



Regional Office
Chhattisgarh Environment Conservation Board
Near Tehsil Office, Rampur, Korba, Dist.-Korba(C.G.)

No. **887** /RO/TS/CECB/2024

Korba, Dated: **23/07/2024**

To,

✓ The Registrar
 Hon'ble National Green Tribunal,
 Faridkot House Copernicus Marg,
 New Delhi- 110001.

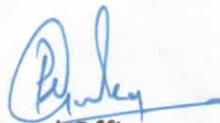
Sub.:- Compliance of the order dated 14.07.2022 by Hon'ble NGT in matter O.A. No. 188/2022.

Ref. No. :- Order of Hon'ble Tribunal dated 14.07.2022 passed in O.A. No. 188/2022.

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With reference to the above subject the action taken by M/s Bharat Aluminium Company Limited, Balco Nagar, Korba in compliance of the order dated 14.07.2022 passed by Hon'ble Tribunal in matter of O.A. No. 188/2022 is herein attached for kind perusal and necessary action.

Enclosure – As per above.


 Regional Officer,
 C.G. Environment Conservation Board
 Korba(C.G.)

Endt. No. /RO/CECB/2024

Korba, Dated : / /2024

Copy to: The Member Secretary, C.G. Environment Conservation Board, Nawa Raipur Atal Nagar, Raipur(C.G.) for kind information please.

✓
 Regional Officer,
 C.G. Environment Conservation Board
 Korba(C.G.)

BALCO/ENVT/A-06(C)/2024/210

Date: 29.06.2024

To,
The Regional Office,
Chhattisgarh Environment Conservation Board,
Korba (C.G.)

Sub: **Compliance status with the recommendations of Hon'ble NGT order dated 14.07.2022 in OA No. 188/2022**

Ref: **Your letter no. 495/RO/CECB/2024, Korba dated 07.06.2024.**

Respected Sir,

BALCO was incorporated in year 1965 as the first Public Sector Undertaking (PSU) in India and since then it has been closely associated with the Indian Industrial Growth, in a pivotal role. In 2001 Govt. of India disinvested 51% shares of Bharat Aluminium Company Limited (BALCO) to Vedanta Limited, successor of Sterlite Industries Limited. 49% is still owned by Government of India. Also, its board of directors include three government nominee director & board matters as well as the financials of the company are approved by such government nominee director.

BALCO has adopted Vedanta Sustainability Framework (VSF) which is based on international guidelines like International Finance Corporation (IFC) and International Council on Mining and Metal (ICMM) which is also being followed by leading natural resources companies across the world. BALCO is also an ISO 14001 certified company and follows best Environmental Management Practices through Integrated Management System (IMS) in place. BALCO has been awarded with many Environmental & Energy accolades which is testimony to its best Environmental Management systems and practices.

BALCO has well laid systems and SOPs for best Air, Water & Solid Waste Management with a vision of achieving Zero Harm, Zero Discharge & Zero Waste.

We have also commissioned robust and regular internal & external auditing system to improve the Environmental performance on continuous basis.

In the context of Hon'ble NGT order dated 14.07.2022, referring Original Application No. 188/2022, certain recommendations were made which were part of the Hon'ble NGT appointed committee recommendations referring various EC conditions which are monitored by MoEF&CC and status submitted on six monthly basis to MOEF&CC.

The updated status of the recommendations is as below.



S. No.	Recommendation	Status
1	As committed by project authority to undertake plantation in 363.27 Ha by FY 24 as per EC condition and the compliance status shall be submitted quarterly basis to respective authorities.	Bharat Aluminium Company is undertaking plantation every year in its vacant land available. In FY 24 we have carried out the plantation of 120111 saplings. We are complying to 33% green belt/plantation requirement on the land under possession of Balco, further Balco is taking community plantation in and around Balco complex. We are committed for green belt and plantation on the vacant land as an when available on regular basis.
2	The Legacy Ash Stock of 18.2 million tons shall be liquidated by December 2024 for which the district level Fly Ash committee may take time frame line and execution plan of the same	Out of 9 ash dykes, 5 ash dykes have been rehabilitated & reclaimed with plantation totalling 12.6 million tons of ash utilisation due to this. Presently, we have 4 dykes which are operational in compliance with the amendment of fly ash notification dated 30.12.2022 and no legacy ash for utilisation. The reclamation certificates for all 5 dykes from Chhattisgarh Environment Conservation Board (CECB) are attached for reference (Annexure-1) .
3	To install more number of piezometers around the fly ash dykes to check the ground water quality	We have installed around 36 piezometers across ash dykes in different levels to monitor the water level and the piezometric readings are used for calculating safety factor of the dykes. Additionally, we are in process of installing another 15 piezometers in various sections of dykes to measure the water table to further monitoring and consequently using the data for calculating factor of safety. Tata Consulting Engineers are engaged for regular monitoring of dyke stability. Further, we are collecting 8 number ground water samples (4 around ash dykes and 4 from surrounding area) for water quality measurement through

		NABL accredited laboratory. The reports are submitted to CECB on monthly basis (Reports attached as Annexure-2).
4	As the major emissions are fluoride from the pot Rooms roof, the sampling frequency should be increased, sampling is done at multiple locations.	We have increased the frequency and number of locations of saplings of pot Room roof samples from 4 to 8 locations. The results are reported on monthly basis to Chhattisgarh Environment Conservation Board (Annexure-3).

Further, we would also like to submit the following compliance as directed by Hon'ble NGT.

1. Safety measures to be taken for dyke and preventing air pollution:

Tata Consulting Engineers (TCE) has been engaged for [dyke safety stability monitoring. 36 piezometers and 30 numbers of settlement monuments have been installed to monitor dyke safety factor on regular basis. Satellite monitoring & drone surveys are conducted for dyke movement monitoring through Central University of Punjab (Report attached **Annexure-4**).

For preventing air pollution from dyke following measures are undertaken

- a) High Concentration Slurry Disposal (HCSD) method is adopted for transporting ash to ash dyke.
- b) Grass turfing is done on slopes and soil covering on bonds to avoid fugitive dust.
- c) 8 number of water sprinklers are engaged on everyday basis for water sprinkling on ash dykes additionally fixed type sprinklers and manual sprinkling is carried out during summer.
- d) Road sweeping machines are deployed on roads
- e) Multipurpose mist Canon is engaged for dust control.

2. Liquidating Legacy Ash Stock:

Out of 9 ash dykes, 5 ash dykes have been rehabilitated & reclaimed with plantation totalling 12.6 million tons of ash utilisation due to this. Presently, we have 4 dykes which are operational in compliance with the amendment of fly ash notification dated 30.12.2022 and no legacy ash for utilisation. The reclamation certificates for all 5 dykes from Chhattisgarh Environment Conservation Board (CECB) are attached for reference (**Annexure-1**).

3. Conducting Risk Assessment of all ponds:

Daily & monthly monitoring by ash team and quarterly monitoring by Tata consulting Engineer is done for risk assessment and actions are taken as per recommendation. Further annual inspection and assessment is done through designer/experts to assess the risk and recommendations are complied with.

4. Timely installation of FGD and complying norms of SO₂ :

We have already completed basic engineering. Survey and soil testing has been done for installation of FGD. There is already space provision for installation of FGD. However, as per latest MoEF&CC Notification dated 31.03.2021 the deadline for achieving emission norms by TPP's has been extended and for BALCO TPP's the new deadline stands at 31.12.2025 since BALCO falls under category B of Notification. We have further engaged NEERI, Nagpur for evaluating the Environmental benefit vis a vis impact to appropriately take up with MOEF&CC regarding installation of FGD.

5. Compliance of the guidelines on Red Mud :

Our Alumina Plant has been non-operational since September 2009 and consequently, we do not have red mud generation since then.

Further, we would also like to mention that as permitted by MoEF&CC and CECB we have converted our red mud ponds to ash dykes and are following the necessary requirement from time to time on the same.

Therefore, compliance with the Guidelines for Handling & Management of Red Mud Generated from Alumina Plants, in our humble understanding, will not be applicable to us.

However, we are following and complying with the guidelines for Ash Dyke management as per the Fly Ash Notification for the same.

We have stabilized and reclaimed 5 out of 9 ash ponds as per MoEF& CC guidelines and have obtained Certificate of reclamation from CECB (**Annexure-1**).

We are complying with the recommendations of our ash dyke designer from time to time and ensuring stability & safety of the dyke as per the experts advise.

We stand affirm on our assurance that the best Environmental practices are being followed at BALCO and all the recommendations in the Hon'ble NGT orders have been complied with.

However, as a responsible Environment conscious corporate BALCO shall remain committed to Environment protection.

Yours Sincerely,
For Bharat Aluminium Company Limited (BALCO)



(Authorized Signatory)



**REGIONAL OFFICE
C.G. ENVIRONMENT CONSERVATION BOARD,
NEAR TEHSIL OFFICE RAMPUR, KORBA, DISTT-KORBA (C.G.)
Email Id:- rocecbkorba@gmail.com**

No. 1118 /R.O./ C.E.C.B/2022

Korba. Dated: 28/12/2022

CERTIFICATE

This is to certify that **M/s Bharat Aluminum Company Limited, 1200 MW TPP, Balco Nagar Korba, Distt-Korba (C.G.)** has reclaimed its ash dyke situated at Parsabhatha dyke no.5 having a total land area of 12.53 Heactare. The ash dyke contains 1434395 MT quantity of fly ash. The dyke is not in service from Dec 2019 and around 32609 no. saplings has been planted in the reclaimed area.

Sprinda
Regional Officer,

Chhattisgarh Environment Conservation Board,
Korba (C.G.)

Entd. No. /R.O./ C.E.C.B/2022

Korba. Dated: / /2022

Copy to:

The Member Secretary, Chhattisgarh Environment Conservation Board,
Nawa Raipur Atal Nagar, Raipur for favour of information please.

Regional Officer,

Chhattisgarh Environment Conservation Board,
Korba (C.G.)



**REGIONAL OFFICE
C.G. ENVIRONMENT CONSERVATION BOARD,
NEAR TEHSIL OFFICE RAMPUR, KORBA, DISTT-KORBA (C.G.)
Email Id:- rocecbkorba@gmail.com**

No.1124 /R.O./ C.E.C.B/2022

Korba. Dated: 28/12/2022

CERTIFICATE

This is to certify that **M/s Bharat Aluminum Company Limited, 540 MW TPP, Balco Nagar Korba, Distt-Korba (C.G.)** has reclaimed its ash dyke situated at Parsabhatha dyke no.3 having a total land area of 28.67 Heactare. The ash dyke contains 2547671 MT quantity of fly ash. The dyke is not in service from July 2018 and around 21127 no. saplings has been planted in the reclaimed area.

S. Prasad
Regional Officer,

Chhattisgarh Environment Conservation Board,
Korba (C.G.)

Entd. No. /R.O./ C.E.C.B/2022

Korba. Dated: / /2022

Copy to:

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Nawa Raipur Atal Nagar, Raipur for favour of information please.

/_____
Regional Officer,

Chhattisgarh Environment Conservation Board,
Korba (C.G.)



**REGIONAL OFFICE
C.G. ENVIRONMENT CONSERVATION BOARD,
NEAR TEHSIL OFFICE RAMPUR, KORBA, DISTT-KORBA (C.G.)
Email Id:- rocecbkorba@gmail.com**

No. 1126/R.O./ C.E.C.B/2022

Korba. Dated: 28/ 12/2022

CERTIFICATE

This is to certify that **M/s Bharat Aluminum Company Limited, 540 MW TPP, Balco Nagar Korba, Distt-Korba (C.G.)** has reclaimed its ash dyke situated at Parsabhatha dyke no.1 having a total land area of 17.08 Heactare. The ash dyke contains 1834273 MT quantity of fly ash. The dyke is not in service from Dec 2013 and around 44251 no. saplings has been planted in the reclaimed area.

Spirida
Regional Officer,

Chhattisgarh Environment Conservation Board,
Korba (C.G.)

Entd. No. /R.O./ C.E.C.B/2022

Korba. Dated: / /2022

Copy to:

The Member Secretary, Chhattisgarh Environment Conservation Board,
Nawa Raipur Atal Nagar, Raipur for favour of information please.

/
Regional Officer,

Chhattisgarh Environment Conservation Board,
Korba (C.G.)



**REGIONAL OFFICE
C.G. ENVIRONMENT CONSERVATION BOARD,
NEAR TEHSIL OFFICE RAMPUR, KORBA, DISTT-KORBA (C.G.)
Email Id:- rocecbkorba@gmail.com**

No. 1120 /R.O./ C.E.C.B/2022

Korba. Dated: 28/12/2022

CERTIFICATE

This is to certify that **M/s Balco Captive Power Plant, 270 MW Jannipali, Distt-Korba (C.G.)** has reclaimed its ash dyke situated at Village-Balgikhar having a total land area of 29.13 Heactare. The ash dyke contains 1979156 MT quantity of fly ash. The dyke is not in service from Dec- 2015 and around 35000 no. saplings has been planted in the reclaimed area.

Srinika
Regional Officer,

Chhattisgarh Environment Conservation Board,
Korba (C.G.)

Entd. No. /R.O./ C.E.C.B/2022

Korba. Dated: / /2022

Copy to:

The Member Secretary, Chhattisgarh Environment Conservation Board,
Nawa Raipur Atal Nagar, Raipur for favour of information please.

/

Regional Officer,

Chhattisgarh Environment Conservation Board,
Korba (C.G.)



**REGIONAL OFFICE
C.G. ENVIRONMENT CONSERVATION BOARD,
NEAR TEHSIL OFFICE RAMPUR, KORBA, DISTT-KORBA(C.G.)
Email Id:- rocecbkorba@gmail.com**

No. 1122/R.O./C.E.C.B/2022

Korba. Dated: 28/12/2022

CERTIFICATE

This is to certify that **M/s Balco Captive Power Plant, 270 MW, Jamnipali, Distt-Korba (C.G.)** has reclaimed its ash dyke situated at Village-Daganiakhar having a total land area of 63.53 Heactare. The ash dyke contains 4801169 MT quantity of fly ash. The dyke is not in service from Dec- 2015 and around 50326 no. saplings has been planted in the reclaimed area.

Spirida
Regional Officer,

Chhattisgarh Environment Conservation Board,
Korba (C.G.)

Entd. No. /R.O./C.E.C.B/2022

Korba. Dated: / /2022

Copy to:

The Member Secretary, Chhattisgarh Environment Conservation Board,
Nawa Raipur Atal Nagar, Raipur for favour of information please.

Regional Officer,

Chhattisgarh Environment Conservation Board,
Korba (C.G.)

Vimta Labs Limited

Registered Office
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Hyderabad-500 051, Telangana, India
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Vimta

Driven by Quality. Inspired by Science.

ISSUED TO:

M/s. Bharat Aluminum Company Limited,
BALCO
KORBA
Chhattisgarh

Report Number : VLL/VLS/24-25/03684/002
Issued Date : 2024-05-31
P.O. No. : 8500005780
P.O. Date : 2022-06-29

Page 1 of 1

SAMPLE PARTICULARS : SURFACE WATER SAMPLE (BALCO PLANT)

Sample Registration Date : 2024-05-13 Sampling Date : 2024-05-09
Analysis Starting Date : 2024-05-13 Analysis Completion Date : 2024-05-30
Samples Details : SW1-Bailgiri Nala (U/S)-Near Baigiri Village, SW2-Bailgiri Nala (D/S)-Near Baigiri Basti, SW3-Dhengu Nala (U/S) Risbabasti SW4 Dhengu Nala (D/S) near Check post Balco.

SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	Unit	SW1	SW2	SW3	SW4
1	pH	-	7.69	7.33	7.84	7.72
2	Colour	Hazen	2	4	2	2
3	Conductivity	µS/cm	160	295	265	350
4	TDS	mg/l	106	164	167	247
5	DO	mg/l	5.7	4.8	5.3	5.6
6	BOD	mg/l	<3.0	<3.0	<3.0	<3.0
7	COD	mg/l	<5.0	<5.0	<5.0	<5.0
8	Turbidity	NTU	1	2	2	3
9	Total Hardness as CaCO ₃	mg/l	45	184	81	140
10	Total Alkalinity as CaCO ₃	mg/l	50	210	60	110
11	Calcium as Ca	mg/l	10.5	38.4	16.8	26.2
12	Magnesium as Mg	mg/l	4.6	21.5	9.4	13.4
13	Chlorides as Cl	mg/l	18.2	138.6	41.2	56.5
14	Residual free chlorine	mg/l	<0.2	<0.2	<0.2	<0.2
15	Phosphates as PO ₄	mg/l	0.03	0.14	0.05	0.07
16	Sulphates as SO ₄	mg/l	4.6	24.5	12.4	13.2
17	Fluorides as F	mg/l	0.207	0.309	0.237	0.238
18	Nitrates as NO ₃	mg/l	0.60	3.70	1.9	2.5
19	Sodium as Na	mg/l	16.5	29.8	23.5	42.3
20	Potassium as K	mg/l	0.4	2.6	1.2	1.8
21	Total Boron as B	mg/l	0.86	0.11	0.11	0.13
22	Phenolic Compounds	mg/l	<0.001	<0.001	<0.001	<0.001
23	Cyanides as CN	mg/l	<0.02	<0.02	<0.02	<0.02
24	Oil & grease	mg/l	<1.0	<1.0	<1.0	<1.0
25	Cadmium as Cd	mg/l	<0.003	<0.003	<0.003	<0.003
26	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01
27	Copper as Cu	mg/l	0.01	<0.01	0.01	0.013
28	Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01
29	Iron as Fe	mg/l	0.05	0.06	0.09	0.1
30	Chromium as Cr ⁶⁺	mg/l	<0.05	<0.05	<0.05	<0.05
31	Selenium as Se	mg/l	<0.01	<0.01	<0.01	<0.01
32	Zinc as Zn	mg/l	0.03	0.06	0.012	0.055
33	Aluminum as Al	mg/l	0.05	0.07	0.07	0.06
34	Mercury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001
35	SAR	-	1.07	3.84	1.14	1.81
36	Insecticides	mg/l	Absent	Absent	Absent	Absent
37	Anionic detergents as MBAS	mg/l	Absent	Absent	Absent	Absent
38	Total Coliforms	MPN/100	2280	3150	2620	2890

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)

-END OF THE REPORTS-

Name and Designation of Authorized Signatory


VIMTA LABS
REGD. No- DL 33004/99
Dr. Subba Reddy Mahampati
(Manager, Environment)

Life Sciences Campus, # 5, MN Science & Technology Park, Genome Valley, Shamirpet, Hyderabad - 500 101, Telangana, India
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Driven by Quality. Inspired by Science.

ISSUED TO:

M/s. Bharat Aluminum Company Limited,
BALCO
KORBA
Chhattisgarh

Report Number : VLL/VLS/24-25/03684/002
Issued Date : 2024-05-31
P.O. No. : 8500005780
P.O. Date : 2022-06-29

SAMPLE PARTICULARS : SURFACE WATER SAMPLE (BALCO PLANT)
Sample Registration Date : 2024-05-13 Sampling Date : 2024-05-09
Analysis Starting Date : 2024-05-13 Analysis Completion Date : 2024-05-30
Samples Details : SW5-Hasdeo river near Gerwaghat(D/S), SW6- Hasdeo river near kobra(D/S)-1, SW7- Hasdeo Reservoir river near Kobra (D/S)-2, SW8- Hasdeo river near Ramgarh (U/S), and SW9- Hasdeo river near kohariya.

SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

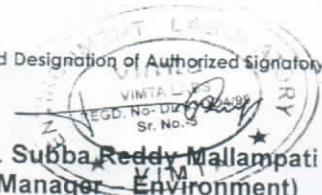
Sr. No.	Parameters	Unit	SW5	SW6	SW7	SW8	SW9
1	pH	-	8.08	7.28	7.87	7.97	7.82
2	Colour	Hazen	2	2	3	2	3
3	Conductivity	µS/cm	346	670	688	285	257
4	TDS	mg/l	226	435	440	181	163
5	DO	mg/l	5.4	4.7	4.8	5.3	5.4
6	BOD	mg/l	<3.0	<3.0	<3.0	<3.0	<3.0
7	COD	mg/l	<5.0	<5.0	<5.0	<5.0	<5.0
8	Turbidity	NTU	4	2	3	3	4
9	Total Hardness as CaCO ₃	mg/l	130	230	212	95	83
10	Total Alkalinity as CaCO ₃	mg/l	110	210	190	80	75
11	Calcium as Ca	mg/l	32	53.6	49.2	17.3	15.6
12	Magnesium as Mg	mg/l	11.8	23.3	21.6	12.5	10.8
13	Chlorides as Cl	mg/l	32.8	66.3	83	33.8	29.2
14	Residual free chlorine	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2
15	Phosphates as PO ₄	mg/l	0.03	0.05	0.04	0.08	0.07
16	Sulphates as SO ₄	mg/l	13.7	24.8	28.3	10.7	8.4
17	Fluorides as F	mg/l	0.486	0.579	0.438	0.363	0.351
18	Nitrates as NO ₃	mg/l	2.30	4.7	5.6	3.5	2.1
19	Sodium as Na	mg/l	17.8	43.4	58.2	21.5	18.9
20	Potassium as K	mg/l	4.5	8.7	3.6	1.1	2.4
21	Total Boron as B	mg/l	0.11	0.11	0.09	0.10	0.08
22	Phenolic Compounds	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
23	Cyanides as CN	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02
24	Oil & grease	mg/l	<1.0	<1.0	<1.0	<1.0	<1.0
25	Cadmium as Cd	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003
26	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
27	Copper as Cu	mg/l	0.01	<0.01	<0.01	<0.01	<0.01
28	Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
29	Iron as Fe	mg/l	0.12	0.08	0.04	0.08	0.09
30	Chromium as Cr ⁶⁺	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
31	Selenium as Se	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
32	Zinc as Zn	mg/l	0.015	0.01	0.012	0.035	0.028
33	Aluminum as Al	mg/l	0.053	0.03	0.03	0.06	0.05
34	Mercury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
35	SAR	-	0.68	1.25	1.74	0.96	0.90
36	Insecticides	mg/l	Absent	Absent	Absent	Absent	Absent
37	Anionic detergents as MBAS	mg/l	Absent	Absent	Absent	Absent	Absent
38	Total Coliforms	MPN/100	2180	2460	2390	2140	2520

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)

-END OF THE REPORTS-

Name and Designation of Authorized Signatory

Dr. Subba Reddy Mallampati
(Manager - Environment)



ISSUED TO:
 M/s. Bharat Aluminum Company Limited,
 BALCO
 KORBA
 Chhattisgarh

Report Number : VLL/VLS/24-25/01975/002
 Issued Date : 2024-04-30
 P.O. No. : 8500005780
 P.O. Date : 2022-06-29

Page 1 of 1

SAMPLE PARTICULARS : SURFACE WATER SAMPLE (BALCO PLANT)

Sample Registration Date : 2024-04-05 Sampling Date : 2024-04-03
 Analysis Starting Date : 2024-04-05 Analysis Completion Date : 2024-04-29
 Samples Details : SW1-Bailgiri Nala (U/S)-Near Baigiri Village, SW2-Bailgiri Nala (D/S)-Near Bailgiri Basti, SW3- Dhengu Nala (U/S) Risbabasti SW4- Dhengu Nala (D/S)-near Check post Baleo.

SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	Unit	SW1	SW2	SW3	SW4
1	pH	-	7.76	7.51	7.30	7.48
2	Colour	Hazen	1	2	2	1
3	Conductivity	µS/cm	206	242	224	302
4	TDS	mg/l	131	155	141	190
5	DO	mg/l	5.8	4.5	5.7	4.9
6	BOD	mg/l	<3.0	<3.0	<3.0	<3.0
7	COD	mg/l	<5.0	<5.0	<5.0	<5.0
8	Turbidity	NTU	1	2	1	3
9	Total Hardness as CaCO ₃	mg/l	13	72	18	38
10	Total Alkalinity as CaCO ₃	mg/l	12	50	15	25
11	Calcium as Ca	mg/l	2.9	15.3	3.7	8.2
12	Magnesium as Mg	mg/l	1.4	8.2	2.1	4.3
13	Chlorides as Cl	mg/l	5.6	37.4	8.6	20.7
14	Residual free chlorine	mg/l	<0.2	<0.2	<0.2	<0.2
15	Phosphates as PO ₄	mg/l	0.04	0.07	0.05	0.06
16	Sulphates as SO ₄	mg/l	3.2	12.3	3.4	12.2
17	Fluorides as F	mg/l	0.113	0.195	0.190	0.250
18	Nitrates as NO ₃	mg/l	0.3	1.6	0.7	1.2
19	Sodium as Na	mg/l	4.6	21.8	6.1	14.2
20	Potassium as K	mg/l	0.6	1.2	0.4	0.5
21	Total Boron as B	mg/l	0.27	0.126	0.128	0.111
22	Phenolic Compounds	mg/l	<0.001	<0.001	<0.001	<0.001
23	Cyanides as CN	mg/l	<0.02	<0.02	<0.02	<0.02
24	Oil & grease	mg/l	<1.0	<1.0	<1.0	<1.0
25	Cadmium as Cd	mg/l	<0.003	<0.003	<0.003	<0.003
26	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01
27	Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01
28	Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01
29	Iron as Fe	mg/l	0.07	0.09	0.07	0.09
30	Chromium as Cr ⁶⁺	mg/l	<0.01	<0.01	<0.01	<0.01
31	Selenium as Se	mg/l	<0.01	<0.01	<0.01	<0.01
32	Zinc as Zn	mg/l	0.04	0.05	0.12	0.13
33	Aluminum as Al	mg/l	0.15	0.19	0.06	0.08
34	Mercury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001
35	SAR	-	1.09	1.22	0.75	1.32
36	Insecticides	mg/l	Absent	Absent	Absent	Absent
37	Anionic detergents as MBAS	mg/l	Absent	Absent	Absent	Absent
38	Total Coliforms	MPN/100	1970	2550	2345	2175

Method of Testing: As per APHA 23rd edition and IS: 3025
 Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)

-END OF THE REPORTS-

Name and Designation of Authorized Signatory



Dr. Subba Reddy Mallampati
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Vimta

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ISSUED TO:

M/s. Bharat Aluminum Company Limited,
BALCO
KORBA
Chhattisgarh

Report Number :
Issued Date :
P.O. No. :
P.O. Date :

VLL/VLS/24-25/01975/002
2024-04-30
8500005780
2022-06-29

Page 1 of 1

SAMPLE PARTICULARS	SURFACE WATER SAMPLE (BALCO PLANT)	
Sample Registration Date	2024-04-05	Sampling Date : 2024-04-03
Analysis Starting Date	2024-04-05	Analysis Completion Date : 2024-04-29
Samples Details	SW5-Hasdeo river near Gerwaghat(D/S), SW6- Hasdeo river near kobra(D/S)-1, SW7- Hasdeo Reservoir river near Kobra (D/S)-2, SW8- Hasdeo river near Ramgarh (U/S), and SW9- Hasdeo river near kohariya .	

SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	Unit	SW5	SW6	SW7	SW8	SW9
1	pH	-	7.21	7.36	7.39	7.23	7.54
2	Colour	Hazen	2	1	2	3	2
3	Conductivity	µS/cm	131	178	144	168	165
4	TDS	mg/l	84	114	92	107	104
5	DO	mg/l	5.2	4.5	4.7	5.4	5.7
6	BOD	mg/l	<3.0	<3.0	<3.0	<3.0	<3.0
7	COD	mg/l	<5.0	<5.0	<5.0	<5.0	<5.0
8	Turbidity	NTU	3	2	1	4	2
9	Total Hardness as CaCO ₃	mg/l	38	50	39	50	46
10	Total Alkalinity as CaCO ₃	mg/l	30	36	25	33	42
11	Calcium as Ca	mg/l	8.3	11.2	7.8	10.7	10.2
12	Magnesium as Mg	mg/l	4.1	5.4	4.7	5.6	4.9
13	Chlorides as Cl	mg/l	16.4	24.9	22.3	23.9	19.1
14	Residual free chlorine	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2
15	Phosphates as PO ₄	mg/l	0.08	0.05	0.04	0.03	0.07
16	Sulphates as SO ₄	mg/l	10.2	14.6	12.7	14.5	11.2
17	Fluorides as F	mg/l	0.43	0.367	0.460	0.271	0.367
18	Nitrates as NO ₃	mg/l	0.6	0.9	1.3	1.5	0.8
19	Sodium as Na	mg/l	12.5	16.9	14.7	15.4	16.1
20	Potassium as K	mg/l	0.4	1.5	0.9	0.4	1.2
21	Total Boron as B	mg/l	0.29	0.122	0.126	0.106	0.116
22	Phenolic Compounds	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
23	Cyanides as CN	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02
24	Oil & grease	mg/l	<1.0	<1.0	<1.0	<1.0	<1.0
25	Cadmium as Cd	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003
26	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
27	Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
28	Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
29	Iron as Fe	mg/l	0.24	0.36	0.45	0.47	0.51
30	Chromium as Cr ⁶⁺	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
31	Selenium as Se	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
32	Zinc as Zn	mg/l	0.042	0.05	0.056	0.026	0.09
33	Aluminum as Al	mg/l	0.18	0.09	0.14	0.16	0.18
34	Mercury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
35	SAR	-	1.05	1.26	1.12	1.46	1.78
36	Insecticides	mg/l	Absent	Absent	Absent	Absent	Absent
37	Anionic detergents as MBAS	mg/l	Absent	Absent	Absent	Absent	Absent
38	Total Coliforms	MPN/100	2356	2174	2280	2372	2440

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)

-END OF THE REPORTS-

Name and Designation of Authorized Signatory
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Sr. No.-5
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Vimta

Report Number : QAL/23/24/243/02
Issued Date : 2024-04-03
P.O. No. : 8500005780
P.O. Date : 2022-06-29

Page 1 of 1

SAMPLE PARTICULARS : SURFACE WATER SAMPLE (BALCO PLANT)

Sample Registration Date : 2024-03-15 Sampling Date : 2024-03-13
Analysis Starting Date : 2024-03-16 Analysis Completion Date : 2024-04-02
Samples Details : SW1-Baigiri Nala (U/S)-Near Baigiri Village, SW2-Baigiri Nala (D/S)-Near Baigiri Basti, SW3-Dhengu Nala (U/S) Risbabasti SW4- Dhengu Nala (D/S)-near Check post Balco.

SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	Unit	SW1	SW2	SW3	SW4
1	pH	-	7.10	7.22	7.28	7.58
2	Colour	Hazen	2	4	3	2
3	Conductivity	µS/cm	260	297	230	325
4	TDS	mg/l	167	191	148	210
5	DO	mg/l	5.4	4.8	5.1	5.3
6	BOD	mg/l	<3.0	<3.0	<3.0	<3.0
7	COD	mg/l	<5.0	<5.0	<5.0	<5.0
8	Turbidity	NTU	1	2	1	2
9	Total Hardness as CaCO ₃	mg/l	87	94	76	106
10	Total Alkalinity as CaCO ₃	mg/l	50	40	45	55
11	Calcium as Ca	mg/l	15.8	17.4	14.6	18.5
12	Magnesium as Mg	mg/l	11.6	12.3	9.7	14.4
13	Chlorides as Cl	mg/l	45.2	59.6	38.2	64.5
14	Residual free chlorine	mg/l	<0.2	<0.2	<0.2	<0.2
15	Phosphates as PO ₄	mg/l	0.03	0.08	0.03	0.07
16	Sulphates as SO ₄	mg/l	13.4	16.8	14.6	12.4
17	Fluorides as F	mg/l	0.078	0.105	0.125	0.237
18	Nitrates as NO ₃	mg/l	1.2	1.5	1.3	1.9
19	Sodium as Na	mg/l	19.2	24.2	17.5	25.2
20	Potassium as K	mg/l	1.3	1.7	1.1	1.9
21	Total Boron as B	mg/l	0.03	0.04	0.03	0.07
22	Phenolic Compounds	mg/l	<0.001	<0.001	<0.001	<0.001
23	Cyanides as CN	mg/l	<0.02	<0.02	<0.02	<0.02
24	Oil & grease	mg/l	<1.0	<1.0	<1.0	<1.0
25	Cadmium as Cd	mg/l	<0.003	<0.003	<0.003	<0.003
26	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01
27	Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01
28	Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01
29	Iron as Fe	mg/l	0.04	0.06	0.05	0.07
30	Chromium as Cr ⁺⁺	mg/l	<0.05	<0.05	<0.05	<0.05
31	Selenium as Se	mg/l	<0.01	<0.01	<0.01	<0.01
32	Zinc as Zn	mg/l	0.06	0.14	0.11	0.14
33	Aluminum as Al	mg/l	0.01	0.03	0.04	0.06
34	Mercury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001
35	SAR	-	0.89	1.09	0.87	1.07
36	Insecticides	mg/l	Absent	Absent	Absent	Absent
37	Anionic detergents as MBAS	mg/l	Absent	Absent	Absent	Absent
38	Total Coliforms	MPN/100	1860	2430	2240	2310

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)

-END OF THE REPORTS-

Name and Designation of Authorized Signatory



Dr. S. M. B. Reddy Mallampati
(Manager - Environment)

ISSUED TO:

M/s. Bharat Aluminum Company Limited,
BALCO
KORBA
Chhattisgarh

Report Number : VLL/VLS/23-24/24330/002
Issued Date : 2024-04-02
P.O. No. : 8500005780
P.O. Date : 2022-06-29

SAMPLE PARTICULARS	: SURFACE WATER SAMPLE (BALCO PLANT)		
Sample Registration Date	: 2024-03-15	Sampling Date	: 2024-03-13
Analysis Starting Date	: 2024-03-16	Analysis Completion Date	: 2024-04-01
Samples Details	: SW5- Hasdeo river near Ramgarh (U/S), SW6- Hasdeo river near kohariya , SW7- Hasdeo river near Gerwaghat , SW8- Hasdeo river near Gerwaghat(D/S), and SW9-, Hasdeo river near sanpur (DIS).		
SAMPLE COLLECTED BY VIMTA LABS LTD.			

