

PROPOSAL FOR PRELIMINARY EXPLORATION (G-3) FOR POTASH
IN BHARUSARI BLOCK, BHARUSARI SUB BASIN,
NORTH WESTERN PART OF RAJASTHAN
(14.17 SQ.KM AREA)
DISTRICT- HANUMANGARH, RAJASTHAN

COMMODITY: POTASH

BY
MINERAL EXPLORATION CORPORATION LIMITED
DR. BABASAHAAB AMBEDKAR BHAWAN
SEMINARY HILLS

PLACE: NAGPUR

DATE: 12th October 2020

Summary of the Block for Preliminary Exploration (G-3)
GENERAL INFORMATION ABOUT THE BLOCK

Features	Details
Block ID	Bharusari Block
Exploration Agency	Mineral Exploration Corporation Limited (MECL)
Commodity	Potash
Mineral Belt	Bharusari Sub Basin, North Western Part of Rajasthan
Completion period with entire Time schedule to complete the project	18 Months
Objectives	<p>The Preliminary Exploration (G-3) is proposed with the following Objectives:</p> <p>i) To confirm the continuity and potentiality of potash bearing zones in the proposed area.</p> <p>ii) To generate data for initial assessment of mineralogy of the potash zones and the K contents.</p> <p>iii) To estimate resources of Potash zones especially with sylvite & sylvinite zones as per UNFC system.</p>
Whether the work will be carried out by the proposed agency or through outsourcing and details thereof. Components to be outsourced and name of the outsource agency	Work will be carried out by the proposed agency.
Name/Number of Geoscientists	Two no Geoscientist (1 Field + 1 HQ)
Expected Field days (Geology, Geophysics, Surveyor)	Geologist Party days: 365 days Survey Party days: 210 days

1.	Location	The proposed block in potash bearing Bharusari Sub basin lies in the Survey of India Toposheet No. 44 K/7. The area is well connected by rail (Bikaner-Suratgarh – Ganganagar rail line of Western railway) and by road from Bikaner-Lunkaransar-Rambagh-Hanumangarh. The National Highway (NH-62) passes near to the Bharusari Basin. Suratgarh is the nearest railway station. Bikaner is around 140 km from the study area (Plate No.-I). Bharusari Block with 14.17 sq.km area is located in the north-central part of the Bharusari sub basin having approximately 1120 sq.km area.																																			
	Latitude- Longitude	<table><tr><th>CARDINAL POINTS</th><th>LATITUDE</th><th>LONGITUDE</th></tr><tr><td>A</td><td>29° 17' 49.1791" N</td><td>74° 15' 47.9400" E</td></tr><tr><td>B</td><td>29° 17' 49.6638" N</td><td>74° 17' 17.2942" E</td></tr><tr><td>C</td><td>29° 16' 32.8668" N</td><td>74° 18' 46.2329" E</td></tr><tr><td>D</td><td>29° 16' 21.8360" N</td><td>74° 19' 25.8283" E</td></tr><tr><td>E</td><td>29° 15' 56.0340" N</td><td>74° 19' 26.1191" E</td></tr><tr><td>F</td><td>29° 15' 55.8817" N</td><td>74° 18' 56.1981" E</td></tr><tr><td>G</td><td>29° 16' 06.1877" N</td><td>74° 17' 17.2239" E</td></tr><tr><td>H</td><td>29° 16' 31.3942" N</td><td>74° 15' 48.5747" E</td></tr><tr><td>I</td><td>29° 16' 57.4367" N</td><td>74° 15' 18.4590" E</td></tr><tr><td>J</td><td>29° 17' 23.8060" N</td><td>74° 15' 18.2677" E</td></tr></table>			CARDINAL POINTS	LATITUDE	LONGITUDE	A	29° 17' 49.1791" N	74° 15' 47.9400" E	B	29° 17' 49.6638" N	74° 17' 17.2942" E	C	29° 16' 32.8668" N	74° 18' 46.2329" E	D	29° 16' 21.8360" N	74° 19' 25.8283" E	E	29° 15' 56.0340" N	74° 19' 26.1191" E	F	29° 15' 55.8817" N	74° 18' 56.1981" E	G	29° 16' 06.1877" N	74° 17' 17.2239" E	H	29° 16' 31.3942" N	74° 15' 48.5747" E	I	29° 16' 57.4367" N	74° 15' 18.4590" E	J	29° 17' 23.8060" N	74° 15' 18.2677" E
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	Villages	Jhakhranwali, Jhuriyanwala, Manaktheri, Thakruwala Daultanwali																																			
	Tehsil/Taluk	-																																			
	District	Hanumangarh																																			
	State	Rajasthan																																			
2.	Area (hectares/ square kilometres)																																				
	Block Area	14.17 sq.km																																			
	Forest Area	Non-Forest area.																																			
	Government Land Area (Bilanam)	Data not available																																			
	Charagaha	Data not available																																			
	Private Land Area	Data not available																																			
3.	Accessibility																																				
	Nearest Rail Head	Suratgarh is the nearest railway station.																																			
	Road	The area is well connected by road from Bikaner-Lunkaransar-Rambagh-Hanumangarh																																			
	Airport	Bikaner (140 km)																																			
4.	Hydrography																																				
	Local Surface Drainage Pattern (Channels)	There is not a single perennial stream in the area. The drainage in the area is served by the old course of river Ghaggar forming a narrow alluvial belt in which a network of canals has been developed. Major canal system i.e. Indira Gandhi Canal passes through Bharusari basin.																																			

