163	E83°08'07.98494"	N19°30'48.37055"
Z35B	723956.048	2158968.636	E83°08'02.71991"	N19°30'46.26951"
Z36	723872.362	2158920.334	E83°07'59.82995"	N19°30'44.73301"
Z36A	723727.858	2158799.450	E83°07'54.82383"	N19°30'40.86139"
Z37	723585.858	2158682.479	E83°07'49.90531"	N19°30'37.11588"
Z37A	723502.169	2158594.135	E83°07'46.99829"	N19°30'34.27751"
Z37B	723465.328	2158548.006	E83°07'45.71552"	N19°30'32.79266"
Z37C	723387.348	2158430.684	E83°07'42.99196"	N19°30'29.00985"
Z37D	723337.637	2158352.730	E83°07'41.25438"	N19°30'26.49551"
Z37E	723258.496	2158203.262	83° 7' 38.4773952"	19° 30' 21.6680436"



2.0 - Location and Accessibility (cont'd)

Point id	UTM-CO-ORDINATES		GEO-GRAPHIC CO-ORDINATES	
	Easting	Northing	Latitude	Longitude
Z38	723134.101	2157938.892	E83°07'34.10010"	N19°30'13.12317"
Z39	723117.433	2157767.212	E83°07'33.45570"	N19°30'07.54834"
Z40	723001.980	2157542.538	E83°07'29.40201"	N19°30'00.29035"
Z40A	722923.977	2157450.781	E83°07'26.68877"	N19°29'57.33863"
Z41	722814.357	2157270.403	E83°07'22.85400"	N19°29'51.51837"
Z41A	722607.976	2157364.464	E83°07'15.91833"	N19°29'54.65942"
Z42	722393.734	2157432.409	E83°07'08.50197"	N19°29'56.95448"
Z43	722260.322	2157548.296	E83°07'03.97706"	N19°30'00.77570"
Z43A	722208.802	2157577.642	E83°07'02.22316"	N19°30'01.75047"
Z43B	722033.908	2157673.484	E83°06'56.26750"	N19°30'04.93660"
Z44	721905.856	2157752.905	E83°06'51.91079"	N19°30'07.57001"
Z45	721724.159	2157940.302	E83°06'45.76044"	N19°30'13.73539"
Z45A	721596.834	2158028.297	E83°06'41.43218"	N19°30'16.64721"
Z46	721527.452	2158074.109	E83°06'39.07272"	N19°30'18.16442"
Z46A	721468.786	2158130.601	E83°06'37.08514"	N19°30'20.02451"
Z46B	721392.247	2158204.994	E83°06'34.49230"	N19°30'22.47379"
Z47	721306.759	2158282.615	E83°06'31.59398"	N19°30'25.03156"
Z47A	721242.742	2158368.810	E83°06'29.43542"	N19°30'27.85950"
Z45A	721596.834	2158028.297	N19°30'16.64721"	E83°06'41.43218"
Z46	721527.452	2158074.109	N19°30'18.16442"	E83°06'39.07272"
Z46A	721468.786	2158130.601	N19°30'20.02451"	E83°06'37.08514"
Z46B	721392.247	2158204.994	N19°30'22.47379"	E83°06'34.49230"
Z47	721306.759	2158282.615	N19°30'25.03156"	E83°06'31.59398"
Z47A	721242.742	2158368.810	N19°30'27.85950"	E83°06'29.43542"

Subsequently, the land schedule has been verified with the revenue authorities and the abstract of the details of land schedule and land use as approved by the revenue authorities is given in Table 2-3 on the next page.

The details of land schedule for Rayagada and Kalahandi have been furnished in Appendix 2-3.



2.0 - Location and Accessibility (cont'd)

**TABLE 2-3 - ABSTRACT OF LAND SCHEDULE AND LAND USE (AREA IN HECTARE)**

District	Village	PRF	DLC	Res. Forest	Subs. Forest	Private	Govt.	Total
Kalahandi	Ambajhola						12.02	12.02
	Chulbari						141.02	141.02
	Mahajal						74.46	74.46
	Nakerandi						14.40	14.40
	Salabali						2.79	2.79
	Tadadei						38.98	38.98
	Tala Ambapadar						8.84	8.84
	Taramundi						210.14	210.14
	Tijamali		66.06	7.49	1.49	28.53	76.40	179.98
	Uper Ambapadar						51.19	51.19
Rayagada	Aliguna		20.66				10.38	31.04
	Bunde!		26.47				0.40	26.87
	Dumerpadar		0.63				7.73	8.36
	Kalibhata		5.26					5.26
	Kutamal		86.33				65.07	151.41
	Malipadara		402.72	19.02		100.57	50.04	572.35
	Pelanakona		10.52					10.52
	Sagabari		1.48				19.28	20.76
<b>Total</b>		<b>0.00</b>	<b>620.13</b>	<b>26.51</b>	<b>1.49</b>	<b>129.10</b>	<b>783.17</b>	<b>1560.40</b>

It may be seen from Table 2-3 above that there is 648.13 Ha forest land (predominantly DLC forest with no canopy cover) and the bulk of area is Government land. The share of forest land is about 41 per cent, where reserve forest and proposed reserve forest is nil.

**INFRASTRUCTURE**

Presently, there are no infrastructural facilities available at the plateau top. However, the infrastructures like road, water, electric power, transport, communication systems and ore transportation systems will be designed and provided before the start of the mining operation. The details of the schemes for development of infrastructural facilities have been discussed in subsequent chapters.



**D**

**3.0 - DETAILS OF APPROVED MINING PLAN**

3.1	Date and reference of earlier approved Mining Plan	Letter No. 314(3)/95-MCCM(C)/MP-16 dated 12th June 1997 issued by Indian Bureau of Mines (IBM).  The above letter is enclosed as Appendix 3-1.
3.2	Details of last modifications if any (for the previous approved period) of approved Mining Plan, indicating date of approval, reason for modification	Not applicable as no modification has been done.
3.3	Give review of earlier approved proposal (if any) in respect of exploration, excavation, reclamation etc.	Not applicable as the mining operation has not started
3.4	Give status of compliance of violations pointed out by IBM.	Not Applicable
3.5	Indicate and give details of any suspension/closure/prohibitory order issued by any Government agency under any rule or Court of law	Not Applicable
3.6	In case the Mining Plan is submitted under rules 9 and 10 of the MCDR'88 or under rule 17(3) of the MCR'2016 for approval of modification, specify reason and justification for modification under these rules.	<p>- Changes in the bauxite production capacities for the Kutrumali (3 MTPY) and Sijimali (6 MTPY) bauxite deposits considering installation of a 3 MTPY alumina refinery so as to achieve economy of scale.</p> <p>- Changed threshold values/cut-off grades for estimation of bauxite resources as stipulated by IBM vide notification dated 16th October 2009 and circular dated 14th July 2010.</p>



3.0 - Details of Approved Mining Plan (cont'd)

		<ul style="list-style-type: none"><li>- Advancement in the technology for scientific and environment friendly mining.</li><li>- Change in area of the leasehold from earlier approved mining plan. Earlier, the mining plan was approved for 1551.013 Ha as per the then land schedule which was available in 1995. However, as per the present record of the revenue authorities and certified by the relevant authorities, the land schedule area is 1560.40 Ha. Moreover, DGPS survey was conducted recently and the area as per the measurement is 1549.086 Ha.</li></ul>
--	--	---

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



# **PART - A**

*d*



## A-1.0 - GEOLOGY AND EXPLORATION

This chapter presents general information on the bauxite deposit of Sijimali and deals with geology, reserves, grades and availability of bauxite from the Sijimali bauxite deposit.

### TOPOGRAPHY AND DRAINAGE

The area forms a part of the Eastern Ghat Hill ranges which have a general NE-SW trend. The central and south-eastern part of the ML area shows series of hills ranging in elevation between 1,130 m and 1,230 m whereas western and northern part of the ML area show relatively flat topography.

The main drainage pattern in this area is controlled by a number of streams, which drains their water into Nagavalli river that flows from north to south. The Barha nadi, a tributary of Nagavalli river, flows along east-west direction on the northern side of the Sijimali plateau. The natural drainage net comprises numerous rills and gullies which drains the collective discharge to a perennial stream, Naragul Nala, flowing along the south-eastern part of Sijimali plateau base which drains into Barha Nadi.

### CLIMATE AND RAINFALL

The area experiences pleasant weather between November and January, when the temperature drops down to 10°C. The temperature rises steadily from January, reaching 35 to 40 °C in the month of May. The annual rainfall in the area is around 1,200 mm distributed between June and September.



**A-1.0 - Geology and Exploration (cont'd)**

The mean humidity is 40% minimum in January and 90% maximum in August-September. The wind velocity varies between 40 km per hour and 80 km per hour, even higher velocities have been reported from time to time.

**GEOLOGY**

**Regional Geology**

The Sijimali bauxite deposits represents a part of the East Coast Bauxite Belt, hosting a number of 'high level' lateritic bauxite deposits at elevations between 900 m and 1,450 m above mean sea level (MSL). The physiography/geomorphology of these bauxite deposits are represented as flat topped and bald hills with thick capping/blanket of laterite-bauxite directly overlying the khondalite (quartz-garnet-feldspar-sillimanite gneisses with or without graphite and its variants) and charnockite (hypersthene-diopside granulites) group of rocks of Eastern Ghat hill ranges. The khondalite-charnockite rock in this area is considered to be the part of the oldest Pre-Cambrian Crust of India.

**Local Geology/Geology of the Deposit**

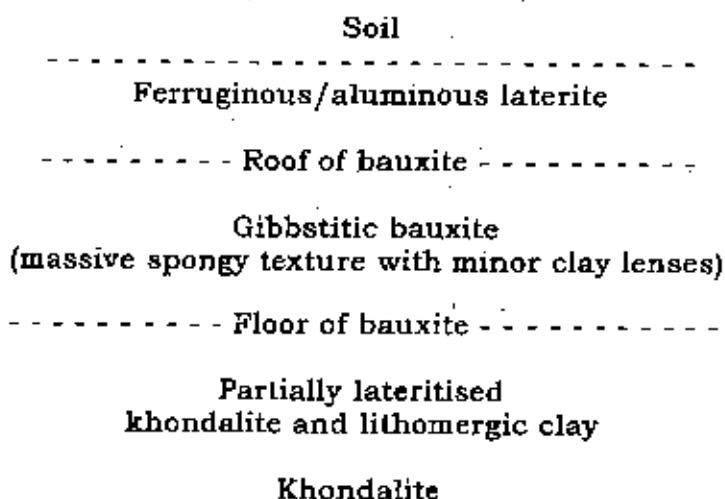
The khondalite suit of rocks often being intruded by charnockite, forms the host rock of bauxite blanket. In the central part of the plateau, the high mound of khondalite is exposed. Lenses and patches of khondalite are exposed in the lateritic residuum. The general trend of the foliation in khondalite is NE-SW with steep dip up to 70° towards south east. The attitudes of strike and dip are variable in places. The duricrust occurs as blanket of bauxite and laterite. Thin and impersistent bands of lithomarge and weathered khondalite are seen within the bauxite blanket. Gibbsite is the major mineral of bauxite, the other minerals being goethite, lepidocrocite, ilmenite and rutile. Peripheries of the bauxite deposits are characterised by cliffs with vertical scarps of 4 m to 30 m height.

A handwritten signature or set of initials, possibly 'd', located at the bottom right of the page.



**A-1.0 - Geology and Exploration (cont'd)**

The general succession of Sijimali bauxite profile reveals the following sequence:



The surface plan and the geological plan of Sijimali mining lease area are represented in Drawings 11420-97C-000-PRM-0026 and 11420-97C-000-PRM-0003 respectively.

**NAME AND ADDRESS OF THE PROSPECTING/EXPLORATION AGENCY**

- a) Geological Survey of India (GSI), Kolkata, India.
- b) Larsen & Toubro Limited through Mineral Exploration Corporation Limited (MECL), Nagpur, Maharashtra.
- c) Larsen & Toubro Limited with internal resources

**DETAILS OF EXPLORATION ALREADY CARRIED OUT**

In late 70s, during the Crash Programme taken up by the Government of India, under East Coast bauxite project, Sijimali bauxite deposit has been identified as potential bauxite source, based on high level flat plateau, satellite imagery and subsequent field reconnaissance. As per the preliminary assessment of GSI, Sijimali had about 244 MT of resources.



A-1.0 - Geology and Exploration (cont'd)

**DETAILS OF EXPLORATION CARRIED OUT BY L&T**

In terms of the PL granted to it over an area of 2776.649 Ha (Refer Appendix-1), L&T carried out detailed explorations on Sijimali bauxite deposit by engaging MECL as well as by deploying its internal resources by drilling at 400 m x 400 m grid intervals in first phase (a total of 91 boreholes) and at 200 m x 200 m grid intervals in second phase (a total of 163 boreholes) during the year 1992 to 1995. The prospecting report is enclosed as Enclosure-2. Based on the outcome of exploration on non-mineralised areas were carved out while applying for mining lease. The revised mining lease area stands at 1560.400 Ha (1549.086 Ha as per DGPS measurement). The details of the exploration carried out over the mining lease area for which this Mining Plan is being prepared are summarised in Table A.1-1 on the next page.

**GEOLOGICAL EXPLORATION PROPOSED TO BE CARRIED OUT**

Since the entire deposit was explored through drilling of 400 m x 400 m grid pattern followed by 200 m x 200 m grid pattern, it will be necessary to continue further investigations comprising drilling at closer intervals. The location plan for additional boreholes to be drilled is presented in Drawing 11420-97C-000-PRM-0004. The exploration programme for the first five years is presented in Table A.1-2 in Page A.1-6.

**METHOD OF ESTIMATION OF RESERVES / RESOURCES**

The raw exploration data as furnished by L&T were reviewed and properly formatted to make the data suitable for processing into GEO-MINING software. The exploration database was created for Sijimali deposit by making the assay and collar file. The assay file contains chemical analyses of different radicals ( $\text{SiO}_2$  %,  $\text{Al}_2\text{O}_3$  %,  $\text{Fe}_2\text{O}_3$  %,  $\text{TiO}_2$  %) along with LOI % of samples dominantly taken at 1 m interval. The assay file is presented in Appendix A.1-1. The collar file



**A-1.0 - Geology and Exploration (cont'd)**

contains the local X and Y coordinates along with RL (Z collar) and depth of each borehole and is presented in Appendix A.1-2. The assay and collar data for the boreholes were imported into the software in pre-processing stage and were subjected to processing through krigging method for grade interpolation.

**TABLE A.1-1 - SUMMARY OF THE DETAILED INVESTIGATIONS CARRIED OUT BY L&T IN SIJIMALI DEPOSIT**

<b>Sl. No.</b>	<b>Description</b>	<b>Investigations carried out</b>
1.	Topographical survey	1:2000 scale, contouring at 2 m interval (All the drawings in this mining plan are however made on 10m contour interval for the sake of brevity)
2.	Geological mapping	1:2000 scale and 1:10000 scale
3.	Drilling	91 boreholes, totaling to 2316 m were drilled at 400 x 400 m intervals during the year 1992 to 1993  Additional 136 boreholes, totaling to 3975 m were drilled to make 200 m x 200 m grid intervals during the year 1994 to 1995  Boreholes were carried out with vacuum suction drilling machine
4.	Sampling	Metre-wise samples (6382 numbers) were collected
5.	<b>Analytical data:</b>	
	Metre-wise assay	6382 metre-wise samples were analysed for LOI. Out of these, 5772 were analysed for SiO <sub>2</sub> & Al <sub>2</sub> O <sub>3</sub> and 3114 were analysed additionally for Fe <sub>2</sub> O <sub>3</sub> and TiO <sub>2</sub> . These analyses were carried out at various accredited laboratories, including at MECL.
	Check samples	165 check samples were prepared and analysed
6.	Expenditure incurred in different phases of prospecting operation	Rs. 80 Crores



A-1.0 - Geology and Exploration (cont'd)

**TABLE A.1-2 - EXPLORATION PROGRAMME FOR THE FIRST FIVE YEARS**

Year	Numbers of boreholes	Nature of exploration	Remarks
Year 1	104	Total drilling meterage of 2600 m at 200 m grid intervals	To ensure that the entire plateau is covered by 200m grid.
Year 2	268	Total drilling meterage of 6700 m at 100 m grid intervals	Entire Block-I
Year 3	368	Total drilling meterage of 9200 m at 50 m grid intervals	Specified areas in Block-I covered under first five (5) years of commercial exploitation
Year 4	143	Total drilling meterage of 3575 m at 100 m grid intervals	Part of Block-II
Year 5	139	Total drilling meterage of 3475 m at 50 m grid intervals	Specified areas in Block-I covered beyond first five (5) years of commercial exploitation

**Considerations and Assumptions for Reserves / Resources Estimation**

The following parameters have been considered in evaluating the reserves/resources and grades of bauxite at Sijimali:

- a) Irregular occurrence of non-bauxite zone (Saprolite and pallid zone characterised by partially lateritised khondalite (PLK) and aluminous clay) within the bauxite zone.
- b) Undulating roof and floor of bauxite duricrust.
- c) Cut-off consideration for bauxite:

Alumina ( $Al_2O_3$ ) (+)30% and Reactive silica (-)5% as per IBM Circular No. 3/2010. L&T carried out studies to determine correlation between reactive silica and total silica for Sijimali through Jawaharlal Nehru Aluminium Research Development and Design Centre (JNARDDC) (Refer Appendix A.1-3). Based on the above studies, it is revealed that reactive silica is about 0.82 times of the total silica. So the total silica ( $SiO_2$ ) considered for resource estimation is  $5/0.82 = 6.09\%$  say 6%.



**A-1.0 - Geology and Exploration (cont'd)**

- d) Tonnage factor for bauxite and overburden/mineral reject have been considered as 2 tonnes/cu m as per the studies carried out by the BEML for determination of seismic wave velocity in Sijimali deposit and the same is enclosed as Appendix A.1-4.

**Resource Assessment by Geostatistical Method**

The following steps have been adopted to estimate the resources and grades of Sijimali deposits:

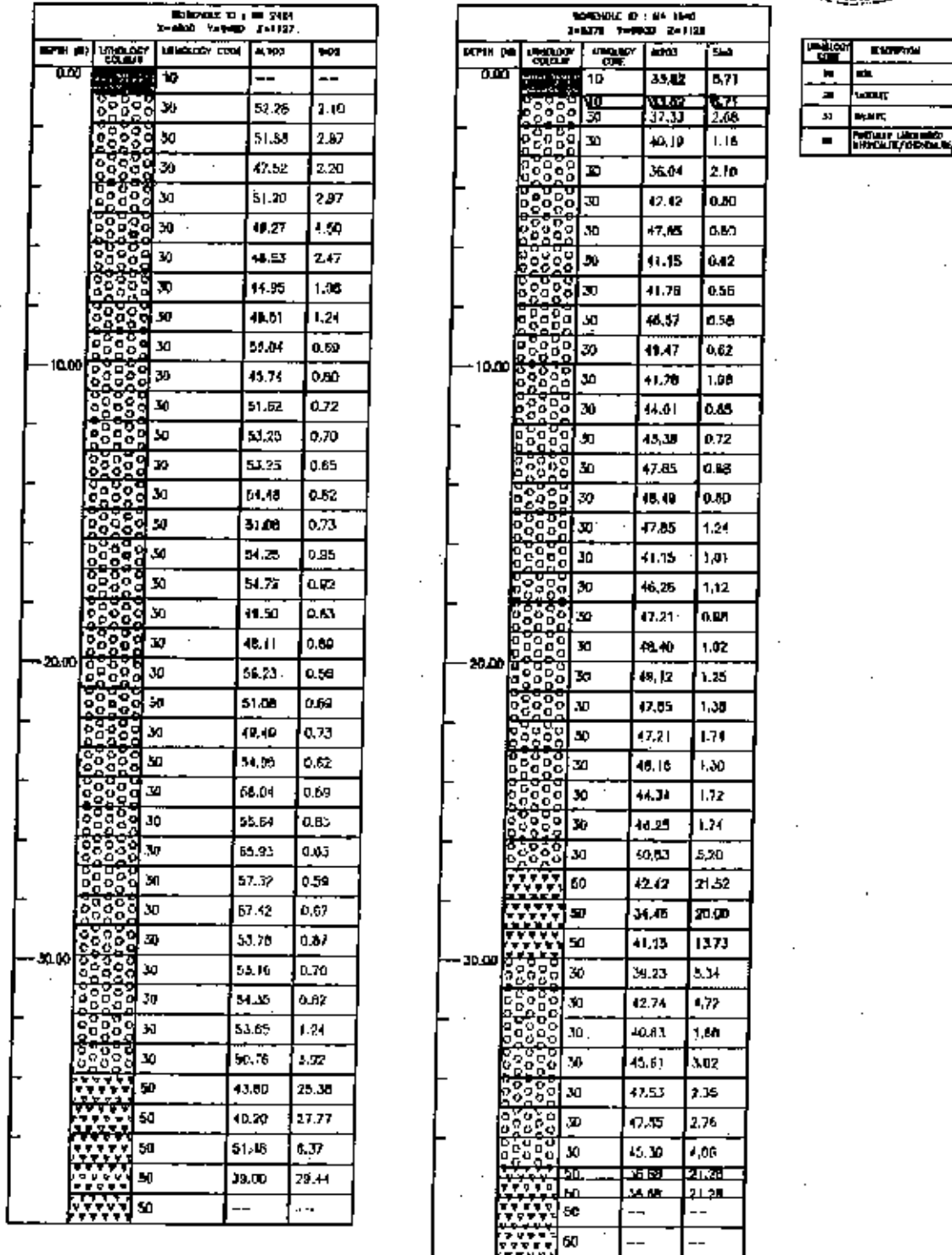
- a) Metre-wise chemical assay of each borehole was fed to computer along with RL and coordinates of each borehole. Typical borehole section is given in Fig. A.1-1 on the next page.
- b) Topographical model has been created from the collar data of each borehole as well as contours at 10 m interval through the application of digital terrain model (DTM).
- c) Geological sections have been prepared by taking into account the dispositions of overburden/mineral reject, bauxite and PLK/khondalite in the sub-surface. As the boreholes were drilled largely at 200 m grid intervals geological sections have also been prepared at 200 m interval and shown in Drawings 11420-97C-000-PRM-0007 to 11420-97C-000-PRM-0010.
- d) From the above sections, solid models have been created for overburden/mineral reject and bauxite zones.
- e) Experimental semi-variograms  $[Y(h)]$  were built up based on  $Al_2O_3\%$  and  $SiO_2\%$ . Based on experimental semi-variogram, the model parameters, namely nugget variance (Co), continuities (C) and range of influence (a/R) for each of the variable model has been identified.
- f) Using the above model variables of semi-variogram, block krigging at 200 m for individual variables, namely  $SiO_2\%$  and  $Al_2O_3\%$  were carried out.
- g) Finally individual krigged block model at 200 m for individual variables were appended to build up the final krigged model at 200 m grid for Sijimali.

The semi-variograms parameters and other parameters considered for estimation of resources are indicated in Table A.1-3 in Page A.1-9.

**LARSEN & TOUBRO LIMITED**  
**Sijimal Bauxite Deposit**  
**Modified Mining Plan**



**A-1.0 - Geology and Exploration (cont'd)**



**FIG. A.1-1 - TYPICAL BOREHOLE SECTIONS**



A-1.0 - Geology and Exploration (cont'd)

**TABLE A.1-3 - SEMI-VARIOGRAMS PARAMETERS AND OTHER PARAMETERS CONSIDERED FOR ESTIMATION OF RESOURCES**

Parameters	Description
Minimum and Maximum composing sample length	Minimum - 0.05 m Maximum - 1.0 m
Nugget (C0)	Al <sub>2</sub> O <sub>3</sub> - 19.570 SiO <sub>2</sub> - 1.388
Variance (C1)	Al <sub>2</sub> O <sub>3</sub> - 3.122 SiO <sub>2</sub> - 0.370
Sill (C0+C1)	Al <sub>2</sub> O <sub>3</sub> - 22.692 SiO <sub>2</sub> - 1.758
Major Axis of Ellipsoid (X)	Al <sub>2</sub> O <sub>3</sub> - 343.044 m SiO <sub>2</sub> - 421.356 m
Semi-Major Axis of Ellipsoid (Y)	Al <sub>2</sub> O <sub>3</sub> - 218.499 m SiO <sub>2</sub> - 421.356 m
Minor Axis of Ellipsoid (Y)	Al <sub>2</sub> O <sub>3</sub> - 9.51 m SiO <sub>2</sub> - 421.356 m
Maximum search distance in Horizontal plane	Al <sub>2</sub> O <sub>3</sub> . X- 343.044 m and Y- 218.499 m SiO <sub>2</sub> . X- 421.356 m and Y- 421.356 m
Maximum search distance in Vertical plane	Al <sub>2</sub> O <sub>3</sub> . Z- 9.51 m SiO <sub>2</sub> . Z- 421.356 m
Block Size	Standard Size - 25 m x 25 m x 5 m (X,Y,Z)  Sub-Block Size - 6.25 m x 6.25 m x 1.25 m (X,Y,Z)
Minimum and Maximum No. of samples considered for Block Estimation	Minimum - 03 Nos. Maximum - 15 Nos.