TEST REPORT

Sr. No.	Parameters	Unit	SW5	SW6	SW7	SW8	SW9
1	pH	-	7.39	7.42	7.33	7.28	7.21
2	Color	Hazen	3	3	2	2	3
3	Conductivity	µS/cm	235	240	295	310	325
4	IDS	mg/l	150	153	189	198	205
5	DO	mg/l	4.8	5.2	4.9	5.2	5.1
6	BOD	mg/l	<3.0	<3.0	<3.0	<3.0	<3.0
7	COD	mg/l	<5.0	<5.0	<5.0	<5.0	<5.0
8	Turbidity	NTU	2	3	2	2	2
9	Total Hardness as CaCO ₃	mg/l	74	73	97	100	91
10	Total Alkalinity as CaCO ₃	mg/l	50	60	70	62	65
11	Calcium as Ca	mg/l	16.7	18.7	21.2	19.6	17.5
12	Magnesium as Mg	mg/l	7.8	6.3	10.6	12.3	11.5
13	Chlorides as Cl	mg/l	38.7	33.10	42.4	51.8	54.7
14	Residual free chlorine	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2
15	Phosphates as PO ₄	mg/l	0.04	0.02	0.06	0.06	0.08
16	Sulphates as SO ₄	mg/l	10.7	11.10	13.6	16.2	17.5
17	Fluorides as F	mg/l	0.319	0.40	0.428	0.341	0.439
18	Nitrates as NO ₃	mg/l	1.1	1.20	1.7	1.5	1.9
19	Sodium as Na	mg/l	19.6	21.2	22.4	24.3	32.2
20	Potassium as K	mg/l	1.1	1.20	1.3	2.3	1.8
21	Total Boron as B	mg/l	0.04	0.04	0.03	0.04	0.03
22	Phenolic Compounds	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
23	Cyanides as CN	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02
24	Oil & grease	mg/l	<1.0	<1.0	<1.0	<1.0	<1.0
25	Cadmium as Cd	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003
26	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
27	Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
28	Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
29	Iron as Fe	mg/l	0.07	0.05	0.09	0.05	0.08
30	Chromium as Cr ⁶⁺	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
31	Selenium as Se	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
32	Zinc as Zn	mg/l	0.19	0.06	0.12	0.11	0.15
33	Aluminum as Al	mg/l	0.02	0.03	0.05	0.04	0.06
34	Mercury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
35	SAR	-	0.99	1.08	0.99	1.06	1.47
36	Insecticides	mg/l	Absent	Absent	Absent	Absent	Absent
37	Anionic detergents as MBAS	mg/l	Absent	Absent	Absent	Absent	Absent
38	Total Coliforms	MPN/100	2270	2160	2640	2150	2260

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)

-END OF THE REPORTS-

Name and Designation of Authorized Signatory

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ISSUED TO:

M/s. Bharat Aluminum Company Limited,
BALCO
KORBA
Chhattisgarh

Report Number : VLL/VLS/24-25/03684/001
Issued Date : 2024-05-31
P.O. No. : 8500005780
P.O. Date : 2022-06-29

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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-05-13 Sampling Date : 2024-05-09
Analysis Starting Date : 2024-05-13 Analysis Completion Date : 2024-05-29
Test Required : Water Analysis as per IS 10500 : 2012
SAMPLE COLLECTED BY VIMTA LABS LTD

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Parsabhata (B/W)	Parsabhata (D/W)	Karma Talkies(B/W)	Bhadrapada D/W)
1	pH value	-	6.5-8.5 (NR)	7.23	6.95	6.81	6.92
2	Color	Hazen	5(15)	Colorless	Colorless	Colorless	Colorless
3	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5	Turbidity	NTU	1(5)	1	1	1	1
6	Total dissolved solids at 180°C	mg/l	500(2000)	488	425	248	350
7	Total Hardness as CaCO ₃	mg/l	200(600)	240	232	112	179
8	Total Alkalinity as CaCO ₃	mg/l	200(600)	210	190	105	150
9	Calcium as Ca	mg/l	75(200)	54.4	51.3	23.7	39.5
10	Magnesium as Mg	mg/l	30(100)	25.2	25.2	12.7	19.6
11	Free Residual chlorine	mg/l	0.2(1.0)	<0.2	<0.2	<0.2	<0.2
12	Boron as B	mg/l	0.5(1.0)	0.13	0.09	0.08	0.082
13	Chlorides as Cl	mg/l	250(1000)	79.8	74	44.5	67.2
14	Sulphate as SO ₄	mg/l	200(400)	47.8	33.2	21.8	24.2
15	Fluorides as F	mg/l	1.0(1.5)	1.34	0.65	0.098	0.074
16	Nitrates as NO ₃	mg/l	45(NR)	3.8	2.9	1.9	4.3
17	Phenolic Compounds as C ₆ H ₅ OH	mg/l	0.001(0.002)	<0.001	<0.001	<0.001	<0.001
18	Cyanides as CN	mg/l	0.05(NR)	<0.02	<0.02	<0.02	<0.02

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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ISSUED TO:

M/s. Bharat Aluminum Company Limited,
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Chhattisgarh

Report Number : VLL/VLS/24-25/03684/001
Issued Date : 2024-05-31
P.O. No. : 8500005780
P.O. Date : 2022-06-29

Page 2 of 4

SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-05-13 Sampling Date : 2024-05-09
Analysis Starting Date : 2024-05-13 Analysis Completion Date : 2024-05-29
Test Required : Water Analysis as per IS 10500 : 2012

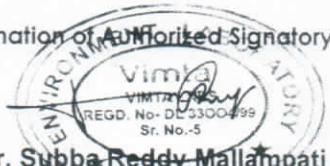
SAMPLE COLLECTED BY VIMTA LABS LTD

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Parsabhata (B/W)	Parsabhata (D/W)	Karma Talkies(B/W)	Bhadrapada D/W)
19	Anionic detergents as MBAS	mg/l	0.2(1.0)	<0.02	<0.02	<0.02	<0.02
20	Mineral oil	mg/l	0.5(NR)	Absent	Absent	Absent	Absent
21	Cadmium as Cd	mg/l	0.003(NR)	<0.003	<0.003	<0.003	<0.003
22	Total Arsenic as As	mg/l	0.01(0.05)	<0.01	<0.01	<0.01	<0.01
23	Copper as Cu	mg/l	0.05(1.5)	0.01	0.01	<0.01	0.01
24	Lead as Pb	mg/l	0.01(NR)	<0.01	<0.01	<0.01	<0.01
25	Manganese as Mn	mg/l	0.1(0.3)	0.03	0.01	0.073	0.058
26	Molybdenum as Mo	mg/l	0.07(NR)	<0.01	<0.01	<0.01	<0.01
27	Nickel as Ni	mg/l	0.02(NR)	<0.01	<0.01	<0.01	<0.01
28	Iron as Fe	mg/l	0.3(NR)	0.08	0.05	0.06	0.067
29	Total Chromium as Cr	mg/l	0.05(NR)	<0.01	<0.01	<0.01	<0.01
30	Selenium as Se	mg/l	0.05(NR)	<0.01	<0.01	<0.01	<0.01
31	Zinc as Zn	mg/l	5.0(15)	0.09	0.03	0.03	0.024
32	Aluminum as Al	mg/l	0.03(0.2)	0.01	0.12	0.024	0.01
33	Mercury as Hg	mg/l	0.001(NR)	<0.001	<0.001	<0.001	<0.001
34	Sulphide as H ₂ S	mg/l	0.05(NR)	<0.05	<0.05	<0.05	<0.05
35	Chloramines as Cl ₂	mg/l	4.0(NR)	<0.05	<0.05	<0.05	<0.05
36	Ammonia (as total ammonia-N	mg/l	0.5(NR)	<0.05	<0.05	<0.05	<0.05
37	Barium as Ba	mg/l	0.7(NR)	0.044	0.03	0.039	0.20
38	Silver as Ag	mg/l	0.1(NR)	<0.01	<0.01	<0.01	<0.01

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory


REGD. No. DL3300499
Sr. No. 5
Dr. Subba Reddy Mallampati
(Manager - Environment)

ISSUED TO:

M/s. Bharat Aluminum Company Limited,
BALCO
KORBA
Chhattisgarh

Report Number : VLL/VLS/24-25/03684/001
Issued Date : 2024-05-31
P.O. No. : 8500005780
P.O. Date : 2022-06-29

SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date	: 2024-05-13	Sampling Date	: 2024-05-09
Analysis Starting Date	: 2024-05-13	Analysis Completion Date	: 2024-05-29
Test Required	: Water Analysis as per IS 10500 : 2012		
SAMPLE COLLECTED BY VIMTA LABS LTD			

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Parsabhata (B/W)	Parsabhata (D/W)	Karma Talkies(B/W)	Bhadrapada D/W)
39	Polychlorinated biphenyls	mg/l	0.0005(NR)	Absent	Absent	Absent	Absent
40	Polynuclear aromatic hydrocarbon as PAH	mg/l	0.0001 (NR)	<0.0001	<0.0001	<0.0001	<0.0001
41	Bromoform	mg/l	0.1(NR)	<0.0001	<0.0001	<0.0001	<0.0001
42	Dibromochloromethane	mg/l	0.1(NR)	<0.01	<0.01	<0.01	<0.01
43	Bromodichloromethane	mg/l	0.06(NR)	<0.01	<0.01	<0.01	<0.01
44	Chloroform	mg/l	0.2(NR)	<0.001	<0.001	<0.001	<0.001
(A)	Pesticides						
45	Alachlor	µg/l	20	<0.01	<0.01	<0.01	<0.01
46	Atrazine	µg/l	2	<0.01	<0.01	<0.01	<0.01
47	Aldrin	µg/l	0.03	<0.01	<0.01	<0.01	<0.01
48	Alpha HCH	µg/l	0.01	<0.01	<0.01	<0.01	<0.01
49	Beta HCH	µg/l	0.04	<0.01	<0.01	<0.01	<0.01
50	Butachlor	µg/l	125	<0.01	<0.01	<0.01	<0.01
51	Chlorpyrifos	µg/l	30	<0.01	<0.01	<0.01	<0.01
52	Delta HCH	µg/l	0.04	<0.01	<0.01	<0.01	<0.01
53	2,4-Dichlorophenoxyacetic acid	µg/l	30	<0.01	<0.01	<0.01	<0.01
54	DDT	µg/l	1	<0.01	<0.01	<0.01	<0.01
55	Endosulfan (alpha, beta and Sulphate)	µg/l	0.4	<0.01	<0.01	<0.01	<0.01
56	Ethion	µg/l	3	<0.01	<0.01	<0.01	<0.01
57	Gamma HCH	µg/l	2	<0.01	<0.01	<0.01	<0.01
58	Isoproturon	µg/l	9	<0.01	<0.01	<0.01	<0.01

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory

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ISSUED TO:

M/s. Bharat Aluminum Company Limited,
BALCO
KORBA
Chhattisgarh

Report Number : VLL/VLS/24-25/03684/001
Issued Date : 2024-05-31
P.O. No. : 8500005780
P.O. Date : 2022-06-29

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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-05-13 Sampling Date : 2024-05-09
Analysis Starting Date : 2024-05-13 Analysis Completion Date : 2024-05-29
Test Required : Water Analysis as per IS 10500 : 2012

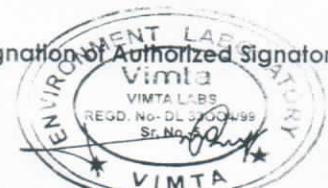
SAMPLE COLLECTED BY VIMTA LABS LTD

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Parsabhata (B/W)	Parsabhata (D/W)	Karma Talkies(B/W)	Bhadrapada D/W)
59	Malathion	µg/l	190	BDL	BDL	BDL	BDL
60	Methyl parathion	µg/l	0.3	BDL	BDL	BDL	BDL
61	Monocrotophos	µg/l	1	BDL	BDL	BDL	BDL
62	Phorate	µg/l	2	BDL	BDL	BDL	BDL
63	E.coli	Per 100 ml	Absent	Absent	Absent	Absent	Absent
64	Total Coliforms	MPN/100ml	Absent	Absent	Absent	Absent	Absent
(B)	Radioactive						
65	Alpha emitters	Bq/l	0.1(NR)	BDL	BDL	BDL	BDL
66	Beta emitters	Bq/l	1.0(NR)	BDL	BDL	BDL	BDL

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

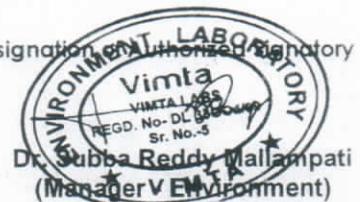
Sample Registration Date : 2024-05-13 Sampling Date : 2024-05-09
Analysis Starting Date : 2024-05-13 Analysis Completion Date : 2024-05-30
Test Required : Water Analysis as per IS 10500 : 2012
SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Rogbheri (B/W)	Rogbheri (D/W)	Bailgiri Basti(B/W)	Bailgiri Basti(D/W)
1	pH value	-	6.5-8.5 (NR)	6.69	7.05	6.83	7.57
2	Color	Hazen	5(15)	Colorless	Colorless	Colorless	Colorless
3	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5	Turbidity	NTU	1(5)	1	1	1	1
6	Total dissolved solids at 180°C	mg/l	500(2000)	484	263	543	355
7	Total Hardness as CaCO ₃	mg/l	200(600)	271	121	280	191
8	Total Alkalinity as CaCO ₃	mg/l	200(600)	240	110	250	175
9	Calcium as Ca	mg/l	75(200)	56.8	24.5	68.5	43.7
10	Magnesium as Mg	mg/l	30(100)	31.4	14.5	26.5	19.8
11	Free Residual chlorine	mg/l	0.2(1.0)	<0.2	<0.2	<0.2	<0.2
12	Boron as B	mg/l	0.5(1.0)	0.09	0.09	0.08	0.09
13	Chlorides as Cl	mg/l	250(1000)	70.3	53.7	89.4	45.8
14	Sulphate as SO ₄	mg/l	200(400)	32.9	17.8	38.5	27.7
15	Fluorides as F	mg/l	1.0(1.5)	0.128	0.217	0.357	0.237
16	Nitrates as NO ₃	mg/l	45(NR)	2.8	2.1	3.4	1.9
17	Phenolic Compounds as C ₆ H ₅ OH	mg/l	0.001 (0.002)	<0.001	<0.001	<0.001	<0.001
18	Cyanides	mg/l	0.05(NR)	<0.02	<0.02	<0.02	<0.02

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation



ISSUED TO:

M/s. Bharat Aluminum Company Limited,
BALCO
KORBA
Chhattisgarh

Report Number : VLL/VLS/24-25/03684/001
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P.O. No. : 8500005780
P.O. Date : 2022-06-29

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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-05-13 Sampling Date : 2024-05-09
Analysis Starting Date : 2024-05-13 Analysis Completion Date : 2024-05-29
Test Required : Water Analysis as per IS 10500 : 2012
SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Rogbheri (B/W)	Rogbheri (D/W)	Bailgiri Basti(B/W)	Bailgiri Basti(D/W)
19	Anionic detergents as MBAS	mg/l	0.2(1.0)	<0.02	<0.02	<0.02	<0.02
20	Mineral oil	mg/l	0.5(NR)	Absent	Absent	Absent	Absent
21	Cadmium as Cd	mg/l	0.003(NR)	<0.003	<0.003	<0.003	<0.003
22	Total Arsenic as As	mg/l	0.01(0.05)	<0.01	<0.01	<0.01	<0.01
23	Copper as Cu	mg/l	0.05(1.5)	0.013	<0.01	0.016	0.01
24	Lead as Pb	mg/l	0.01(NR)	<0.01	<0.01	<0.01	<0.01
25	Manganese as Mn	mg/l	0.1(0.3)	0.08	0.02	0.04	0.02
26	Molybdenum as Mo	mg/l	0.07(NR)	<0.01	<0.01	<0.01	<0.01
27	Nickel as Ni	mg/l	0.02(NR)	<0.01	<0.01	<0.01	<0.01
28	Iron as Fe	mg/l	0.3(NR)	0.13	0.02	0.08	0.01
29	Total Chromium as Cr	mg/l	0.05(NR)	<0.01	<0.01	<0.01	<0.01
30	Selenium as Se	mg/l	0.05(NR)	<0.01	<0.01	<0.01	<0.01
31	Zinc as Zn	mg/l	5.0(15)	0.03	0.08	0.12	0.023
32	Aluminum as Al	mg/l	0.03(0.2)	0.01	0.01	0.01	0.01
33	Mercury as Hg	mg/l	0.001(NR)	<0.001	<0.001	<0.001	<0.001
34	Sulphide as H ₂ S	mg/l	0.05(NR)	<0.05	<0.05	<0.05	<0.05
35	Chloramines as Cl ₂	mg/l	4.0(NR)	<0.05	<0.05	<0.05	<0.05
36	Ammonia (as total ammonia-N)	mg/l	0.5(NR)	<0.05	<0.05	<0.05	<0.05
37	Barium as Ba	mg/l	0.7(NR)	0.058	0.13	0.05	0.08
38	Silver as Ag	mg/l	0.1(NR)	<0.01	<0.01	<0.01	<0.01