	Rivers/ Streams	There is not a single perennial stream in the area. Indira Gandhi Canal passes through Bharusari basin
5.	Climate	
	Mean Annual Rainfall	Average annual rainfall is 10 cm to 30 cm
	Temperatures (December) (Minimum) Temperatures (June) (Maximum)	Minimum temperatures 0°C (Dec-Feb), Maximum temperatures up to 50°C (March-June)
6.	Topography	
	Toposheet Number	44K/7
	Morphology of the Area	The area is almost flat terrain and covered with thick aeolian sand or alluvial sediments. The average height of the area is 250m above MSL.
7.	Availability of baseline geoscience data	
	Geological Map (1:50K/25K)	Geophysical map of Bharusari basin (1:50,000 scale)
	Geochemical Map	Not available.
	Geophysical Map (Aeromagnetic, ground geophysical, Regional as well as local scale GP maps)	Geophysical map of Bharusari basin (1:50,000 scale)
8.	Justification for taking up Reconnaissance Survey/ Regional Exploration	<ol style="list-style-type: none"> 1. In Bharusari Sub basin, Geological Survey of India has carried out preliminary exploration by drilling 10 nos. of boreholes at wider interval. GSI has estimated resources of the order of 388.31 million tonnes with grade 4.68% K and 17.17% Na, covering 71.0 Sq. km, area. Further, MECL has completed Geophysical Exploration (Gravity and Magnetic Survey) covering an area of 1119 sq. km. in Bharusari Sub Basin and based on the finding of geophysical studies, 20 exploratory boreholes up to a depth of 700-750m have been recommended to test/validate the veracity of the G-M survey interpretation in the area and the results of the boreholes would dictate the future exploration strategy. 2. In view of the above, drilling (12 no boreholes with 8600m) at 800m X 800m grid has been proposed within 14.17 sq. km. in the vicinity of GSI drilled boreholes.

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1.0.0 Preamble

- 1.0.1 Potassium, Nitrogen and Phosphorous (K, N & P) are the key chemical contents used in the Fertilizer Industry. Major production of potash in the world is obtained from Sylvite (KCl) and Polyhalite [$K_2Ca_2Mg(SO_4)_4 \cdot 2H_2O$] associated with Halite (NaCl) bearing evaporite sequences. India produces only meager quantity of potash as by-products during the manufacture of common salt from seawater and the entire requirement of potash is met through imports. Sinha et al (1973) of CGWB, while exploring for Ground Water, reported halite from Lakhasar at a depth of 541m and correlated it with the Kohat salt sequence of Pakistan. Presence of halite at a depth of 469m was further reported by CGWB from Satipura in Shri Ganganagar district.
- 1.0.2. In the meeting held on 15th December 2009, under the Chairmanship of Secretary (Fertilizers) to discuss possibility of exploration and augmenting indigenous production of rock phosphate and mining for availability of rock phosphate for the indigenous fertilizer industry, it is suggested in Para 2 of the minutes that Department of Mining & Geology (DMG), Government of Rajasthan, Mineral Exploration Corporation Ltd.(MECL) and Geological Survey of India (GSI) under Ministry of Mines could take up the exploration work for rock phosphate.
- 1.0.3 MECL procured potash report from GSI and prepared the proposal of detailed exploration of potash in Jaitpur Sub basin which was cleared by the Technical Sub Committee of SCPP held on 22-4-2010. The proposal was discussed in 22nd SCPP on 15/6/2010. The proposal was deferred because the area was under R.P. of M/s. Bijam Biotechnology (Nagarjuna Group).
- 1.0.4 In February 2009, a meeting was held in New Delhi under the Chairmanship of Secretary (Mines). In which, it was discussed that potash exploration in North Western part of Rajasthan should be taken up by MECL.
- 1.0.5 In 24th SCPP, Chairman/Addl. Secretary (Mines) advised MECL to approach RSMML for possibility of solution mining technology, if deposits become viable; after detailed exploration by MECL. Accordingly MECL approached RSMML for the same, vide letter dated 2.01.2012. In reply to MECL letter, RSMML suggested Bharusari Sub basin for detailed exploration by MECL, as the area of 878 hectare has been reserved for RSMML.

The proposal was discussed in detail in the Technical Sub Committee of 25th SCPP for approval and was agreed in principle with certain modifications of drilling programme. Committee suggested MECL to propose borehole in a grid pattern instead of boreholes located by RSMML on map.

- 1.0.6 In 31st meeting of Technical Sub Committee of SCPP held on 14.12.2015 at MECL, Corporate Office, Nagpur, the exploration proposal for exploration in Bharusari Sub Basin was discussed in detailed and committee suggested Geophysical survey (Gravity and Magnetic) at 500 x 500 m grid intervals. Administrative approval / Financial sanction for assessment of potash mineralization in Bharusari Sub Basin at an estimated cost of 99,61,353/- has been received vide letter no. 37/2/20-16-M.I.
- 1.0.7 Subsequently, MECL commenced geophysical survey in September 2016 and concluded in January 2017. The report on gravity and magnetic survey for potash in Bharusari Sub Basin has been submitted in May 2017 with recommendation to drill 20 nos. of scout boreholes to test/validate the veracity of the G-M survey interpretation in the area. The results of the boreholes would dictate the future exploration strategy.

1.1.0 Location and Accessibility

- 1.1.1 The proposed block in potash bearing Bharusari Sub basin lies in the Survey of India Toposheet No. 44 K/7 covered by N Latitude -29°16'52" to 29°19'44" and E Longitude 74°17'19" to 74°19'41". The area is well connected by rail (Bikaner-Suratgarh – Ganganagar rail line of Western railway) and by road from Bikaner-Lunkaransar-Rambagh-Hanumangarh. The National Highway (NH-62) passes near to the Bharusari Basin. Suratgarh is the nearest railway station. Bikaner is around 140 km from the study area (Plate No.-I). Bharusari Block with 125.56 sq.km area is located in the north-central part of the Bharusari sub basin having approximately 1120 sq.km area and its coordinates are given in following table.