**GEOLOGICAL RESOURCES AND MINEABLE RESERVES**

On the basis of stipulated cut-off grade, the total geological resources of Sijimali deposit work out to be 383.95 MT having 46.03% Al<sub>2</sub>O<sub>3</sub> and 2.06% SiO<sub>2</sub>. The mining zones have been demarcated



**A-1.0 - Geology and Exploration (cont'd)**

considering overburden/mineral reject to ore ratio less than or equal to 2. Based on this as well as for convenience of mining operation, the deposit has been divided into four (4) promising blocks, namely Block-I, Block-II, Block-III and Block-IV as shown in Drawing 11420-97C-000-PRM-0004.

In order to estimate the mineable reserves, development sections were drawn through the promising blocks. The typical development sections along A-A' and B-B' are shown in Drawing 11420-97C-000-PRM-0005 and 11420-97C-000-PRM-0006 respectively and additional development sections are shown in Drawing 11420-97C-000-PRM-0030. The losses considered for estimation of mineable reserves from geological resources are as follows:

- a) Dilution of 1 m of bauxite, 0.5 m at the roof with lateritic overburden/mineral reject and 0.5 m at bottom with PLK zone. This has been considered taking into account the size of the excavation machineries proposed to be deployed for mining in Sijimali block.
- b) Losses of bauxite statutorily at 7.5 m wide peripheral vicinity of plateau as well as along the lease boundary.
- c) Blocked bauxite under and outside the ultimate pit slope.

The block-wise geological and mineable reserves have been shown in Table A.1-4 below:

**TABLE A.1-4 - BLOCK-WISE GEOLOGICAL AND MINEABLE RESERVES AS ON 01.08.2016**

Block	Geological Reserves			Mineable Reserves		
	Quantity, MT	Grade		Quantity, MT	Grade	
		Al <sub>2</sub> O <sub>3</sub> , %	SiO <sub>2</sub> , %		Al <sub>2</sub> O <sub>3</sub> , %	SiO <sub>2</sub> , %
Block I	125.27	45.75	1.94	76.97	45.77	1.83
Block II	122.36	46.16	2.12	68.57	46.45	2.22
Block III	99.28	46.91	1.96	58.77	46.73	1.91
Block IV	37.04	44.18	2.51	16.08	43.87	2.55
<b>Total</b>	<b>383.95</b>	<b>46.03</b>	<b>2.06</b>	<b>220.39</b>	<b>46.10</b>	<b>2.03</b>

*Handwritten signature/initials*

A-1.0 - Geology and Exploration (cont'd)

**CLASSIFICATION OF RESERVES AND RESOURCES AS PER UNFC  
(UNITED NATIONS FRAMEWORK CLASSIFICATION)**



As discussed, the entire lease area was explored by drilling through 400 m x 400 m grid pattern followed by additional drilling to make 200 m x 200 m grid pattern. Metre-wise samples collected from the drill holes have been analysed. On the basis of the drilled boreholes, samples analyses, exploration status has been categorised in to detailed exploration (G1) and general exploration (G2) under geological axis. The section-wise details of the geological resources estimated based on the above exploration work with in-situ density of 2 ton per cu. metre at (+)30% Al<sub>2</sub>O<sub>3</sub> and (-)6% SiO<sub>2</sub> (total) is indicated in Table A.1-5 on the next page. The geological sections drawn for estimation of resources are shown in Drawings 11420-97C-000-PRM-0007 to 11420-97C-000-PRM-0010.

The details of the exploration carried out in the lease area as per UNFC norms, as defined in Minerals (Evidence of Mineral Contents) Rules, 2015, is indicated in Table A.1-6 in Page A.1-13 and the area showing G1 and G2 level of exploration is indicated in Drawing 11420-97C-000-PRM-0003.

The mineable part of the geological resources is kept under the proved and probable category, while remaining resources is kept under feasibility and pre-feasibility resource category as per the details shown in Table A.1-7 in Page A.1-13:

The laterite occurring as a blanket over the bauxite deposit and falling within the mining zones amounts to about 92 MT with average Al<sub>2</sub>O<sub>3</sub> and SiO<sub>2</sub> of 39.73% and 11.73% respectively. With the available technology at present, this laterite is not techno-economically viable for producing alumina and therefore kept under resource category. The laterite will be stored inside mined out areas as described in Chapter A-4.0.



A-1.0 - Geology and Exploration (cont'd)

**TABLE A.1-5 - SECTION-WISE GEOLOGICAL RESOURCES AS PER  
LEVEL OF EXPLORATION AS ON 01.08.2016**

Section No.	Sectional area, sq m	Volume, million cu m	Million tonnes (tonnage factor at 2 tonnes/cu m) <sup>(1)</sup>	Al <sub>2</sub> O <sub>3</sub> , %	SiO <sub>2</sub> , %
<b>Category-G1: Detailed Exploration : 200 m x 200 m grid pattern</b>					
Section W6-E6	32746	4.00	8.00	44.97	2.02
Section W7-E7	36228	7.57	15.13	46.61	1.81
Section W8-E8	60019	9.69	19.39	45.56	1.88
Section W9-E9	49743	9.20	18.40	46.88	1.84
Section W10-E10	47592	9.54	19.09	47.54	1.73
Section W11-E11	51113	8.76	17.53	46.75	1.82
Section W12-E12	58093	9.95	19.90	45.63	1.86
Section W13-E13	53831	9.45	18.89	46.62	1.71
Section W14-E14	46835	9.27	18.55	46.42	2.15
Section W15-E15	60414	11.04	22.09	46.22	2.13
Section W16-E16	64518	10.88	21.77	47.00	1.81
Section W17-E17	28019	5.78	11.47	46.55	1.88
Section W18-E18	17577	2.69	5.38	44.72	2.03
Section W19-E19	12931	2.29	4.58	43.24	2.02
Section W20-E20	6197	1.29	2.58	44.31	2.30
Section W21-E21	6559	0.64	1.28	42.02	2.14
<b>Sub-Total</b>	<b>632415</b>	<b>112.00</b>	<b>224.00</b>	<b>46.30</b>	<b>1.90</b>
<b>Category-G2: General Exploration : 400 m x 400 m grid pattern</b>					
Section W1-E1	1859	1.25	2.50	43.38	2.68
Section W2-E2	45788	15.81	31.62	45.00	2.01
Section W3-E3	56949	19.30	38.59	46.52	2.30
Section W4-E4	34639	10.57	21.14	46.62	2.02
Section W5-E5	37538	6.67	13.33	46.45	2.25
Section W6-E6	1107	4.52	9.04	46.32	1.90
Section W7-E7	10294	2.30	4.60	47.48	2.09
Section W8-E8	15067	2.43	4.87	43.76	2.61
Section W9-E9	66	0.03	0.05	40.75	3.52
Section W10-E10	7395	1.42	2.84	43.84	2.11
Section W11-E11	6891	1.27	2.55	42.39	2.87
Section W12-E12	4398	0.98	1.96	40.76	3.49
Section W13-E13	6737	1.01	2.01	43.73	2.67
Section W14-E14	1551	0.27	0.54	43.94	4.22
Section W21-E21	2735	1.09	2.19	43.38	2.02
Section W22-E22	9019	2.09	4.18	44.77	2.31
Section W23-E23	16030	2.70	5.40	45.26	2.97
Section W24-E24	4725	1.84	3.69	44.51	3.16
Section W25-E25	9589	2.99	5.98	45.29	2.73
Section W26-E26	13159	1.43	2.86	45.51	3.20
<b>Sub-Total</b>	<b>295436</b>	<b>79.98</b>	<b>159.96</b>	<b>45.64</b>	<b>2.29</b>
<b>Total Resources</b>	<b>927851</b>	<b>191.98</b>	<b>383.95</b>	<b>46.03</b>	<b>2.06</b>

**Note:**

(1) As per the BEML study report for Sijimali deposit (Refer Appendix A.1-4).

**LARSEN & TOUBRO LIMITED**  
**Sijmalla Bauxite Deposit**  
**Modified Mining Plan**



A-1.0 - Geology and Exploration (cont'd)

**TABLE A.1-6 - DETAILS OF EXPLORATION CARRIED OUT IN THE LEASE AREA AS PER UNFC NORMS**

Item of information	Lease area explored as per UNFC norms (In Ha) as on date						Remarks/ Comments including reasons for not carrying out the exploration as per UNFC norms
	Total lease area = A+B+C+D+E+F						
	G1 Level	G2 Level	G3 Level	Explored and found non-mineralised with level of exploration (remarks)		Un-explored lease area	
				G1 Level	G2 Level		
A	B	C	D	E	F		
Area as per level of exploration	726.573	706.504	-	74.065	42.214	-	-
No. of boreholes drilled	151	51	-	19	6	-	-
No. of boreholes considered for resource estimation	151	51	-	-	-	-	-
Meterage drilled	4491.85	1362.40	-	342.85	73.65	-	-
Grid interval	200 m x 200 m	400 m x 400 m	-	200 m x 200 m	400 m x 400 m	-	-
Scale of mapping	1:2000		-	1:2000		-	-

**TABLE A.1-7 - RESERVES/RESOURCES AS PER UNFC**

Reserve/ Resource	Type	UNFC Code	Quantity of bauxite, MT	Grade (Al <sub>2</sub> O <sub>3</sub> /SiO <sub>2</sub> ), %
Reserve	Proved	111	137.47	
	Probable	121	---	
		122	82.92	
<b>Total (a)</b>			<b>220.39</b>	<b>46.10 / 2.03</b>
Remaining Resources	Feasibility	211	86.53	
	Pre-Feasibility	222	77.03	
	Measured	331	---	
	Indicated	332	---	
	Inferred	333	---	
	Reconnaissance	334	---	
<b>Total (b)</b>			<b>163.56</b>	<b>45.94 / 2.13</b>
<b>TOTAL (a+b)</b>			<b>383.95</b>	<b>46.03 / 2.06</b>

*d*



A-1.0 - Geology and Exploration (cont'd)

**JUSTIFICATION IN SUPPORT OF UNFC CODIFICATION**

The total reserves of the deposit estimated by the help of GEO-MINING software through krigging method have been coded as 111 and 122 based on the present status of geological, economical and feasibility axis. The reason for dual coding system is considered as the entire deposit was explored through drilling at a grid pattern of 400 m x 400 m and 200 m x 200 m grid pattern. The justifications of the UNFC coding are given below in Table A.1-8 and supporting Feasibility Report is presented in Enclosure-1.

**TABLE A.1-8 - JUSTIFICATION OF UNFC CODING**

<b>Economic Axis (E1)</b>	<b>Feasibility Axis (F1 &amp; F2)</b>	<b>Geological Axis (G1 &amp; G2)</b>	<b>UNFC Code</b>
<p><b>1. Detailed exploration :</b>                      Exploration was carried out at 200 m x 200 m and 400 m x 400 m grid pattern for reserve estimation and long term planning.</p>	<p><b>1. Geology :</b>                      Detailed geological map has been prepared and the area was explored through drilling with 200 m x 200 m grid interval. The reserve of the deposit has been estimated by geo-mining software. Ground water and surface water studies have been carried out.</p>	<p><b>1. Geological Survey:</b>                      Detailed topographical cum-geological map have been prepared indicating surface geological features, bauxite deposits and boreholes location, etc. Please refer Drawing 11420-97C-000-PRM-0003.</p>	111 and 122
<p><b>2. Mining Report:</b>                      Mining Plan was prepared and approved by IBM in April 1997. However the mining operation not yet started.</p>	<p><b>2. Mining :</b>                      Opencast fully mechanised mining of two shifts operation will be adopted. Mining Plan was prepared and approved by IBM in April 1997. However the mining operation not yet started.</p>	<p><b>2 &amp; 3. Geological and Geophysical Survey :</b>                      The deposit has been explored through adequate drilling with 200 m x 200 m and 400 m x 400 m grid pattern. Hence geophysical and geochemical surveys are not required.</p>	
<p><b>3. End-use Grades of Reserves :</b>                      The mineable reserve estimated to about 220.39 MT with an average grade of 46.06% Al<sub>2</sub>O<sub>3</sub> and 2.06% SiO<sub>2</sub>.</p>	<p><b>3. Environment:</b>                      Baseline data collection has been completed and EIA/EMP under preparation.</p>	<p><b>4. Technological :</b>                      (i) Drilling have been carried out with 400 m x 400 m grid pattern followed by 200 m x 200 m grid pattern.</p>	

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



**D**

**A-1.0 - Geology and Exploration (cont'd)**

Economic Axis (E1)	Feasibility Axis (F1 & F2)	Geological Axis (G1 & G2)	MINE Code
		<p>(ii) Meter-wise drilled powdered samples were analysed for 5 radicals such as Al<sub>2</sub>O<sub>3</sub>%, SiO<sub>2</sub>%, Fe<sub>2</sub>O<sub>3</sub>%, TiO<sub>2</sub>% and LOI%.</p> <p>The assay data of the boreholes and sample details are shown in Appendix A.1-1.</p>	
<p><b>4. Land Use Pattern:</b>                      As per the land schedule approved by the revenue authorities, the forest land is 648.13 Ha, Govt. land is 783.17 Ha and private land is 129.10 Ha.</p>	<p><b>4. Processing:</b>                      The bauxite, mined from the deposit will be crushed to 150 mm size and transported to the proposed captive refinery through belt conveyor.</p>	<p><b>5. Petrographic Study :</b>                      Petrographical study and mineralogy of Khondalite and bauxite have been carried out.</p>	
	<p><b>5. Infrastructure and Services, Construction Activities:</b>                      It has been planned to install/construct road, admin building/offices, canteen, crusher house, workshops, service centre, water reservoirs, store etc</p>	<p><b>6. Geostatistical Analysis :</b>                      The resource and reserve of the deposit have been estimated through geostatistical method by the help of GEO-MINING Software. The block-wise geological and mineable reserve with grade of bauxite and overburden are shown in Table A.1-4.</p>	111 and 122
	<p><b>6. Costing:</b>                      (i) The capital cost of the project is Rs. 676 Crores (Net of CENVAT), (Refer Table 7-1 of the Feasibility Report enclosed).                      (ii) The operating cost of bauxite/tonne is Rs. 341.4 (Refer Table 7-2 of the Feasibility Report enclosed). Bauxite produced from the mine will be used in the proposed captive refinery plant of the Applicant.</p>		
	<p><b>7. Marketing :</b>                      Bauxite produced from the mine will be consumed as raw material in the proposed captive</p>		

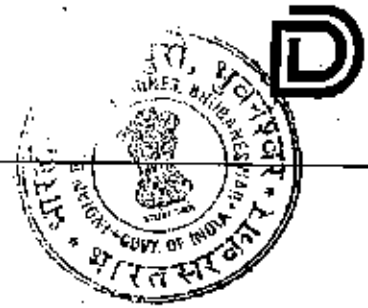
*d*

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



A-1.0 - Geology and Exploration (cont'd)

Economic Axis (E1)	Feasibility Axis (F1 & F2)	Geological Axis (G1 & G2)	UNFC Code
	alumina refinery plant of the Applicant to be located in Kusumasila village, Rayagada district, Odisha.		
	8. <b>Economic Viability:</b> The mine is economically viable. In this context, a Feasibility Report is enclosed.		



## **A-2.0 - MINING**

This chapter discusses the proposed development and production programme for first five years, scale of operation when the mine will operate in its full capacity, method and scheme of mining operation, mine layout and unit operations including ripping, drilling and blasting, excavation, loading, hauling, dumping and related activities.

### **DEVELOPMENT AND PRODUCTION PROGRAMME FOR FIRST FIVE YEARS**

Since the Sijimali deposit occupies a large area, the deposit has been divided into four promising blocks (Block-I, Block-II, Block-III and Block-IV) for convenience of operation. Among all the above four blocks, Block-I and Block-II are having major quantum of mineable reserves. In terms of stripping ratio, Block-I and Block-II are the most promising ones. However, Block-I is having the largest share of mineable reserves and is nearest to the take off point of the long distance conveyor. Hence, it is planned to start the mining activity in the Block-I and mining in this block shall continue for approximately fifteen (15) years. It is also planned to open up two active working faces in Block-I to facilitate production of required bauxite, providing adequate space for unhindered movement of heavy earthmoving machineries, maintaining a balanced lead distance for haulage of overburden/mineral reject and bauxite as well as for the purpose of blending, if required. After completion of mining in Block-I, Block-II will be developed. Block-III and Block-IV can be developed simultaneously to keep the year-wise stripping ratio on the lower side as well as for maintaining a uniform grade of r.o.m bauxite to the extent possible.



A-2.0 - Mining (cont'd)

**Access Road**

Before commencement of overburden/mineral reject stripping, construction work and subsequent mining activity, it will be advisable to develop a suitable access road to the Sijimali plateau top from Kutrumali which in turn, is connected to the proposed alumina plant site at Kusumasila, as the existing approach road to the deposit via Sunger is long and circuitous and is unsuitable for transportation of the required machineries. The access road from Kutrumali of 8 m width will be about 13 km long. The road gradient and curvature will be as per IRC norms.

The access road will be laid alongside the belt conveyor connecting Kutrumali and Sijimali as far as practicable. Besides transportation of machineries for development and construction, the road will also be used for regular transportation of employees from township to mine, maintenance of belt conveyor installation and also to maintain a regular surface linkage between the mines and alumina plant.

**Pre-Mining Development**

Before the commencement of actual mining operation in Block-I, it is proposed to remove the top soil/overburden/mineral reject to gain access to the bauxite benches in respective active working areas. The top soil will be stacked separately in earmarked areas for future use in the backfilled and reclaimed areas. The overburden/mineral reject strips are planned to be loosened by using rippers and drilling and blasting. The loosened material will be piled up by dozer and the same will be loaded into rear-dump trucks by front-end loaders and hydraulic excavators for transportation to overburden/mineral reject dump. Further, during the process of pre-mining development in a span of about one year, about 100,000 tonnes of bauxite would be raised which would be stacked in the area earmarked for r.o.m ore stockpile proposed

A handwritten signature or set of initials in black ink, located at the bottom right of the page.



**A-2.0 - Mining (cont'd)**

to be provided near crusher house. The bauxite thus stockpiled will be reclaimed and used for trial run of the crushing plant and the belt conveyor system as well as during subsequent regular operation.

Besides removal of overburden/mineral reject, the work pertaining to subsequent bench formation, laying of some of the roads and preparation of overburden/mineral reject/top soil/ore stockpile areas will be undertaken during this period spanning about twelve (12) months before commissioning of the mine.

Procurement of equipment required for pre-mining development will have to be initiated well in advance so that these equipment are available at site within a short period after the completion of access road. After the completion of pre-mining development and commissioning of the mine, the above equipment will be inducted in the fleet of equipment for regular mining operation.

**Calendar Plan**

The calendar plan for an open cast mine depicts the excavation of quantum of minerals and overburden rocks or rejects for each year of mining operation up to a specific period of mining. It ensures planned mine layout and determines the requirements of mining equipment, infrastructural and auxiliary facilities. Besides it gives an early prediction of landform changes, which helps in planning the most viable land management plan.

The development of bauxite mine at Sijimali will be in phases and concomitant to installation of alumina plant. Since the requirement of bauxite at the alumina plant in the second year of mining operation at Sijimali will be about 2.0 MT, the initial one year before the commissioning of the alumina plant will be utilised for the development and pre-mining activities. In third year of mining operation at Sijimali, the requirement of bauxite at the alumina plant will be around 4.5 MT.

A handwritten signature or set of initials, possibly 'Dr', written in dark ink at the bottom right of the page.

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



**A-2.0 - Mining (cont'd)**

During fourth year of mining operation, Sijimali will reach its peak production capacity of 6 MTPY. However, the requirement of bauxite in the alumina plant during fourth year of mining operation in Sijimali is around 7.5 MT which will be met by additional 1.5 MT bauxite supply from Kutrumali bauxite deposit.

The year-wise excavation plan for the first five years of mining activity in Sijimali is presented below in Table A.2-1 and details level-wise of excavation plan have been given in Table A.2-2 on the next page.

**TABLE A.2-1 - IN-SITU TENTATIVE EXCAVATION FOR FIRST FIVE YEARS AT SIJIMALI**

Year	Total tentative excavation, cu m	Top soil, cu m	OB/SB/IB, cu m	ROM, cu m		Mineral reject	ROM/Overburden ratio
				Ore	Mineral reject		
<b>A . PIT-A</b>							
I	534,758	266,151	-	50,000	-	218,607	0.10
II	860,823	105,908	16,504	710,286	-	28,125	4.72
III	1,677,920	104,102	4,395	1,535,684	-	33,740	10.80
IV	2,064,005	91,748	138,184	1,735,782	-	98,291	5.29
V	2,453,717	75,635	449,609	1,675,885	-	252,588	2.15
<b>Total A</b>	<b>7,591,223</b>	<b>643,544</b>	<b>608,691</b>	<b>5,707,637</b>	<b>-</b>	<b>631,351</b>	<b>3.03</b>
<b>B . PIT-B</b>							
I	-	-	-	-	-	-	-
II	404,603	75,178	3,906	255,645	-	69,873	1.72
III	927,684	70,376	99,268	712,929	-	45,112	3.32
IV	1,573,682	116,803	23,096	1,265,745	-	168,039	4.11
V	1,521,547	40,116	4,395	1,328,285	-	148,752	6.87
<b>Total B</b>	<b>4,427,516</b>	<b>302,473</b>	<b>130,664</b>	<b>3,562,603</b>	<b>-</b>	<b>431,776</b>	<b>4.12</b>
<b>Total A+B</b>	<b>12,018,739</b>	<b>946,016</b>	<b>739,355</b>	<b>9,270,240</b>	<b>-</b>	<b>1,063,126</b>	<b>3.37</b>

**LARSEN & TOUBRO LIMITED**  
Sijmali Bauxite Deposit  
Modified Mining Plan

**D**

A-2.0 - Mining (cont'd)



**TABLE A.2-2 - LEVEL-WISE REMOVAL OF TOPSOIL, ORE AND OVERBURDEN/MINERAL REJECT**

Year	Pit	Level	Top Soil	OB/SB/IB	Ore	Mineral Reject
		(m)	(cu. m)	(cu. m)	(cu. m)	(cu. m)
I	A	1134.0 - 1138.0	2144	0	0	3906
		1130.0 - 1134.0	77686	0	4822	63129
		1126.0 - 1130.0	117684	0	34682	112949
		1122.0 - 1126.0	67146	0	10285	38623
		1118.0 - 1122.0	1429	0	11	0
	1114.0 - 1118.0	62	0	0	0	
	B	-	-	0	0	0
<b>Total (Year - I)</b>			<b>266151</b>	<b>0</b>	<b>50000</b>	<b>218607</b>
II	A	1126.0 - 1134.0	39	0	11643	508
		1118.0 - 1126.0	97451	14336	635683	25391
		1110.0 - 1118.0	8418	2168	63060	2227
	B	1166.0 - 1174.0	19173	527	52520	24521
		1158.0 - 1166.0	28420	2598	101063	40049
		1150.0 - 1158.0	27585	781	102062	5303
<b>Total (Year - II)</b>			<b>181086</b>	<b>20410</b>	<b>966931</b>	<b>97998</b>
III	A	1126.0 - 1134.0	352	0	18028	391
		1118.0 - 1126.0	22119	3594	729217	10576
		1110.0 - 1118.0	81631	801	788440	22773
	B	1150.0 - 1158.0	17339	25342	155615	21240
		1142.0 - 1150.0	50280	73926	441653	22993
		1134.0 - 1142.0	2663	0	110936	791
		1126.0 - 1134.0	93	0	4724	88
<b>Total (Year - III)</b>			<b>174477</b>	<b>103662</b>	<b>2248613</b>	<b>78852</b>
IV	A	1110.0 - 1118.0	391	126953	1118141	51660
		1102.0 - 1110.0	91357	11230	617641	46631
	B	1142.0 - 1150.0	4476	7832	34347	2772
		1134.0 - 1142.0	66073	14746	616100	67158
		1126.0 - 1134.0	46255	518	615297	98109
<b>Total (Year - IV)</b>			<b>208551</b>	<b>161279</b>	<b>3001827</b>	<b>266330</b>
V	A	1102.0 - 1110.0	5059	429063	984158	167432
		1094.0 - 1102.0	69629	19385	666738	82305
		1086.0 - 1094.0	947	1162	24989	2852
	B	1126.0 - 1134.0	8063	1104	353285	5026
		1118.0 - 1126.0	30962	2334	900682	133704
		1110.0 - 1118.0	1091	957	74317	48625
<b>Total (Year - V)</b>			<b>115751</b>	<b>454004</b>	<b>3004170</b>	<b>401339</b>

APPROVED



**A-2.0 - Mining (cont'd)**

The year-wise mine development plan as per the above excavation programme indicating the pit boundaries for the first five years has been presented in Drawings 11420-97C-000-PRM-0011 to 11420-97C-000-PRM-0015 and the composite mine development plan is shown in Drawings 11420-97C-000-PRM-0029. Progress of mining activity during this period has also been reflected in development section Drawings 11420-97C-000-PRM-0005 and 11420-97C-000-PRM-0006 and additional development section Drawing 11420-97C-000-PRM-0030.