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-05-13 Sampling Date : 2024-05-09
Analysis Starting Date : 2024-05-13 Analysis Completion Date : 2024-05-29
Test Required : Water Analysis as per IS 10500 : 2012
SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Rogbheri (B/W)	Rogbheri (D/W)	Bailgiri Basti(B/W)	Bailgiri Basti(D/W)
39	Polychlorinated biphenyls	mg/l	0.0005(NR)	Absent	Absent	Absent	Absent
40	Polynuclear aromatic hydrocarbon as PAH	mg/l	0.0001(NR)	<0.0001	<0.0001	<0.0001	<0.0001
41	Bromoform	mg/l	0.1(NR)	<0.0001	<0.0001	<0.0001	<0.0001
42	Dibromochloromethane	mg/l	0.1(NR)	<0.01	<0.01	<0.01	<0.01
43	Bromodichloromethane	mg/l	0.06(NR)	<0.01	<0.01	<0.01	<0.01
44	Chloroform	mg/l	0.2(NR)	<0.001	<0.001	<0.001	<0.001
(A)	Pesticides						
45	Alachlor	µg/l	20	<0.01	<0.01	<0.01	<0.01
46	Atrazine	µg/l	2	<0.01	<0.01	<0.01	<0.01
47	Aldrin	µg/l	0.03	<0.01	<0.01	<0.01	<0.01
48	Alpha HCH	µg/l	0.01	<0.01	<0.01	<0.01	<0.01
49	Beta HCH	µg/l	0.04	<0.01	<0.01	<0.01	<0.01
50	Butachlor	µg/l	125	<0.01	<0.01	<0.01	<0.01
51	Chlorpyrifos	µg/l	30	<0.01	<0.01	<0.01	<0.01
52	Delta HCH	µg/l	0.04	<0.01	<0.01	<0.01	<0.01
53	2,4-Dichlorophenoxyacetic acid	µg/l	30	<0.01	<0.01	<0.01	<0.01
54	DDT	µg/l	1	<0.01	<0.01	<0.01	<0.01
55	Endosulfan (alpha, beta and Sulphate)	µg/l	0.4	<0.01	<0.01	<0.01	<0.01
56	Ethion	µg/l	3	<0.01	<0.01	<0.01	<0.01
57	Gamma HCH	µg/l	2	<0.01	<0.01	<0.01	<0.01
58	Isoproturon	µg/l	9	<0.01	<0.01	<0.01	<0.01

Method of Testing: As per APHA 23rd edition and IS: 3025

Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)

Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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SAMPLE PARTICULARS

: **GROUND WATER SAMPLES (BALCO PLANT)**

Sample Registration Date : 2024-05-13 Sampling Date : 2024-05-09
Analysis Starting Date : 2024 05 13 Analysis Completion Date : 2024-05-29
Test Required : Water Analysis as per IS 10500 : 2012

SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Rogbheri (B/W)	Rogbheri (D/W)	Bailgiri Basti(B/W)	Bailgiri Basti(D/W)
59	Malathion	µg/l	190	BDL	BDL	BDL	BDL
60	Methyl parathion	µg/l	0.3	BDL	BDL	BDL	BDL
61	Monocrotophos	µg/l	1	BDL	BDL	BDL	BDL
62	Phorate	µg/l	2	BDL	BDL	BDL	BDL
63	E.coli	Per 100 ml	Absent	Absent	Absent	Absent	Absent
64	Total Coliforms	MPN/100ml	Absent	Absent	Absent	Absent	Absent
(B)	Radioactive						
65	Alpha emitters	Bq/l	0.1(NR)	BDL	BDL	BDL	BDL
66	Beta emitters	Bq/l	1.0(NR)	BDL	BDL	BDL	BDL

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

-END OF THE REPORTS-

Name and Designation of Authorized Signatory

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Chhattisgarh

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Issued Date : 2024-04-30
P.O. No. : 8500005780
P.O. Date : 2022-06-29

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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-04-05 Sampling Date : 2024-04-03
Analysis Starting Date : 2024-04-05 Analysis Completion Date : 2024-04-29
Test Required : Water Analysis as per IS 10500 : 2012
SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Bailgiri Basti(B/W)	Bailgiri Basti(D/W)	Rogbaheri (B/W)	Rogbaheri (D/W)
1	pH value	-	6.5-8.5 (NR)	6.79	6.88	6.80	7.04
2	Color	Hazen	5(15)	Colorless	Colorless	Colorless	Colorless
3	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5	Turbidity	NTU	1(5)	2	2	1	1
6	Total dissolved solids at 180°C	mg/l	500(2000)	498	412	556	242
7	Total Hardness as CaCO ₃	mg/l	200(600)	230	165	279	120
8	Total Alkalinity as CaCO ₃	mg/l	200(600)	160	90	135	80
9	Calcium as Ca	mg/l	75(200)	51.3	34.2	63.1	24.6
10	Magnesium as Mg	mg/l	30(100)	24.6	19.3	29.4	14.2
11	Free Residual chlorine	mg/l	0.2(1.0)	<0.2	<0.2	<0.2	<0.2
12	Boron as B	mg/l	0.5(1.0)	0.098	0.122	0.077	0.068
13	Chlorides as Cl	mg/l	250(1000)	131.2	142.5	175.3	59.8
14	Sulphate as SO ₄	mg/l	200(400)	35.2	22.7	42.1	22.8
15	Fluorides as F	mg/l	1.0(1.5)	0.36	0.208	0.19	0.11
16	Nitrates as NO ₃	mg/l	45(NR)	4.1	3.4	6.3	3.2
17	Phenolic Compounds as C ₆ H ₅ OH	mg/l	0.001(0.002)	<0.001	<0.001	<0.001	<0.001
18	Cyanides	mg/l	0.05(NR)	<0.02	<0.02	<0.02	<0.02

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-04-05 Sampling Date : 2024-04-03
Analysis Starting Date : 2024-04-05 Analysis Completion Date : 2024-04-29
Test Required : Water Analysis as per IS 10500 : 2012

SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Bailgiri Basti(B/W)	Bailgiri Basti(D/W)	Rogbheri(B/W)	Rogbheri(D/W)
19	Anionic detergents as MBAS	mg/l	0.2(1.0)	<0.02	<0.02	<0.02	<0.02
20	Mineral oil	mg/l	0.5(NR)	Absent	Absent	Absent	Absent
21	Cadmium as Cd	mg/l	0.003(NR)	<0.003	<0.003	<0.003	<0.003
22	Total Arsenic as As	mg/l	0.01(0.05)	<0.01	<0.01	<0.01	<0.01
23	Copper as Cu	mg/l	0.05(1.5)	<0.01	<0.01	<0.01	<0.01
24	Lead as Pb	mg/l	0.01(NR)	<0.01	<0.01	<0.01	<0.01
25	Manganese as Mn	mg/l	0.1(0.3)	0.024	<0.01	0.082	<0.01
26	Molybdenum as Mo	mg/l	0.07(NR)	<0.01	<0.01	<0.01	<0.01
27	Nickel as Ni	mg/l	0.02(NR)	<0.01	<0.01	<0.01	<0.01
28	Iron as Fe	mg/l	0.3(NR)	0.21	0.13	0.19	0.06
29	Total Chromium as Cr	mg/l	0.05(NR)	<0.01	<0.01	<0.01	<0.01
30	Selenium as Se	mg/l	0.05(NR)	<0.01	<0.01	<0.01	<0.01
31	Zinc as Zn	mg/l	5.0(15)	0.033	0.003	0.12	0.008
32	Aluminum as Al	mg/l	0.03(0.2)	0.03	0.04	0.01	0.14
33	Mercury as Hg	mg/l	0.001(NR)	<0.001	<0.001	<0.001	<0.001
34	Sulphide as H ₂ S	mg/l	0.05(NR)	<0.05	<0.05	<0.05	<0.05
35	Chloramines as Cl ₂	mg/l	4.0(NR)	<0.05	<0.05	<0.05	<0.05
36	Ammonia (as total ammonia-N)	mg/l	0.5(NR)	<0.05	<0.05	<0.05	<0.05
37	Barium as Ba	mg/l	0.7(NR)	0.034	0.099	0.057	0.104
38	Silver as Ag	mg/l	0.1(NR)	<0.01	<0.01	<0.01	<0.01

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

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P.O. No. : 8500005780
P.O. Date : 2022-06-29

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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-04-05 Sampling Date : 2024-04-03
Analysis Starting Date : 2024-04-05 Analysis Completion Date : 2024-04-29
Test Required : Water Analysis as per IS 10500 : 2012
SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Bailgiri Basti(B/W)	Bailgiri Basti(D/W)	Rogbheri (B/W)	Rogbheri (D/W)
39	Polychlorinated biphenyls	mg/l	0.0005(NR)	Absent	Absent	Absent	Absent
40	Polynuclear aromatic hydrocarbon as PAH	mg/l	0.0001(NR)	<0.0001	<0.0001	<0.0001	<0.0001
41	Bromoform	mg/l	0.1(NR)	<0.0001	<0.0001	<0.0001	<0.0001
42	Dibromochloromethane	mg/l	0.1(NR)	<0.01	<0.01	<0.01	<0.01
43	Bromodichloromethane	mg/l	0.06(NR)	<0.01	<0.01	<0.01	<0.01
44	Chloroform	mg/l	0.2(NR)	<0.001	<0.001	<0.001	<0.001
(A)	Pesticides						
45	Alachlor	µg/l	20	<0.01	<0.01	<0.01	<0.01
46	Atrazine	µg/l	2	<0.01	<0.01	<0.01	<0.01
47	Aldrin	µg/l	0.03	<0.01	<0.01	<0.01	<0.01
48	Alpha HCH	µg/l	0.01	<0.01	<0.01	<0.01	<0.01
49	Beta HCH	µg/l	0.04	<0.01	<0.01	<0.01	<0.01
50	Butachlor	µg/l	125	<0.01	<0.01	<0.01	<0.01
51	Chlorpyrifos	µg/l	30	<0.01	<0.01	<0.01	<0.01
52	Delta HCH	µg/l	0.04	<0.01	<0.01	<0.01	<0.01
53	2,4-Dichlorophenoxyacetic acid	µg/l	30	<0.01	<0.01	<0.01	<0.01
54	DDT	µg/l	1	<0.01	<0.01	<0.01	<0.01
55	Endosulfan (alpha, beta and Sulphate)	µg/l	0.4	<0.01	<0.01	<0.01	<0.01
56	Ethion	µg/l	3	<0.01	<0.01	<0.01	<0.01
57	Gamma HCH	µg/l	2	<0.01	<0.01	<0.01	<0.01
58	Isoproturon	µg/l	9	<0.01	<0.01	<0.01	<0.01

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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KORBA
Chhattisgarh

Report Number : VLL/VLS/24-25/01975/001
Issued Date : 2024-04-30
P.O. No. : 8500005780
P.O. Date : 2022-06-29

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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-04-05 Sampling Date : 2024-04-03
Analysis Starting Date : 2024-04-05 Analysis Completion Date : 2024-04-29
Test Required : Water Analysis as per IS 10500 : 2012

SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Bailgiri Basti(B/W)	Bailgiri Basti(D/W)	Rogbheri (B/W)	Rogbheri (D/W)
59	Malathion	µg/l	190	BDL	BDL	BDL	BDL
60	Methyl parathion	µg/l	0.3	BDL	BDL	BDL	BDL
61	Monocrotophos	µg/l	1	BDL	BDL	BDL	BDL
62	Phorate	µg/l	2	BDL	BDL	BDL	BDL
63	E. coli	Per 100 ml	Absent	Absent	Absent	Absent	Absent
64	Total Coliforms	MPN/100ml	Absent	Absent	Absent	Absent	Absent
(B)	Radioactive						
65	Alpha emitters	Bq/l	0.1(NR)	BDL	BDL	BDL	BDL
66	Beta emitters	Bq/l	1.0(NR)	BDL	BDL	BDL	BDL

Method of Testing: As per APHA 23rd edition and IS 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

-END OF THE REPORTS-

Name and Designation of Authorized Signatory



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P.O. No. : 8500005780
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Page 1 of 4

SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

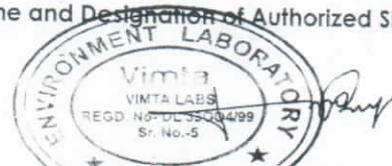
Sample Registration Date : 2024-04-05 Sampling Date : 2024-04-03
Analysis Starting Date : 2024-04-05 Analysis Completion Date : 2024-04-29
Test Required : Water Analysis as per IS 10500 : 2012
SAMPLE COLLECTED BY VIMTA LABS LTD

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Bhadrapada (D/W)	Karma Talkies(B/W)	Parsabhata (B/W)	Parsabhata (D/W)
1	pH value	-	6.5-8.5 (NR)	6.88	6.75	6.72	6.86
2	Color	Hazen	5(15)	Colorless	Colorless	Colorless	Colorless
3	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5	Turbidity	NTU	1(5)	1	1	1	2
6	Total dissolved solids at 180°C	mg/l	500(2000)	375	202	605	492
7	Total Hardness as CaCO ₃	mg/l	200(600)	188	92	274	225
8	Total Alkalinity as CaCO ₃	mg/l	200(600)	70	60	140	125
9	Calcium as Ca	mg/l	75(200)	38.5	19.4	60.5	44.7
10	Magnesium as Mg	mg/l	30(100)	22.4	10.7	29.8	27.5
11	Free Residual chlorine	mg/l	0.2(1.0)	<0.2	<0.2	<0.2	<0.2
12	Boron as B	mg/l	0.5(1.0)	0.082	0.074	0.126	0.085
13	Chlorides as Cl	mg/l	250(1000)	129.1	49.6	176.2	148.6
14	Sulphate as SO ₄	mg/l	200(400)	32.7	23.4	70.3	39.9
15	Fluorides as F	mg/l	1.0(1.5)	0.07	0.11	0.362	0.16
16	Nitrates as NO ₃	mg/l	45(NR)	5.4	3.8	5.6	4.2
17	Phenolic Compounds as C ₆ H ₅ OH	mg/l	0.001(0.002)	<0.001	<0.001	<0.001	<0.001
18	Cyanides as CN	mg/l	0.05(NR)	<0.02	<0.02	<0.02	<0.02

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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Chhattisgarh

Report Number : VLL/VLS/24-25/01975/001
Issued Date : 2024-04-30
P.O. No. : 8500005780
P.O. Date : 2022-06-29

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SAMPLE PARTICULARS

: **GROUND WATER SAMPLES (BALCO PLANT)**

Sample Registration Date : 2024-04-05 Sampling Date : 2024-04-03
Analysis Starting Date : 2024-04-05 Analysis Completion Date : 2024-04-29
Test Required : Water Analysis as per IS 10500 : 2012

SAMPLE COLLECTED BY VIMTA LABS LTD

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Bhadrapada (D/W)	Karma Talkies(B/W)	Parsabhata (B/W)	Parsabhata (D/W)
19	Anionic detergents as MBAS	mg/l	0.2(1.0)	<0.02	<0.02	<0.02	<0.02
20	Mineral oil	mg/l	0.5(NR)	Absent	Absent	Absent	Absent
21	Cadmium as Cd	mg/l	0.003(NR)	<0.003	<0.003	<0.003	<0.003
22	Total Arsenic as As	mg/l	0.01(0.05)	<0.01	<0.01	<0.01	<0.01
23	Copper as Cu	mg/l	0.05(1.5)	<0.01	<0.01	<0.01	<0.01
24	Lead as Pb	mg/l	0.01(NR)	<0.01	<0.01	0.03	<0.01
25	Manganese as Mn	mg/l	0.1(0.3)	0.031	0.066	0.482	0.226
26	Molybdenum as Mo	mg/l	0.07(NR)	<0.01	<0.01	<0.01	<0.01
27	Nickel as Ni	mg/l	0.02(NR)	<0.01	<0.01	<0.01	<0.01
28	Iron as Fe	mg/l	0.3(NR)	0.04	0.12	0.15	0.06
29	Total Chromium as Cr	mg/l	0.05(NR)	<0.01	<0.01	<0.01	<0.01
30	Selenium as Se	mg/l	0.05(NR)	<0.01	<0.01	<0.01	<0.01
31	Zinc as Zn	mg/l	5.0(15)	<0.01	<0.01	<0.01	<0.01
32	Aluminium as Al	mg/l	0.03(0.2)	0.01	<0.01	0.097	0.07
33	Mercury as Hg	mg/l	0.001(NR)	<0.001	0.01	0.01	0.01
34	Sulphide as H ₂ S	mg/l	0.05(NR)	<0.05	<0.001	<0.001	<0.001
35	Chloramines as Cl ₂	mg/l	4.0(NR)	<0.05	<0.05	<0.05	<0.05
36	Ammonia (as total ammonia-N)	mg/l	0.5(NR)	<0.05	<0.05	<0.05	<0.05
37	Barium as Ba	mg/l	0.7(NR)	0.143	0.127	0.035	0.168
38	Silver as Ag	mg/l	0.1(NR)	<0.01	<0.01	<0.01	<0.01