Co-ordinates of the cardinal points of Block Boundary of the Bharusari Block

CARDINAL POINTS	NORTHING	EASTING	LATITUDE	LONGITUDE	AREA Sq. Km.
A	3241115.871	428452.129	29° 17' 49.1791" N	74° 15' 47.9400" E	14.17
B	3241115.871	430862.905	29° 17' 49.6638" N	74° 17' 17.2942" E	
C	3238737.886	433248.500	29° 16' 32.8668" N	74° 18' 46.2329" E	
D	3238392.165	434315.000	29° 16' 21.8360" N	74° 19' 25.8283" E	
E	3237597.990	434318.266	29° 15' 56.0340" N	74° 19' 26.1191" E	
F	3237597.990	433510.759	29° 15' 55.8817" N	74° 18' 56.1981" E	
G	3237931.103	430841.652	29° 16' 06.1877" N	74° 17' 17.2239" E	
H	3238721.697	428454.197	29° 16' 31.3942" N	74° 15' 48.5747" E	
I	3239528.371	427646.632	29° 16' 57.4367" N	74° 15' 18.4590" E	
J	3240340.000	427646.632	29° 17' 23.8060" N	74° 15' 18.2677" E	

1.2.0 Physiography & Climate

- 1.2.1 The entire area of Nagaur-Ganganagar basin is covered by thick aeolian sand or alluvial sediments except the southern part where scanty outcrops could be seen. The present study area Bharusari Sub basin is entirely covered by thick aeolian or alluvial sediments. The major part of the Bharusari Sub basin presents a monotonous topography of NW-SE trending longitudinal dunes and interdunal areas. The elevation of area varies between 147m to 375m above MSL.
- 1.2.2 There is not a single perennial stream in the area. The drainage in the area is served by the old course of river Ghaggar forming a narrow alluvial belt in which a network of canals has been developed. Major canal system i.e. Indira Gandhi Canal passes through Bharusari basin.
- 1.2.3 The area experiences extreme climate with temperature varying from 0°C during winter to as high as 50°C during summer months. Dust storms are common during summer months. Rainfall is scanty and averages 10 cm to 30 cm annually and is mostly received during July-August. However, where irrigation facilities of canal system are developed, there is good vegetation and agricultural crops are grown round the year.

1.2.0 Previous work

- 1.3.1 The presence of evaporite minerals like gypsum, anhydrite and halite were known from Nagaur and Bikaner areas since 1930's. Halite in Bikaner is reported by P.K. Ghosh 1952, Gypsum in Nagaur by Roy Chowdhury et al 1965 and anhydrite inter section in boreholes drilled by Central Ground Water Board (CGWB) and Oil & Natural Gas Corporation (ONGC). George I. Smith (1968) of the USGS evaluated the data of GSI and identified that Nagaur basin is one of the area geologically most favourable for occurrence of potash bearing marine evaporite deposit.
- 1.3.2 R.S. Jain and Premchandra (1973), based on the data from ONGC & CGWB, identified several negative Bouguer Gravity anomalies and related these to the presence of a thick evaporite sequence in the Nagaur basin. A total of 12 gravity low sites, mostly in the southern part of the basin were recommended for drilling.
- 1.3.3 Based on the above studies, GSI has launched exploration programme for potash in 1974. GSI has carried out potash exploration in an area of 28,500 Sq.Km. out of the total area of 50,000 sq.km. of Nagaur-Ganganagar basin. GSI has drilled a total of 58,733.95m of drilling in 68 closed & 2 abandoned boreholes. All the boreholes were drilled vertical, assuming that the host rock (halite) is disposed horizontally to sub horizontally with 3° -

5° rolling dips towards NW. In Bharusari Sub basin, GSI drilled eight boreholes, aggregating 5262.45m.

- 1.3.4 Mineralised Zones intersected in GSI boreholes on different cut offs 1% K & 3% K are given below:

**Mineralised Zones Intersected in GSI Boreholes in at 1.00% K cut-off in
Bharusari Sub basin**

Sl.	Borehole No.	Depth (m)		Thickness (m)	Average K %	Average Na %
		From	To			
1.	P-49	572.71	578.55	5.84	1.33	28.33
		584.25	594.00	9.75	1.45	30.55
2.	P-51	562.29	573.43	11.14	3.03	26.56
		575.27	580.39	5.12	1.50	31.06
		582.65	587.32	4.67	1.00	31.97
		596.40	598.00	1.60	1.10	36.03
		618.55	620.05	1.50	1.81	32.89
		680.99	682.77	1.78	1.28	29.11
3.	P-56	551.00	556.94	5.94	3.09	24.60
		558.48	559.99	1.51	7.19	17.37
		563.19	566.67	3.48	1.50	29.64
		570.07	572.12	2.05	1.01	32.85
4.	P-59	554.55	559.73	5.18	2.42	26.89
		565.80	571.40	5.60	1.08	31.90
		608.19	610.00	1.81	1.31	34.95
5.	P-62	500.95	503.18	2.23	1.95	21.40
		504.24	508.01	3.98	1.30	30.32
		512.59	520.10	7.51	2.71	16.10
		533.10	534.67	1.57	1.00	36.50
		602.95	605.10	2.15	1.40	35.20
6.	P-64	578.15	580.45	2.30	5.06	26.33
		583.24	584.74	1.50	1.97	26.80
		586.52	588.02	1.50	1.19	28.17
		600.65	602.33	1.68	1.10	34.75
		613.96	616.50	2.54	1.05	38.00
		625.42	626.92	1.50	1.19	35.29
7.	P-66	543.11	561.27	8.16	2.36	22.40
		564.33	565.83	1.50	1.38	32.01
		575.25	576.80	1.55	1.30	33.11
		577.75	580.25	2.50	1.05	32.50