The development section for first five years of operation has been given in Drawing 11420-97C-000-PRM-0030.

**PROPOSED RATE OF PRODUCTION WHEN THE MINE IS FULLY DEVELOPED**

**Bauxite**

The scale of operation would depend upon the conversion factor, i.e. the quantity of bauxite required to produce 1 tonne of alumina. This conversion factor generally takes into account a number of considerations, namely the mineralogical composition and grade of bauxite, the process parameters established by appropriate testwork to optimise the alumina recovery and the economy of operation.

L&T has recently carried out studies in JNARDDC to find out the correlation between the available alumina and total alumina in bauxite for Sijimali deposit (Refer Appendix A.1.3). It has been found that the available alumina is 90% of the total alumina content of bauxite. Hence, the efficiency of recovery of alumina has been assumed at about 90% for the purpose of this report. Moreover, as the mineable reserves of Sijimali deposit is significantly more than double that of Kutrumali deposit, it is proposed to feed the refinery with required quantum of bauxite in 2:1 ratio from Sijimali and Kutrumali. Accordingly, the weighted average alumina content in bauxite feed to the alumina refinery is estimated at

**D**



A-2.0 - Mining (cont'd)

approximately 44.2%. Based on this assumption as well as considering average moisture content at 10 per cent, ranging from 7 to 13 per cent and mining and handling losses at 5 per cent, the annual requirement of bauxite for production of 1 MT of alumina works out to 2.94 MT.

However, the tests were carried out with only five (5) samples from the Sijimali deposit. Moreover, the test report indicates that, the above correlation between the available alumina and total alumina is valid for a fixed alumina varying from 37% to 47% and total silica varying from 0.8% to 4.79%. However, from the bore hole assay data, it is observed that there are instances where the alumina value is below the above valid range and silica value is above the valid range. Hence, the annual requirement of bauxite for production of 1 MT of alumina has been considered at 3 MT for the purpose of this report, which is also the industry norm.

Out of the total bauxite requirement of 9 MT, 6 MT will be supplied from Sijimali deposit and the rest 3 MT will be supplied from the Kutrumali deposit.

**Overburden/Mineral Reject**

Based on the mineable reserves of bauxite and associated overburden/mineral reject quantities, the average overburden/mineral reject to ore ratio in Block-I works out to about 0.42:1. Incidence of overburden/mineral reject in relation to bauxite will be higher than these average figures during the initial years of operation when comparatively larger quantity of overburden/mineral reject is required to be removed to expose the top bauxite benches. The overburden/mineral reject to ore ratio will, however, reduce progressively with the advancement of mining faces. Considering all four blocks, the average



**A-2.0 - Mining (cont'd)**

overburden/mineral reject to ore ratio has been estimated at 0.51:1 which will give rise to about 3 MT of overburden/mineral reject per year for production of 6 MT of bauxite.

**Working Duration**

The annual effective working hours have been computed on the basis of following assumptions:

- a) Eight months of dry season and four months of monsoon season.
- b) Two shifts of operations per day of eight hours duration each.
- c) 330 days of annual working comprising of 220 days in dry season and 110 days during monsoon season.
- d) Effective working hours at fourteen per day during dry season and ten per day during monsoon.

Based on the above assumption, the annual effective working duration has been estimated at 4,180 hours, comprising of 3080 hours during dry season and 1100 hours during monsoon season.

**Average Raising Rate**

In view of the foregoing, the average raising rate of r.o.m material would be as follows:

Bauxite .. 6000000 tonnes per annum

Overburden ... 3060000 tonnes per annum

Raising rate of bauxite =  $\frac{6000000}{4180} = 1435$  tonnes per hour

Raising rate of overburden =  $\frac{3060000}{4180} = 732$  tonnes per hour

Total excavation =  $1435 + 732 = 2167$  tonnes per hour



A-2.0 - Mining (cont'd)

Accordingly, monthly raising rate of bauxite would be approximately 552630 tonnes and 394740 tonnes during dry season and monsoon respectively.

**MINEABLE RESERVES AND ANTICIPATED LIFE OF THE MINE**

The total mineable reserves of bauxite in the promising blocks (Block-I, Block-II, Block-III and Block-IV) of Sijimali deposit have been estimated at approximately 220 MT as described in the previous chapter. The mineable reserves of Block-I which is selected for carrying out initial mining activities have been estimated at approximately 77 MT.

The annual raising rate of bauxite being about 6 MT, the above reserves will last for about thirty nine (39) years from the commencement of mining operation at Sijimali. The mineable reserves in Block-I alone may support the mining operation for approximately 15 years, including early years of limited production.

**PROPOSED METHOD OF MINING**

**Open Cast Working**

Taking into consideration factors, such as nature of occurrence, geological setting of the deposit, topography, scale of operation, ore to overburden/mineral reject ratio etc., it is proposed to adopt open cast mechanised mining by top slicing method in multiple benches. The details of the mining scheme are described below.

**Basic approach:** As indicated earlier, the Sijimali deposit has been divided into four promising blocks (Block-I, Block-II, Block-III, and Block-IV) for convenience of operation. Among all the above four blocks, Block-I is having largest share of mineable reserves. In terms of stripping ratio, Block-I and Block-II are the most promising ones. Hence, it is proposed to initially develop Block-I having largest mineable

A-2.0 - Mining (cont'd)

reserves of about 77 MT which would last for approximately 15 years at the end of which Block-II will be taken up for development and production. This will ensure availability of ore on a sustained basis over a prolonged period, and, at same time, enable resource concentration leading to better management and limit the disturbance to the existing landscape to a minimum. However, it has been planned that after a few years of working, when the load on equipment engaged for removal of overburden/mineral reject in Block-I is reduced, the same will be diverted in a phased manner to Block-II for developing the mining benches ahead of bauxite mining there and also to enable installation of crusher(s) in mineral free area.

Considering the factors, such as lead between the mine faces and the crusher house, heterogeneity of the ore body, degree of quality control required, daily output etc., it is proposed to carry out mining activities using two (2) pits in Block-I, namely Pit-A and Pit-B. Multiple bauxite benches will be developed in each of these areas. However, the two pits will merge in due course. The mine workings proposed for the initial five years will be confined within the gridlines 5000E to 7000E and 8000N to 11000N.

Based on the respective reserve base and the average grade, it is planned to excavate around 60 per cent of the annual bauxite requirement of bauxite from Pit-A and about 40 per cent from Pit-B. The suggested quantum of excavation from two pits is, however, provisional only, and may be adjusted suitably depending upon the quality requirements and day-to-day situation in the field.

The above scheme of mining would result in following advantages:

- a) Some of the shallow depth bauxite benches in Pit-B would be exhausted and the bottom of bauxite mineralisation would be reached within a relatively short period to make room for



A-2.0 - Mining (cont'd)

dumping of overburden/mineral reject concurrently as [unclear] out of mining. This would minimise/eliminate the requirement of external overburden/mineral reject dumps.

- b) Simultaneous excavation of bauxite at two different locations would enable effective pit blending and homogenisation required for quality control.
- c) Simultaneous working at two locations at varying distances from crusher house, rather than attacking the block from one extreme, would effectively keep the average lead from mine faces to the crusher house more or less uniform throughout the working life of the mine.

In order to ensure sustained availability of bauxite, the development work of overburden/mineral reject removal will continue during production stage, generally keeping a lead of about twelve months over the progress of bauxite mining. The overburden/mineral reject raised will be disposed off to the overburden/mineral reject dump in the initial stages and the r.o.m bauxite will be delivered either to crusher house directly or to r.o.m ore stockpile. The space for r.o.m stockpile has been provided near the primary crusher house.

**Layout of mining benches:** The layout/orientation of the mining benches depends mainly on:

- a) Method of working
- b) Topography of the area
- c) Degree of variations in grade within the deposit
- d) Degree of intercalations in the deposit
- e) Required output of r.o.m material per day
- f) Degree of pit blending required for quality control

It has been planned to leave a safety barrier of about 7.5 m width all around the periphery of the plateau as well as along the mining lease area to prevent boulders rolling down or surface run-off spilling into the hill slope. It is proposed to create a green belt on the safety barrier.

A handwritten signature or set of initials in dark ink, located at the bottom right of the page.



A-2.0 - Mining (cont'd)

**Bench height:** Determination of bench height for exploitation of mineral deposit depends largely on geological characteristics of the deposit, maximum reach of the excavation equipment and the scale of operation. It is regulated by the provisions of Mines Act, 1952 and the Metalliferous Mines Regulations, 1961.

At Sijimali, the bench height in an 8 m slice may vary from place to place depending upon topography, as well as varying thickness of overburden/mineral reject and ore. The benches are proposed to be planned generally to follow the contour and topography without much loss on dilution.

Accordingly, the overburden/mineral reject having varying thickness will be removed ahead of bauxite excavation. The bulk of the bauxite will be mined at 8 m bench height while benches of 4 m height will be developed in overburden/mineral reject. However, some of the benches, for both bauxite and overburden/mineral reject, will be less than 4 m in height and will be exploited by ripping. Moreover, the floor of bauxite will be uneven due to undulating nature of khondalite. Care would be taken to excavate bauxite from the floor with back-hoe excavators.

**Overall pit slope:** The economy of excavation for profitable operation is influenced to a large extent by the overall pit slope. Steeper slope angle enables larger recovery of usable ore and reduction in volume of overburden/mineral reject rock excavation. However, economic benefits gained by steepening the slope may be negated by a major slope failure, if the slopes are not designed properly. Proper pit slope in any mine is usually estimated based on the following:

- a) Type and nature of material to be excavated
- b) Geological disturbances causing instability to the vertical walls of the benches

A handwritten signature or set of initials, possibly 'd', located at the bottom right of the page.



A-2.0 - Mining (cont'd)

- c) Susceptibility to weathering
- d) Height of the benches

The bauxite/laterite is a highly heterogenous matrix, rich in sesquioxides which harden on exposure to air and thus becomes resistant to sliding. The uniaxial compressive strength and tensile strength of bauxite in Sijimali deposit are generally of the order of 40 to 50 Mega Pascals (MPa) and 6 to 8 MPa respectively, while the hardness varies between 2.5 to 3.5 in Moh's scale.

In the lateritic regions, water is mainly confined to lithomarge. In Sijimali, the typical lithomarge sequence is absent and the floor of bauxite directly overlies partially lateralized khondalite. While drilling boreholes in Sijimali, water body was not encountered. Hence, disturbance to water body and consequent destabilisation of pit wall during mining operation are not anticipated.

Khondalite is the predominant lithounit of the most stable oldest craton in Eastern Ghat of Pre-Cambrian age and is considered to be the host rock on which the bauxite residuum rests. The area is tectonically stable and not siesmogenic since it is located far away from shield margin contract. As per the seismic zoning map of India (as per BIS, 1893-2002), the area falls under Zone-II.

In light of the foregoing, apparently a steep overall pit slope is expected to be stable with 8 m bench height. However, to assess this aspect more precisely, certain additional information, such as angle of friction and coefficient of cohesiveness of the rock are required which are not presently available. It is, therefore, planned to maintain the overall pit slope at 45 degree, in line with the practice adopted in other bauxite

A handwritten signature or set of initials, possibly 'ch', written in dark ink.



A-2.0 - Mining (cont'd)

deposits in the area and as stipulated in the Metalliferrous Mines Regulations. This slope is considered to be well within the safe limit in view of the earlier discussions.

**Roads:** Roads for haulage and access to different installations in the mine will be constructed, the layout for which will be developed complying with the statutory regulations stipulated in the Metalliferrous Mines Regulations, 1961. The salient features of the roads are as follows:

- a) The main haul road and feeder roads shall generally be of 26 m width, the width of 100 ton rear-dump trucks envisaged for haulage of bauxite being about 6.89 m.
- b) For a part of the road where the above mentioned width is not possible to maintain, definite turnouts and waiting points shall be provided at suitable locations.
- c) Road gradient shall generally be maintained at 1 in 16, except in cases of ramps, where gradient, not steeper than 1 in 10, shall be provided.
- d) For stretches of roads laid above the level of the surrounding area, a strong berm/parapet wall/embankment of 1 m height or the height equal to diameter of the tyre of dumpers, whichever is higher shall be provided to prevent any out-of-control vehicle from getting off the road.
- e) If there exists an overhead structure or power line that could obstruct the passage of any vehicle, load carried on the vehicle, or any extended part of the same at its highest position, suitable minimum ground clearance shall be provided for the same. Also, one or more prominent road signs will be put up on both sides of the possible obstruction, indicating the clearance between overhead structure or power line and the ground.
- f) A separate road of 5 m width shall be provided along the main haul road for movement of light vehicles wherever practicable.



A-2.0 - Mining (cont'd)

The layout of roads including haul roads and feeder roads are shown in Drawing 11420-97C-000-PRM-0016. The alignment of haul roads and feeder roads are liable to be altered with the progress of mining work. The alignment of trunk haul road, however, has been planned in such a manner that it could serve for a reasonably long period during initial years.

**MINE GENERAL LAYOUT**

General layout of the mine showing the proposed mining areas, overburden/mineral reject and top soil dumps, primary crushing plant, service facility area, electrical sub-station, on-ground water reservoir, explosive magazine, haul roads, roads to crusher house and overburden/mineral reject disposal area etc. is given in Drawing 11420-97C-000-PRM-0016.

**EXTENT OF MECHANISATION**

The entire mining activity involving fragmentation/loosening of in-situ rock mass, excavation, loading and hauling, sizing and subsequent handling/transportation etc is envisaged to be carried out by employing equipment like rippers, drills, excavators and loaders, rear-dump trucks, crusher, feeders, belt conveyors etc.

The economics of mining operation depends largely on the proper selection of equipment. The major criteria for selection of equipment are scale of operation, working method, type of material, topography, capital requirements and availability of standard size of equipment in the market. Each of the unit operations associated with the mining work are described below with particular emphasis on selection of equipment and the selected equipment with brief specification are listed in Table A.2-3 on the next page.



A-2.0 - Mining (cont'd)

**TABLE A.2-3 - LIST OF MAJOR EQUIPMENT - MINING**

Sl. No.	Description	Quantity, Nos.
1.	Ripper Dozer 850 HP	3
2.	Drill 150 mm	4
3.	Excavator, 11.7 cu m	2
4.	Loader 10.1 cu m	2
5.	Rear Dump Trucks, 100 ton	13
6.	Crawler Dozer, 410 HP	4
7.	Wheel Dozer, 350 HP	1
8.	Grader, 175 HP	1

**UNIT OPERATIONS**

The sequence of unit operations in open cast mechanised mining consists of fragmentation/loosening of ore and overburden/mineral reject material from in-situ ore/overburden/mineral reject mass, excavation, loading and hauling, and some other miscellaneous work.

The primary activity in mining operation, i.e. fragmentation/loosening of in-situ rock mass, is conventionally carried out by drilling and blasting. However, as an alternative, ripping technique which obviates some of the disadvantages of drilling and blasting has gained importance in bauxite mining in this country, particularly in environmentally sensitive areas. Hence, it is envisaged that forty (40%) per cent of both required bauxite and overburden/mineral reject would be excavated with the help of ripper dozer and for remaining sixty per cent (60%) of bauxite and overburden/mineral reject, drilling and blasting would be adopted. However, possibility of introduction of surface miner at a later stage has also been discussed in this chapter. It may be noted that, for calculation, in-situ and bulk density of bauxite

*Handwritten signature or initials.*



**A-2.0 - Mining (cont'd)**

and overburden/mineral reject have been considered at 2 tonnes/cu m and 1.5 tonnes/cu m respectively keeping in view the industrial standards for the same.

**RIPPING AND DOZING**

Ripping is a process in which a ripper, a plough type attachment fitted to a crawler tractor, is used to loosen the rock. The loosened rock is then piled up by dozing for loading and transportation. Before deciding on the use on ripping technique, it is necessary to determine the rippability of rocks.

**Rippability of Rocks**

Rippability of rocks mainly depends upon the nature and degree of consolidation of the rocks. Presence of faults, fractures and planes of weakness, coarser grain size, high degree of stratification, foliation, gneissosity etc favour ripping. Rippability of rocks also depends upon their compressive strength, shear strength, moisture content etc.

To determine the above characteristics and establish rippability of the rocks, the following tests are usually carried out:

- a) Laboratory scale tests to determine physic-mechanical parameters of the rocks.
- b) Seismic refraction test.
- c) Field trial with suitable ripper dozer.

The test data are required to establish rippability of rock, to select equipment including size and number of equipment, to estimate capital and operating costs etc.



A-2.0 - Mining (cont'd)

**Seismic Refraction Test at Sijimali**

BEML carried out pilot test for determination of seismic wave velocity in Sijimali deposit during April 1993 (Refer Appendix A.1-4). The results of this test are summarised below:

Number of test locations	..	11
Number of impact station in each location	..	32
Total number of impact stations	..	352

**Distribution of impact stations:**

<u>Seismic velocity, m/sec</u>		<u>Per cent distribution</u>
500 to 2500	..	90.34
2500 to 3000	..	7.38
3000 to 4500	..	2.28
<b>Total</b>	..	<b>100.00</b>

**Observations on Testwork**

Some of the observations on the testwork are given below:

- The deposit is generally amenable to ripping as seismic wave velocity was observed to be below 2500 m/sec in over 90 per cent of the impact stations.
- Low velocities observed in certain locations may be due to presence of clay intercalations and porous rocks
- In a small percentage of locations, velocities are high presumably due to presence of highly consolidated boulders. In such localised spots, blasting with light charge may have to be carried out to optimise the ripping operation in this area.

Though the testwork generally indicates a condition favourable for ripping, it is not advisable to plan to carry out the entire work by ripping, at this stage, in view of the following:

- The mining zones are required to be covered more extensively by testwork at the engineering stage.

*ch*



A-2.0 - Mining (cont'd)

- b) Confirmatory field trials should be conducted with one of the equipment before taking a final decision on the extent of work for which the technology is to be adopted.

In view of the above, it is planned at this stage, to deploy adjustable parallelogram type single shank ripper driven by 850 HP diesel engine with facilities for adjustment of ripping angle and penetration depth of ripper shank for a part of the work on the basis of techno-economic considerations keeping in view the experience gained in other similar deposits.

**Deployment of Ripper - Techno-Economic Consideration**

Some of the techno-economic factors considered for deciding upon the extent of work to be covered by ripping are discussed below:

- a) Deployment of ripper obviates to a large extent some of the disadvantages associated with drilling and blasting, such as ground vibration, fly rock, noise, safety hazard etc., as well as controls the over size of boulders and achieves better fragmentation. Therefore, if the rock characteristic and other parameters are permitting, it is desirable to deploy rippers for as much of the loosening work as possible.
- b) For low depth working, ripping provides for better effective machine utilisation as, in such cases, frequent shifting of drilling machine eats away considerable period from available machine hours.
- c) For low depth working, the height of the pile formed after blasting is low which is inconvenient to be handled by loader equipment.
- d) Blasting efficiency is usually observed to be reduced in low height benches
- e) Drilling followed by blasting in high benches has an edge in respect of economy of operation over ripping in view of higher utilisation of drilling machine, particularly in soft deposits. At Sijimali, a drilling rate of 18 to 20 m per hour is likely to be achieved.



A-2.0 - Mining (cont'd)

In view of the foregoing, it is planned that ripper will be deployed for overburden/mineral reject removal, stripping thin layer of overburden/mineral reject material as well as for bauxite production, where bench height is comparatively lower. Drilling and blasting techniques will majorly be adopted in benches ranging between 4 m and 8 m height.

On the basis of above as well as the topography of the area, depth of overburden/mineral reject and bauxite layers, scheme and scale of mining operation etc, it has been planned to use ripper for about forty (40) per cent of the total quantum of work, and drilling and blasting for the balance work.

**Number of Ripper Required for Ripping**

The total quantity of overburden/mineral reject and bauxite to be loosened by ripping has been estimated at about 3.62 MTPY. For this purpose, it has been envisaged to employ ripper driven by 850 HP diesel engine fitted with single shank ripper attachment. Ripping and dozing capacity of this equipment has been estimated assuming the following:

a) Speed of ripping	..	2.50 kmph
b) Speed of dozing	..	3.0 kmph
c) Depth of ripping	..	810 mm
d) Spacing between passes	..	800 mm
e) Operator efficiency	..	80 %
f) Material factor	..	85 %

Based on above assumptions, the capacity of the machine works out to about 480 tonnes per hour. The number of rippers required to meet the annual target has been worked out as follows:

a) Annual quantity to be ripped and dozed	..	3.62 x 10 <sup>6</sup> tonnes
b) Annual operating hours	..	4180 (approx.)



A-2.0 - Mining (cont'd)

c) Machine capacity	..	480 tonnes per hour
d) Number of rippers required for the work	..	$\frac{3.62 \times 10^6}{4180 \times 480} = 1.80$
e) Availability factor	..	0.75
f) Visibility factor	..	0.85
g) Fleet strength of ripper	..	$\frac{1.80}{(0.75 \times 0.85)} = 2.83$ Say, 3

### DRILLING

The drilling is followed by blasting and the actual quantum of drilling work will depend upon blasting parameters such as production requirement, burden, spacing, yield per hole etc. Some of the relevant aspects of drilling as well as selection of drilling equipment are discussed below.

#### Sub-Grade Drilling

Often it is necessary to provide a certain amount of sub-grade drilling to avoid toe formation. For vertical holes, sub-grade drilling is carried out to a depth approximately equal to one-third of the burden or about 8 to 10 per cent of the height of the bench.

#### Inclined Hole Drilling

Inclined hole drilling is progressively gaining importance and is being adopted in many opencast mines in the world, because of several advantages of inclined holes over vertical holes as enumerated below:

- Better fragmentation and improved efficiency of blasting due to better utilisation of blasting energy.
- Reduction in the requirement of secondary blasting.



A-2.0 - Mining (cont'd)

- c) Reduction of the possibility of toe formation and back-break.
- d) Increased burden and spacing leading to reduction in meterage per ton of rock and consumption of explosives.
- e) Reduction in ground vibration.
- f) Greater throw of muck pile
- g) Reduced sub-grade drilling etc.

In view of the above, it has been planned to procure drills with facilities for inclined drilling at the time of implementation of the project. However, during actual mining operation, blasting of a few trial rounds of holes inclined at 20 degrees or so should be carried out and the results in respect of fragmentation, explosive consumption and yield, cost and other parameters shall be compared to the results of blasting of vertical holes. Based on this, the decision on the choice of type of blast holes may be finalised.