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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 Chhattisgarh

Report Number : VLL/VLS/24-25/01975/001
 Issued Date : 2024-04-30
 P.O. No. : 8500005780
 P.O. Date : 2022-06-29

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SAMPLE PARTICULARS

: GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-04-05 Sampling Date : 2024-04-03
 Analysis Starting Date : 2024-04-05 Analysis Completion Date : 2024-04-29
 Test Required : Water Analysis as per IS 10500 : 2012
 SAMPLE COLLECTED BY VIMTA LABS LTD

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Bhadrapada (D/W)	Karma Talkies(B/W)	Parsabhata (B/W)	Parsabhata (D/W)
39	Polychlorinated biphenyls	mg/l	0.0005(NR)	Absent	Absent	Absent	Absent
40	Polynuclear aromatic hydrocarbon as PAH	mg/l	0.0001(NR)	<0.0001	<0.0001	<0.0001	<0.0001
41	Bromoform	mg/l	0.1(NR)	<0.0001	<0.0001	<0.0001	<0.0001
42	Dibromochloromethane	mg/l	0.1(NR)	<0.01	<0.01	<0.01	<0.01
43	Bromodichloromethane	mg/l	0.06(NR)	<0.01	<0.01	<0.01	<0.01
44	Chloroform	mg/l	0.2(NR)	<0.001	<0.001	<0.001	<0.001
(A)	Pesticides						
45	Alachlor	µg/l	20	<0.01	<0.01	<0.01	<0.01
46	Atrazine	µg/l	2	<0.01	<0.01	<0.01	<0.01
47	Aldrin	µg/l	0.03	<0.01	<0.01	<0.01	<0.01
48	Alpha HCH	µg/l	0.01	<0.01	<0.01	<0.01	<0.01
49	Beta HCH	µg/l	0.04	<0.01	<0.01	<0.01	<0.01
50	Butachlor	µg/l	125	<0.01	<0.01	<0.01	<0.01
51	Chlorpyrifos	µg/l	30	<0.01	<0.01	<0.01	<0.01
52	Delta HCH	µg/l	0.04	<0.01	<0.01	<0.01	<0.01
53	2,4-Dichlorophenoxyacetic acid	µg/l	30	<0.01	<0.01	<0.01	<0.01
54	DDT	µg/l	1	<0.01	<0.01	<0.01	<0.01
55	Endosulfan (alpha, beta and Sulphate)	µg/l	0.4	<0.01	<0.01	<0.01	<0.01
56	Ethion	µg/l	3	<0.01	<0.01	<0.01	<0.01
57	Gamma HCH	µg/l	2	<0.01	<0.01	<0.01	<0.01
58	Isoproturon	µg/l	9	<0.01	<0.01	<0.01	<0.01

Method of Testing: As per APHA 23rd edition and IS: 3025
 Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
 Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory

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 REG. NO. DLB5004995
 Sr. No. 6
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 (Manager - Environment)

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**ISSUED TO:**

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Report Number : VLL/VLS/24-25/01975/001
Issued Date : 2024-04-30
P.O. No. : 8500005780
P.O. Date : 2022-06-29

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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024 04 05 Sampling Date : 2024-04-03
Analysis Starting Date : 2024-04-05 Analysis Completion Date : 2024-04-29
Test Required : Water Analysis as per IS 10500 : 2012

SAMPLE COLLECTED BY VIMTA LABS LTD

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Bhadrapada (D/W)	Karma Talkies(B/W)	Parsabhata (B/W)	Parsabhata (D/W)
59	Malathion	µg/l	190	BDL	BDL	BDL	BDL
60	Methyl parathion	µg/l	0.3	BDL	BDL	BDL	BDL
61	Monocrotophos	µg/l	1	BDL	BDL	BDL	BDL
62	Phorate	µg/l	2	BDL	BDL	BDL	BDL
63	E. coli	Per 100 ml	Absent	Absent	Absent	Absent	Absent
64	Total Coliforms	MPN/100ml	Absent	Absent	Absent	Absent	Absent
(B)	Radioactive						
65	Alpha emitters	Bq/l	0.1(NR)	BDL	BDL	BDL	BDL
66	Beta emitters	Bq/l	1.0(NR)	BDL	BDL	BDL	BDL

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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Chhattisgarh

Report Number : VLL/VLS/23-24/24330/001
Issued Date : 2024-04-01
P.O. No. : 8500005780
P.O. Date : 2022-06-29

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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

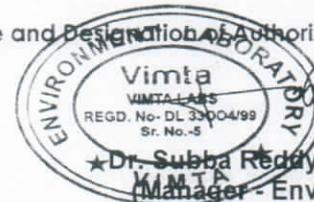
Sample Registration Date : 2024-03-15 Sampling Date : 2024-03-13
Analysis Starting Date : 2024-03-16 Analysis Completion Date : 2024-04-01
Test Required : Water Analysis as per IS 10500 : 2012
SAMPLE COLLECTED BY VIMTA LABS LTD

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Parsabhata (B/W)	Parsabhata (D/W)	Karma Talkies(B/W)	Bhadrapada D/W)
1	pH value	-	6.5-8.5 (NR)	7.16	6.89	6.82	6.69
2	Color	Hazen	5(15)	Colorless	Colorless	Colorless	Colorless
3	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5	Turbidity	NTU	1(5)	1	1	1	1
6	Total dissolved solids at 180°C	mg/l	500(2000)	478	447	358	257
7	Total Hardness as CaCO ₃	mg/l	200(600)	217	190	188	152
8	Total Alkalinity as CaCO ₃	mg/l	200(600)	140	145	70	50
9	Calcium as Ca	mg/l	75(200)	51.5	45.5	48.8	35.6
10	Magnesium as Mg	mg/l	30(100)	19.8	18.6	16.0	15.4
11	Free Residual chlorine	mg/l	0.2(1.0)	<0.2	<0.2	<0.2	<0.2
12	Boron as B	mg/l	0.5(1.0)	0.12	0.07	0.23	0.17
13	Chlorides as Cl	mg/l	250(1000)	143.2	121.3	131.5	95.4
14	Sulphate as SO ₄	mg/l	200(400)	25.3	26.5	21	18.9
15	Fluorides as F	mg/l	1.0(1.5)	0.214	0.158	0.063	0.087
16	Nitrates as NO ₃	mg/l	45(NR)	2.4	3.5	4.8	3.1
17	Phenolic Compounds as C ₆ H ₅ OH	mg/l	0.001(0.002)	<0.001	<0.001	<0.001	<0.001
18	Cyanides as CN	mg/l	0.05(NR)	<0.02	<0.02	<0.02	<0.02

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-03-15 Sampling Date : 2024-03-13
Analysis Starting Date : 2024-03-16 Analysis Completion Date : 2024-04-01
Test Required : Water Analysis as per IS 10500 : 2012
SAMPLE COLLECTED BY VIMTA LABS LTD

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Parsabhata (B/W)	Parsabhata (D/W)	Karma Talkies(B/W)	Bhadrapada D/W)
39	Polychlorinated biphenyls	mg/l	0.0005(NR)	Absent	Absent	Absent	Absent
40	Polynuclear aromatic hydrocarbon as PAH	mg/l	0.0001(NR)	<0.0001	<0.0001	<0.0001	<0.0001
41	Bromoform	mg/l	0.1(NR)	<0.0001	<0.0001	<0.0001	<0.0001
42	Dibromochloromethane	mg/l	0.1(NR)	<0.01	<0.01	<0.01	<0.01
43	Bromodichloromethane	mg/l	0.06(NR)	<0.01	<0.01	<0.01	<0.01
44	Chloroform	mg/l	0.2(NR)	<0.001	<0.001	<0.001	<0.001
(A)	Pesticides						
45	Alachlor	µg/l	20	<0.01	<0.01	<0.01	<0.01
46	Atrazine	µg/l	2	<0.01	<0.01	<0.01	<0.01
47	Aldrin	µg/l	0.03	<0.01	<0.01	<0.01	<0.01
48	Alpha HCH	µg/l	0.01	<0.01	<0.01	<0.01	<0.01
49	Beta HCH	µg/l	0.04	<0.01	<0.01	<0.01	<0.01
50	Butachlor	µg/l	125	<0.01	<0.01	<0.01	<0.01
51	Chlorpyrifos	µg/l	30	<0.01	<0.01	<0.01	<0.01
52	Delta HCH	µg/l	0.04	<0.01	<0.01	<0.01	<0.01
53	2,4-Dichlorophenoxyacetic acid	µg/l	30	<0.01	<0.01	<0.01	<0.01
54	DDT	µg/l	1	<0.01	<0.01	<0.01	<0.01
55	Endosulfan (alpha, beta and Sulphate)	µg/l	0.4	<0.01	<0.01	<0.01	<0.01
56	Ethion	µg/l	3	<0.01	<0.01	<0.01	<0.01
57	Gamma HCH	µg/l	2	<0.01	<0.01	<0.01	<0.01
58	Isoproturon	µg/l	9	<0.01	<0.01	<0.01	<0.01

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory

Vimta
VIMTA LABS
REGD. No- 5L 3004/99
Sr. No.-5
Dr. Subba Reddy Mallampati
(Manager - Environment)

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Chhattisgarh

Report Number : VLL/VLS/23-24/24330/001
Issued Date : 2024-04-01
P.O. No. : 8500005780
P.O. Date : 2022-06-29

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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-03-15 Sampling Date : 2024-03-13
Analysis Starting Date : 2024-03-16 Analysis Completion Date : 2024-04-01
Test Required : Water Analysis as per IS 10500 : 2012

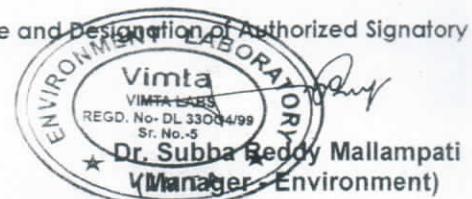
SAMPLE COLLECTED BY VIMTA LABS LTD

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Parsabhata (B/W)	Parsabhata (D/W)	Karma Talkies(B/W)	Bhadrapada D/W)
19	Anionic detergents as MBAS	mg/l	0.2(1.0)	<0.02	<0.02	<0.02	<0.02
20	Mineral oil	mg/l	0.5(NR)	Absent	Absent	Absent	Absent
21	Cadmium as Cd	mg/l	0.003(NR)	<0.003	<0.003	<0.003	<0.003
22	Total Arsenic as As	mg/l	0.01(0.05)	<0.01	<0.01	<0.01	<0.01
23	Copper as Cu	mg/l	0.05(1.5)	<0.01	<0.01	0.02	<0.01
24	Lead as Pb	mg/l	0.01(NR)	<0.01	<0.01	<0.01	<0.01
25	Manganese as Mn	mg/l	0.1(0.3)	0.015	0.012	0.017	0.019
26	Molybdenum as Mo	mg/l	0.07(NR)	<0.01	<0.01	<0.01	<0.01
27	Nickel as Ni	mg/l	0.02(NR)	<0.01	<0.01	<0.01	<0.01
28	Iron as Fe	mg/l	0.3(NR)	0.06	0.03	0.05	0.07
29	Total Chromium as Cr	mg/l	0.05(NR)	<0.01	<0.01	<0.01	<0.01
30	Selenium as Se	mg/l	0.05(NR)	<0.01	<0.01	<0.01	<0.01
31	Zinc as Zn	mg/l	5.0(15)	0.15	0.12	0.23	0.07
32	Aluminum as Al	mg/l	0.03(0.2)	0.03	0.04	0.05	0.02
33	Mercury as Hg	mg/l	0.001(NR)	<0.001	<0.001	<0.001	<0.001
34	Sulphide as H ₂ S	mg/l	0.05(NR)	<0.05	<0.05	<0.05	<0.05
35	Chloramines as Cl ₂	mg/l	4.0(NR)	<0.05	<0.05	<0.05	<0.05
36	Ammonia (as total ammonia-N	mg/l	0.5(NR)	<0.05	<0.05	<0.05	<0.05
37	Barium as Ba	mg/l	0.7(NR)	0.014	0.011	0.017	0.019
38	Silver as Ag	mg/l	0.1(NR)	<0.01	<0.01	<0.01	<0.01

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

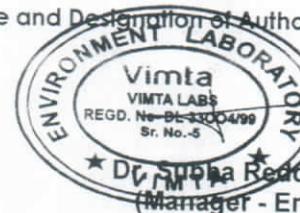
Sample Registration Date : 2024-03-15 Sampling Date : 2024-03-13
Analysis Starting Date : 2024-03-16 Analysis Completion Date : 2024-04-01
Test Required : Water Analysis as per IS 10500 : 2012
SAMPLE COLLECTED BY VIMTA LABS LTD

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Parsabhata (B/W)	Parsabhata (D/W)	Karma Talkies(B/W)	Bhadrapada D/W)
59	Malathion	µg/l	190	BDL	BDL	BDL	BDL
60	Methyl parathion	µg/l	0.3	BDL	BDL	BDL	BDL
61	Monocrotophos	µg/l	1	BDL	BDL	BDL	BDL
62	Phorate	µg/l	2	BDL	BDL	BDL	BDL
63	E. coli	Per 100 ml	Absent	Absent	Absent	Absent	Absent
64	Total Coliforms	MPN/100ml	Absent	Absent	Absent	Absent	Absent
(B)	Radioactive						
65	Alpha emitters	Bq/l	0.1(NR)	BDL	BDL	BDL	BDL
66	Beta emitters	Bq/l	1.0(NR)	BDL	BDL	BDL	BDL

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-03-15 Sampling Date : 2024-03-13
Analysis Starting Date : 2024-03-16 Analysis Completion Date : 2024-04-01
Test Required : Water Analysis as per IS 10500 : 2012
SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Rogbheri (B/W)	Rogbheri (D/W)	Bailgiri Basti(B/W)	Bailgiri Basti(D/W)
1	pH value	-	6.5-8.5 (NR)	6.89	6.96	6.92	7.21
2	Color	Hazen	5(15)	Colorless	Colorless	Colorless	Colorless
3	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5	Turbidity	NTU	1(5)	1	1	1	1
6	Total dissolved solids at 180°C	mg/l	500(2000)	424	268	436	498
7	Total Hardness as CaCO ₃	mg/l	200(600)	187	166	244	222
8	Total Alkalinity as CaCO ₃	mg/l	200(600)	65	60	150	160
9	Calcium as Ca	mg/l	75(200)	36.8	41.5	54.4	48.8
10	Magnesium as Mg	mg/l	30(100)	23.2	15.1	26.2	24.2
11	Free Residual chlorine	mg/l	0.2(1.0)	<0.2	<0.2	<0.2	<0.2
12	Boron as B	mg/l	0.5(1.0)	0.11	0.07	0.14	0.17
13	Chlorides as Cl	mg/l	250(1000)	168.4	93.2	110.5	127.8
14	Sulphate as SO ₄	mg/l	200(400)	27.5	19.4	29.6	35.4
15	Fluorides as F	mg/l	1.0(1.5)	0.093	0.044	0.239	0.114
16	Nitrates as NO ₃	mg/l	45(NR)	3.1	2.5	3.7	5.4
17	Phenolic Compounds as C ₆ H ₅ OH	mg/l	0.001(0.002)	<0.001	<0.001	<0.001	<0.001
18	Cyanides	mg/l	0.05(NR)	<0.02	<0.02	<0.02	<0.02

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory

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★ **Dr. Subba Reddy Mallampati**
(Manager - Environment)

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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-03-15 Sampling Date : 2024-03-13
Analysis Starting Date : 2024-03-16 Analysis Completion Date : 2024-04-01
Test Required : Water Analysis as per IS 10500 : 2012

SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Rogbheri (B/W)	Rogbheri (D/W)	Bailgiri Basti(B/W)	Bailgiri Basti(D/W)
19	Anionic detergents as MBAS	mg/l	0.2(1.0)	<0.02	<0.02	<0.02	<0.02
20	Mineral oil	mg/l	0.5(NR)	Absent	Absent	Absent	Absent
21	Cadmium as Cd	mg/l	0.003(NR)	<0.003	<0.003	<0.003	<0.003
22	Total Arsenic as As	mg/l	0.01(0.05)	<0.01	<0.01	<0.01	<0.01
23	Copper as Cu	mg/l	0.05(1.5)	<0.01	<0.01	<0.01	<0.01
24	Lead as Pb	mg/l	0.01(NR)	<0.01	<0.01	<0.01	<0.01
25	Manganese as Mn	mg/l	0.1(0.3)	0.02	<0.01	0.01	0.01
26	Molybdenum as Mo	mg/l	0.07(NR)	<0.01	<0.01	<0.01	<0.01
27	Nickel as Ni	mg/l	0.02(NR)	<0.01	<0.01	<0.01	<0.01
28	Iron as Fe	mg/l	0.3(NR)	0.06	0.05	0.09	0.07
29	Total Chromium as Cr	mg/l	0.05(NR)	<0.01	<0.01	<0.01	<0.01
30	Selenium as Se	mg/l	0.05(NR)	<0.01	<0.01	<0.01	<0.01
31	Zinc as Zn	mg/l	5.0(15)	0.14	0.05	0.16	0.14
32	Aluminum as Al	mg/l	0.03(0.2)	0.05	0.03	0.04	0.03
33	Mercury as Hg	mg/l	0.001(NR)	<0.001	<0.001	<0.001	<0.001
34	Sulphide as H ₂ S	mg/l	0.05(NR)	<0.05	<0.05	<0.05	<0.05
35	Chloramines as Cl ₂	mg/l	4.0(NR)	<0.05	<0.05	<0.05	<0.05
36	Ammonia (as total ammonia-N)	mg/l	0.5(NR)	<0.05	<0.05	<0.05	<0.05
37	Barium as Ba	mg/l	0.7(NR)	0.015	0.012	0.017	0.019
38	Silver as Ag	mg/l	0.1(NR)	<0.01	<0.01	<0.01	<0.01

Method of Testing: As per APHA 23rd edition and IS: 3025

Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)

Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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SAMPLE PARTICULARS**GROUND WATER SAMPLES (BALCO PLANT)**

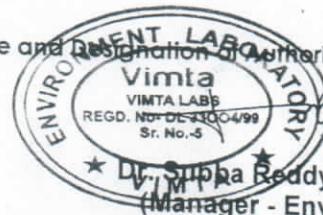
Sample Registration Date : 2024-03-15 Sampling Date : 2024-03-13
Analysis Starting Date : 2024-03-16 Analysis Completion Date : 2024-04-01
Test Required : Water Analysis as per IS 10500 : 2012
SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Rogbheri (B/W)	Rogbheri (D/W)	Bailgiri Basti(B/W)	Bailgiri Basti(D/W)
39	Polychlorinated biphenyls	mg/l	0.0005(NR)	Absent	Absent	Absent	Absent
40	Polynuclear aromatic hydrocarbon as PAH	mg/l	0.0001(NR)	<0.0001	<0.0001	<0.0001	<0.0001
41	Bromoform	mg/l	0.1(NR)	<0.0001	<0.0001	<0.0001	<0.0001
42	Dibromochloromethane	mg/l	0.1(NR)	<0.01	<0.01	<0.01	<0.01
43	Bromodichloromethane	mg/l	0.06(NR)	<0.01	<0.01	<0.01	<0.01
44	Chloroform	mg/l	0.2(NR)	<0.001	<0.001	<0.001	<0.001
(A)	Pesticides						
45	Alachlor	µg/l	20	<0.01	<0.01	<0.01	<0.01
46	Atrazine	µg/l	?	<0.01	<0.01	<0.01	<0.01
47	Aldrin	µg/l	0.03	<0.01	<0.01	<0.01	<0.01
48	Alpha HCH	µg/l	0.01	<0.01	<0.01	<0.01	<0.01
49	Beta HCH	µg/l	0.04	<0.01	<0.01	<0.01	<0.01
50	Butachlor	µg/l	125	<0.01	<0.01	<0.01	<0.01
51	Chlorpyrifos	µg/l	30	<0.01	<0.01	<0.01	<0.01
52	Delta HCH	µg/l	0.04	<0.01	<0.01	<0.01	<0.01
53	2,4-Dichlorophenoxyacetic acid	µg/l	30	<0.01	<0.01	<0.01	<0.01
54	DDT	µg/l	1	<0.01	<0.01	<0.01	<0.01
55	Endosulfan (alpha, beta and Sulphate)	µg/l	0.4	<0.01	<0.01	<0.01	<0.01
56	Ethion	µg/l	3	<0.01	<0.01	<0.01	<0.01
57	Gamma HCH	µg/l	2	<0.01	<0.01	<0.01	<0.01
58	Isoproturon	µg/l	9	<0.01	<0.01	<0.01	<0.01

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP-MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

Name and Designation of Authorized Signatory



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SAMPLE PARTICULARS : GROUND WATER SAMPLES (BALCO PLANT)

Sample Registration Date : 2024-03-15 Sampling Date : 2024-03-13
Analysis Starting Date : 2024-03-16 Analysis Completion Date : 2024-04-01
Test Required : Water Analysis as per IS 10500 : 2012
SAMPLE COLLECTED BY VIMTA LABS LTD.

TEST REPORT

Sr. No.	Parameters	UOM	Limit IS 10500 : 2012	Rogbheri (B/W)	Rogbheri (D/W)	Bailgiri Basti(B/W)	Bailgiri Basti(D/W)
59	Malathion	µg/l	190	BDL	BDL	BDL	BDL
60	Methyl parathion	µg/l	0.3	BDL	BDL	BDL	BDL
61	Monocrotophos	µg/l	1	BDL	BDL	BDL	BDL
62	Phorate	µg/l	2	BDL	BDL	BDL	BDL
63	E. coli	Per 100 ml	Absent	Absent	Absent	Absent	Absent
64	Total Coliforms	MPN/100ml	Absent	Absent	Absent	Absent	Absent
(B)	Radioactive						
65	Alpha emitters	Bq/l	0.1(NR)	BDL	BDL	BDL	BDL
66	Beta emitters	Bq/l	1.0(NR)	BDL	BDL	BDL	BDL

Method of Testing: As per APHA 23rd edition and IS: 3025
Instrument Used: ICP-OES (Perkin-Elmer) & ICP MS (agilent)
Analysis as per IS 10500: 2012 Drinking Water specification

-END OF THE REPORTS-

Name and Designation of Authorized Signatory



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			Issue Date:	2024-06-04			
			P.O.No:	8500005780			
			P.O. Date:	2022-06-29			
FUGITIVE EMISSION MONITORING AT POT LINE - 2							
Registration Date:	2024-05-29		Sampling Date:	2024-05-28			
Analysis starting date :	2024-05-29		Analysis Completion date:	2024-05-31			
Test Required :- PM, Fluoride;							
TEST RESULTS							
S. No.	Parameter	Units	POT LINE -2				
			Section 1	Section 2	Section 7	Section 8	
			2024-05-28	2024-05-29	2024-05-29	2024-05-28	
1	PM	ug/Nm ³	483	474	452	445	
2	Fluoride	ug/Nm ³	330.7	267.5	343.9	334.2	

Remarks: Instrument Used APM 460 BL Respirable Dust Sampler.



Sensitivity: Internal (C3)

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M/s. Bharat Aluminium Company Limited,		Issue Date:	2024-05-04			
KORBA (C.G.)		P.O.No:	8500005780			
		P.O. Date:	2022-06-29			
FUGITIVE EMISSION MONITORING AT POT LINE - 1						
Registration Date:		2024-04-13	Sampling Date:		2024-04-12	
Analysis starting date :		2024-04-13	Analysis Completion date:		2024-04-26	
Test Required :- PM, Fluoride;						
TEST RESULTS						
S. No.	Parameter	Units	POT LINE -1			
			Section 1	Section 2	Section 7	Section 8
			2024-04-12	2024-04-23	2024-04-23	2024-04-12
1	PM	ug/Nm ³	474	472	485	456
2	Fluoride	ug/Nm ³	233	302	274	259

Remarks: Instrument Used – Handy Sampler & APM 460 BL Respirable Dust Sampler.



Dr. Subba Reddy Mallampati
 Manager - Environment

Sensitivity: Internal (C3)

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	Issue Date:	2024-05-04
	P.O.No:	8500005780
	P.O. Date:	2022-06-29

FUGITIVE EMISSION MONITORING AT POT LINE - 2

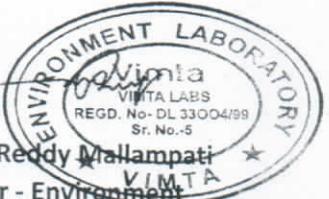
Registration Date: 2024-04-11 Sampling Date: 2024-04-10
Analysis starting date : 2024-04-11 Analysis Completion date: 2024-04-16

Test Required :- PM, Fluoride;

TEST RESULTS

S. No.	Parameter	Units	POT LINE -2			
			Section 1	Section 2	Section 7	Section 8
			2024-04-10	2024-04-11	2024-04-11	2024-04-10
1	PM	ug/Nm ³	496	506	470	487
2	Fluoride	ug/Nm ³	223	262	293	282

Remarks: Instrument Used – APM 460 RI Respirable Dust Sampler.

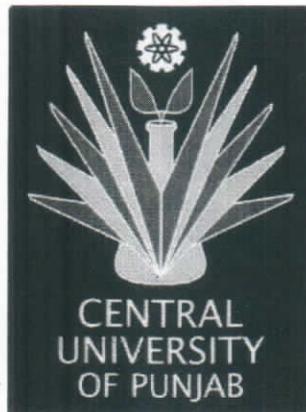


 Dr. Subba Reddy Mallampati
 Manager - Environment

Sensitivity: Internal (C3)

Project Consultancy Report
on

**SAR & UAV technology-based
monitoring of BALCO Ash Dykes**

Submitted to
Bharat Aluminium Company Ltd. (BALCO)
Korba, Chhattisgarh, INDIA



Prepared by

Sunil Mittal

Dr. Sunil Mittal
(Consultant)

Pritam Chand

Dr. Pritam Chand
(Consultant)

School of Environment and Earth Sciences
Central University of Punjab
Bathinda-151401, India

Report

on

**SAR & UAV technology-based monitoring of BALCO ash
dyke**

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CHAPTER-1

Introduction

1.1. Project reference and background

In India, due to progressively increase in number and capacity of coal based thermal power plant huge amount of fly ash is generated. In current scenario only 40-50% fly ash are used and rest of the fly ash is disposed of and restored in ash pond with dyke to reduce the land wastage. The failure rate of ash dyke is much higher than that of dams because seepage analysis is not considered while design of the former. So, regular monitoring of ash dyke becomes a top priority for engineers as its occasional failure creates havoc in safety of surrounding people. It causes economic losses as well as environmental and water pollution which is dangerous for both human and aquatic life. The failure of ash dyke may be due to various factors.

Generally, different people have done different investigation in the field of ash dam failure. Failure of ash dyke may take place due to following reasons like a) Seepage of water; b) Stability of dikes; c) Soil properties in starter dyke; d) Method of compaction; and e) Absence of drainage filter. Moreover, the failure of ash dykes can be related to nature of subsidence or land subsidence. Land subsidence can be defined as the lowering of the land-surface elevation due to changes that occur underground. Moreover, it is the downward, vertical movement of the Earth's surface, which can be brought on by both natural and human forces. It involves little or no horizontal movement, which distinguishes it from slope movement. Processes that lead to subsidence include dissolution of underlying carbonate rock by groundwater; gradual compaction of sediments; withdrawal of fluid lava from beneath a solidified crust of rock; mining; pumping of subsurface fluids, such as groundwater or petroleum; or warping of the Earth's crust by tectonic forces. Subsidence resulting from tectonic deformation of the crust is known as tectonic subsidence and can create accommodation for sediments to accumulate and eventually lithify into sedimentary rock. Ground subsidence is of global concern to geologists, geotechnical engineers, surveyors, engineers, urban planners, landowners, and the public in general.

1.2. Project Purpose and Scope

The main objective of this study is to detect and quantify the probability of land subsidence for the active and inactive ash dykes of BALCO by using InSAR data with the supplement of field data that will be provided by BALCO. This report presents the results and interpretations of spatially detailed maps of vertical land-surface changes particularly the Ash Dyke generated using InSAR data collected from Jan. 2023 to September 2023. Additionally, the study provides the land use and cover surface characteristics and morphology changes of these dykes over the period.

1.3. Description of Study Area, accessibility and climate

The Korba mining area is located within the central Indian state of Chhattisgarh. Specifically, it encompasses the Korba Coalfield (KCF) region, which is situated in the Korba district of Chhattisgarh, spanning the geographic coordinates of approximately 22° 15' N to 22° 30' N latitude and 82° 15' to 82° 55' E longitude. This region is prominently recognized for its substantial coal mining activities and is an integral component of the expansive Hasdeo-Arand coalfields, one of India's largest coal-rich regions. These KCF coal mines primarily produce non-coking coal and are strategically located within the Hasdeo River basin, a tributary of the Mahanandi River. The Hasdeo River flows southward, effectively dividing the coalfield into two unequal sections, namely the western and eastern parts. The eastern part has undergone partial exploration and possesses limited coal potential, while the western section exhibits vast potential for high-grade coal resources, particularly for power generation. Notably, the major opencast mining projects within the Korba Coalfield are concentrated in the western sector. The Korba region is renowned for its extensive mining operations, particularly in the coal sector. It hosts a multitude of open-cast and underground coal mines, contributing significantly to coal reserves that serve as a cornerstone for powering thermal power plants both within the region and in neighboring states. Consequently, the mining activities in this area have had a profound impact on the local economy and environment, leading to the establishment of various industrial units and essential infrastructure, including power plants, coal washeries, and ancillary industries.

The Korba Coalfield is well-connected by motorable roads, with easy access through Champa Township (approximately 50 km away) and Bilaspur (about 100 km). The nearest towns of significance are Korba and Champa, both situated around 50 km from the coalfield. The Korba railway station, located on the Bilaspur – Champa - Korba branch line of the Southeastern Railway, facilitates rail transport within the region. Additionally, the Champa railway station, part of the main rail line, is the nearest station for connecting to Delhi and Ranchi. For air travel, the closest airstrip is in Raipur, accessible by road from Korba. Furthermore, a small airstrip has been constructed in Bilaspur to accommodate smaller aircraft. The KCF region experiences a tropical climate, with scorching temperatures reaching approximately 45°C in May and June, and relatively cooler temperatures of about 2-4°C between December and January. The annual rainfall averages around 1287 mm, with the majority occurring during the monsoon season from June to September, accounting for over 85% of the total annual precipitation.

1.4. Physiography & Geological/ Hydrogeology description

The Korba coalfield displays a typical erosional topography, featuring plains and plateaus. The terrain is characterized by undulating features, with elevated hills predominantly on its eastern side. The highest elevation point, reaching 983 meters, is situated in the eastern sector near Pawan Akhar Pahar. In contrast, the western and northern regions exhibit relatively flatter terrain. The area encompasses various major physiographic units, including dissected plateaus, residual hills, undulating pediplains, valley fills, and intermontane valleys. The eastern section of the area is primarily drained by the Beigar, Dhengur, Pathari, and Dom streams, which flow westward and discharge directly into the Hasdo River. Conversely, the western part of the coalfield is demarcated by a northwest-southeast trending watershed. The eastern portion is drained by the Aharan, Kholar, Saliha, and Jhulna streams, ultimately discharging into the Hasdo River. The western segment is drained by the Gunjan, Ganjar, Lilagar, and Pitni streams. The plateau regions feature a notably thin soil cover, while the pediplains are characterized by the presence of thick alluvial soil with a loamy to sandy composition. Geologically, the Korba mining area is primarily underlain by sedimentary rock formations rich in coal deposits. It is an integral part of the Hasdeo-Arand basin, renowned for its significant coal reserves, rendering it a pivotal center for coal mining

and related industries. Specifically, it is situated within the Barakar Formation of the Gondwana Super Group, overlaying the Precambrian schist. These formations exhibit a general southward dip ranging from 5° to 8° and are oriented in an east-west direction. Notably, several transverse faults traverse the region in various orientations, including northeast-southwest, northwest-southeast, and east-west, each with distinct fault throw magnitudes. Of particular significance is the east-west trending fault in the northern part of the study area, characterized by a southerly throw. This fault juxtaposes the Upper and Lower Barakar formations and demarcates the division between them, eventually tapering off or having negligible throw near the Hasdeo River.

1.5. Dyke locations and coordinates

The study focused to monitor the eight Ash dykes of the BALCO plants which of them few are active, and few are inactive. The coordinates of each ash dyke given in the below tables and their location shown in the below figures. Some Ash dykes are lie individual (Dykes 1, BCPP Old Dyke, Daganiakhar and BCPP New Dyke, Balgikhar) where others are merged and sharing the boundaries (Dykes 2-7) as same can be seen in the below figures 1-3 and related coordinates mentioned in Table-1.