**Mineralised Zones Intersected in GSI Boreholes in at 3.00% K cut-off in
Bharusari Sub basin**

Sl.	Borehole No.	Depth along hole (m)		Thickness (m)	Average K %	Average Na %
		From	To			
1.	P-51	562.29	556.21	3.92	5.29	19.51
2.	P-56	551.00	552.97	1.97	5.27	17.37
		558.48	559.99	1.51	7.19	17.37
3.	P-59	556.18	557.99	1.81	3.97	24.22
4.	P-62	516.38	518.23	1.85	3.96	14.15
5.	P-64	578.15	580.45	2.30	5.06	26.33
6.	P-66	543.11	546.65	3.54	3.25	12.09

- 1.3.4 GSI has computed potash resources in three sub basins i.e. Satipura, Bharusari and Lakhasar, based on the intersection of potash mineralisation at 3% K and 1.50 m minimum stopping width (MSW). The resources computed in these basins are given below:-

Potash Resource in Satipura, Bharusari and Lakhasar sub basin

Sub basin	Area (Sq.Km.)	Ore Resources (Million Tonnes)		Grade	
		Probable	Possible	K%	Na %
Satipura	245.61	202.30	1429.95	4.80	25.08
Bharusari	71.00	88.16	300.15	4.68	17.17
Lakhasar	29.50	113.73	342.29	4.39	23.51
Total	346.11	404.19	2072.39	4.70	23.54

Total resources are of order of 2476.58 million tones with 4.70% K and 23.54% Na. Out of which, Bharusari Sub basin contain 388.31million tonnes resources with 4.68% K and 17.17 % Na.

- 1.3.6 During the year 2016-17 and 2017-18, MECL carried out Geophysical Exploration (Magnetic and Gravity Survey) in Bharusari Sub Basin and suggested for further exploration in the area.

2.0.0 Regional Geology

- 2.1.0 The entire area of the Nagaur-Ganganagar basin is covered by thick aeolian sand or alluvium sediments except in the southern part where scanty out crops are observed.

The Nagaur-Ganganagar basin is an intra-cratonic basin in which marine sediments of the Marwar Supergroup were deposited on the basement rocks of the Malani Igneous suite and/or Delhi metamorphites. A generalized stratigraphic sequence built up is as follows:

Generalized Stratigraphic sequence of Nagaur-Ganganagar basin

Age	Supergroup	Group	Thickness (m)
Recent to Sub recent	Quaternary	--	0 – 373
----- Unconformity -----			
Lower Eocene	Tertiaries		38 – 120
----- Unconformity -----			
Lower Cambrian	Marwar	Nagaur Bilara / HEG Jodhpur	50 – 290 Bilara 100-300 HEG 103-652 246-423
----- Unconformity -----			
Pre Cambrian	Malani Igneous Suite Delhi Supergroup	---- Ajabgarh	Basement rocks

- 2.1.2 The Hanseran Evaporite Group (HEG) appears to be homotaxially time equivalent and Facies Variant of the Bilara Group and comprises cyclic deposits of halite (most dominant constituents) alternating with anhydrite, clay, dolomite & magnesite.

2.2.0 Description of Lithounits

2.2.1 Basement Rocks (Malaini Igneous suite rocks)

The basement rocks of Delhi Supergroup (Ajabgarh group) are exposed towards East, north and northeastern margin and the rocks of Malaini Igneous suites are exposed towards south & southwest margin of Nagaur-Ganganagar basin. In Bharusari Sub basin, rocks of Nagaur, Hanseran Evaporite Group & Bilara Group are exposed (as shown in Plate No. II).

Meta sediments of Delhi Super Group are represented by massive quartzites; quartz sericite schist, phyllites, slate and amphibolite intruded by post Delhi quartz veins.

Rocks of Malaini Igneous suites are represented by rhyolites, tuffs and rhyolite porphyry intruded by Jalore & Siwana granites.

2.2.2 Marwar Super Group

The Marwar Super Group consists of

- (i) Jodhpur Group
- (ii) The Bilara Group and the Hanseran Evaporite Group (HEG) which are homotaxially time equivalent and facies variant
- (iii) Nagaur Group.

Jodhpur Group

The rocks of Jodhpur Group unconformably over lie the basement rocks and have gradational contact with the overlying Bilara Group or Hanseran Evaporite Group. The Jodhpur Group mainly comprises micaceous sandstone reddish to buff and grey coloured, medium to coarse grained and often calcareous and glauconitic with occasional interbands of shale & siltstones.

Bilara Group

The Jodhpur Group rocks are unconformably overlain by those of the Bilara Group, which comprises three calcareous dominating rock formations and serves as marker horizon between the Jodhpur & Nagaur Groups. The stratigraphic sequence of the Bilara Group as worked by Khan and Sogani (GSI 1973) is given below:

Stratigraphic sequence of Bilara Group

Nagaur Group	
----- Conformable contact -----	
Pondlo Dolomite	Dolomite, dolomitic limestone, chert dolomite, Stromatolitic limestone and dolomite, siliceous, oolites & pisolites.
Gotan limestone	Limestone with bands of chert & dolomite.
Dhanapa Dolomite	Stromatolitic limestone, dolomite, dolomitic limestone, chert and cherty dolomite
----- Conformable contact -----	
Jodhpur Group	

The Bilara limestone emits fetid odour when freshly chipped. It also yields small quantity of oil and inflammable gas on distillation (Heron, 1932).

Hanseran Evaporite Group (HEG)

The HEG is named after the locality Hanseran, is sandwiched between the under lying Jodhpur Group and the overlying Nagaur Group of rocks. It comprises claystone, dolomite, magnesite, anhydrite and halite. Halite is the most dominant constituent of HEG with minor polyhalite, occasional sylvite, rare langbeinite and traces of carnalite.