**Selection of Drilling Equipment**

It is proposed to carry out exploitation of the deposit employing drilling and blasting technique for a total yield of 5.44 MTPY of overburden/mineral reject and bauxite, where the bench heights are 4 m and 8 m respectively. Considering the efficiency of blasting and standardisation of equipment, it is envisaged to provide 150 mm dia blast hole for both bauxite and overburden/mineral reject benches.

**Number of Drilling Machine Required**

The requirements of 150 mm crawler-mounted drills to meet the respective production target have been worked out, the details of which are presented in Table A.2-4 on the next page.

A handwritten signature or set of initials, possibly 'd', written in dark ink.



A-2.0 - Mining (cont'd)

TABLE A.2-4 - DETAILS OF DRILLING

	150 mm dia drill	150 mm dia drill
	Bauxite	Overburden/ Mineral reject
Hole depth, m	8.8	4.4
Yield/hole(1), tonnes	320	126
Annual production target, tonnes	$3.6 \times 10^6$	$1.84 \times 10^6$
No. of holes required/year	$3.6 \times 10^6$ 320 = 11250	$1.84 \times 10^6$ 126 = 14603
Total meterage to be drilled/year, m	$11250 \times 8.8$ = 99000	$14603 \times 4.4$ = 64250
Capacity of drill (assumed), m/hour	20	18
Expected operating efficiency, %	75	75
Annual operating hours	4180	4180
Meterage per machine/year, m	$20 \times 4180 \times 0.75$ = 62,700	$18 \times 4180 \times 0.75$ = 56,430
No. of drill machine required	$\frac{99000}{62700}$ = 1.58	$\frac{64250}{56430}$ = 1.14
Availability factor (assumed)	0.70	0.70
Fleet strength of drill machine	$\frac{1.58}{0.7}$ = 2.25	$\frac{1.14}{0.7}$ = 1.62
Total number of drill machine required	3.87 Say, 4	

*de*



A-2.0 - Mining (cont'd)

Accordingly, it is proposed to provide altogether four drilling machines including standby for drilling in bauxite and overburden/mineral reject material.

**Dust Abatement**

Bailing of drill-cuttings from holes by forced draft at the time of drilling operation generates considerable dust. To protect the operators from dust nuisance, it is proposed to equip the drill machine with dust collector/extractor facilities.

**BLASTING**

Blasting shall be done for fragmentation of both bauxite and overburden/mineral reject. However, due to certain disadvantages, mainly environmental, effort was made to minimise the quantum of drilling and blasting. Hence, it was decided to use drilling and blasting only for sixty per cent (60%) of both bauxite and overburden/mineral reject excavation requirement. Ripping will be used for fragmentation of the remaining bauxite and overburden/mineral reject, specifically where the bench height will be low.

As discussed earlier, the benches in bauxite will generally be of 8 m height and that in overburden/mineral reject will be 4 m. For convenience of operation and standardisation of equipment, it was decided to use same 150 mm dia drill holes for blasting in both bauxite and overburden/mineral reject. The broad blasting parameters are mentioned in Table A.2-5 on the next page.

**Charging and Stemming**

Explosive charge proposed to be used for blasting will consist of eighty per cent (80%) of Ammonium Nitrate Fuel Oil (ANFO) mixture and twenty per cent of (20%) high explosives. ANFO will be used as column



A-2.0 - Mining (cont'd)

charge and the high explosives will be used as base charge. However, during rainy season, slurry/emulsion explosives will be used in place of ANFO. The top of the blast holes will be subjected to stemming with drill cuttings to prevent generation of fly rocks. Minimum one-third of the hole depth will be subjected to stemming.

**TABLE A.2-5 - BROAD BLASTING PARAMETERS**

Sl. No.	Blasting Parameters	Bauxite	Overburden/ mineral reject
1.	Hole diameter	150 mm	150 mm
2.	Bench height	8 m	4 m
3.	Hole depth	8.8 m	4.4 m
4.	Burden	4 m	3.5 m
5.	Spacing	5 m	4.5 m
6.	Charging	17.2 kg/m (approx.)	17.2 kg/m (approx.)
7.	Explosive charge/hole	92 kg (approx.)	34 kg (approx.)
8.	Powder factor	3.5 t/kg (approx.)	3.67 t/kg
9.	Blasting pattern	Staggered	Staggered
10.	Hole initiation system	NONEL	NONEL
11.	Frequency of blasting	Daily	Daily

**Secondary Blasting**

Secondary blasting has not been envisaged for mining at Sijimali deposit. Provision of a hydraulic rock breaker will be made for breaking of the oversize boulders for enabling easy loading of the broken materials into dump trucks.

**Storage and Transportation of Explosives**

During dry season and monsoon season, the average monthly explosive requirement would be approximately 134 tonnes and 116 tonnes respectively. Keeping in view the above consumption rate, it is proposed to construct an explosive magazine having capacity of 50 tonnes for storage of slurry explosives and blasting accessories. Provision of a separate magazine house having capacity of more than 30 tonnes will be made for storage of Ammonium Nitrate. Magazine



D

A-2.0 - Mining (cont'd)

house construction will be made as per applicable prevailing rules and regulations. A 9 tonnes/10 tonnes capacity explosive van will be made available for transportation of explosives. An ANFO mixing and loading truck of 5 tonnes capacity will also be provided. Road of adequate width will be maintained for vehicle transportation to and from magazine house. Security guards will be provided at the magazine house.

Apart from the above, adequate safety precautions will be taken for carrying out blasting at the mine site. Statutory manpower will be provided for blasting and proper signaling and warning will be given prior to blasting. Provision of blasting shelters will be made available at site. Blasting will be carried out at day time only.

**EXCAVATION AND LOADING**

From the point of view of mobility, maneuverability and speedy deployment at any point of the work site, front-end loaders are preferred for carrying out the loading of ore and overburden/mineral reject into rear-dump trucks for transportation to crusher house/r.o.m ore stockpile and overburden/mineral reject dump area. Front end loaders are also considered to be convenient for loading of stacked/heaped material formed by ripping and dozing. However, for loading of drilled and blasted material from relatively higher benches, hydraulic excavators are preferred. It is planned to deploy 11.7 cu m capacity hydraulic excavators for loading of ore from 8 m benches in the following manner:

Equipment	Annual tonnage to be loaded
Hydraulic excavator, 11.7 cu m	5.44 x 10 <sup>6</sup> tonnes
Front-end loader, 10.1 cu m	3.62 x 10 <sup>6</sup> tonnes



A-2.0 - Mining (cont'd)

Sizes of the equipment have been selected considering the scale of operation and the standard sizes of equipment available in the market. It may be noted that, the front end loader and rear dump trucks will also be used for loading of bauxite from the r.o.m stockpile to be formed near the crusher house.

**Number of Excavator/Loader Required**

The number of 11.7 cu m hydraulic excavators and 10.1 cu m capacity front-end loaders for loading blasted/ripped ore and overburden/mineral reject has been worked out and is presented below in Table A.2-6 and Table A.2-7 respectively.

**TABLE A.2-6 - REQUIREMENT OF HYDRAULIC EXCAVATORS**

Capacity of bucket	11.7 cu m
Bucket fill factor	85%
Bulk density of material	1.5 tonnes/cu m
Tonnage handled/bucket	$11.7 \times 0.85 \times 1.5$ = 15 tonnes (approx.)
Cycle time	35 seconds
Expected operating efficiency	85%
Truck presentation factor	90%
No. of loading cycles/hour	$60 \times 60 \times 0.85 \times 0.90$ 35 = 78.68 Say, 78
Tonnage handled by one excavator per hour	$78 \times 15$ = 1170 tonnes
Tonnage handled by one excavator per year	$1170 \times 4180$ = 4890600 tonnes
Annual production target	$5.44 \times 10^6$ tonnes
No. of excavator required for the work	$\frac{5.44 \times 10^6}{4890600}$ = 1.11
Availability factor (assumed)	0.8
Fleet strength of excavator	$\frac{1.11}{0.8}$ = 1.39 Say, 2

*dr*



**D**

A-2.0 - Mining (cont'd)

**TABLE A.2-7 - REQUIREMENT OF FRONT-END LOADER**

Capacity of bucket	10.1 cu m
Bucket fill factor	85%
Bulk density of material	1.5 tonnes/cu m
Tonnage handled/bucket	$10.1 \times 0.85 \times 1.5$ = 12.9 tonnes (approx.)
Cycle time	45 seconds
Expected operating efficiency	80%
Truck presentation factor	85%
No. of loading cycles/hour	$\frac{60 \times 60 \times 0.80 \times 0.85}{45}$  = 54.4 Say, 54
Tonnage handled by one machine per hour	$54 \times 12.9$ = 700 tonnes (approx.)
Tonnage handled by one machine per year	$700 \times 4180$ = 2926000 tonnes
Annual production target	$3.62 \times 10^6$ tonnes
No. of front-end loaders required for the work	$\frac{3.62 \times 10^6}{2926000}$ = 1.23
Availability factor (assumed)	0.75
Fleet strength of front-end loaders	$\frac{1.23}{0.75}$ = 1.65 Say, 2

*d*



A-2.0 - Mining (cont'd)

Accordingly, two hydraulic excavators and two front-end loaders including standby have been provided. Generally loading shovels will be deployed as excavators. Apart from the above, one back-hoe hydraulic excavator of 3.4 cum bucket capacity has been considered for selective mining of bauxite at undulating floor as well as for making drains and other miscellaneous activities in the mine. Working at floor bauxite benches will be restricted to day time only as far as practicable.

**HAULING**

**Selection of Hauling Equipment**

Rear-dump trucks are required to be provided for transportation of bauxite and overburden/mineral reject to respective disposal areas. Bauxite will be transported from the mining zones, namely Pit-A and Pit-B, to crusher house or r.o.m ore stockpile located near the crusher house. The overburden/mineral reject from Pit-A and Pit-B will be dumped in external overburden/mineral dump. Top soil will be stacked separately at an earmarked area. 90 tonnes rear-dump trucks, commensurate with the capacity of the loaders, are envisaged for the purpose.

The effective lead for transportation of bauxite and overburden/mineral reject has been considered at 2 km and 1.5 km respectively based on the locations of the mining pits, overburden/mineral reject dumps and the primary crusher house at the initial stages.

**Number of Hauling Equipment**

The number of rear-dump trucks required for bauxite and overburden/mineral reject transportation has been worked out on the basis of respective production targets and the average leads, the details of which are presented in Table A.2-8 on the next page.



**D**

A-2.0 - Mining (cont'd)

**TABLE A.2-8 - REQUIREMENT OF REAR-DUMP TRUCKS**

	<b>Bauxite transportation</b>	<b>Overburden/mineral reject transportation</b>
<b>Cycle time per trip in minutes:</b>		
a) Loading, minutes	3.9	3.9
b) Spotting near loader, minutes	0.6	0.6
c) Haulage, minutes	8.0	6.0
d) Turning, spotting and dumping, minutes	1.5	1.5
e) Return journey, minutes	6.0	4.50
<b>Total Cycle Time, minutes</b>	<b>20.60</b>	<b>17.10</b>
Expected operating efficiency, %	85	85
No. of trips per dumper/hour	$\frac{60 \times 0.85}{20.6}$ = 2.48	$\frac{60 \times 0.85}{17.1}$ = 2.98
No. of trips per dumper/year	$4180 \times 2.48$ = 10,366	$4180 \times 2.98$ = 12,456
Payload of dumper, tonnes	90	90
Quantity of material transported by one dumper in one year, tonnes	$10366 \times 90$ = 9,32,940	$12456 \times 90$ = 11,21,040
Quantity of bauxite to be transported annually, tonnes	$6 \times 10^6$	$3.06 \times 10^6$
No. of dumpers required	$\frac{6 \times 10^6}{932940}$ = 6.43	$\frac{3.06 \times 10^6}{1121040}$ = 2.73
Availability factor (assumed)	0.75	0.75
Fleet strength of dumpers	8.58 Say, 9	3.64 Say, 4

The requirements of 90 tonnes dumpers for transportation of bauxite and overburden/mineral reject have been separately calculated and worked out to 9 and 4 respectively.

*dh*



A-2.0 - Mining (cont'd)

**MISCELLANEOUS OPERATION - DEPLOYMENT OF EQUIPMENT**

Besides rippers, drills, excavators, front-end loaders and rear-dump trucks, different equipment will be provided for maintenance of roads, cleaning of mining benches, management of stockpile etc. The list of miscellaneous equipment is presented below in Table A.2-9:

**TABLE A.2-9 - MISCELLANEOUS EQUIPMENT**

Sl. No.	Equipment	Quantity	Purpose for which provided
1.	Back-hoe hydraulic excavator, 3.4 cum	1	For making drains, excavation of bauxite at undulating floor
2.	Crawler-mounted bulldozer powered by 410 HP diesel engine	4	Dressing and levelling of top soil, overburden/mineral reject and r.o.m stockpile, cleaning bench floors, maintenance of roads, etc.
3.	Tyre-mounted bulldozer powered by 350 HP diesel engine	1	- do -
4.	Road grader powered by 175 HP diesel engine	1	Maintenance of roads
5.	Water tanker, 28 kl	3	Sprinkling of water on roads for dust suppression
6.	Tyre-mounted hydraulic rock breaker	1	Breaking of oversize boulders in mining benches and r.o.m ore stockpile near crusher house
7.	Diesel Tanker	2	Fuelling of semi mobile mining machineries
8.	Explosive Van, 9/10 tonnes	1	Carrying explosives
9.	ANFO mixing and loading truck, 5 tonnes	1	ANFO mixing and loading
10.	Mobile Crane	1	For assisting breakdown maintenance of mining machineries
11.	Material Truck, 10 tonnes	1	Carrying material from store/workshop to mines
12.	Fire Tender	1	Fire Fighting
13.	Tower mounted DG sets	8	Lighting in the working areas inside the mine
14.	Repair and maintenance van	2	Repair and maintenance of heavy machineries in the mine



A-2.0 - Mining (cont'd)

**POSSIBILITY OF INTRODUCTION OF SURFACE MINER**

The possibility of introduction of surface miners has been explored for mining in Sijimali. While it is quite possible that majority of the bauxite having compressive strength of up to 50 MPa can be cut by using surface miner, the productivity will vary depending upon the compressive and tensile strength and jointing of the material. However, there seems to be possibilities of encountering harder bauxite of uniaxial compressive strength up to 70 MPa or more. Further, application of surface miners in laterite will have to be studied in detail. In general, the surface miner productivity will depend upon the following factors:

- a) Uniaxial compressive strength
- b) Tensile strength
- c) Jointing (distance, number and direction)
- d) Length and width of variant strata
- e) Abrasivity (Cerchar Hardness Index)

It may be noted that, while surface miners have been successfully deployed for coal and limestone mines in India, the application of surface miner have not been popular in India when it comes to bauxite mining.

The obvious advantage with use of surface miners are its environment friendliness compared to drilling and blasting. The ground vibrations caused by drilling and blasting can be eliminated by the use of surface miners especially where there are restrictions to drilling and blasting. Moreover, it can be used as a continuous/semi-continuous mining system where high productivity can be achieved.

It is gathered that, a surface miner with a 2.5 m wide drum can achieve productivities in the range of 340 tonnes per hour to 950 tonnes per hour where uniaxial compressive strength varies from 10 MPa to 70 MPa.

A handwritten signature or set of initials in dark ink, located at the bottom right of the page.



A-2.0 - Mining (cont'd)

Hence, in view of the above uncertainties, it is not envisaged to deploy surface miner for bauxite mining at this stage. However, after the start of mining operation at Sijimali, required tests may be done to examine the applicability of surface miners. Further, if the material test results are found to be encouraging, trial tests will be carried out with surface miners and a decision will be made based on the results achieved during the trial tests.

**CONCEPTUAL MINE PLANNING**

The entire Sijimali deposit has been divided into four blocks namely Block-I, II, III and IV for the convenience of mining operation. While planning for excavation of the ore body, due consideration has been given for the early extraction of ore zones having lesser overburden/mineral reject thickness so as to create enough void for dumping of overburden/mineral reject directly into the worked out areas.

Block-I has a reserve of about 77 MT which will last for about fifteen (15) years as per the planned production schedule. Subsequently Block -II, III and IV will be extracted. It may be noted that, Block-IV has lesser amount of mineable reserves compared to the other three blocks. Hence, Block-IV, being nearer to Block-III, can be mined simultaneously with Block-III. With all the above four blocks, the mining operation will last for about thirty-nine (39) years. There is no proposal of expansion at present. After the mineable reserves are mined out, the remaining resources may be mined considering techno- economic viability at that point of time. The plan and sections of excavation during the first five years have already been shown earlier. The formation of ultimate pits in the subsequent five year periods till the end of lease period has been shown in the Conceptual Mining Plan Drawing 11420-97C-000-PRM-0017 and a few relevant development sections has been shown in Drawings 11420-97C-000-PRM-0019 and 11420-97C-000-PRM-0020.

A handwritten signature or set of initials in dark ink, appearing to be 'de'.



A-2.0 - Mining (cont'd)

The r.o.m bauxite of Sijimali satisfies the requirement of the alumina refinery. Hence, up-gradation of bauxite has not been envisaged. However, sizing of r.o.m bauxite has been considered. The double roll crushers have been located in Block-I as mining in the initial fifteen years have been envisaged in the same block and the same has been shown in Drawing 11420-97C-000-PRM-0016. However, in subsequent years, mining will be done in Block-II, III and IV respectively. Hence, the crusher locations will have to be changed. The probable future locations of crushers have been shown in Drawing 11420-97C-000-PRM-0016. It may be noted that, at this stage, Crusher Location-III is proposed to cater to both Block-III and Block-IV.

The overburden/mineral reject generated during the extraction of Block-I will be kept in separate areas marked for soil and overburden/mineral reject on the surface over mineralized zone. Thereafter the fresh generation of overburden/mineral reject will be dumped in-pit to fill the voids created out of mining the ore. The overburden/mineral reject dumped outside of pit will be re-handled suitably at a later stage for backfilling.

It becomes necessary to reclaim the degraded land to its original topography as far as practicable. During the first five years it may not be possible to reclaim the degraded land due to formation of different benches in different levels simultaneously for achieving the targeted production. However, the backfilling will be started from the 3rd year in Pit-B as bauxite in some of the areas will be exhausted. The restoration will cover backfilling and terracing of the mined out area by dumping of overburden/mineral reject and surfacing with top soil. The backfilling of overburden/mineral reject and top soil during the first five years of operation have indicated in Chapter A. 4-0. The proposed backfilling of mined out lands progressively during the life of the mine have been

A handwritten signature or set of initials in dark ink, located at the bottom right of the page.



A-2.0 - Mining (cont'd)

shown in Drawings 11420-97C-000-PRM-0013 to 11420-97C-000-PRM-0015. At the end of the proposed total extraction of ore from Sijimali, some portions of the land would remain degraded due to mining and it is proposed to reclaim the degraded land to bring back its original contour as far as possible by backfilling and terracing with overburden/mineral reject materials.

As a part of eco restoration; it is decided to carry out afforestation in the following manner:

Initially afforestation will be done along the safety barrier against the lease/geological boundary for Block-I. At later stages, when the mining activity will progress to the other blocks, afforestation along the safety barriers will be accordingly done.

Restoration of mined out land in five year period have been shown in Drawing 11420-97C-000-PRM-0018.

Backfilling work will start during the third year of mining operation. After backfilling of voids, the area will be sprayed with top soil for enabling plantation. It is envisaged that, plantation on the reclaimed areas will start during the second five year period of mining operation.

It is also proposed to create a green belt on the periphery of the important installations like administrative building, approach roads to the mine as well as road to the alumina plant.

Overburden/mineral reject dumping at outside dumps will continue beyond the first five years. These dumps will be re-handled at a later stage when sufficient space will be created in the mined out areas. Hence, temporary stabilisation and protection measures like



A-2.0 - Mining (cont'd)

creation of garland drains etc. will be taken, if needed, for these overburden/mineral reject dumps. If any technological advancement is done in future for extraction of alumina or any other metal from the mineral rejects, then the lessee may approach to relevant Government / statutory authority with new proposal.

At the end of the lease period, some area will be void with RL 1150 to 1200. Part of this area may be used as water reservoir for supply of water to the local villages and also for pisciculture. The reclaimed area may be used for cultivation/afforestation.

The manpower requirement has been given in Table A.7-9. The requirement of mining equipment has also been indicated in Table A.2-3. The remaining manpower after the end of life of the Sijimali mines may be deployed suitably in other establishment of the lessee. The machineries may also be utilized in the other divisions of the lessee if they have not reached their working life. Otherwise, the machineries will be scraped.

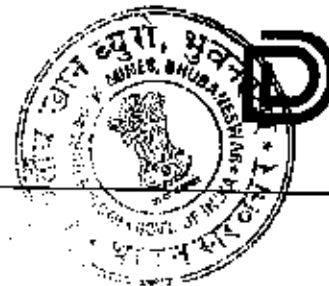


### A-3.0 - MINE DRAINAGE

The Sijimali plateau has a generally undulating topography. There are 2/3 small hillocks in the central and southern part which slopes down gently towards the edges of the plateau. The natural drainage, therefore, follows a radial pattern and discharges the surface run-off into the valleys all round which ultimately converges with the main water courses.

The mine drainage for Sijimali bauxite deposit has been discussed below:

- a) Preliminary observations from the hydrogeological study at Sijimali region reveal that the effect of mining on ground water table within the mine lease-hold area is remote. The highest contour in the plateau is about 1200 m MSL, while the lowest contour is about 997.6 m MSL. The drilling of borehole at the lowest contour to a depth of about 23.68 m equivalent to 973.92 m MSL does not encounter any sub-surface water and it was possible to draw samples of laterite and bauxite from a level of about 973 m MSL through suction drilling. Majority of the springs in Sijimali study area are generally found to lie within 800 to 1000 metres above MSL. Taking all these into considerations, the possibility of disturbing the springs and their discharge rate during the mining operation has not been anticipated.
- b) The minimum and maximum depth of mine working is at 982 m and 1094 m above MSL. Moreover, the following points noted:
  - i) At the plateau top, no sub-surface water has been encountered up to a level of 973 m above MSL.
  - ii) Since the plateau is characterized by quaquaversal slopes, a substantial quantity of rain water is now lost by quick run-off. During mining operation depression formed by the removal of bauxite will act as recharge reservoir of ground water by retaining the rain water and hence better recharging of springs.



**A-3.0 - Mine Drainage (cont'd)**

- iii) The actual surface area at the plateau top to be covered under mining is less compared to the total exposed surface of the plateau.
- iv) Further removal of the old-harden top lateritic duricrust (which are concretionary in texture, less porous and less permeable) will expose fresh laterite and bauxite profile which will accelerate the rate of infiltration of the surface precipitation and hence, better recharging of the springs.

In view of this, it may be concluded that the impact on the ground water resource due to mining at Sijimali will not cause any adverse impact.

- c) Due to surface topography and sub-surface bauxite disposition, mine working level will generally be above the cliff level where a peripheral barrier of about 7.5 m will be kept. Considering this, the working bench floors shall be maintained at a self-draining slope towards the natural drainage of the plateau. A set of catch drains will be made to channelize the surface run-off which will be merged to the natural water courses at the plateau top. In the course of mining, some localized depressions may be created. In some depressions, where water logging may cause difficulty in mine operation, a portable diesel pump of 100 cu m per hour capacity will be employed to pump out the accumulated water and discharge the same to the natural water courses for ultimate discharge to main water course. The peripheral barrier will be breached at places and culverts will be provided on the roads wherever necessary for evacuation of the water from mining area. The place(s) where the mine water is finally proposed to be discharged has been shown in Drawing 11420-97C-000-PRM-0027.
- d) The total area of the lease is 1560.400 Ha (1549.086 Ha as per DGPS survey). The annual rainfall is 1200 mm. Based on the above, it is envisaged that approximately 18.60 million cu m of rain water will flow through the mining lease area. During initial years of mine operations, top soil and overburden/mineral reject excavated shall be dumped in selected sites. Retaining wall will be provided along the periphery of the dumps to arrest the wash off. Moreover, peripheral drains all around the dumps shall be made to trap rain water washings out of the dumps, which in turn will reduce the load of suspended solids in the discharged water. Sump pits will be provided along the length of the drains for

A handwritten signature or set of initials, possibly 'd', written in dark ink at the bottom right of the page.