Table 1: Dyke locations and coordinates

SI. No.	Dyke Number	Points	Co-ordinates
1	1	Point 1	22°24'01.0"N 82°43'24.0"E
		Point 2	22°24'13.0"N 82°43'19.0"E
		Point 3	22°24'21.0"N 82°43'32.0"E
		Point 4	22°24'17.0"N 82°43'36.0"E
		Point 5	22°24'10.0"N 82°43'30.0"E
2	2	Point 1	22°24'22.0"N 82°43'43.0"E
		Point 2	22°24'45.0"N 82°43'31.0"E
		Point 3	22°24'50.0"N 82°43'51.0"E
		Point 4	22°24'39.0"N 82°43'56.0"E
3	7	Point 1	22°24'44.0"N 82°44'03.0"E
		Point 2	22°25'00.0"N 82°44'07.0"E

		Point 3	22°25'05.0"N 82°44'16.0"E
		Point 4	22°24'57.0"N 82°44'18.0"E
4	6	Point 1	22°24'57.0"N 82°44'36.0"E
5	5	Point 1	22°24'49.0"N 82°44'54.0"E
		Point 2	22°24'40.0"N 82°44'56.0"E
		Point 3	22°24'30.0"N 82°44'40.0"E
		Point 4	22°24'33.0"N 82°44'39.0"E
6	4	Point 1	22°24'34.0"N 82°44'20.0"E
7	3	Point 1	22°24'32.0"N 82°44'04.0"E
8	BCPP Old Dyke (Daganiakhar)	Point 1	22°21'44.0"N 82°40'10.0"E
		Point 2	22°21'49.0"N 82°39'53.0"E
		Point 3	22°22'19.0"N 82°40'01.0"E
		Point 4	22°22'14.0"N 82°40'17.0"E
9	BCPP New Dyke (Balgikhar)	Point 1	22°22'26.0"N 82°39'44.0"E
		Point 2	22°22'47.0"N 82°39'42.0"E
		Point 3	22°22'40.0"N 82°39'58.0"E
		Point 4	22°22'27.0"N 82°40'01.0"E



Figure 1: Google earth images showing the Dyke-1 and its outer coordinates.

CHAPTER-2

Datasets and Methodology

2.1. Remote Sensing of land subsidence

Elevation or elevation-change measurements are fundamental to monitoring land subsidence and have been measured by using interferometric synthetic aperture radar (InSAR), continuous GPS (CGPS) measurements, campaign global positioning system (GPS) surveying, and spirit-levelling surveying (Figure 4). In recent years, as an effective method to measure land subsidence, remote sensed based interferometric synthetic aperture radar (InSAR) can study the past by exploring data archives and is a powerful technology for extracting information related to land subsidence with day-and-night and all-weather imaging capabilities, broad spatial coverage, high spatial and temporal resolution, and it can acquire data remotely. Remote sensing is the practice of acquiring information about an object or area without direct physical contact, using data collected by a non-contact device. The term 'remote sensing' typically refers to techniques that utilize electromagnetic energy, such as light, heat, and radio waves, to detect and measure characteristics of objects. All physical objects on the Earth's surface naturally emit electromagnetic radiation due to the movements of their atomic particles.

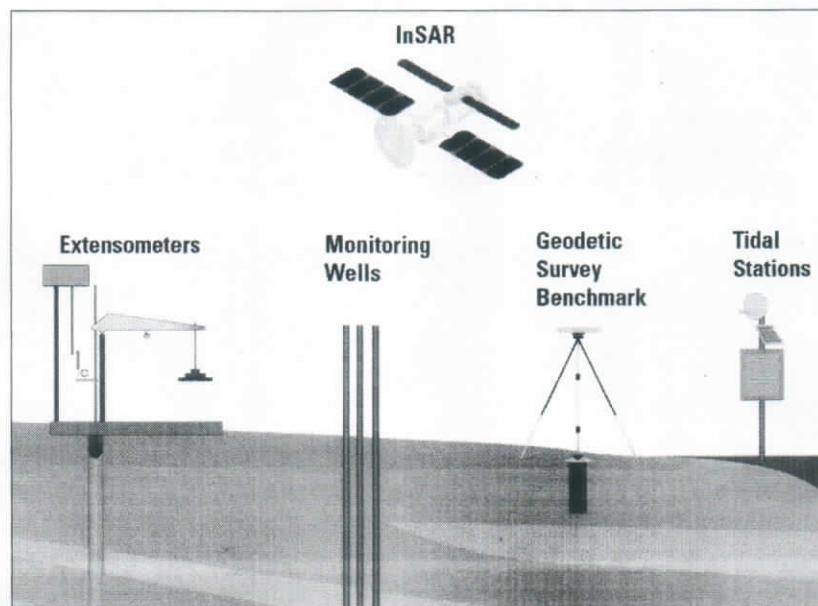


Figure 4: Different methods use for monitoring the land subsidence/displacement.

Remote sensing primarily focuses on the measurement of electromagnetic energy from the Sun, which is either reflected, scattered, or emitted by objects on the Earth's surface. Examining data collected by sensors operating within the microwave segment of the electromagnetic spectrum is referred to as Microwave Remote Sensing. The microwave portion of the spectrum encompasses wavelengths in the approximate range of 1 millimetre to 1 meter. These longer wavelengths possess the unique capability of penetrating through cloud cover, effectively mitigating the atmospheric interferences encountered in the visible and infrared regions of the electromagnetic spectrum. In active mode, microwave remote sensing involves measuring reflections (backscattering) from the Earth's surface, while passive mode entails detecting emissions. Unlike visible, infrared, or thermal sensing, microwave sensors are not constrained by specific acquisition times, making them time independent. Moreover, the reflections and emissions in the microwave spectrum are unrelated to their counterparts in other segments of the spectrum. These distinctive responses provide valuable insights into surface characteristics, such as size, shape, configuration, and electrical properties. Consequently, microwave remote sensing offers a substantially different perspective on the environment. While more sophisticated systems can measure the amplitude, polarization, and phase of the return signal, simpler setups typically record only the amplitude.

In recent years, InSAR has been proved to be a powerful geodetic tool to monitor land subsidence caused by anthropogenic and natural processes for instance underground water resources recharge and discharge, mine subsidence, volcanic eruptions and deflation, landslides, and earthquakes. InSAR scan the land surface at regular intervals on defined orbits around the earth producing "scenes" over time. These scenes are compared and any differences show whether the land surface or surface features is moving toward the satellite (uplift) or away from the satellite (subsidence). More specifically, any movement of the ground surface toward or away from the satellite can be measured and portrayed as a "picture" – not of the surface itself but of how much the surface moved (deformed) during the time between images. To create this radar deformation "picture" a pulse of radar energy is emitted from a satellite, scattered by the Earth's surface, and recorded back at the satellite with two types of information: amplitude and phase. The amplitude is the strength of the return

signal, influenced by the physical properties of the surface. The round-trip distance from the satellite to the ground and back again is measured in units of the radar wavelength, and changes in that distance between the time two radar images were collected show up as a phase difference. Combining these two images is called "interfering" because combining two waves causes them to either reinforce or cancel one another. InSAR greatly extends the ability of scientists to monitor subsidence because, unlike other techniques that rely on measurements at a few points, InSAR produces a map of ground deformation that covers a very large spatial area with centimetre-scale accuracy. Although, InSAR has few limitations. For instance, dense vegetation and high humidity can scatter radar signals, decreasing data accuracy, so InSAR is best used in dry environments that are free of vegetation. Additionally, the optical remote sensing satellite images, which capture visible and near-infrared light, are highly applicable to mining areas, providing valuable insights and information for a range of purposes in the mining industry. optical imagery helps monitor changes in land cover and land use over time. In mining areas, this can be essential for tracking the expansion of mining operations, identifying environmental impacts, and ensuring compliance with regulations. It can assist in monitoring reclamation efforts in post-mining areas. It helps assess the progress of rehabilitation projects, such as reforestation and revegetation, aimed at restoring the land to its natural state. Moreover, it can be used for perimeter monitoring, identifying potential hazards, and ensuring the safety of on-site personnel. Overall, optical remote sensing satellite images are a powerful tool in the mining industry for exploration, environmental management, safety, and operational efficiency.

2.2. Data source and characteristics of Sensor

This study uses Sentinel-1 Radar imagery of descending and ascending tracks to analyze the target area from two different positions by the satellite. The SAR data acquisition involves Electromagnetic Microwaves pulses (1 mm–1 m in wavelength, with 0.3 to 300-GHz frequency) transmitted from a space-borne SAR instrument, offering a high density of measuring points over the remote, unapproachable, and risky areas. InSAR technology has been the most integrated and functional tool in measuring the displacement of the earth's surface on a millimetre scale. It is being

used worldwide and has widespread utilization in measuring displacement related to naturally occurring events of as earthquakes, volcanic activity, tsunamis, and landslides. Sentinel-1 C-band data from the European Space Agency (ESA) were used in this study. Sentinel-1 A was launched in April 2014, but its initial observations in the study area were marred by gaps that rendered them unsuitable for multitemporal InSAR analysis. The launch of Sentinel-1 B in April 2016 enabled consistent observations to be made. As a result, the observations were consistent and the revisit time from beginning of 2017 to date was reduced from 24 days to 12 days. The Sentinel-1 data are acquired in interferometric wide (IW) mode, and each image consists of three sub-swaths that can act independently. The IW is imaged through the ScanSAR mode called Terrain Observation with Progressive Scan (TOPS) to improve the uniform signal-to-noise ratio (SNR). The product is distributed with a swath of 250 km and a resolution of 5×20 in range and azimuth, respectively (Geudtner et al. 2014). This study has been used Sentinel 1 imagery of descending track to analyse the target area from two different position by the satellite. This satellite images of 06 March,2023 and 14 September,2023 have downloaded through the Alaskan satellite facility (ASF) using the European Space Agency. Sentinel 1 A single look complex (SLC) datasets were used for path 19 frame 517 for descending track. It contains three interferometric wide swaths IW1, IW2 AND IW3 and nine bursts. This analysis has been focused on IW3 and the coordinates of Korba was adjusted. The acquired sentinel images are in VV+ VH polarisation. These images are utilised in Sentinel Application Processing Toolbox (SNAP) for InSAR, DInsar data and phase unwrapping processing. Additionally, the study also used the Sentinel-2 data from the Copernicus program of the European Space Agency (see Table S1 for details). We resampled all the imageries to a 10-meter grid using the nearest neighbour approach. Sentinel-2 Level 2A products with a cloud cover < 70% comprising the study region in the year of 2023 were obtained and processed via Google Earth Engine (Gorelick et al., 2017). We masked out clouds and shadows using the scene classification (SLC) band provided in the Level 2A product. Additionally, the median pixel value per season was used for the analysis of land surface characteristics of all BALCO Ask Dykes. Additionally, the digital elevation model with 30 m spatial resolution was obtained from NASA (Earth data Search, <https://earthdata.nasa.gov/>) for co-

registration and other elevation characteristics. The basic properties of a satellite's sensor system used in the present study is summarised in Table-2 as: (a) spectral coverage/resolution, i.e., band locations/width; (b) spectral dimensionality: number of bands and Polarization; (c) radiometric resolution or quantisation; (d) spatial resolution/instantaneous field of view or IFOV; and (e) temporal resolution or flight direction.

Table 2. Description of data sets were used in this study.

Sentinel-1 Synthetic Aperture Radar Data

S. No	No of images	Date	Specification	Polarization	Flight direction
1	1*	2023-03-06	S1A_IW_SLC	VV + VH	Descending
2	1*	2023-09-14	S1A_IW_SLC	VV + VH	Descending
3	1*	2024-03-10	S1A_IW_SLC	VV + VH	Descending

Sentinel-2 Multispectral Instrument (MSI)

S. No	No of images	Date	Spatial resolution	Spectral coverage or bands	Temporal resolution
1	12	January 2023 to February 2024	10m (for optical and NIR band only)	13 Spectral bands optical, NIR, SWIR with varying spatial resolution	10 days at the equator with one satellite

Unmanned Aerial Vehicle (UAV) Data

S. No	No of images	Date	Spatial resolution	Spectral coverage or bands	Temporal resolution
1	Many Pairs	04-09 November 2023	50 Cm	Optical band	Single Static Survey Date

2.3. Data Processing & Methodology

This study involves the following processing steps and methodology:

- **Data import/ Pre-processing:** In data Preprocessing the data has been organize, and preprocess including radiometric calibration, terrain correction,

and geometric correction to eliminate geometric distortions. Accordingly, the first step of the process includes importing of both master (06 March,2023) and slave image (14 September,2023). These both SLC images contain three Interferometric wide swaths and nine bursts. According to the region/area of interest (AOI/ROI) the both images has been split using S-1 TOPS split Tool of Radar in SNAP environment. The study ensured that all images are co-registered to a common reference, as slight variations in the sensor's position and orientation can affect the InSAR analysis.

- **In-SAR analysis/Processing (Interferometric SAR):** In-SAR basically used for DEM generation. It helps to convert phase differences between two images to relative heights. This referenced DEM has been used to extract the absolute height. It involves various steps like co-registration of images which include Back- Geocoding, Enhanced Spectral Diversity of images. Besides this it is also involve interferogram generation and TOPSAR Deburst of images. Generated interferograms from the stacked radar images. Interferograms depict the phase difference between two radar acquisitions.
- **DInSAR Processing (Differential Interferometric SAR):** This technique used to measure and monitor terrain deformation or displacement. It basically observes phase changes between two images in each time. It mainly involves Topographic phase removal, Goldstein filtering and phase wrapping steps which further help to extract displacement map of the study area. Moreover, phase unwrapping processing has been done. Unwrap the interferometric phase to convert it into continuous displacement values. This is a crucial step for accurate subsidence measurement.
- **Interpretation and Report writing:** It includes the analysis and visualization by interpreting the results and visualize the subsidence patterns. Identify areas of concern and potential causes of land subsidence. Accordingly, the report has been prepared with findings, methods, and results. It mainly includes maps, graphs, and tables to convey the information effectively.

CHAPTER-3**Results and Findings****3.1. Spatial distribution of displacement and subsidence:**

The subsidence maps reveal the spatial distribution of movement in the study area. The below large map shows the spatial patterns of subsidence at regional scale whereas the zoomed map at finer scale shows the pattern of subsidence at mapped Ash Dykes and its surrounding areas (Figure 5).

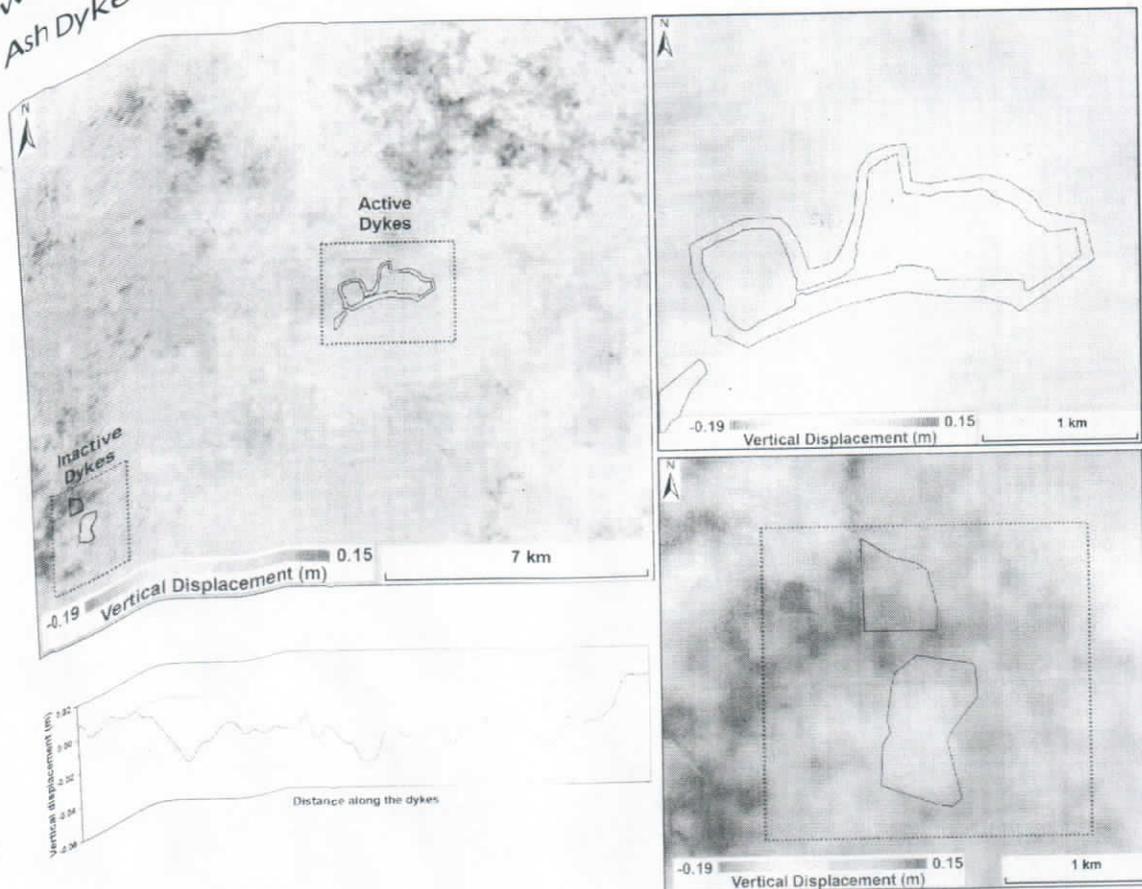


Figure 5: Spatial distribution of displacement and subsidence on a regional scale and along or near the monitored ash dykes. Moreover, the profile shows the data for the above boundary location of the dyke 2 to 7. Note the data shows insignificant subsidence or displacement by considering the range within uncertainty, resolution of images, and measures taken by BALCO

The color-coded maps depict the magnitude and direction of subsidence. Begin by examining the color scale and legend provided with the subsidence map shows insignificant subsidence at Ash Dykes and its surrounding areas although on regional

scale it shows varying rate for north-western part of the Korba district. The dark red and blue colour associate with displacement values where darker colors (e.g., shades of red or blue) usually represent greater subsidence, while lighter colours (e.g., yellow or light cyan) signify lesser or no displacement.