Thickness of HEG ranges from 103.20m to 652.15m containing halite zones having a cumulative thickness of 488.50m. So far seven halite cycles; number H1, H2...-- H7 from bottom to top, have been identified. These halite cycles are separated from one another by clays and/or anhydrite and/or dolomite.

The HEG has been classified into eight formations and seventeen units on the basis of their lithological character and order of superposition.

The presence of variable rock assemblage at the same stratigraphic horizon could be due to a gradual change in the environment of deposition.

Nagaur Group

The Nagaur Group has a gradational contact with the underlying HEG in the northern part of the basin. The Nagaur Group extends from Merta road to Mundwa and Nagaur in NW direction and takes arcuate turn westwards indicating a reducing shore line of the basin. North-Eastwards it overlies the HEG. The Nagaur Group comprises a sequence of brick red to red claystone, siltstone and sandstone often with blotches and bands of green clay.

Subsequent to the deposition of Nagaur Group, it appears, no sedimentation have taken place during Tertiary times except in few places where presence of late Palaeozoic to early Mesozoic sediments have been reported at Pugal (By ONGC) and between Lamba Jatin & Riyan Shyamdas (U. Bose et al 1986).

Tertiary Sediments

The Nagaur Group rocks are overlain by the Tertiary sediments in parts of Southern & Western sector of Nagaur-Ganganagar basin. The contact is unconformable with the Nagaur Group of rocks. Tertiary sedimentation appears to have taken place along the sea arms extending from SW (Jaisalmer basin) through Pokaran to north of Ganganagar and limiting its eastern extent by the subsurface Dulmera High passing through Kanchian-Suratgarh-Harsinghpura-Lunkaransar-Dulmera and Lakhusar. The Sub surface stratigraphy inferred by Ghosh and Srivastava (1971) is given below:

Stratigraphic sequence of Tertiary in Nagaur-Ganganagar basin

Recent & Sub recent			Thickness (m)
----- Unconformity -----			
Tertiary	Jogira Fullers Earth (Eocene)	Shale, marl, fuller's earth, limestone, Foraminiferal limestone & siltstones.	116-121m
	Marl Sandstone (Paleocene)	Ferruginous sandstone and glass sand with clay and siltstone; lignite with alternating sandstone and claystone beds.	200-210m
	Palana Shales (Palaeocene)	Variegated shales and clays, associated with carbonaceous c <u>base-not shale</u> ; shaly lignite, silt & sandstone.	157m
----- Unconformity -----			
Nagaur Group			

Quaternary Sediments

Quaternary Sediments comprising aeolian sand (forming dunes) alluvial sand, clay, kankar, grit, gravel, calcareous sandstone, caliche, gypsite and reworked limestone fragments lie unconformably either over the Nagaur Group of rocks or over the Tertiary sediments varying in thickness from 0.00 to 373.00m in Nagaur-Ganganagar basin.

3.0.0 Structure

- 3.1.0 The Nagaur-Ganganagar basin, covering an area of 50,000 Sq.Km. is bounded by the Aravalli Range in the east, Lahore Delhi Sub surface ridge in north & north east and Jodhpur-Pokharan-Chotan-Malani ridge in the South. The basin appears to extend upto Sardarsahar-Bidasar fault in the east, upto 12 Km South and upto Devikot-Nachana Sub surface high in the West & South west and the basin appears to merge with the Indus basin in the North West. The Sardarsahar-Bidasar fault trend N-S with steep dips towards west and down throw also towards West and marks the Eastern limit of HEG. The sediments are mostly disposed horizontally and sub horizontally with 3° to 5° rolling dips towards NW. Locally the halite beds show steep dips due to salt flowage. A number of vertical to sub vertical faults trending N-S, NE-SW and E-W with down throw towards W, NW and S respectively have been inferred on the basis of drill data. Some of these faults are inter formational, while others are intra formational.

4.0.0 Mineralisation

- 4.1.0 The Hanseran Evaporite Group (HEG) comprises cyclic deposits of halite (most dominant constituent) alternating with anhydrite, clay-dolomite and magnesite. The most dominant constituent of Group is halite (NaCl) with minor polyhalite [$K_2 Mg Ca_2 (SO_4)_4 2H_2O$], sylvinite (KCl, NaCl), sylvite (KCl), langbeinite ($K_2 SO_4 2 Mg SO_4$) and carnallite (KCl, $Mg Cl_2 6H_2O$), in order of their abundance. A maximum of seven halite cycles, numbered as H1, H2-- H7 from bottom to top have been identified. The halite cycles are separated from one another by intervening zones comprising anhydrite, clay, dolomite and occasionally glauconite.

5.0.0 Proposed Exploration by MECL

5.1.0 Strategy

- 5.1.1 In the Bharusari Sub Basin, GSI has established 88.16 mt. probable and 300.15 mt. possible resources with an average grade of 4.68% K in 71.00 sq. km. area. During 2016-17 and 2017-18, MECL has completed Geophysical Exploration (Gravity and Magnetic Survey) covering an area of 1119 sq. km. in Bharusari Sub Basin and prepared synergetic gravity and magnetic map of the study area. The entire area has been categorized based on high or low residual gravity and magnetic anomalies. Nine different zones have been delineated based on the residual anomalies and have been represented by different colour in the plan (Plate –II). Based on the above analysis, 20 exploratory boreholes up to a depth of 700-750m have been recommended to test/validate the veracity of the G-M

survey interpretation in the area and the results of the boreholes would dictate the future exploration strategy. The proposed borehole locations based on the geophysical survey studies interpretation have been shown on the Plan (Plate II). The seven boreholes drilled by GSI fall in the magnetic low- gravity low zones Z-II, III & V. On the basis of the borehole data of the GSI already drilled in the ML-GL zone which validates the finding of geophysical survey, MECL planned to take up G-3 stage exploration in the area where already drilled boreholes of GSI shows more than 5% k and considerable working thickness. The proposal for exploratory drilling has been prepared to establish the potentiality of potash in the area in Bharusari Sub Basin where GSI had already established the existence of potash. A total of 12 no. of boreholes with a total of 8600 m of drilling at 800m X 800m grid has been proposed within 14.17 sq. km. in vicinity of GSI drilled boreholes and the block has been designated as Bharusari Block.