**A-3.0 - Mine Drainage (cont'd)**

effective trapping of rain water washings. The water from these peripheral garland drains and other surface discharge will be collected in settling tanks. After settling of the suspended solids, clear water will be discharged at places from the lease area to the main water courses.

The mine drainage plan for Sijimali has been represented in Drawing 11420-97C-000-PRM-0027.



#### **A-4.0 - STACKING OF MINERAL REJECT/SUB-GRADE MATERIAL AND DISPOSAL OF WASTE**

During the operation of mine, substantial quantity of overburden/mineral reject will be generated. In order to dispose of this, a suitable disposal scheme has been formulated and discussed below:

##### **NATURE AND RATE OF GENERATION OF OVERBURDEN/MINERAL REJECT**

The overburden/mineral reject generated in course of pre-mining development and subsequent mining operation will consist of top soil and laterite with occasional occurrences of khondalite. The rate of generation of overburden/mineral reject is expected to be of the order of 3 MTPY considering an average overburden/mineral reject to ore ratio of about 0.51:1. However, during first five years of operation, including one year of pre-mining development, the total generation of overburden/mineral reject and top soil has been estimated at about 2.75 million cu m, of which the top soil is around 0.95 million cu m.

##### **SCHEME OF DISPOSAL**

It is planned to stack top soil and overburden/mineral reject separately on ground till some of the bauxite benches have been worked out. After some portions of the mine are exhausted of bauxite, fresh generation of overburden/mineral reject from other areas will be dumped in the mined out areas and worked out benches. Top soil, stacked separately, would be spread over the reclaimed areas as well as on the safety barriers, to enable planting and growing of trees. The overburden/mineral reject stacked on ground during the initial years of operation will be utilised to fill the worked out areas at the end of the working life of the mine as well as during the interim period, as and



**A-4.0 - Stacking of mineral reject/sub-grade material and disposal of waste (cont'd)**

when practicable. The quantity of overburden/mineral reject to be backfilled in the mined-out benches with top soil spreading on it during the first five years of operation is shown in the Table A.4-1 below:

**TABLE A.4-1 - FIRST FIVE YEARS TOP SOIL AND MINERAL REJECTS/LATERITE MANAGEMENT PLAN**

Year	Top Soil, cu m		Mineral Rejects/Overburden, cu m <sup>(1)</sup>			
	Rense / spreading	Storage	Back-filling	Storage	Blending	Bene-ficiation
I	53,644	212,507	-	284,189	-	-
II	12,212	168,874	-	153,931	-	-
III	-	174,477	120,000	117,269	-	-
IV	2,546	206,005	97,454	458,438	-	-
V	18,938	96,813	731,062	380,884	-	-
<b>Total</b>	<b>87,340</b>	<b>858,676</b>	<b>948,516</b>	<b>1,394,710</b>	-	-

**Note:**

(1) Swelling factor of 1.3 has been considered for the overburden/mineral reject.

**SELECTION OF DUMPING SITE**

Considering the extension of mining zone and disposition of the working faces, separate locations have been selected for dumping of top soil and overburden/mineral reject as shown in Drawing 11420-97C-000-PRM-0016. Three separate sites for top soil and one site each for overburden and mineral reject has been selected to restrict the lead from mining areas to a reasonable limit, as well as taking into account the space required for stacking the requisite quantum of material, the topography of the areas available for the purpose, limiting the number of terraces and site leveling requirement. A total of approximately 25 hectares of land have been provided for these dump sites. The above dump sites are located over mineralized zone to reduce the lead distance.



A-4.0 - Stacking of mineral reject/sub-grade material and disposal of waste (cont'd)

However, these dumps are temporary in nature and will be re-handled progressively for backfilling in the mined out areas. Generation of sub-grade material has not been envisaged and hence, disposal of any sub-grade material also has not been considered.

#### **SITE PREPARATION**

No special preparation of site is envisaged except for levelling the area. However, garland drains will be provided around the dumps to trap the fine particles from the dumps washed away by rain. The drains will be 1200 mm wide at the top and 1500 mm deep and shall be provided with sump pits at suitable interval along its lengths. Further, a green belt is proposed to be provided around the dumps.

#### **MODE OF OVERBURDEN/MINERAL REJECT DISPOSAL, DUMP FORMATION AND CONFIGURATION**

The top soil loosened by ripping dozing and overburden/mineral reject loosened by ripping as well as drilling and blasting would be loaded on rear-dump trucks for transportation to overburden/mineral reject/soil disposal areas. Overburden/mineral reject dumps would be of stepped construction. Maximum height of the dumps would be 30 m, each step being 10 m high. A terrace of 20 m width will be provided on top of each step along the periphery. The next higher step will be formed inside this peripheral terrace. The terrace will be utilised to build an approach ramp to the next terrace.

Formation of the dump would be initiated by dumping of overburden/mineral reject materials on ground all along the outer periphery of the demarcated area. Once this is completed, further quantity of the overburden/mineral reject would be dumped immediately inside the perimeter of the dump already formed. This process would



**A-4.0 - Stacking of mineral reject/sub-grade material and disposal waste (cont'd)**

continue and the dump would be gradually built up progressing towards the interior of the demarcated area till the entire space is filled up. A dozer will be used to dress, level and formation of the dump. It may be mentioned that, while the dump is in formation, the external slope which has already been formed may be subjected to temporary stabilisation measures, if needed.

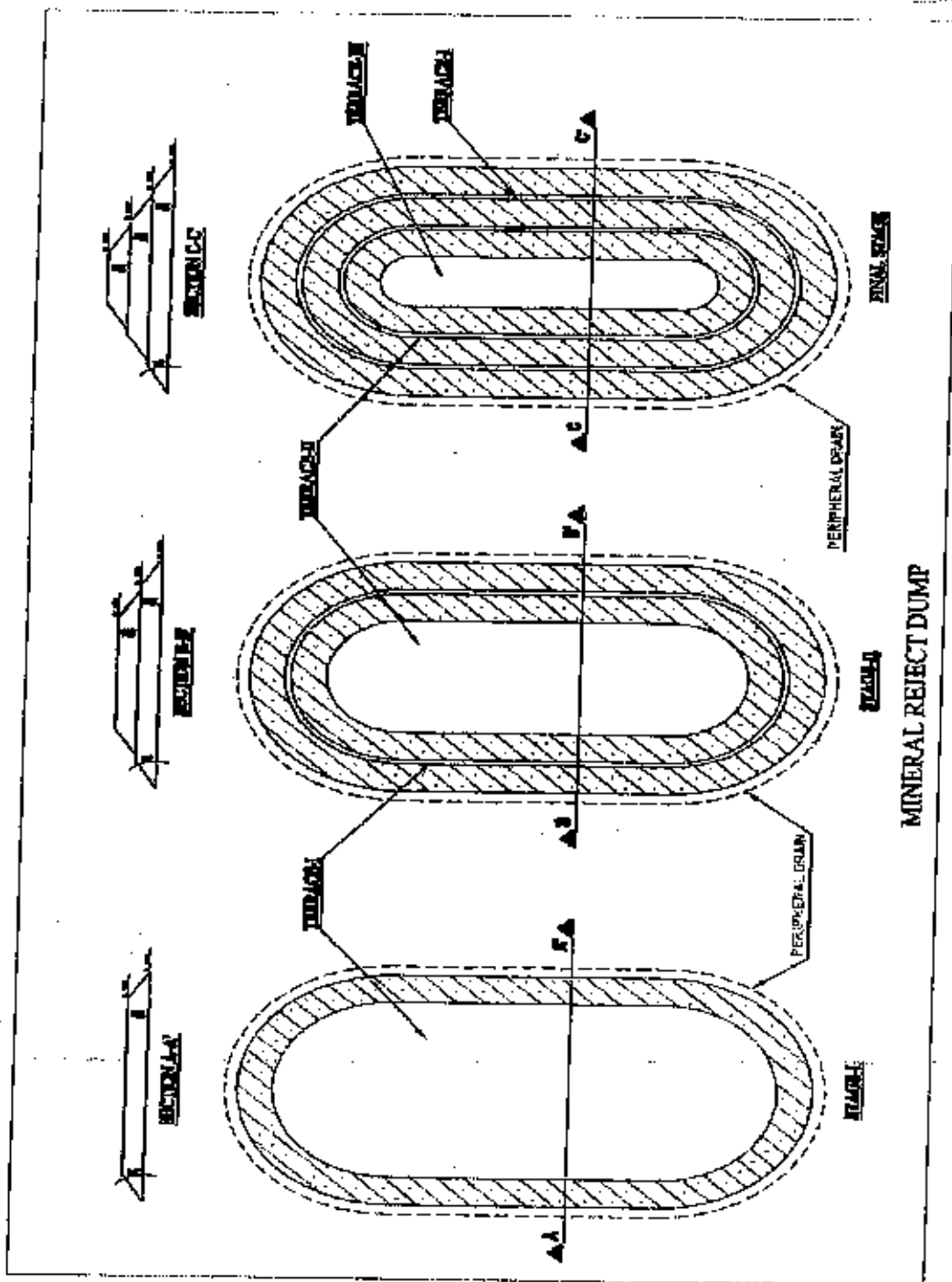
Thereafter, a ramp will be built on the approach road to enable dumper to climb the dump and unload the material on the top of it in the manner as described above to build the dump up to the first terrace level of 10 m in height. The process would continue till the final height of the dump is reached. Angle of repose of material has been considered at 35° for formation of dumps. A typical illustration depicting the formation of dumps for mineral rejects, overburden and top soil at different stages are given in Fig. A.4-1, A.4-2 and A.4-3 respectively in the following pages.

The base level of overburden and mineral reject dumps will be around 1170 mRL - 1180 mRL. The height of the dumps will be 30 m having three terraces of 10 m height. Hence the top level of the overburden and mineral reject dumps will vary between 1200 mRL and 1210 mRL. The overall capacity of the mineral reject dump would be around 1 million cubic metres. The cumulative capacity utilization of mineral rejects dump during the first five years of operation would be approximately 16%, 26%, 33%, 60% and 82% respectively. Similarly, the overall capacity of the overburden dump would be around 0.62 million cu m. The cumulative capacity utilization of overburden dump during the first five years of operation would be approximately 20%, 30%, 40%, 70% and 95% respectively.

A handwritten signature or set of initials in dark ink, located at the bottom right of the page.



A-4.0 - Stacking of mineral reject/sub-grade material and disposal waste (cont'd)



**FIG. A.4-1 - FORMATION OF MINERAL REJECT DUMP AT DIFFERENT STAGES**

*ds*



A-4.0 - Stacking of mineral reject/sub-grade material and disposal waste (cont'd)

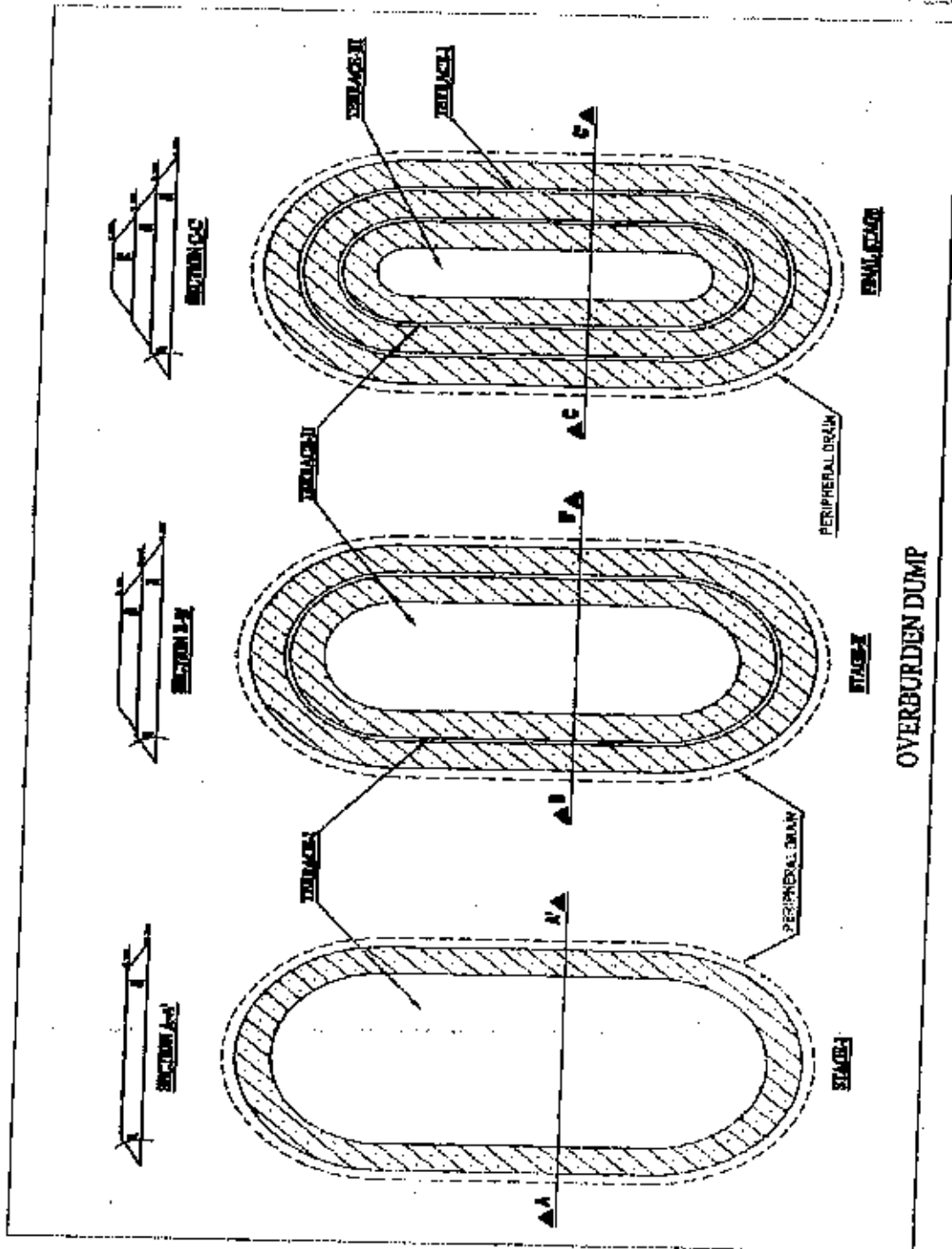


FIG. A.4-2 - FORMATION OF OVERBURDEN DUMP AT DIFFERENT STAGES

*ch*

A-4.0 - Stacking of mineral reject/sub-grade material and disposal of waste (cont'd)

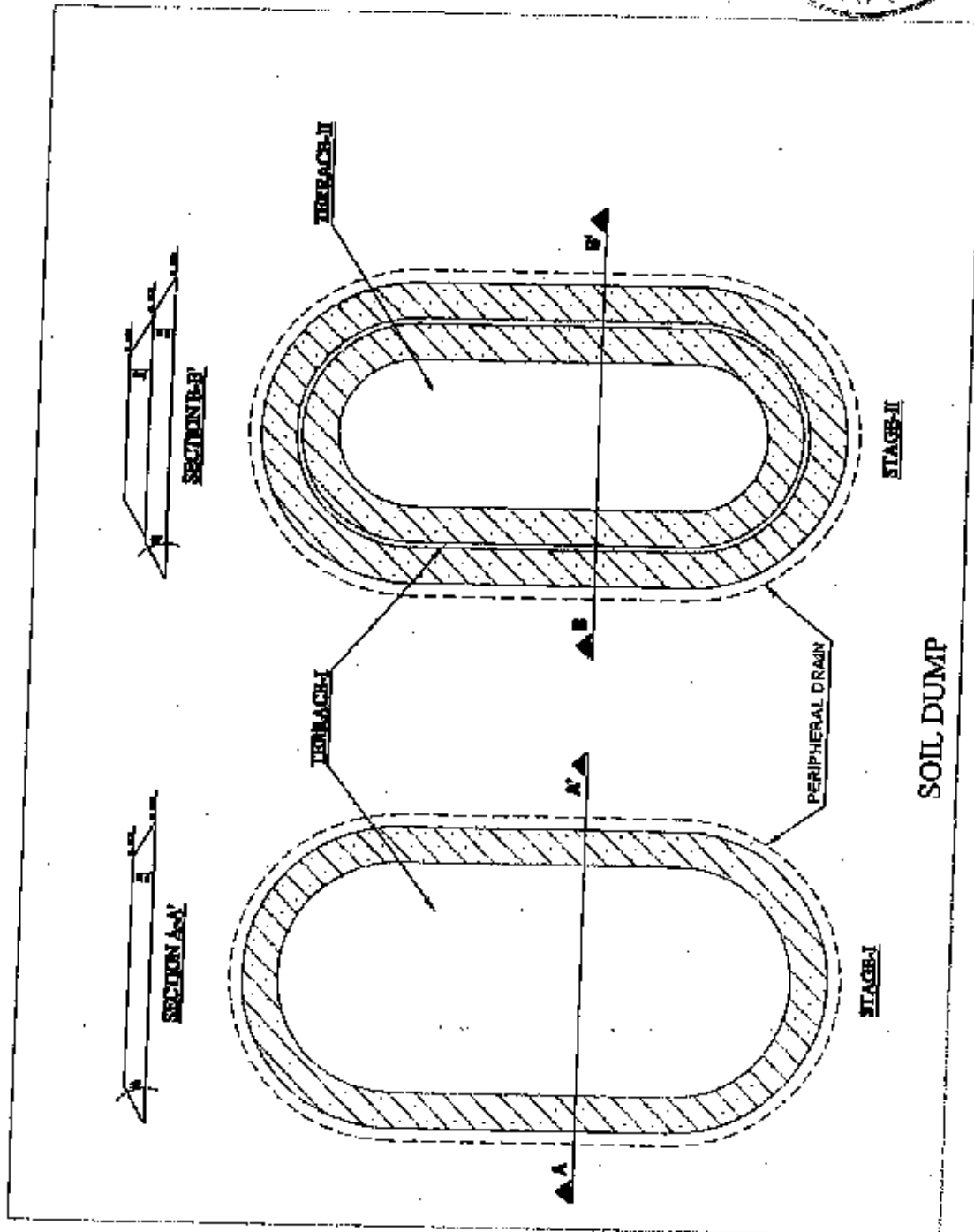


FIG. A.4-3 - FORMATION OF TOP SOIL DUMP AT DIFFERENT STAGES

*ds*



A-4.0 - Stacking of mineral reject/sub-grade material and disposal of waste (cont'd)

The top soil will be stacked separately. The base level of the top soil dumps will be around 1170 mRL - 1180 mRL. The top soil dumps will have two terraces of 3 m height each and the same will be formed in the same manner proposed for dumping of overburden/mineral reject material. Hence, the top level of the top soil dumps will vary between 1176 mRL and 1186 mRL.

#### **SIDE SLOPE AND STABILITY**

The slope of the individual terraces will be dictated by the angle of repose of mineral reject/overburden which, considering the size of material is about 35 degrees. Considering this and the dump configuration presented in above figures, the overall slope will be maintained at about 15 to 20 degrees, well inside the stipulated limit. In addition to the garland drain, retaining wall around the dumps are proposed to be provided to arrest the finer particles of the overburden/mineral reject dump as well as the top soil which are susceptible to rain water washings. Settling tanks will be provided to collect the rain water washings for settling of suspended solids before the water can be used or discharged to the nearby streams.



#### A-5.0 - USE OF MINERAL AND MINERAL REJECT

The use of mineral and mineral reject has been discussed in the following paragraphs:

- a) The bauxite deposit of Sijimali will be used as a captive source for production of metallurgical grade alumina. The proposed alumina plant will be installed at Kusumasila in Rayagada district, Odisha at a distance of about 22 km from its captive bauxite mine - to be developed at Sijimali. As per the process requirement, the bauxite feed to the alumina plant should contain  $Al_2O_3$  over 40 % and  $SiO_2$  around 2.2 %.
- b) Since the bauxite of Sijimali is of high grade, averaging at approximately 46.06 %  $Al_2O_3$  and 2.06 %  $SiO_2$ , and meets the specifications of refinery feed requirement, up-gradation of bauxite has not been envisaged before it is being used for production of alumina.
- c) The entire bauxite to be mined from Sijimali will be used in Alumina refinery at Kusumasila. Hence, this will entirely be used for captive consumption.
- d) As indicated earlier, the Sijimali bauxite will be used for captive consumption. Also, the bauxite grade of Sijimali satisfies the requirement of the refinery.
- e) As the r.o.m bauxite fulfills the requirement of the refinery, no up-gradation of the r.o.m is required. However, sizing of r.o.m bauxite has been proposed.

Overburden/mineral reject material is presumed to be non-saleable or non-usable for any industrial processes with the presently available technology. This overburden/mineral reject material will be initially dumped outside pits till some areas in the mine are exhausted of bauxite. Once, exhausted pits are available, fresh arising of overburden/mineral reject material will be dumped on the same. The



A-5.0 - Use of Mineral and Mineral Reject (cont'd)

overburden/mineral reject material dumped outside the pit will gradually be used for backfilling of the exhausted pits as and when practicable during the life of the mine. In future, if suitable technology is developed, the above mineral rejects may be used for industrial purposes.

A handwritten signature or set of initials, possibly 'Ch', located at the bottom right of the page.



## **A-6.0 - PROCESSING OF ROM AND MINERAL REJECT**

The bauxite excavated from Sijimali mine will be crushed and transported by a belt conveyor system to the alumina plant and used for production of metallurgical grade alumina there. The ore being of high grade, any preliminary treatment/beneficiation is not envisaged at the mine head. However, to enable smooth and easy transportation by a belt conveyor, the minus 800 mm r.o.m. bauxite will be required to be reduced to a suitable size. This necessitates installation of a crushing plant at the mine head. The crushing plant capacity, feed and product characteristics, plant site and layout, and the facilities provided in the plant for ore receiving, controlled feeding, crushing, handling etc are described below.

### **DESIGN BASIS**

Design of the plant and associated systems, development of flow sheet, selection and sizing of equipment have been carried out based on quantity of ore to be treated in the plant, characteristics of r.o.m. ore and desired product, characteristics of equipment etc.

### **Plant Capacity**

The following annual plant throughput requirement and working duration have been considered for determination of plant capacity:

- a) Crushing plant and conveyor system to be designed to process and transfer 6 MT of bauxite per year as required by the alumina plant. However, the conveyor from Kutrumali to the alumina refinery will convey 9 MT of bauxite, 6 MT from Sijimali and remaining 3 MT from Kutrumali.
- b) Crushing plant and conveyor system to operate 12 months in a year considering 8 dry months and 4 monsoon months.

A handwritten signature or set of initials, possibly 'd', written in dark ink.



A-6.0 - Processing of ROM and Mineral Reject (cont'd)

- c) The crushing plant and conveyor systems have been designed for 330 days operation per year with 2 shifts operation per day.
- d) The effective working hours per shift during dry and monsoon season has been considered at 7 hours and 5 hours respectively.

Based on above, the plant has been designed for 4180 hours of operation per year with 1435 tonnes per hour of rated throughput rate commensurate with processing and transfer requirement. However, the crushing plant has been designed with a design capacity of 25% more than its rated capacity to take care of any shortfall in production, if required. It may be noted that a stockpile is envisaged to be provided ahead of the crusher house to serve as buffer between the mine and the plant as well as for storage of excess mined out bauxite during dry season for using the same during monsoon season. Some degree of flexibility in respect of actual plant throughput would be available taking advantage of the above buffer stock.

**Bauxite Stockpile**

It may be noted that the demand of bauxite at the alumina plant works out to about 500,000 tonnes per month from Sijimali. In view of this, the seasonal fluctuation in mine production would give rise to a surplus of approximately 52,630 tonnes of bauxite during each of 8 dry months and a shortfall of approximately 105,260 tonnes during each of monsoon months. To accommodate the surplus production during dry months, a stockpile of approximately 421,000 tonnes capacity needs to be provided. The stock could be reclaimed and made use of to supplement the low r.o.m. ore production during monsoon months. It is planned to provide space for this stock at the alumina plant in view of obvious advantage in respect of operational logistics and proper homogenization through blending. The plant at the mine head would be



**A-6.0 - Processing of ROM and Mineral Reject (cont'd)**

served by a comparatively smaller stockpile of around 100,000 tonnes capacity to take care of daily/hourly fluctuation of mine production other exigencies, as indicated earlier.

**Characteristics of Feed**

The characteristics of r.o.m. ore considered for design of the plant are given below in Table A.6-1:

**TABLE A.6-1 - CHARACTEREISTICS OF R.O.M. ORE CONSIDERED FOR DESIGN**

Top size, mm	800
Moisture content, per cent	7 to 13
Bulk density, tonnes/cu m	1.5
Angle of repose, degree	35 to 37
Uniaxial compressive strength, MPa	Generally 40 to 50, Maximum being 70 MPa
Hardness, Mobs scale	2.5 to 3.5
Material quality and structure	The material is soft, porous, friable, pitted and earthy having clay intercalations, fine to medium grained, having indistinct/imperfect cleavage
Mineral composition	Mostly gibbsite, in association with minerals like goethite, kaolinite, boehmite etc.
Average chemical composition:	
a) Al <sub>2</sub> O <sub>3</sub> , %	46.10
b) SiO <sub>2</sub> , %	2.03

**Product**

The size of the product to be obtained after crushing in the plant will be minus 150 mm (d<sub>85</sub>) to suit the 1400 mm wide belt conveyor system proposed to be provided for transportation of material from mine head to the surge bin at Kutrumali.



A-6.0 - Processing of ROM and Mineral Reject (cont'd)

It may be noted that, as upgradation of bauxite is envisaged, the crushing plant will not generate any tailings, and the grade of despatchable product will be same as that of feed ore at a hundred per cent recovery.

**PLANT LOCATION AND LAYOUT**

As explained earlier, it is planned to carry out exploitation of the Sijimali deposit block by block, each block being served by a separate crusher location. Initially the excavation is envisaged to commence in the Block-I with the crusher installed in Crusher Location-I as shown in mine general layout Drawing 11420-97C-000-PRM-0016.

It is proposed to adopt a fixed crusher location for each of the blocks as mentioned above. However, as the mineable reserve in Block-IV is less, the crusher location in Block-III may serve for Block-IV as well. However, this proposal is provisional only and the same will be firmed up during the actual operation stage.

Location of the crushing unit in a mine is generally influenced by the disposition of ore body, topography etc. Ideally the crusher house should be located on a barren zone to keep the entire ore bearing area free for excavation, within a reasonable distance from mining areas and at a relatively lower level that enables downhill hauling. Based on the above factors, it is proposed to install the crusher house for exploitation of Block-I on the eastern part near the edge of the plateau as shown in the mine general layout Drawing 11420-97C-000-PRM-0016. The location is at a level relatively lower than major part of the block. The location would enable to restrict the lead of truck transportation within 2 km which is considered reasonable for the type and scale of operation. The location is outside the demarcated mining area and on a non-mineralised zone and hence would not hinder the operation in any part of the block.



**A-6.0 - Processing of ROM and Mineral Reject (cont'd)**

The crushing plant will consist of four sections, namely:

- i) R.O.M. ore stockyard,
- ii) Crushing section,
- iii) Crushed ore conveyor, and
- iv) Surge bin

The location of the surge bins and layout of the crushed ore conveyors is dependent upon long distance overland transport conveyor routing. The route proposed will be finalised after contour survey of proposed alley. In Drawing 11420-97C-000-PRM-0016, the location of surge bins and layout of crushed ore conveyors has been shown considering transport conveyor take-off point on the eastern side.

**MAJOR EQUIPMENT AND FACILITIES**

The flow sheet of the crushing plant is shown in Drawing 11420-97C-000-PRM-0021. Plan and sections of the crushing plant are shown in Drawings 11420-97C-000-PRM-0022 and 11420-97C-000-PRM-0023. The crushing plant will comprise of two sets of crushers of 720 tonnes per hour (rated) capacity each alongwith apron feeders and vibrating grizzly. The crushed material from the two crushers will be conveyed and stored in two surge bins of around 200 tonnes capacity. Material from these two surge bins will be drawn out by an apron feeder and discharged onto the long distance overland conveyor. This would enable the crushing plant to run at least one crusher when the other is under maintenance. The major items of equipment and facilities are briefly described below and the list of major equipment is given in Table A.6-2 on the next page.



A-6.0 - Processing of ROM and Mineral Reject (cont)

**TABLE A.6-2 - LIST OF MAJOR EQUIPMENT - CRUSHING PLANT**

Sl. No.	Description	Quantity
1.	Heavy Duty Apron Feeder, 2000 mm x 9200 mm	2 Nos.
2.	Heavy Duty Apron Feeder, 1500 mm x 6000 mm	2 Nos.
3.	Vibrating Grizzly, 2000 mm x 4500 mm	2 Nos.
4.	Toothed Double Roll Crusher, 2100 mm x 2000 mm	2 Nos.
5.	Belt Conveyors - BC-1, BC-2 of 1200 mm belt width	1 Lot
6.	Long Distance Transport Conveyor of 1400 mm belt width	1 Lot
7.	Belt Scale	4 Nos.
8.	Suspended Magnet	2 Nos.
9.	E.O.T Crane, 40/5 ton	1 No.
10.	Mechanical Hoist, 2 ton/3 ton	1 Lot

**R.O.M. ORE STOCKYARD**

As indicated earlier, one r.o.m. ore stockpile of around 100,000 tonnes capacity will be maintained near the crusher house. This stockpile would not only enable to absorb the imbalance in mine raisings during dry season and monsoon to some extent, but would also serve as a buffer between the mine and the crushing plant in the event of stoppage of either of these. The stockpile may also be judiciously utilised for maintaining supply of bauxite of stipulated grade. The ore transported from the mine may be dumped directly into the crusher or to the stockpile depending upon the grade of bauxite and the requirement of the crushing plant. Subsequently, bauxite from the stockpile may be reclaimed in appropriate proportions conforming to the stipulated blending requirement and dumped into the crusher hopper. For reclamation of ore from stockpile, 11.8 cu m front-end loader and



A-6.0 - Processing of ROM and Mineral Reject (cont'd)

100 tonnes rear-dump trucks will be provided which will be supplemented, if required, by diverting additional equipment from mine during lean period of mine working.

**CRUSHING SECTION**

**Receiving Hopper**

Two r.c.c. hoppers will be provided at the crusher house to receive the ore directly transported from the mine and dumped by rear-dump trucks. Ore reclaimed from the r.o.m. stockpile will also be received in this hopper. The rear-dump trucks will approach the hoppers through a ramp. The hoppers will be of about 200 tonnes capacity each and fitted with MS grid on top to arrest stray plus 800 mm boulders. The oversize boulders will be fragmented with the help of a hydraulic rock breaker provided for the purpose.

**Apron Feeder**

The hopper will be equipped with heavy duty apron feeders of 2000 mm x 9200 mm size installed at the bottom of hopper, suitable to withstand the load of big boulders dumped by 100 tonnes rear-dump trucks from large tipping height. The apron feeder will be driven by variable speed D.C. motor, and draw out and deliver the material at a regulated rate to a set of stationary grizzly.

**Vibrating Grizzly**

A set of vibrating grizzly feeder of robust construction and 2000 mm x 4500 mm size, having wedge shaped opening tapering out towards the discharge end, will be installed ahead of the crushers for scalping out as much minus 150 mm fraction as possible from the r.o.m. material to avoid unnecessary volumetric loading of the crusher.



**A-6.0 - Processing of ROM and Mineral Reject (cont'd)**

**Crusher**

Oversize of the grizzly will be fed directly to the crushers to reduce the same to minus 150 mm. Considering the size and other physical characteristics of the feed ore, throughput rate and the stipulated product size, it is proposed to provide toothed double-roll crusher having inlet mouth opening of 2100 mm x 2000 mm. Each of the rolls will have separate squirrel cage induction motor drive, and will run at different speeds to ensure efficient crushing by the process of compaction and shearing.

**BELT CONVEYOR SYSTEM**

A belt conveyor system comprising conveyors BC-1 and BC-2 will be provided to collect the minus 150 mm crushed material, dribble material of apron feeder and the scalped grizzly product and transfer the same to the surge bins, located near the long distance bauxite transport conveyor system. Each of these conveyors will be 1200 mm wide operating at a speed of about 2 m per second, and will be laid over a fairly level land.

**SURGE BIN**

Two surge bins will be provided to collect the minus 150 mm material and feed the same at a uniform rate to the long distance conveyor transport system.

**Bin Compartment**

The single-compartment surge bins will be of steel construction having 200 tonnes capacity each. The bins with suitable liners will enable to even out any fluctuation in the feed rate of the incoming material and maintain a uniform rate of loading of the long distance transport conveyor throughout the period of its operation.



A-7.0 - Site Service Facilities (cont'd)

**Source of Power**

The equipment covered under the proposed mine and plant are distributed over a wide geographical area stretching around 16 km. Due to the above, power distribution arrangement to the equipment has been divided in three (3) segments with respect to its power sources. The first segment of source will feed power to the equipment to be installed in Sijimali including long distance conveyor C1. The second segment of source will feed power to the equipment to be installed in Kutrumali including long distance conveyor C2, C3 and C4. The third segment of source will feed power to the equipment to be installed at alumina plant end including long distance conveyor C5.

Power for first and second segment as referred above will be made available from the grid substation of Kasipur at 33 kV to main receiving step down substation (MRSS) at Kutrumali (approx. distance 15 km) over double circuit overhead line on tower structure. At Sijimali, one no. load block step down substation (LBSS) will be considered. This LBSS will receive power from MRSS at 33 kV over double circuit overhead line on tower structure and will feed power to the first segment of the plant. Second segment of the plant will receive power from MRSS. Power for the third segment will be made available from the alumina plant substation at 6.6 kV to Load centre substation (LCSS).

**Power Distribution Scheme**

Power at 33 kV to MRSS at Kutrumali will be received from grid substation of Kasipur over double circuit overhead line on tower structure. Extension of two nos. 33 kV bays at Kasipur substation has been envisaged in this regard.

At MRSS, one no. 33 kV switchboard will be considered for primary distribution of power. From this switchboard power will be fed to the 6.6 kV switchboard-cum-motor control centre of MRSS through two nos.



**A-7.0 - Site Service Facilities (cont'd)**

full capacity 33/6.9 kV, 6.3 MVA transformers. 6.6 kV switchboard-cum-MCC will feed power to 415 V switchboard through two nos. full capacity 6.6/0.433 kV transformers, motors for crusher and motors for long distance conveyor C-2, C-3 and C-4 through variable speed drives (VSD) with converter transformers.

One no. LBSS will be considered at Sijimali for feeding power to the equipment to be considered therein. Two nos. 33 kV unit vacuum circuit breaker (VCB) panels will be considered in LBSS. These panels will receive power from MRSS over double circuit overhead line. At LBSS two nos. full capacity 33/6.9 kV, 2500 kVA transformers will be considered. These transformers will be connected to 6.6 kV switchboard-cum-MCC. 6.6 kV switchboard-cum-MCC will feed power to 415 V switchboard through two nos. full capacity 6.6/0.433 kV transformers, motors for crushers and motors for long distance conveyor C-1 through VSD with converter transformer.

33 kV outdoor yard comprising gantry structure, disconnecting switch, lightning arrester etc. will be considered in both MRSS and LBSS.

At alumina plant end, one no. LCSS will be considered. One 6.6 kV switchboard-cum-MCC will be considered in LCSS. This switchboard-cum-MCC will feed power to 415 V switchboard through two nos. full capacity 6.6/0.433 kV transformers and motors for long distance conveyor C-5 through VSD with converter transformer.

Power to 415 V MCC, power distribution boards, lighting distribution boards etc. will be available from the 415 V switchboard as specified above.



**A-7.0 - Site Service Facilities (cont'd)**

Automatic power factor compensation equipment will be considered for improvement of power factor at 415 V level to 0.95 in all the areas, as required.

Overall power distribution arrangement has been shown in the single line diagram Drawing 11420-97C-000-ELE-0001.

**Selection of Electrical Equipment**

The type and ratings of major electrical equipment proposed to be adopted for the mine and plant including power transformers, high and low voltage switchgear, motors and controls, cables etc. are briefly discussed below:

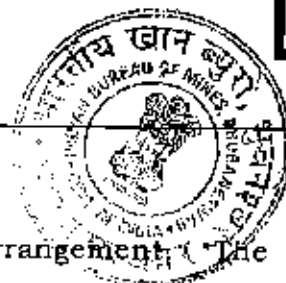
**Power transformers:** The ratings of the step down transformers, proposed to be adopted for the mine and plant are given below in Table A.7-1:

**TABLE A.7-1 - RATINGS OF STEP-DOWN TRANSFORMERES**

Location	Rating, MVA	Transformer type	Voltage ratio, kV
MRSS	6.3	ONAN	33/6.9
	1.0	AN	6.6/0.433 - 0.240
LBSS	2.5	ONAN	33/6.9
	1.0	AN	6.6/0.433 - 0.240
LCSS	0.4	AN	6.6/0.433 - 0.240

**High voltage switchgear:** The details of high voltage circuit breakers proposed to be adopted are indicated in Table A.7-2 on the next page.

**Low voltage switchgear:** The 415 V switchboards will be provided with indoor draw out type air circuit breakers (ACB) or moulded case circuit breakers (MCCB) or combination thereof. The switchboards



A-7.0 - Site Service Facilities (cont'd)

will be of single front, multi-tier, compartmental arrangement. The continuous current ratings of the circuit breakers proposed to be adopted are 1600 A, 630 A, 400 A and 250 A with short circuit interrupting rating of 50 kA.

**TABLE A.7-2 - DETAILS OF HIGH VOLTAGE CIRCUIT BREAKERS**

System voltage, kV	Type of circuit breaker	Symmetrical breaking capacity, kA	Nominal rating of circuit breaker, A
33	Vacuum	40	1250
6.6	Vacuum	40	1250

The list of major equipment for the power systems at Sijimali is given in Table A.7-3 on the next page.

**Motors and Controls**

For continuous duty application, it is proposed to adopt general purpose industrial type, energy efficient and squirrel cage induction motors.

Squirrel cage induction motors will generally be of TEFC/TETV design. However, motors for long distance conveyors will be of CACA design.

For starting of motors with high inertia, suitable soft starters will be considered, if required.

6.6 kV motors will be controlled from 6.6 kV switchboard-cum-MCC comprising requisite number of draw out type motor feeders with vacuum contactor, fuse and comprehensive motor protection relays. For



**A-7.0 - Site Service Facilities (cont'd)**

long distance conveyors, 6.6 kV power will be made available from 6.6 kV switchboard and the motors shall be fed through convert transformer and VSDs. VCB will be considered in the MCC for these feeders with feeder protection relays.

**TABLE A.7-3 - LIST OF EQUIPMENT FOR ELECTRICAL**

Sl. No.	Equipment/Item	Unit	Quantity
1.	33 kV overhead line	kM	7
2.	33 kV outdoor equipment	Lot	1
3.	33 kV unit VCB panel and control and relay panel	Sets	2
4.	2500 kVA, 33/6.9 kV ONAN type transformer with NGR, isolating switches and other accessories	Sets	2
5.	6.6 kV switchboard-cum-MCC and wall mounted control panel	Set	1
6.	1000 kVA, 6.6/0.433 kV, AN type transformer with accessories	Sets	2
7.	415 V switchboard	Set	1
8.	415 V APFC panel	Sets	2
9.	415 V motor control centre	Lot	1
10.	Variable speed drives	Lot	1
11.	Miscellaneous items (i.e. power and control junction box, local control station, safety switches, sirens etc.)	Lot	1
12.	Cables and cabling accessories	Lot	1
13.	Auxiliary power wiring system	Lot	1
14.	Earthing and lightning protection system	Lot	1
15.	Illumination system	Lot	1

415 V AC, squirrel cage induction motors will be provided with direct on-line starters comprising moulded case circuit breakers, magnetic contactors and electronic overload relays. Motor controls will be realised through factory assembled and wired motor control centres (MCCs) on the basis of technological and logical grouping. VSDs will be considered for apron feeders.



**A-7.0 - Site Service Facilities (cont'd)**

Earth leakage protection will be considered for all motors

Various field mounted devices such as safety switches, limit switches, proximity switches, encoders, transducers and brakes will be adopted for smooth control of process as required. It is proposed to standardise on various control devices.

**Auxiliary Power Distribution**

For auxiliary power distribution, factory assembled and wired power distribution boards (PDB) will be provided. MCCBs will be adopted for incoming and outgoing feeders to feed switch socket outlets, auxiliary MCCs, starter panels etc.

**Power and Control Cables**

33 kV and 6.6 kV cables will be of cross linked, polyethylene (XLPE) insulated, armoured type with aluminium conductors. 11 kV (E) grade cables will be used for 6.6 kV systems.

Cables for 415 V systems will be 1.1 kV grade, XLPE/PVC insulated, PVC sheathed, armoured/unarmoured and overall PVC sheathed type with aluminium conductors.

Multi core, PVC insulated, PVC sheathed, armoured/unarmoured and overall PVC sheathed type cables with copper conductors will be used for control applications.

PVC insulated, individually and overall shielded, PVC sheathed with high conductivity annealed tinned copper conductor in multi-pair/triad formation will be considered for analog signals.

A handwritten signature or set of initials in black ink, located at the bottom right of the page.



A-7.0 - Site Service Facilities (cont'd)

**Earthing and Lightning Protection System**

6.6 kV systems will be earthed through resistance so as to reduce the earth fault current. 415 V systems, however, will be solidly earthed at transformer neutral.

In designing the plant electrical installation, due attention will be given to the necessity for effective and efficient earthing of all non-current carrying metallic parts of various electrical equipment. Separate earth network with earth stations will be provided for special electronic and computer system earthing.

Lightning protection system as required will be provided for substations, plant buildings including ancillary buildings etc.

**Plant Illumination System**

The illumination system will be planned to cater to the illumination requirements for different units of the plant. The lighting power supply will be at 240 V AC.

Fittings with HPSV lamps are proposed in maintenance workshop, godown, store etc. However, for substations, canteen, admin building etc., fittings with LED lamps are envisaged. Well glass fittings with HPSV lamps are envisaged for low bay areas. High bay type fittings with HPSV lamps will be provided for high bay areas.

For the illumination of outdoor yards, flood light fitting with metal halide lamps are envisaged. Lighting fittings with HPSV lamps giving maximum light on the road surface are proposed for road lighting. Road and area lighting will be controlled through synchronous timer/automation system to avoid day time burning and thereby saving of energy.

**A-7.0 - Site Service Facilities (cont'd)**

In substations, admin building, canteen etc. emergency lighting backed up by UPS will be provided in addition to the general lighting.



**INSTRUMENTATION AND LEVEL-1 AUTOMATION SYSTEM**

The various units of Sijimali and Kutrumali bauxite deposits including stockpile, crusher units, reclaiming, belt conveyor and material handling system, will be provided with instrumentation and Level-1 automation system following the latest state-of-art technology. Required numbers of PLC will be provided at suitable locations considering the process requirement and plant area layout. The Level-1 automation system configuration has been considered based on the following:

- a) **Programmable Logic Controllers (PLCs)**
  - i) One no. PLC for material handling system (MHS).
  - ii) Required numbers of IO and remote IO panels will be provided, which will be located suitably.

Each of the above PLC will have CPU rack with central processing unit (CPU), power supply unit (PSU) and communication module and other cards/modules as may be considered necessary. The system will be provided with required numbers of remote input/output modules interfaced with CPU racks over field bus (Foundation field bus/Profibus/Profinet etc.).

- b) **Engineering station (ES) and Operator Stations (OS)**
  - i) One no. PC based Engineering-cum-Operator Station (ES/OS) for MHS.
  - ii) One no. PC based Operator Station (OS) for MHS.
  - iii) One no. Printer.



A-7.0 - Site Service Facilities (cont'd)

The Level-1 automation system will be configured for process control and monitoring functions as well as drive controls, interlocking and sequencing functions. The system will have necessary hardware and software features to ensure plant safety as well as ease in operation and maintenance. All ES/OS will be interfaced over ethernet network.

The software for the Level-1 automation system will be simple, user-friendly and having the provision of on-line editing and program development and diagnostic features without interrupting the process. Complete instrumentation and Level-1 automation system will be powered through UPS with battery back-up for duration of minimum sixty (60) minutes.

Various types of instruments/switches will be provided for weighing, vibration etc. measurements, indication and controls as per process requirement. Further, safety switches like belt sway switches, pull cord switches, proximity sensors, speed sensors, limit switches, hooters, beacons etc. will be provided for material handling system as per process requirement. All the field mounted instruments/sensors etc. will be interfaced over hardwired inputs/outputs and/or field bus technique to the remote I/Os. Various intelligent sub-systems (like belt-scales, VVVF drives, vibration systems, etc.) will be interfaced using suitable field bus (RS 485/Modbus/Foundation Field bus/Profibus etc.) technique.

Optical fiber cables (OFC) will be used for various communication buses which will be single mode or multimode type considering distance to be covered for the respective communication link.

Ergonomically designed control desk/console will be provided in control room, along with required furniture.

A handwritten signature or set of initials in dark ink, located at the bottom right of the page.



A-7.0 - Site Service Facilities (cont'd)

Due care will be taken while selecting the system/services in order to minimise use of different types of items, reduce spares inventory, provide easy interchange ability to simplify maintenance as far as possible.

The list of major equipment for instrumentation and Level-1 automation systems is presented below in Table A.7-4:

**TABLE A.7-4 - LIST OF MAJOR ITEMS FOR INSTRUMENTATION AND LEVEL-1 AUTOMATION SYSTEM**

Sl. No.	Description	Quantity
1.	PLC system	1 Lot
2.	HMI/Ethernet Switch/Printer	1 Lot
3.	Software/License	1 Lot
4.	Field Devices/Instruments	1 Lot
5.	FO Cable / Instrument Cable/ Control Cable	1 Lot
6.	Control Desk	1 Lot
7.	UPS with Battery	1 Lot
8.	Erection Hardware	1 Lot

**COMMUNICATION SYSTEM**

The communication facilities in Sijimali mining area, as envisaged, will include CCTV system, telephone system and wireless communication system.

IP based closed circuit television (CCTV) system will be provided for viewing critical operating areas of mines area from control room. The CCTV system will comprise of IP cameras, PC based video monitoring and control stations, active and passive network components and cable network. The CCTV system will be powered from UPS.



A-7.0 - Site Service Facilities (cont'd)

Telephone system will be provided for extending telephone connections at various office rooms and control rooms in mines area. Telephone system will have centralised telephone exchange and telephone network. Telephone network will comprise of cable distribution cabinet (DC), cable termination (CT) boxes, armoured and unarmoured telephone cables etc. Telephone exchange will support connectivity of trunk/PSTN/ISDN lines for providing communication to the outside world from mining area.

The external trunk/PSTN/ISDN lines will be arranged by the client from external service providers.

One integrated VHF/UHF based wireless communication system is envisaged for communication within and among Sijimali and Kutrumali mines area as well as with alumina plant. Communication between moving machine operators and control rooms as well as amongst operational and maintenance personnel within respective mines area will also be ensured through this system. Wireless communication system will comprise of required numbers of portable handheld sets, stationary/vehicle mounted transreceiver sets, repeater station (if necessary) with rechargeable battery and other accessories. Necessary site survey for line of sight clearance will be done for finalising wireless communication infrastructure during execution.

Allocation of frequency from Wireless Planning Commission, New Delhi will be arranged by the client.

**FIRE DETECTION AND ALARM (FDA) SYSTEM**

Intelligent addressable type FDA system is envisaged in Sijimali mines area for detection of fire and obtaining location details of fire. The system will comprise of microprocessor based fire alarm control panel,



**A-7.0 - Site Service Facilities (cont'd)**

administrative workstation, printer, various types of intelligent addressable automatic and manual detectors/devices, audio and visual fire indicators, different types of input/output interface modules and power and signal cables, as applicable. FDA system will be UPS power driven or provided with battery back-up.

FDA system will provide necessary interfaces with fire suppression systems, wherever applicable, for their automatic actuation in case of fire. It will have interlocking with air-conditioning and ventilation system for their automatic shut-off in case of fire.