5.2.0 Objectives

The Preliminary Exploration (G-3) is proposed with the following Objectives:

- iv) To confirm the continuity and potentiality of potash bearing zones in the proposed area.
- v) To generate data for initial assessment of mineralogy of the potash zones and the K contents.
- vi) To estimate resources of Potash zones especially with sylvite & sylvinite zones as per UNFC system.

5.3.0 Methodology of Exploration

- 5.3.1 Survey:** Proposed area will be tied up with triangulation network using DGPS and the surface features will be picked up and marked on a map on 1:10,000 scale. Topographic contouring will be done at 1m interval. Co-ordinates & R.L. of the new boreholes will be determined with reference to this network. The block boundary will be surveyed by DGPS & total station in WGS-84 Datum for demarcation of Block Boundary points and ancillary area to facilitate the state governments for auctioning of blocks.
- 5.3.2 Geological Mapping:** Large scale geological mapping on 1: 10,000 scale will be carried out in the entire block by taking geological traverses and all the geological/structural features will be recorded. This map will be the Base map for future work.
- 5.3.3 Drilling:** A total of 12 no. of boreholes are proposed at 800m X 800m grid in the unexplored area of the Bharusari sub basin. A total of 8600 m of drilling in 12 vertical boreholes have been proposed in the block. The location of proposed boreholes is given as Plate No- II and details with proposed depth & total meterage to be drilled is given in following table.

Details of Proposed Boreholes in Bharusari Sub Basin

Sr. No.	BH No.	Proposed depth in meter (m)	Sr. No.	BH No.	Proposed depth in meter (m)
1	PBH-1	730	7	PBH-7	720
2	PBH-2	720	8	PBH-8	715
3	PBH-3	735	9	PBH-9	710
4	PBH-4	725	10	PBH-10	705
5	PBH-5	715	11	PBH-11	705
6	PBH-6	725	12	PBH-12	695
Total					8600.00

5.3.4 The location of these boreholes may change slightly subject to approachability owing to terrain conditions. All the formations i.e. Quaternary / Tertiary sediments, Nagaur Group, Hanseran Evaporite Group and Jodhpur Group will be drilled by coring.

4.3.5 Geophysical Studies.

Borehole Geophysical Logging [Duel Density, Spectral Gamma, Resistivity, Neutron, Caliper and Deviation] is proposed in all the boreholes in the Bharusari block. Borehole Geophysical logging will be carried for all the 12 boreholes (8600m)

4.3.6 Drill core Logging and Sampling

Detailed core logging will be carried out for all the boreholes and various details i.e., litho units/formations, intercalations and parting, core recovery, colour; structures and textures etc will be recorded. In the Hanseran 'Evaporite Group, special attention is required to identify Polyhalite and other Potash bearing minerals.

4.3.7 Sampling:

The primary samples will be drawn at every **0.20m** in the potash bearing (Polyhalite & Potash) zones identified on visual basis and reconciled with borehole geophysical survey interpretation and at 1.00m length in the non potash bearing Halite zones. Thereafter composite samples will be prepared after delineation of Potash mineralized zones at different cut-offs. Standard procedure will be adopted for preparation of samples.

This will generate about 3000 no of Primary samples along with 150 no (5% of primary samples) internal check samples 300 no (10% of primary samples) external check samples. Composite Samples will be prepared borehole wise and potash zone wise based on the result of Primary samples. A total of 100 nos. of Composite samples are likely to be generated.

5.0.0 Laboratory Studies

5.1.0 Chemical Analysis:

- a) All the Primary and Internal & External Check samples [3450 no; = 3000 Primary & 150 Internal Check (5%), 300 External Check (10%) of Primary samples] will be analyzed for 9 radicals i.e. K, Na, Mg, Cl, Br, I, Li, CaSO₄ & Water insolubles.

- b) A total of 100 numbers of Composite samples are likely to be generated from the Potash mineralized zones of 12 boreholes which will be subjected to analysis of 9 radicals K, Na, Mg, Cl, Br, I, Li, CaSO_4 & Water insolubles.

5.2.0 X.R.D. Studies: About 10 composite samples will be sent for X-ray Diffraction studies.

5.3.0 Petrographic Studies: A total of 10 numbers of borehole core samples from different lithology will be subjected to petrographic studies.

5.4.0 Specific gravity determination: Specific Gravity will be determined on 10 nos. drill core specimen of halite and other rock types of Hanseran Evaporite Group.

5.5.0 Exploration Report: Data generated from proposed exploration along with integration of earlier data of GSI & MECL will be utilized in Report preparation.

5.6.0 Quantum of work:

5.6.1 The quantum of work proposed in the present exploration scheme is given in Table below:

**Quantum of work proposed for Potash Exploration in Bharusari Sub Basin,
District- Hanumangarh, Rajasthan.**

Sl. No.	Item of work	Unit	Quantum
1.	Topographic Survey (1 m Contour interval) & Geological mapping on 1:10,000 scale	Sq. Km.	14.17
2.	Drilling : i) 12 boreholes on 800m X 800m Grid	m.	8600m (12 BHs)
3.	Geophysical Studies		
	i) Borehole Geophysical Logging	m.	8600m (12 BHs)
4.	Laboratory Studies		
	A. Primary + Check Samples		
	i. Primary samples for 9 radicals i.e. K, Na, Mg, Cl, Br, I, Li, CaSO_4 & Water insolubles	Nos.	3000
	ii. Internal check samples (5% of Primary samples) for 9 radicals i.e. K, Na, Mg, Cl, Br, I, Li, CaSO_4 & Water insolubles from MECL Lab.		150
	iii. External check samples (10% of Primary samples) for 9 radicals i.e. K, Na, Mg, Cl, Br, I, Li, CaSO_4 & Water insolubles from External NABL Lab.	Nos.	300
	B. Composite Samples		
	i. for 9 radicals (K, Na, Mg, Cl, Br, I, Li, CaSO_4 & Water insolubles)	Nos.	100
	ii. X-Ray Diffraction Studies	Nos.	10
5.	Petrographic Studies	Nos.	10
6.	Specific Gravity Determination	Nos.	10
7.	Report Preparation (Digital Format)	Nos.	1