FDA system will be considered for electrical buildings, office buildings, cable cellars, cable galleries etc as applicable.

Statutory clearance, as required, from local fire authority for the FDA system will be arranged by the L&T.

**WATER SYSTEM**

For Sijimali bauxite mining area, unfiltered water will be required for dust suppression of haul road and maintenance of top soil, dust suppression system at crushers, bins and material transfer points at conveyors, washing and cleaning of earthmoving equipments, watering of green belts planted to comply with requisite environmental guidelines. Filtered water will be used for drinking and sanitation purpose. The water requirement for Sijimali bauxite mining area is given in Table A.7-5 on the next page.

**Source of Water**

Source of water is Naragul Nallah (800 m RL) and water collecting point is situated at an approximate distance of 4000 metres from Sijimali hill top. The tentative location of the proposed tapping point of the Nallah is indicated in Drawing 11420-97C-000-PRM-0002.



A-7.0 - Site Service Facilities (cont'd)



**TABLE A.7-5 - WATER REQUIREMENT FOR SIJIMALI BAUXITE MINING AREA**

<b>Sl. No.</b>	<b>Consuming area</b>	<b>Water requirement, cu m/day</b>
1.	Haul road dust suppression including maintenance of top soil	460
2.	Washing and cleaning of earthmoving equipment (service water system)	100
3.	Drinking system	40
4.	High pressure fogging system at crusher	30
5.	Dry fog dust suppression system at bin and conveyors	20
6.	Vegetation and Horticulture	40
7.	Afforestation	70
8.	Miscellaneous	25
9.	<b>Total (adding Sl. No. 1 to 8)</b>	<b>785</b>
10.	Recycled water retrieved from water treatment plant at workshop	60
11.	<b>Net (Sl. No. 9 minus 10)</b>	<b>725</b>

Naragul Nallah is a perennial water stream, mostly fed by spring. The nallah originates from the hill near Majhigao, flows along the valley between Kutrumali and Sijimali plateau towards north-east to discharge into Barah Nadi, which in turn meets Nagaveli River in Kalyansinghpur. During this course, the flow in Naragul nallah is augmented by a number of spring fed streams discharging into it.

However, it is required to collect actual data/information regarding availability of required water from the Naragul Nallah and to obtain necessary permission from the concerned Government Authority to establish this stream as source of water to Sijimali mines.



**D**

A-7.0 - Site Service Facilities (cont'd)

**Water Supply System**

To enable drawal of water, a pick-up weir will be constructed on the Naragul Nallah. An intake well will be constructed on the Nallah bed at upstream side of the pick-up weir. On the basis of sixteen hours working per day, two pumps (one working and one standby), each of 50 cu m/hour capacity at approximately 750 mwc head will be provided in the intake well to pump water from the intake well to a ground water reservoir in the mines area.

**Water Storage and Distribution System**

The ground water reservoir will consist of two compartments, each of 750 cu m capacity storage capacity commensurate with one day's consumption), and is envisaged to be located on the service centre facility area of the Sijimali mines. Distribution of water from the ground water reservoir to various consuming points is planned to be carried out by gravity taking advantage of the gradient available.

Suitable connections will be provided at suitable locations for filling water tankers for haul road dust suppression system through stand-post type watering stations, as well as for watering vegetation, horticulture, afforestation and miscellaneous purpose.

**Drinking water system:** Water from ground water reservoir will be filtered in pressure filter, chlorinated and will be fed to the various PVC storage tanks, located at roof top of the office building, canteen and workshop. From the roof top tanks water will be distributed to consuming points.

**Service water system:** A dedicated circuit comprising of wash tank, re-circulating pump and settling tank shall be provided for washing and cleaning of various earthmoving equipment in workshop.



A-7.0 - Site Service Facilities (cont'd)

After washing and cleaning of equipment, waste water will be treated in a settling tank and recycled back to the wash tank. Necessary oil removal facility shall be provided in the settling tank. Make-up water from the ground water reservoir will be added to the wash tank.

**Dust suppression System at crushers, bins and conveyors:**

High pressure fogging system shall be provided for dust suppression at crusher house. For this, a dedicated tank and high pressure pumps shall be provided. Required make-up water will be provided to the tank from ground water reservoir.

For dry fog dust suppression system at bins and material transfer points of conveyors, pump, compressor and air receiver will be installed in a pump house. Duty parameters of pumps, compressor and air receiver will be selected considering the number of application points that will work at a time.

The schematic water flow diagram is given in Drawing I1420-97C-000-WTS-0001.

**Distribution Pipe Work**

Mild steel pipes will be considered for water services, except drinking water, which will be of galvanized mild steel. All pipelines except drinking water line and service water line in workshop will be routed over ground in the yard. Workshop internal pipes will be protection painted and will be routed through building structure. The pipe work will comprise of all necessary valves, fittings complete with all other accessories.

The list of equipment envisaged for water supply system is given in Table A.7-6 on the next page.



A-7.0 - Site Service Facilities (cont'd)

**TABLE A.7-6 - LIST OF EQUIPMENT FOR WATER SUPPLY**

Sl. No.	Description	Quantity
1.	Vertical turbine type intake pump, 50 cu m/hour, 750 mwc head	2 Nos.
2.	High pressure fogging system at crusher comprising water sump and high pressure pumping system	1 Lot
3.	Dry fog dust suppression system at bins and conveyors comprising water sump, pumping system, compressors etc.	1 Lot
4.	Drinking water system comprising pressure filter, water sump, pumping system, on line chlorination System, water tanks etc.	1 Lot
5.	Earth moving vehicles cleaning system comprising wash tank, pumping system, waste water treatment plant including settling tank and oil removing system etc.	1 Lot
6.	Pipe work including valves and fittings	1 Lot

**UTILITIES AND AUXILIARIES**

**Compressed Air**

Compressed air will be required for air filling in the tyres of heavy vehicles, cars and also cleaning and washing of the same. Dry compressed air will also be required for drying the washed cars/vehicles in the wash ramp area.

To meet the above requirement, two numbers (one working + one standby) reciprocating type air compressors with refrigerant type air dryers (one working + one standby) complete with oil filter are envisaged. Two numbers air receivers of suitable capacity will also be provided.



A-7.0 - Site Service Facilities (cont'd)

**Fuel System**

A fuel filling station will be provided inside the service centre facility area. The diesel filling station will comprise of underground diesel storage tanks and dispensing arrangement having a small shed and fire fighting facilities. Diesel will be received by means of road tankers. The same will be drawn by pumps and stored in tanks after filtration. During the day, the distribution pumps will ensure delivery of required quantity of diesel to the consumers. Storage tanks of suitable capacity with unloading pumps (one working + one standby each) and fuel filling pumps (one working + one standby) are envisaged.

**Air Conditioning System**

Air conditioning and ventilation system is required to create comfort ambience in the various areas for human and also for process equipments. Each system shall be interlocked with fire fighting system through fire fighting panel such that in the event of fire, concerned air conditioning and ventilation system are stopped automatically. All equipment shall be suitable for continuous duty.

Air conditioning system shall be air cooled package type for big room and for small room industrial split type will be considered. Refrigerants shall be environment friendly, R-407C or R-22 as available.

Details of the air conditioning system proposed are indicated in Table A.7-7 on the next page.

**Ventilation**

Ventilation system shall be designed so that room inside temperature shall be limited to 5°C over outside ambient temperature. The ventilation systems shall be designed on the basis of minimum 15 air changes per hour or heat load calculation, whichever is higher.



A-7.0 - Site Service Facilities (cont'd)

**TABLE A.7-7 - DETAILS OF THE AIR CONDITIONING SYSTEM**

Premises to be covered	Type	Maintenance parameters
Control rooms, PLC rooms, Electrical rooms, HT switchgear rooms, LT switchgear and MCC rooms, Capacitor room etc.	Air cooled package AC	Below 28°C and RH 55% (±)5%
Miscellaneous rooms and offices requiring air conditioning	Split AC units	Below 28°C

Dry ventilation system shall consist of tube axial supply air fan complete with dry air filter, flexible connection, duct work, fire damper, rain protection cowl, bird screen etc. Each exhaust fan capacity shall be ten per cent less than corresponding supply fan capacity to maintain slight room over pressure so as to prevent dust ingress inside each premises/area to be ventilated.

**Fire Fighting System**

The fire fighting system comprises of fire detection and alarm system followed by fire extinguishing system. Portable/mobile fire extinguishers shall be provided in different areas of the mine and plant area in adequate quantities as per the requirement. All portable/mobile type fire extinguishers shall conform to relevant Indian Standards. Each fire extinguisher shall have the instructions for operating the extinguisher on its body itself. All fire extinguishers shall have IS marking and certification.

The detail of fire fighting system is indicated in Table A.7-8 on the next page.

*d*



A-7.0 - Site Service Facilities (cont'd)

**TABLE A.7-8 - DETAILS OF FIRE FIGHTING SYSTEM**

Premises to be covered	Type
Electrical control buildings, PLC room, control rooms, computer room and sophisticated control room, switchgear rooms, MCC rooms, transformer rooms	Portable/mobile type fire extinguishers
Cable tunnel, cable basement, cable cellar etc.	Portable fire extinguishers.
Miscellaneous rooms and offices, heavy machineries	Portable/mobile type fire extinguishers

Apart from the above, portable fire extinguishers will be installed on the heavy earthmoving machineries for protection against fires. All premises will be provided with passive fire protection, automatic fire detection and alarm system and fixed fire hydrant, sand buckets etc. as per requirement.

#### **OTHER FACILITIES**

##### **Quality Control Centre**

A chemical laboratory has been provided for analysing advance check samples from benches, check samples from exploratory boreholes, as well as samples from blast holes and crushing plant.

It is envisaged that about 20 samples will be analysed daily by wet chemical method to determine:

- a)  $Al_2O_3$ ,  $SiO_2$ ,  $Fe_2O_3$  and LOI in all samples, and
- b)  $TiO_2$ ,  $V_2O_5$  and  $MnO_2$  in about 10 per cent of the total samples analysed.

**A-7.0 - Site Service Facilities (cont'd)**



The laboratory will operate in general shift only and six days a week. Besides above, it is also planned to provide computer facilities for data storage, quality control and production planning. The facility may be utilised for stores inventory control also.

**Repair and Maintenance Shop**

To ensure high level of availability and smooth operation of the mine and plant equipment of the type and size envisaged under this project, it is essential to provide captive facilities for preventive maintenance and breakdown repair, particularly in view of the fact that Sijimali is situated in remote interior area, and is not having any readily available infrastructure in the near vicinity.

Accordingly, it is proposed to set up a central repair and maintenance shop at Sijimali which will be equipped with facilities for machining, fabrication and assembly, structural repair, rebuilding of spares and components, smithy work, engine overhauling, auto-electric and battery reconditioning, tyre repair etc as well as servicing of mobile equipment and transport vehicles. The central repair shop will be generously spaced to facilitate easy handling of material and movement of equipment. For this purpose a travelling electric hoist of 10 ton capacity will be installed inside the shed. Besides, a large open yard is provided inside the campus adjacent to repair shop for parking the mobile equipment and attending the same.

To enable the repair crew to speedily attend to breakdowns in the field, it is proposed to make provision for mobile repair vans equipped with air compressor, hand drill, pneumatic grinder, pipe threading device, volume pump and grease gun, welding and gas cutting set, set of tools etc. A mobile crane of 10 ton capacity will also be provided for dismantling and mounting of component assemblies and subassemblies of field equipment.



A-7.0 - Site Service Facilities (cont'd)

**Stores**

To ensure uninterrupted production in the mine, adequate stock of slow and fast moving spares are planned to be maintained in a store which will be located adjacent to the central repair and maintenance shop in the proposed service centre facility complex. Facilities will be provided for storage of all spare parts and bulk materials, consumables, steel sections and plates, pipes and fittings, oil and lubricants etc.

The store will consist of the following:

- a) Store office and receiving section
- b) General stores for spares and consumables
- c) Open store yard, and
- d) P.O.L. godown

Provision for fork lift truck, a jib crane, couple of trolleys, weigh scales, adequate number of racks and some tools will be made to facilitate transportation, unloading, handling and storing of materials. The computer provided in the quality control centre may be made use of for the purpose of inventory control.

**Administrative Building**

The administrative building will accommodate the offices of the General Manager and other senior officers and their staff. It will be located inside the service centre facility compound. Area for parking of cars and other light vehicles will be provided near the administrative building compound. Offices of contractors, if any, will be provided inside the administrative building.



**A-7.0 - Site Service Facilities (cont'd)**

**Gate House and Check Posts**

A room for security guard will be provided in the gatehouse located on the access road at its entry point in the plateau to exercise effective control over incoming and outgoing vehicles and personnel. Besides, two check posts, one each at the entry point of administrative office compound and service centre facility compound will be provided.

**Time Office**

A time office has been provided in the service centre facility/administrative building area, with counter opening and queuing space for the working personnel to record their attendance after disembarking from the bus and before proceeding to their work station. The time office may be used for disbursement of payment also, if deemed fit.

**First Aid Station**

A first aid station under the charge of medical assistant will be provided in the service centre, as required by the Mines Rules, 1955, for rendering first aid and preliminary medical assistance to employees working in the mine. Provision of an ambulance will be made for quick transport of sick and injured workers to the nearby hospital.

**Training Centre**

A training centre will be set up to render vocational training to the persons working in the mine, in accordance with the Mines Vocational Training Rules, 1966.

**Canteen**

A central canteen, located in the service centre area will serve snacks and refreshments to the workers, supervisory and office staff working in the administrative building and adjacent areas. In addition, canteen vans will be provided to supply snacks to the workers and supervisory staff of the mine and the crushing plant.



**A-7.0 - Site Service Facilities (cont'd)**

**Rest Shelter and Ablution Block**

One rest shelter and ablution block will be located in the service centre facility area for the workers employed and will be provided with lockers, bathrooms, washing troughs and water closets.

**Transport**

Jeeps and pick-up vans will be provided for transport of supervisory staff to work site and to facilitate inspection and supervision of work. These vehicles will also be used by supervisory staff and workers to attend to breakdown of mining and plant equipment, as and when necessary. Buses will be provided for transport of workers to work sites. Trucks will be employed for distribution of materials in the mine and the plant, and also for collection of materials from alumina plant or the nearest railway station. Provision will be made for canteen van and ambulance van as described earlier. Wheel-mounted water tankers will also be provided for miscellaneous work. A diesel tanker will be used for disbursing fuel to the semi-mobile crawler-mounted equipment stationed in the mine site.

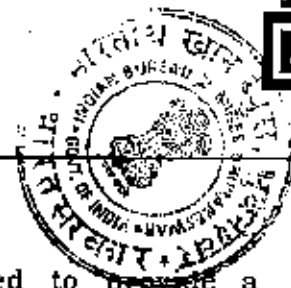
**EMPLOYMENT POTENTIAL**

This section deals with the organisation structure and the manpower required for efficient management and smooth operation of the mine.

**Organisation Structure**

To ensure sustained supply of bauxite conforming to the stipulated chemical specification to the alumina plant, it is proposed to develop the Sijimali bauxite deposit as a captive mine.

A handwritten signature or set of initials, possibly 'd', located at the bottom right of the page.



A-7.0 - Site Service Facilities (cont'd)

The organisation structure has been developed to provide a management control system based on functional requirements, lines of responsibility and span of control. In developing the organisation structure, practices prevailing in the captive mines of the country have generally been taken into consideration.

From the organisational viewpoint and for administrative convenience, the organisation for the mine will be headed by a General Manager.

The General Manager will be responsible for the overall administration and operation of the mine and the crushing plant as well as conveying system including planning; surveying, quality control, maintenance, cost, safety and labor relations. The Mines Manager will be directly responsible for administration and operation of the mine. The General Manager will be directly assisted by a number of other managers heading respective departments. The office of the General Manager will be located in the administrative building at the mine.

**Manpower Requirement**

Actual requirement of manpower is generally worked out after detail engineering study during project implementation stage. However, a preliminary estimate has been made to indicate the order of manpower requirement. It must be emphasized that systematic industrial engineering study of the mine, crushing plant, ore transportation system and auxiliary facilities etc needs to be carried out later, to determine the manpower requirement. Such a study should take into account the finalised details of equipment and other facilities, as well as the standard norm of L&T in respect of designation, organisation structure etc.



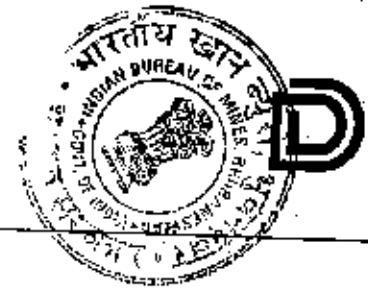
A-7.0 - Site Service Facilities (cont'd)

A preliminary estimate of the manpower requirement is given below in Table A.7-9:

**TABLE A.7-9 - DETAILS OF MANPOWER**

<b>Category</b>	<b>Manpower</b>
Managerial	20
Supervisory	20
Clerical	15
Skilled	145
Semi-skilled	30
Un-skilled	10

A handwritten signature or set of initials is located at the bottom right of the page.



**A-8.0 - PROGRESSIVE MINE CLOSURE PLAN UNDER RULE  
23 OF MCDR' 1988**

**ENVIRONMENT BASE LINE INFORMATION**

In order to determine the pre-project environmental status at the study area, field monitoring was carried out during the pre-monsoon season from 1st March 2016 to 31st May 2016. Summary of monitored baseline data is given below.

**Existing Land Use Pattern**

The land use pattern of the study area (covering 10 km area around the mining lease area) based on IRS RS-2 LISS-IV FX indicating the areas are given below in Table A.8-1:

**TABLE A.8-1 - LAND USE PATTERN OF THE STUDY AREA**

Sl.No.	Particulars	Area, in sq.km	Area, in %
1.	Settlements	18.504	3.60
2.	Scrub forest	111.024	21.60
3.	Single crop agricultural land	12.850	2.50
4.	Scrub land	340.782	66.30
5.	Waste land without scrub	2.056	0.40
6.	Water body	28.784	5.60
	<b>Total</b>	<b>514.000</b>	<b>100.00</b>

The land use pattern of the proposed mining lease area of Sijimali bauxite deposit is given in Table A.8-2 on the next page.

**Drainage Pattern of the Sijimali Bauxite Mine**

The main drainage pattern in this area is controlled by a number of streams, which drains their water into Nagavalli River that flows from north to south. The Barha Nadi, a tributary of Nagavalli



A-8.0 - Progressive Mine Closure Plan under Rule 23  
(cont'd)

River, flows along east-west direction on the northern side of the Sijimali plateau. The natural drainage net comprises numerous rills and gullies which drain the collective discharge to a perennial stream, Naragul Nala, flowing along the south-eastern part of Sijimali plateau base which drains into Barha Nadi. No streams are passing through the ML area.

**TABLE A.8-2 - LAND USE PATTERN OF THE PROPOSED ML AREA**

Land use	Sijimali ML area, Ha
Settlements	1.787
Land with scrub	1538.036
Land without scrub	20.577
Streams <sup>(1)</sup>	Included in land with scrub
<b>Total area</b>	<b>1560.400</b>

**Note:**

- (1) Land occupied by streams/water body to be finalized.

**Ambient Air Quality**

Ambient Air Quality Monitoring (AAQM) stations were set up at eight locations. The summary of the results for each location are presented in Appendix A.8-1.

**Water Quality**

Four (4) surface water and eight (8) ground water sources in the study area were examined for physico-chemical, heavy metals and bacteriological parameters in order to assess the effect of mining and other activities on surface and ground water. The analytical results of surface water samples are given in Table A.8-3 on the next page. The analytical results of ground water samples are presented in Appendix A.8-2.



A-8.0 - Progressive Mine Closure Plan under Rule 23 (cont'd)

**TABLE A.8-3 - SURFACE WATER QUALITY**

Code	Location
SW-1	Barha Nadi
SW-2	Naragui nala
SW-3	Naghulu Nadi
SW-4	Sujingabandh nala

Sr. No	Parameters	Units	SW1	SW2	Sw 3	SW 4
1	pH	-	7.4	7.6	7.5	7.6
2	Colour	Hazen	7	6	10	8
3	Conductivity	-	75.0	108.0	138.0	82.0
4	TDS	-	51.0	75.0	98.0	45.0
5	DO	µS/cm	5.9	5.8	5.6	5.7
6	BOD	NTU	<3	<3	<3	<3
7	COD	mg/l	<5	<5	<5	<5
8	Total Hardness as CaCO <sub>3</sub>	mg/l	32.0	40.0	46.0	22.0
9	Total Alkalinity as CaCO <sub>3</sub>	mg/l	23.0	36.0	22.0	21.0
10	Calcium as Ca	mg/l	6.4	8.0	10.4	6.4
11	Magnesium as Mg	mg/l	3.9	4.9	4.9	1.5
12	Chlorides as Cl	mg/l	4.3	4.3	2.8	2.8
13	Residual free chlorine	mg/l	<0.2	<0.2	<0.2	<0.2
14	Phosphates as PO <sub>4</sub>	mg/l	<0.1	<0.1	<0.1	<0.1
15	Sulphates as SO <sub>4</sub>	mg/l	7.7	11.1	38.0	2.6
16	Fluorides as F	mg/l	<0.1	0.1	0.1	0.1
17	Nitrites as NO <sub>2</sub>	mg/l	1.0	<1.0	3.7	5.1
18	Sodium as Na		1.4	3.7	6.3	2.6
19	Potassium as K		2.3	5.2	7.5	3.5
20	Total Boron as B	mg/l	0.08	0.07	0.17	0.05
21	Phenolic Compounds	mg/l	<0.001	<0.001	<0.001	<0.001
22	Cyanides	mg/l	<0.02	<0.02	<0.02	<0.02
23	Oil & grease	mg/l	<1.0	<1.0	<1.0	<1.0
24	Cadmium as Cd	mg/l	<0.003	<0.003	<0.03	<0.003
25	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01
26	Copper as Cu	mg/l	0.01	0.01	0.12	0.02
27	Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01
28	Iron as Fe	mg/l	1.06	0.15	8.47	1.63
29	Chromium as Cr <sup>+6</sup>	mg/l	<0.05	<0.05	<0.05	<0.05
30	Selenium as Se	mg/l	<0.01	<0.01	<0.01	<0.01
31	Zinc as Zn	mg/l	0.03	0.02	0.06	0.01
32	Aluminum as Al	mg/l	1.34	0.04	5.85	2.26
33	Mercury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001
34	SAR	mg/l	0.11	0.25	0.40	0.24
35	Insecticides	mg/l	Ab	Ab	Ab	Ab
36	Anionic detergents as MBAS	-	<0.2	<0.2	<0.2	<0.2
37	Total Coliforms	MPN/100	10	13	18	15



A-8.0 - Progressive Mine Closure Plan under Rule 23 of MMR, 1982  
 (cont'd)

### Ambient Noise Level

The noise monitoring has been conducted for determination of ambient noise levels at eight (8) locations in the study area. The noise levels at each location were recorded for 24 hours. The statistical analysis is done for measured noise levels at eight locations. The parameters are analyzed for L10, L50, L90, Leq, Lday, Lnight, and Ldn. The statistical analysis results are given below in Table A.8-4:

**TABLE A.8-4 - NOISE LEVELS [(DB (A)) IN THE STUDY AREA**

Code	Location	L10	L50	L90	Leq	Lday	Lnight	Ldn
N1	ML Area	46.3	42.6	39.0	43.5	44.1	40.9	47.9
N2	Amapadar	41.4	37.5	33.7	38.5	39.4	35.8	42.9
N3	Nagarundi	42.7	38.9	35.4	39.8	40.4	37.4	44.4
N4	Melarapa	44.8	41.0	37.5	41.9	42.5	39.5	46.5
N5	Kuturmali	45.7	42.1	38.4	43.0	43.5	40.5	47.5
N6	Sargipadar	43.5	39.6	35.8	40.6	41.6	37.7	44.9
N7	Sunger	50.1	46.4	42.8	47.3	47.8	44.9	51.9
N8	Aliguna	49.9	46.3	42.6	47.2	47.7	44.6	51.6

### ECOLOGY AND BIODIVERSITY

An ecological survey of the study area was conducted particularly with reference to the listing of species and assessment of the existing baseline ecological (Terrestrial and Aquatic ecosystem) conditions in the study area.