6.0.0 Manpower Deployment

6.0.1 Manpower deployment List may be provided later.

7.0.0 Time Schedule and Cost Estimates:

7.1.0 **Time Schedule:** The proposed exploration programme like drilling, Geology, Laboratory work including Camp setting & winding and Laboratory studies will be completed in 15 months time. Report writing will take additional 5 months including 2 month overlap with laboratory studies. Thus the total time proposed for completion of work is **18 months**. The bar chart showing Action Plan/time schedule is given in Table-6.1.

7.2.0 **Cost Estimate:** Cost for 2020-21, 2021-22 and 2022-23 has been estimated based on rates of SOC of NMET dated 01.04.2020. However the rates for consecutive financial years 2021-22 and 2022-23 will be estimated as per actual escalation based on RBI indices. The total estimated cost is **Rs 1754.13 Lakhs**. The details of cost estimates are given in Table 6.2 and summary is given below;

Summary of Cost Estimates

S no	Item	Total
1	Geological Work	1,07,85,900
2	Geophysical Survey	41,96,800
3	Drilling	11,11,46,800
4	Laboratory studies	1,37,75,200
5	Drill Core Preservation	63,60,000
6	Report Preparation	20,00,000
7	Proposal Preparation	3,80,000
8	Peer Review	10,000
	Subtotal (1-5)	14,86,54,700
	GST-18%	2,67,57,846
	Total	17,54,12,546

Say- Rs 1754.13 Lakhs.

8.0.0 Justification:

8.1.1 In Bharusari Sub basin, Geological Survey of India has carried out preliminary exploration by drilling 10 nos. of boreholes at wider interval. GSI has estimated resources of the order of 388.31 million tonnes with grade 4.68% K and 17.17% Na, covering 71.0 Sq. km, area. Further, MECL has completed Geophysical Exploration (Gravity and Magnetic Survey) with covering an area of 1119 sq. km. in Bharusari Sub Basin and based on the finding of geophysical studies, 20 exploratory boreholes up to a depth of 700-750m have been recommended to test/validate the veracity of the G-M survey interpretation in the area and the results of the boreholes would dictate the future exploration strategy.

8.1.2 In view of the above, drilling (12 no boreholes with 8600m) at 800m X 800m grid has been proposed within 14.17 sq. km. in near vicinity of GSI drilled boreholes.

Cost Estimate for Reconnaissance Survey (G4) of Potash Mineralisation in Bharsusi Sub-Basin, I Hanumangarh, Rajasthan													
S.N	Item of Work	Unit	Rates as per NMET SoC		Estimated Cost of the Proposal								Remarks
			SoC-Item - Sl No.	Rates as per SoC	Year 2020-2021		Year 2021-2022		Year 2022-2023		Total		
					Qty.	Amount (Rs)	Qty.	Amount (Rs)	Qty.	Amount (Rs)	Qty.	Amount (Rs)	
A GEOLOGICAL WORK													
1a	Survey Party days (1 party)	day	1.6.1a	8,300	60	4,98,000	150	12,45,000	-	-	210	17,43,000	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
1b	4 labours/ party (Rs 350/day/labour)	day	5.7	1,400	60	84,000	150	2,10,000	-	-	210	2,94,000	
1c	Bore Hole Fixation and determination of co-ordinates & Reduced Level of the boreholes by DGPS	Nos	1.6.2	19,200	4	76,800	8	1,53,600	-	-	12	2,30,400	
2a	Geologist Party days (1 party)-Field	day	1.2	11,000	60	6,60,000	305	33,55,000	-	-	365	40,15,000	
2b	Geologist Party days (1 party)-HQ	day	1.2	9,000	-	-	90	8,10,000	90	8,10,000	180	16,20,000	
2c	4 labours/ party (Rs 350/day/labour)	day	5.7	1,400	60	84,000	305	4,27,000	-	-	365	5,11,000	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
3a	Core Sampling - 1 Samplers	day	1.5.2	5,100	60	3,06,000	305	15,55,500	-	-	365	18,61,500	
3b	4 labours/ party (Rs 350/day/labour)	day	5.7	1,400	60	84,000	305	4,27,000	-	-	365	5,11,000	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
	Sub-Total A					17,92,800		81,83,100		8,10,000		1,07,85,900	
B GEOPHYSICAL SURVEY													
1	Dual Density	m	3.11d	102	-	-	8,600	8,77,200	-	-		8,77,200	
2	Spectral Gamma	m	3.11o	164	-	-	8,600	14,10,400	-	-	8,600	14,10,400	
3	Resistivity	m	3.11c	39	-	-	8,600	3,35,400	-	-	8,600	3,35,400	
4	Neutron	m	3.11f	74	-	-	8,600	6,36,400	-	-	8,600	6,36,400	
5	Caliper	m	3.11g	19	-	-	8,600	1,63,400	-	-	8,600	1,63,400	
6	Deviation	m	3.11m	90	-	-	8,600	7,74,000	-	-	8,600	7,74,000	
	Sub-Total B					-		41,96,800		-		41,96,800	
C DRILLING													
1	Drilling (4 rigs) up to 300m	m	2.2.1.4a	11,500	1,600	1,84,00,000	2,000	2,30,00,000	-	-	3,600	4,14,00,000	
	Drilling (4 rigs) 301-600m	m	2.2.1.4b	12,420	-	-	3,600	4,47,12,000	-	-	3,600	4,47,12,000	
	Drilling (4 rigs) 601-900m	m	2.2.1.4c	13,225	-	-	1,400	1,85,15,000	-	-	1,400	1,85,15,000	
2	Land / Crop Compensation	per borehole	5.4	20,000	4	80,000	8	1,60,000	-	-	12	2,40,000	Amount will be reimburse as per actuals or max. Rs. 20000 per BH with certification from local authorities
3	Construction of concrete Pillar (12"x12"x30")	per borehole	2.2.7a	2,000	-	-	12	24,000	-	-	12	24,000	
4	Borehole plugging by cement	m	2.2.7b	150	-	-	8,600	12,90,000	-	-	8,600	12,90,000	
5	Transportation	Km	2.2.8	36	4,800	1,72,800	-	-	4,800	1,72,800	9,600	3,45,600	
6	Accommodation for 4 rigs/month	Month	2.2.9	1,00,000	6	6,00,000	18	18,00,000	-	-	24	24,00,000	
8	Camp Setting	Nos	2.2.9a	2,50,000	4	10,00,000	-	-	-	-	4	10,00,000	
9	Camp Winding	Nos	2.2.9b	2,50,000	-	-	-	-	4	10,00,000	4	10,00,000	
10	Road Making (Flat Terrain)	Km	2.2.10a	22,020	5	1,10,100	5	1,10,100	-	-	10	2,20,200	Road Making will be considered as per the requirement and Road Making Charges will be reimbursed accordingly.
	Sub Total C					2,03,62,900		8,96,11,100		11,72,800	-	11,11,46,800	
D LABORATORY STUDIES													
I Chemical Analysis													
i) Primary & Check samples													
	a. Analysis for 9 Radicals i.e. K, Na, Mg, Cl, Br, I, Li, CaSO ₄ , W (BH core samples)	Nos	4.1.7a + 7b	3,846	-	-	3,000	1,15,38,000	-	-	3,000	1,15,38,000	

S.N	Item of Work	Unit	Rates as per NMET SoC 2020-21		Estimated Cost of the Proposal						Remarks	
			SoC-Item - SI No.	Rates as per	Year 2020-2021		Year 2021-2022		Year 2022-2023			
					Qty.	Amount (Rs)	Qty.	Amount (Rs)	Qty.	Amount (Rs)		
	b-Internal (5%) and External(10%) Check samples from NABL Lab for 9 Radficals i.e. K,Na,Mg,Cl,Br,I,Li,CaSO ₄ ,Wt (BH core samples)	Nos	4.1.7a + 7b	3,846	-	450	17,30,700	-	-	450	17,30,700	
	ii) Composite Samples										-	
	9 Radicals i.e. K,Na,Mg,Cl,Br,I,Li,CaSO ₄ ,Wt	Nos	4.1.7a + 7b	3,846	-	80	3,07,680	20	76,920	100	3,84,600	
2	Physical & Petrological Studies										-	
	i) X-RD Studies on composite	Nos	4.5.1	4,000	-	5	20,000	5	20,000	10	40,000	
	ii) Specific Gravity determination	Nos	4.8.1	1,605	-	5	8,025	5	8,025	10	16,050	
	iii) Preparation of thin section	Nos	4.3.1	2,353	-	5	11,765	5	11,765	10	23,530	
	iv) Complete petrographic study report	Nos	4.3.4	4,232	-	5	21,160	5	21,160	10	42,320	
	Sub-Total - D				-		1,36,37,330		1,37,870		1,37,75,200	
E	Drill Core Preservation											
	One complete borehole plus mineralised cores of all the BHs of the Block, all cost included (700 for one borehole, 300m halite zone for remaining 11 Bhs, (700+(300x11)=4000m)	m	5.3	1,590	-	-	-	4,000	63,60,000	4,000	63,60,000	
	Sub-Total - E				-		-		63,60,000		63,60,000	
F	Total A to E				2,21,55,700		11,56,28,330		84,80,670		14,62,64,700	
G	Geological Report Preparation	5 Hard copies with a soft copy	5.2	For the projects having cost more than Rs. 300 lakhs - A minimum of Rs. 9 lakhs or 3% of the value of work whichever is more subject to Max. Rs. 20 lakhs	-	-	-		20,00,000		20,00,000	
H	Proposal Preparation	5 Hard copies with a soft copy	5.1	2% of the Cost or Rs. 3.8 Lakhs whichever is lower	-	-	-		3,80,000		3,80,000	EA has to submit the Hard Copies and the soft copy of the final proposal along with Maps and Plan as suggested by the TCC-NMET in its meeting while clearing the proposal.
I	Peer review Charges				-		-		10,000		10,000	
J	Total Estimated Cost without GST				2,21,55,700		11,56,28,330		1,08,70,670		14,86,54,700	
K	Provision for GST (18% of L)	%			39,88,026		2,08,13,099		19,56,721		2,67,57,846	GST will be reimburse as per actual and as per notified prescribed rate
L	Total Estimated Cost with GST				2,61,43,726		13,64,41,429		1,28,27,391		17,54,12,546	
											or Say Rs. 1754.13 Lakhs	

Note -
1. If any part of the project is outsourced, the amount will be reimbursed as per the Paragraph 3 of NMET SoC and Item no. 6 of NMET SoC. In case of execution of the project by NEA on its own, a Certificate regarding non outsourcing of any component/project is required.
2. Rates are calculated as per NMET SOC issued on 31st March 2020 without escalation. Although billing for subsequent financial years will be done as per the actual escalations as per RBI Indices.