### Vegetation Structure and Composition

The region falls under the Tropical Mixed Dry Deciduous type of vegetation mainly disturbed, and undisturbed thick covered with leaf litters. The species in the region are Albizzia sp., Anogeissus latifolia, Artocarpus heterophyllus, Bauhinia sp, Bombax cieba,



A-8.0 - Progressive Mine Closure Plan under Rule 23 of MCR  
(cont'd)

*Butea frondosa*, *Shorea robusta*, *Madhucia indica*, *Mangifera indica*,  
*Ficus religiosa*, *Syzgium cumini*, *Terminalia tomentosa*, *Terminalia*  
*bellerica*, *Adhatoda vasica*, *Cassia fistula*, *Capparis spinosa*, *Calotropis*  
*sp.*, *Dalbergia sp.*, *Embluca officinalis*, *Hibiscus sp.*, *Lantana camara*,  
*Wrightia tinctoria*, *Zizyphus sp.*, *Aegeratum conzyoides*, *Achyranthes*  
*aspera*, *Argemone Mexicana*, *Indigofera tinctoria*, *Tridax procumbens*,  
*Alternanthera sessilis*, *Sida rhombifolia*.

#### **Endangered Plants**

The study area did not record the presence of any critically threatened species. The records of Botanical Survey of India and forest department also did not indicate presence of any endangered and or vulnerable species in this area.

#### **National Park/Sanctuary**

As per Ministry of Environment Notifications and Local forest notifications there are no wildlife sanctuaries, National parks/ biospheres within 10 km radius from the lease boundary. The Karlapat Sanctuary is 12.9 km, North direction.

#### **Avifauna**

The area is rich in avian biodiversity with forest and woodland birds such as *Tyto alba* (Barn owl), *Turdoides striata*- Jungle babblers are found in the buffer zone along with *Pavo cristatus*-Peafowl in the study area, along with Baya weavers-*Ploceus philipinus*.

#### **Rare, Endangered and Threatened Fauna in the Study Area**

There are no endangered fish and nor there are no threatened and rare, endangered plants in the study area, as per the classification of the Botanical Survey of India, records. Fauna like Wild boar were observed in the field study along with the mammalian fauna and other fauna listed in the study area.



A-8.0 - Progressive Mine Closure Plan under Rule 23 of  
 (cont'd)

## CLIMATIC CONDITIONS

### Meteorological Data Generated at Site

The meteorological parameters have been recorded on hourly basis during the study period and the parameters recorded at site includes wind speed, wind direction (from 0 to 360 degrees), temperature, relative humidity, atmospheric pressure, rainfall and cloud cover. The site specific data is presented below in Table A.8-5:

**TABLE A.8-5 - SUMMARY OF THE METEOROLOGICAL DATA MONITORED AT SITE**

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	Cloud Cover (Oktas)
	Min	Max	Min	Max		
March' 16	20.4	37.4	53.4	76.1	79.6	5/8
April' 16	24.1	39.8	32.2	51.9	41.8	3/8
May' 16	25.2	40.1	28.7	49.5	48.9	4/8
Range	20.4 - 40.1		28.7 - 76.1		170.3	

### Wind Speed/Direction

The wind roses for the study period representing pre-monsoon season shows that predominant winds are mostly from SW (18.9%), NW (16.8%). Calm condition prevailed for 13.7% of the total time.

## DEMOGRAPHY

### Distribution of Population

As per 2011 census the study area consisted of 38,515 persons inhabited in study area. The distribution of population in the study area is shown in Table A.8-6 on the next page.



A-8.0 - Progressive Mine Closure Plan under Rule 23(2) of the Mines Act, 1952 (cont'd) 1988

**TABLE A.8-6 - DISTRIBUTION OF POPULATION**

Particulars	0-3 km	3-7 km	7-10 km	0-10 km
No. of Households	1,995	4,042	4,136	10,173
Male Population	3,839	7,778	8,645	20,262
Female Population	4,200	8,568	8,797	21,565
Total Population	8,039	16,346	17,442	41,827
Male Population (0-6 years)	790	1,554	1,698	4,042
Female Population (0-6 years)	801	1,591	1,659	4,051
Total Population (0-6 years)	1,591	3,145	3,357	8,093
% of 0-6 years population	19.79	19.24	19.25	19.35
Average Household Size	4.03	4.04	4.22	4.11
% of males to the total population	47.75	47.58	49.56	48.44
% of females to the total population	52.25	52.42	50.44	51.56
Sex Ratio (no of females per 1000 males)	1,094	1,102	1,018	1,064
Density	424	315	256	301

Source: District Census Hand Book -2011

The average household size of the project area is 4.11 with 48.44% male and 51.56% female. About 18.555% of the population belongs to SC and 66.28% ST. They are considered at low levels of social strata and calls for special attention by project proponent for improving their socio economic status apart from preservation and protection of their culture and traditional rights of livelihood. The literacy level is 37.62% which is less than the literacy levels at the two districts concerned (Rayagada 49.8% and Kalahandi 59.2%). The work participants of the area are 47.46% and the non worker is 52.52% of the total population. Out of work participants, main workers are 37.7% and marginal workers are 62.3%.

The environment plan is shown in Drawing 11420-97C-000-ENV-0001.



A-8.0 - Progressive Mine Closure Plan under Rule 23 of MCDR, 1988  
(cont'd)

## **POTENTIAL IMPACT AND MITIGATION MEASURES**

### **Land Area Degradation**

The total leasehold area of Sijimali bauxite deposit is 1560.400 Ha (1549.086 Ha as per the DGPS Survey). Out of this, about 980 Ha area will be degraded due to mining operation and about 3.35 Ha for infrastructure workshop etc.

The overburden/mineral reject generated during mining operation initially will be kept at a separate area and after few years of working when sufficient void is created the area will be backfilled and gradually it will reclaim by putting the topsoil over the backfilled area. As far as practicable, original contour is to be restored. The adequate tree plantation will be done on the reclaimed area in a progressive manner.

### **Air Quality**

There will be generation of dust and gases during the mining operation. Level of particulate matter is also likely to increase due to HEMM deployment for mining operation. The exhaust emission from machineries will result in slight increase of level of SO<sub>2</sub> and NO<sub>x</sub>. But the increase in the work place is significant since it is an open cast mine. Proper maintenance as per manufacturer guidelines is to be done to control the emission levels of SO<sub>2</sub> and NO<sub>x</sub>. Sufficient green belt will be developed along the periphery of the mine boundary.

To avoid creation of dust, drilling with dust extractor/wet drilling will be used. Dust mask will be provided to protect the workmen who are exposed to prolonged dust.



A-8.0 - Progressive Mine Closure Plan under Rule 23 of MCD 1968  
(cont'd)

Periodical monitoring of air will be carried out throughout the life of the mine. The phase wise monitoring will be confined to 8 hours per day per season (two day per week for one month) and four seasons per year throughout the life of the mine.

#### **Water Quality**

No toxic materials from the mine will be generated. Impact on water quality would be due to flow of sediments mostly during rainy season. A set of catch drains will be made to channelize the surface runoff which will be merged to the natural water courses at the plateau top. Peripheral drains all around the dumps shall be made to trap rain water washings out of the dumps, which in turn will reduce the load of suspended solids in the discharged water. Sump pits will be provided along the length of the drains for effective trapping of rain water washings and discharging the clear overflow water to the nearby streams.

#### **Noise Levels**

There will be increase in noise level due to crusher, conveyor and heavy vehicles.

Equipments will be maintained as per guideline of the manufacturer to keep the noise level below the permissible limits. Workers will be provided with necessary protective equipment, e.g. ear plug, ear muffs etc. Sufficient green belt will be provided along the periphery of the mine boundary and along the road and reclaimed area.

#### **Vibration Levels (Due to Blasting)**

Care would be taken to keep the vibration levels due to blasting within safe and permissible limits. Based on the experience of field trials of blasting in the mine, charging of holes would be optimized to control



A-8.0 - Progressive Mine Closure Plan under Rule 23 of MMR, 1983  
(cont'd)

the vibration levels. Controlled blasting technique will be used where the working is nearby any surface infrastructure to minimize the effect of vibration to the extent possible.

#### **Water Regime**

During the summer month (April to June) maximum water is required for dust suppression and plantation. About 520 cu.m. of water is required per day, out of that 50 cu.m. will be recycled. Hence, net requirement of raw water is 470 cu.m. which will be sourced from Naragul nalla through intake pumps. Disturbance to ground water level due to mining is not envisaged as the mine working depth would be lesser than the ground water table depth.

#### **Acid Mine Drainage**

There is possibility of grease and oil mixing with the discharge water from the work shop. To mitigate this, water treatment plant will be installed.

#### **Socio-Economic Impact**

Due mining activity, there will be direct employment as well indirect employment which may be three to five times of the direct employment. The project proponent is committed to take up the socio economic initiatives not only to minimize the negative impact on the population but also to improve the socio economic status of the population lying within the 10 km. radius of the project as part of Corporate Social Responsibility. Developing of infrastructure facilities such as medical facilities for healthcare, schools for education, road for communication etc. will also be a part of the CSR activities. As a result there will be considerable change in life style and general cultural awareness amongst the people in the area.



**D**

A-8.0 - Progressive Mine Closure Plan under Rule  
(cont'd)

**Historical Monuments etc.**

There are no historical monuments within the lease area and hence, no damage to historical monuments is envisaged for this project.

**PROGRESSIVE RECLAMATION PLAN**

The overburden/mineral reject generated during the extraction of Block-I will be kept in earmarked areas. Thereafter the fresh generation of overburden/mineral reject will be dumped in-pit to fill the voids created out of mining the ore. The in-pit filling of voids will start during the third year of mining operation and will continue in combination with outside dumping. The outside dumping will continue till sufficient void is created in-pit to accommodate the fresh arising of overburden/mineral reject. The overburden/mineral reject dumped outside of pit will ultimately be re-handled suitably at a later stage for backfilling of exhausted mine pits.

**Mined Out Land**

It becomes necessary to reclaim the mined out land to its original shape as far as practicable. During the first five years it may not be possible to reclaim the degraded land due to formation of different benches in different levels simultaneously for achieving the targeted production. However, backfilling will be started from the 3rd year in Pit-B as bauxite in some of the areas will be exhausted. The restoration will cover backfilling and terracing of the mined out area by dumping of over burden and surfacing with top soil. The backfilling of mined out lands proposed to be done during first five years of mining operation have been shown in Drawings 11420-97C-000-PRM-0013 to 11420-97C-000-PRM-0015.

A handwritten signature or set of initials, possibly 'd', located at the bottom right of the page.



A-8.0 - Progressive Mine Closure Plan under Rule 23 of the Mines Act, 1952 1988  
(cont'd)

During subsequent years, mined out pits will be similarly backfilled with overburden/mineral reject generated from the mine workings and the same will be surfaced with topsoil before afforestation can be done for reclamation of the land. At the end of the proposed total extraction of ore from Sijimali, some portions of the land would remain degraded due to mining and it is proposed to reclaim the degraded land to bring back its original contour as far as possible by backfilling and terracing with overburden/mineral reject materials. The progress of proposed reclamation activity in five yearly periods has been shown in Drawing 11420-97C-000-PRM-0018.

As a part of eco restoration, it is decided to carry out afforestation in the following manner:

- a) Initially afforestation will be done along the safety barrier against the lease/geological boundary for Block-I and the periphery of the service centre area. At later stages, when the mining activity will progress to the other blocks, afforestation along the safety barriers will be accordingly done.
- b) Backfilling work will start during the third year of mining operation. After backfilling of voids, the area will be sprayed with top soil for enabling plantation. It is envisaged that, plantation on the reclaimed areas will start at the end of five year period of mining operation.

It is also proposed to create a green belt on the periphery of the important installations like administrative building, approach roads to the mine as well as road to the alumina plant.

Overburden/mineral reject dumping at outside dumps will continue beyond the first five years. These dumps will be re-handled at a later stage when sufficient space will be created in the mined out areas. Hence, temporary stabilization and protection measures like creation of garland drains etc. will be taken, if needed, for these overburden/mineral reject dumps.



**D**

A-8.0 - Progressive Mine Closure Plan under Rule 28 of MCDR, 1988  
(cont'd)

#### **Topsoil Management**

The topsoil removed ahead of bauxite mining will generally be stored in the earmarked areas over mineralized zone temporarily during the initial years of operation. However, some of the removed top soil will be utilized for plantation on the safety barrier as well as around the periphery of the service centre area during the first five years. The topsoil spreading on backfilled areas is envisaged to start in the fourth year and will continue with the progress of the backfilled areas. The topsoil stored on the surface will be utilised and spread on the backfilled areas as per requirement.

#### **Tailings Dam Management**

Since upgradation of bauxite is not envisaged, no tailings will be generated from the mine. Hence, there will not be any tailing pond for the mine.

#### **Acid Mine Drainage**

There is possibility of grease and oil mixing with the discharge water from the work shop. To mitigate this, water treatment plant will be installed.

#### **Year-wise Proposal for Progressive Reclamation Plan**

The summary of year-wise proposal for progressive reclamation plan is presented in Table A.8-7 on the next page.

#### **DISASTER MANAGEMENT AND RISK ASSESSMENT**

Proper training will be given to all the employees to mitigate any accident/disaster condition. Standing order will be framed in consultation with all concerned. Mock rehearsal will be conducted in regular interval for effective implementation.

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



A-8.0 - Progressive Mine Closure Plan under Rule 23  
 (cont'd)

**TABLE A.8-7 - SUMMARY OF YEAR-WISE PROPOSAL FOR PROGRESSIVE RECLAMATION PLAN**

Items	Details	Year										Re- marks
		I		II		III		IV		V		
		Pro- posed	Act ual	Pro- posed	Act Ual	Pro- posed	Act ual	Pro- posed	Act ual	Pro- posed	Act ual	
Dump man- agement	Area afforested (ha)	Nil		Nil		Nil		Nil		Nil		
	No of saplings planted	NA		NA		NA		NA		NA		
	Cumulative no of plants	NA		NA		NA		NA		NA		
	Cost including watch and care during the year	NA		NA		NA		NA		NA		
Man- agement of worked out benches	Area available for rehabilitation (ha)	Nil		Nil		Nil		Nil		Nil		
	Affores- tation done(ha)	NA		NA		NA		1.27		6.30		
	No of saplings planted in the year	NA		NA		NA		NA		NA		
	Cumulative no of plants	NA		NA		NA		NA		NA		
	Any other method of rehabilitation (specify)	-		-		-		-		-		
	Cost including watch and care during the year	NA		NA		NA		NA		NA		
Recla- mation and Rehabi- litation by back- filling	Void available for Backfilling (L x B x D) pit wise/stope wise	Nil		Nil		246678 Area 15417 sq m Depth 16 m		203700 Area 12731 sq m Depth 16 m		1515017 Area 63125 sq m Depth 24 m		Figures are in cu. m
	Void filled by waste / tailings	-		-		120000		100000		750000		Figures are in cu. m
	Affores- tation on the backfilled area	NA		NA		NA		NA		NA		
	Rehabi- litation by	Nil		Nil		Nil		Nil		Nil		

*ch*

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



A-8.0 - Progressive Mine Closure Plan under Rule 23 of MCR 21988  
 (cont'd)

Items	Details	Year										Remarks	
		I		II		III		IV		V			
		Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual		
	Making water reservoir												
	Any other means (specify)												
Rehabilitation of waste land within lease	Area available (ha)												
	Area rehabilitated												
	Method of rehabilitation												
Others	Plantation on safety barrier and service centre (ha)	0.6		0.7		0.7		0.7		1.0			
	Retaining wall	L - 552 m W - 1.5 m											
	Garland drain	L - 17633 m W - 1.5 m											
	Settling tank	A - 3000 sq m											

The entire mining operation will be mechanized operation and hence, concentration of workmen in a given place is minimal. About 60% of the required fragmentation will be carried out by blasting. To mitigate the risk of accident due to blasting, following steps will be taken:

- a) Blasting will be done only in day time specially during shift change over.
- b) Sufficient warning system will be followed during blasting.
- c) Controlled blasting technique will be used whenever required.

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



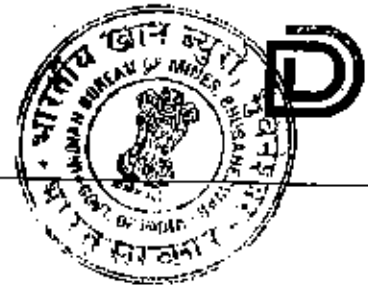
A-8.0 - Progressive Mine Closure Plan under Rule 23 of MCDR 1988  
(cont'd)

Mining operation will be carried out on the plateau top region. Thus, there will be minimal chance of inundation due to inrush of water from nallah or any other external water sources. The ground water table also will not be disturbed by mining operation and hence, inrush of ground water is not anticipated. To channelize the rain water, the working bench floors shall be maintained at a self-draining slope towards the natural drainage of the plateau. A set of catch drains will be made to channelize the surface run-off which will be merged to the natural water courses at the plateau top. In the course of mining, some localized depressions may be created. In some depressions, where water logging may cause difficulty in mine operation, a portable diesel pump of 100 cu m per hour capacity will be employed to pump out the accumulated water and discharge the same to the natural water courses for ultimate discharge to main water course. The peripheral barrier will be breached at places and culverts will be provided on the roads wherever necessary for evacuation of the water from mining area. A suitable standing order will be framed for proper implementation.

There is a chance of collapse/slope failure in mining benches. To avoid this, suitable angle will be maintained so that there should not be any collapse of benches especially in monsoon. Suitable studies will be carried out to find out the safe slope of benches in the mine. Care would be taken to avoid damage to men and machineries due to bench collapse.

In addition to the above, there are chances of fires on the heavy machineries and inside the infrastructure areas. Keeping in view the above, potable fire extinguishers will be provided at suitable places inside the service facility complex as well as on the heavy machineries.





**B-9.0 - CERTIFICATES/UNDERTAKINGS/CONSENTS**

**CONSENT LETTER/UNDERTAKING/CERTIFICATE FROM THE APPLICANT**

The letter issued by L&T in this regard is presented in Appendix B.9-1.

**CERTIFICATE FROM QUALIFIED PERSON**

The Certificate from Qualified Person is appended in Appendix B.9-2.

A handwritten signature or set of initials in black ink, located at the bottom right of the page.



D

**B-10.0 - LIST OF PLANS AND SECTIONS**

This list of Plans and Sections is given below:

Drawing No.	Description
11420-97C-000-PRM-0001	Location plan
11420-97C-000-PRM-0002	Key plan
11420-97C-000-PRM-0003	Geological plan
11420-97C-000-PRM-0004	Borehole plan for additional drilling
11420-97C-000-PRM-0005	Development section along A-A' - First five years operation
11420-97C-000-PRM-0006	Development section along B-B' - First five years operation
11420-97C-000-PRM-0007	Geological sections for estimation of resources - Along W1-E1 to W7-E7
11420-97C-000-PRM-0008	Geological sections for estimation of resources - Along W8-E8 to W13-E13
11420-97C-000-PRM-0009	Geological sections for estimation of resources - Along W14-E14 to W19-E19
11420-97C-000-PRM-0010	Geological sections for estimation of resources - Along W20-E20 to W26-E26
11420-97C-000-PRM-0011	Mine development plan - First year
11420-97C-000-PRM-0012	Mine development plan - Second year
11420-97C-000-PRM-0013	Mine development plan - Third year
11420-97C-000-PRM-0014	Mine development plan - Fourth year
11420-97C-000-PRM-0015	Mine development plan - Fifth year
11420-97C-000-PRM-0016	Mine general layout
11420-97C-000-PRM-0017	Conceptual mining plan
11420-97C-000-PRM-0018	Reclamation Plan
11420-97C-000-PRM-0019	Development section along A-A' - Conceptual mining plan
11420-97C-000-PRM-0020	Development section along B-B' - Conceptual mining plan

*[Handwritten signature]*



B-10.0 - List of Plans and Sections (cont'd)

Drawing No.	Description
11420-97C-000-PRM-0021	Crushing plant - Flow sheet
11420-97C-000-PRM-0022	Crushing plant - Plan
11420-97C-000-PRM-0023	Crushing plant - Section
11420-97C-000-PRM-0024	Key plan and profile of long distance conveyor
11420-97C-000-PRM-0025	Service centre facilities
11420-97C-000-PRM-0026	Surface plan
11420-97C-000-PRM-0027	Mine drainage plan
11420-97C-000-PRM-0028	Financial assurance plan
11420-97C-000-PRM-0029	Composite mine development plan - First five years operation
11420-97C-000-PRM-0030	Additional development section - First five years operation
11420-97C-000-ELE-0001	Overall Single line diagram
11420-97C-000-WTS-0001	Water flow diagram
11420-97C-000-ENV-0001	Environment plan
Map FDC-220/1	DGPS Survey Map for Kalahandi
Map FDC-220/2	DGPS Survey Map for Rayagada

The above Drawings and Maps are presented in Volume-III in two (2) parts, Part-A (Drawings 11420-97C-000-PRM-0001 to 11420-97C-000-PRM-0015) and Part-B (Drawings 11420-97C-000-PRM-0016 to 11420-97C-000-PRM-0030, 11420-97C-000-ELE-0001, 11420-97C-000-WTS-0001, 11420-97C-000-ENV-0001 and Maps FDC-220/1 and Map FDC-220/2).

**B-11.0 - LIST OF DOCUMENTS ANNEXED**



This list of documents annexed along with the Modified Mining Plan for Sijimali Bauxite Deposit is given below:

Sl. No.	Documents	Reference
1.	Copy of PL deed	Refer Appendix-1
2.	In case of grant / renewal of mining plan Form-I and Form-J under MCR, 1960.	Refer Appendix 2-1 (ML application for Kalahandi and Rayagada districts), Appendix 2-2 (Amended Mining Lease plan along with revised land schedule for Kalahandi and Rayagada districts)
3.	Land schedule - Rayagada district	Refer Appendix 2-3
4.	Approval letter from Indian Bureau of Mines for the earlier Mining Plan	Refer Appendix 3-1
5.	Assay data of boreholes	Refer Appendix A.1-1
6.	Collar data of boreholes	Refer Appendix A.1-2
7.	Report prepared by JNARDDC on studies in correlation between total silica and reactive silica for Sijimali bauxite	Refer Appendix A.1-3
8.	Report on seismic wave velocity test conducted by BEML	Refer Appendix A.1-4
9.	Ambient air quality - Summary of the report	Refer Appendix A.8-1
10.	Analytical results of ground water samples	Refer Appendix A.8-2
11.	Consent letter/Undertaking from the Applicant	Refer Appendix B.9-1
12.	Certificate from Qualified Person along with copies of qualification and experience certificates	Refer Appendix B.9-2
13.	Grant/Renewal application receipt in form - D of MCR, 1960	Not Applicable

*dh*

**LARSEN & TOUBRO LIMITED**  
**Sijimali Bauxite Deposit**  
**Modified Mining Plan**



B-11.0 - List of documents annexed (cont'd)

Sl. No.	Documents	Reference
14.	In case of grant of ML Letter of Intent of State Government	Not Applicable
15.	In case of grant cases of minerals of part C of the first schedule of MMDR Act, 1957 copy of the prior approval letter of the Central Government.	Not Applicable
16.	In case of Scheme of Mining copies of violation letters issued by Indian Bureau of Mines and its compliance thereof.	Not Applicable
17.	Copies of analysis report from NABL accredited laboratory or similar accredited laboratory	Refer Appendix B.11-1
18.	Certificate of registration of the company	Refer Appendix B.11-2
19.	List of members of Board of Directors.	Refer Appendix B.11-3
20.	Photographs showing the boundary pillars and land use of the lease area	Refer Appendix B.11-4
21.	Photo Identity Card of Lessee with permanent address proof	Refer Appendix B.11-5
22.	Power of Attorney and Board Resolution	Refer Appendix B.11-6
23.	Memorandum of the Association	Memorandum of Association and Articles of Association of L&T is presented in Appendix B.11-7.
24.	Enclosure-1	Feasibility Report
25.	Enclosure-2	Prospecting Report

The Appendices/documents mentioned under Sl. No. 1 to Sl. No. 23 above are presented in Volume-II of Modified Mining Plan. Enclosure-1 and Enclosure-2 are submitted separately.