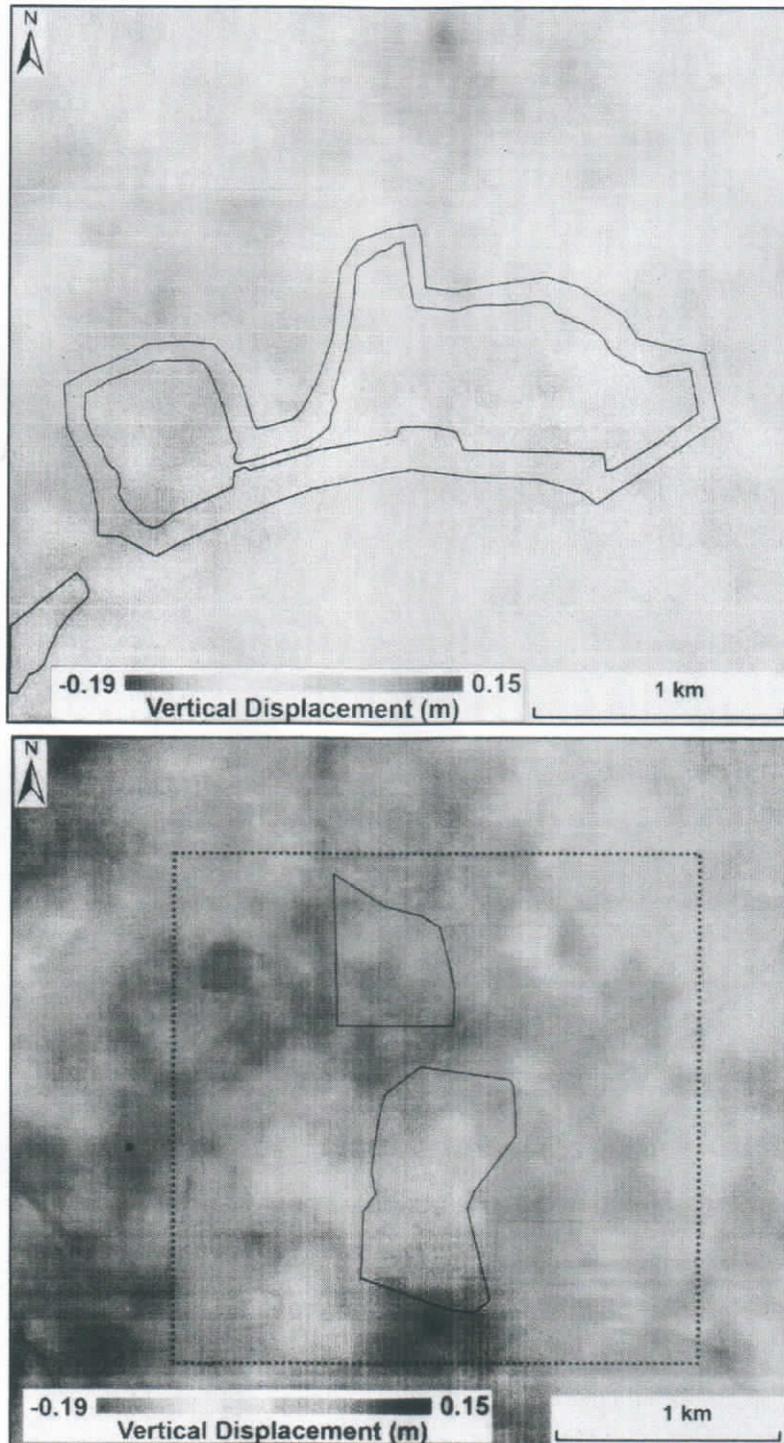


Figure 6: Spatial distribution of displacement and subsidence on regional scale and along or near the monitored ash dykes.

The subsidence maps highlight distinct spatial patterns and trends. The following findings include:

- The map implies lesser or no displacement or subsidence at the Ash Dykes (Dykes-1,2,3,4,5,6,7 and BCPP Old Dyke, Daganiakhar) and its surrounding areas (Figure 6).
- One of the inactive ash dykes (i.e., BCPP New Dyke, Balgikhar) reveal slightly localized areas of uplift which must comprehend by looking into the field based potential factors behind this trend.

3.2. Subsidence and Displacement rates

The analysis yielded varying displacement and subsidence rates for different parts of the study area and the monitored ash dykes. The results for regional scale and its spatial patterns can be inferred from the legend given in the above maps. Moreover, the results along the Ash Dykes are shown in the below plots (Figure 7) and related data summarized in Annexure Tables 1-4. It is showing the displacement/subsidence rates in meters during the study period i.e., March to September 2023. The following findings can be drawn from these plots and tabulated data:

- There is no significant subsidence or displacement rate observed along all the monitored Ash Dykes. For instance, the maximum rate of subsidence is $\sim -46.7 \pm 10$ mm (millimeter) observed at the above part of the dykes boundary of dykes-2 to 7 over the period of time, which even comes within the uncertainty values. However, the average subsidence or displacement rate along the boundary of Ash Dykes comes within $\sim -20 \pm 6$ mm which shows insignificant subsidence or displacement by considering the range within uncertainty and resolution of images. Moreover, the maximum rate of subsidence across the dykes is $\sim -120 \pm 35$ mm (millimeter) observed in dykes-2 to 7 over the period of time which is even not come under any critical threshold of subsidence or displacement by considering the range within uncertainty and the morphological changes during the routine maintenance of dykes by BALCO.
- The inactive Ash Dykes shows even no subsidence or displacement rate however one of the inactive Ash Dyke (i.e., BCPP New Dyke, Balgikhar) reveal slightly localized areas of uplift with an average of ~ 40 mm which must comprehend by looking into the field based potential factors. This might be due

to change in topography or dielectric constant of the material causing change in backscatter values and it must need further study based on field.

- It is important to acknowledge the limitations of the InSAR analysis with limited PS density in certain areas may result in gaps in the subsidence maps. Moreover, the accuracy of the results depends on various factors, including data quality, exact surface and atmospheric conditions at the time of acquiring data which further validate with the field-based methods.
- The subsidence/displacement rates data extracted along the boundary of ash dykes which is mapped using high resolution google earth images which further need validation in field for refinement of the results.

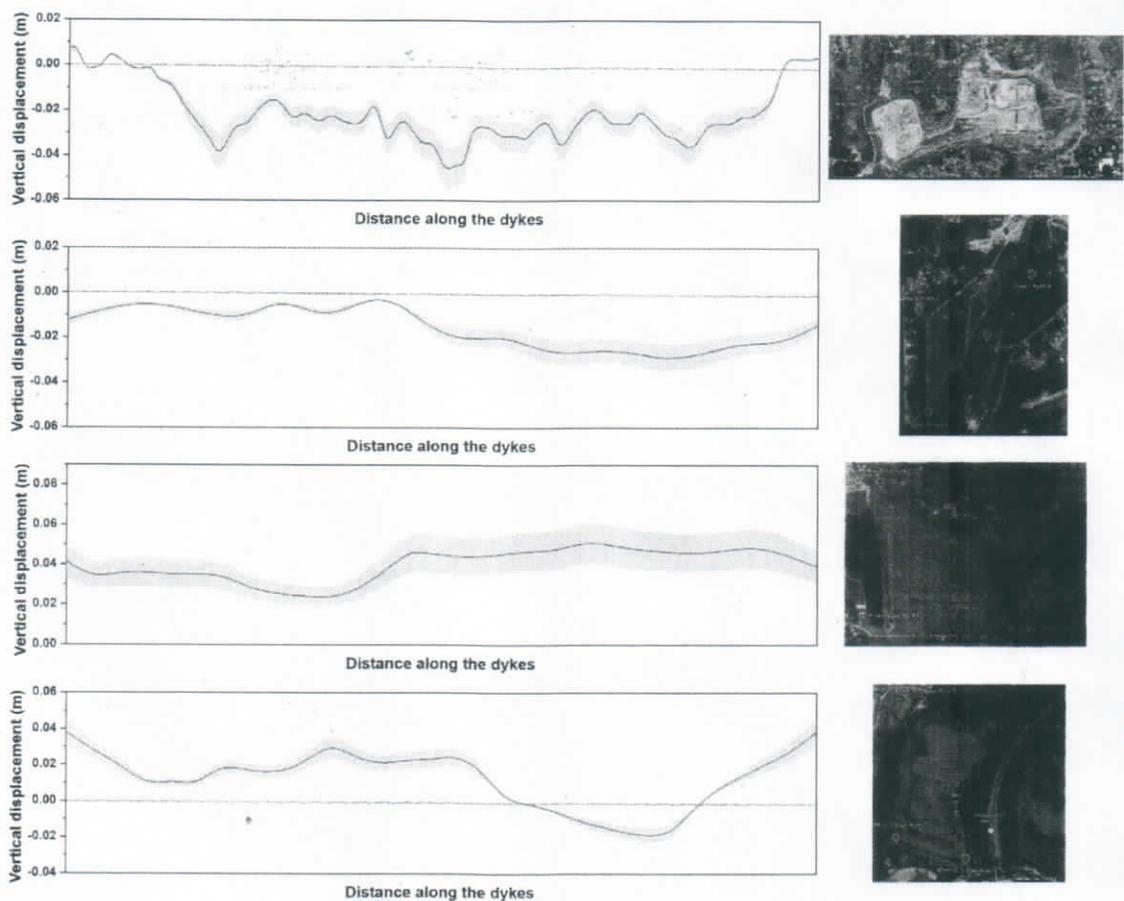


Figure 7: Subsidence and Displacement rates along the monitored ash dykes. Note the subsidence/displacement rates data extracted along the boundary of ash dykes which is mapped using high-resolution google earth images that further need validation in the field for refinement of the results.



Figure 8: Highlighted area needs to be checked in the field to validate the calculated displacement and subsidence rate along the Boundary of Dykes 2-7. However, the data shows no significant subsidence or displacement by considering the range within uncertainty and the morphological changes during the routine maintenance of dykes by BALCO.

Table 3: Summary table of status of subsidence or displacement in the observed active and inactive dykes of BALCO

S. No.	Dyke Name	Subsidence Status	Remarks
1.	Dyke-1 (Inactive Dyke)	<ul style="list-style-type: none"> No significant subsidence or displacement rate observed for Dyke-1. Maximum subsidence or displacement observed along the dykes above boundary is -29.4 mm which is not comes under any significant threshold. 	No significant subsidence or displacement rate observed for Dyke-1.
2.	Dyke 2 to 7 (Active Dyke Dkye-2,4,7.6 & Inactive Dyke-3,4)	<ul style="list-style-type: none"> No significant subsidence or displacement rate observed for Dykes 2 to 7. Maximum subsidence or displacement observed along the dykes above boundary is -46.7 mm which is not comes under any significant threshold. Maximum rate of subsidence observed across the dykes-2 to 7 over the period of time is $\sim 120 \pm 35$ mm (millimeter) observed in dykes-2 which is even not come under any critical threshold of subsidence or displacement by considering the range within uncertainty and the morphological changes during the routine maintenance of dykes by BALCO. 	<p>No significant subsidence or displacement rate observed for Dykes 2 to 7.</p> <p>It is recommended to monitor and maintain the area highlighted in Figure-8.</p>
3.	BCPP Old Dyke (Daganiakhar) BCPP New Dyke (Balgikhar)	<ul style="list-style-type: none"> Inactive Ash Dykes (i.e. BCPP Old and New Dyke) shows even no subsidence or displacement rate. One of the inactive Ash Dyke (i.e., BCPP New Dyke, Balgikhar) reveal slightly localized areas of uplift with an average of ~ 40 mm which must comprehend by looking into the field-based potential or dyke maintenance efforts by BALCO 	No significant subsidence or displacement rate observed for Inactive Ash Dykes (i.e. BCPP Old and New Dyke)



Figure 8: Sentinel-2 MSI images of February, 2024 to monitor surface and land cover characteristics of ash dykes.

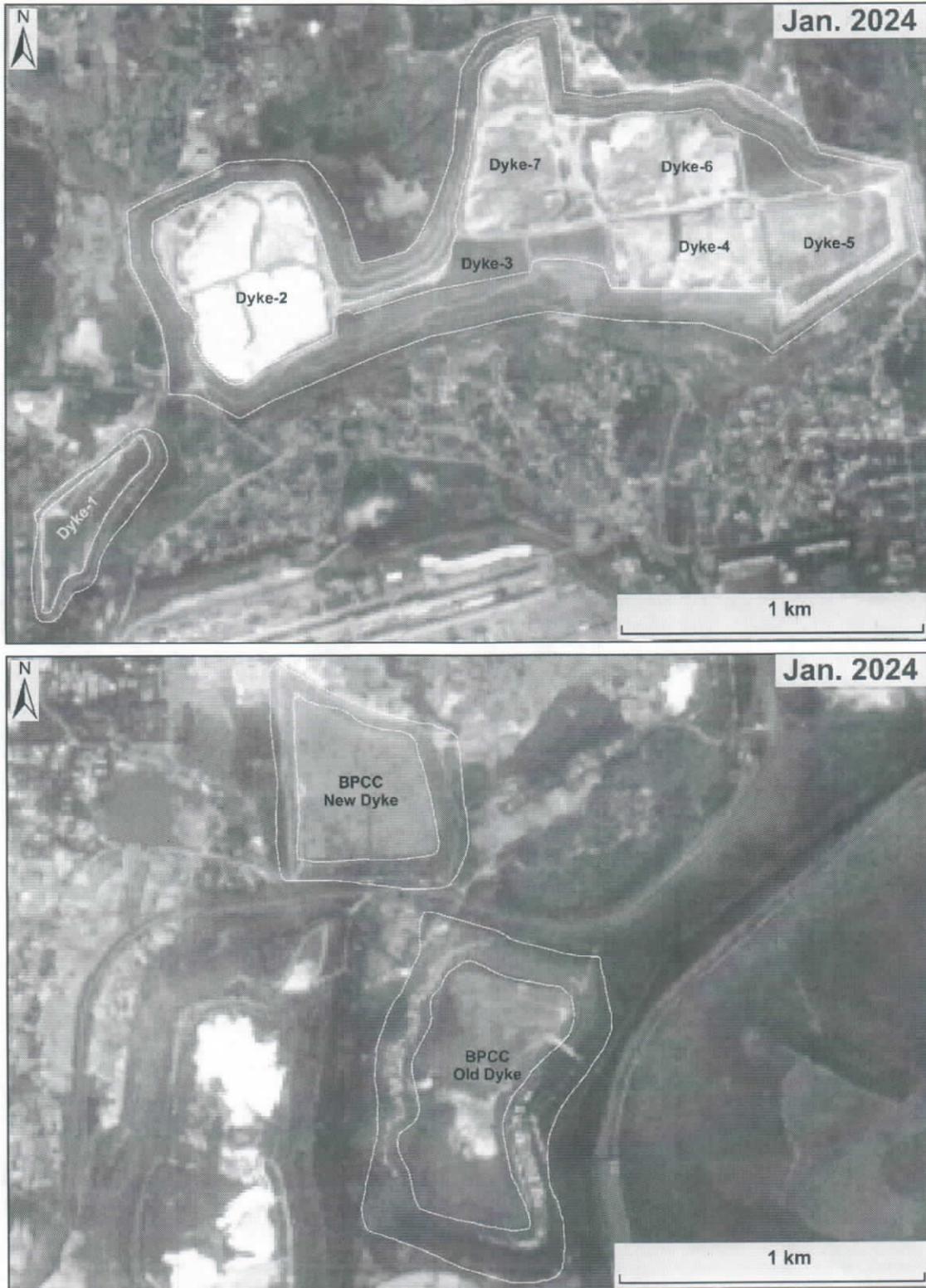


Figure 9: Sentinel-2 MSI images of January 2024 to monitor surface and land cover characteristics of ash dykes.

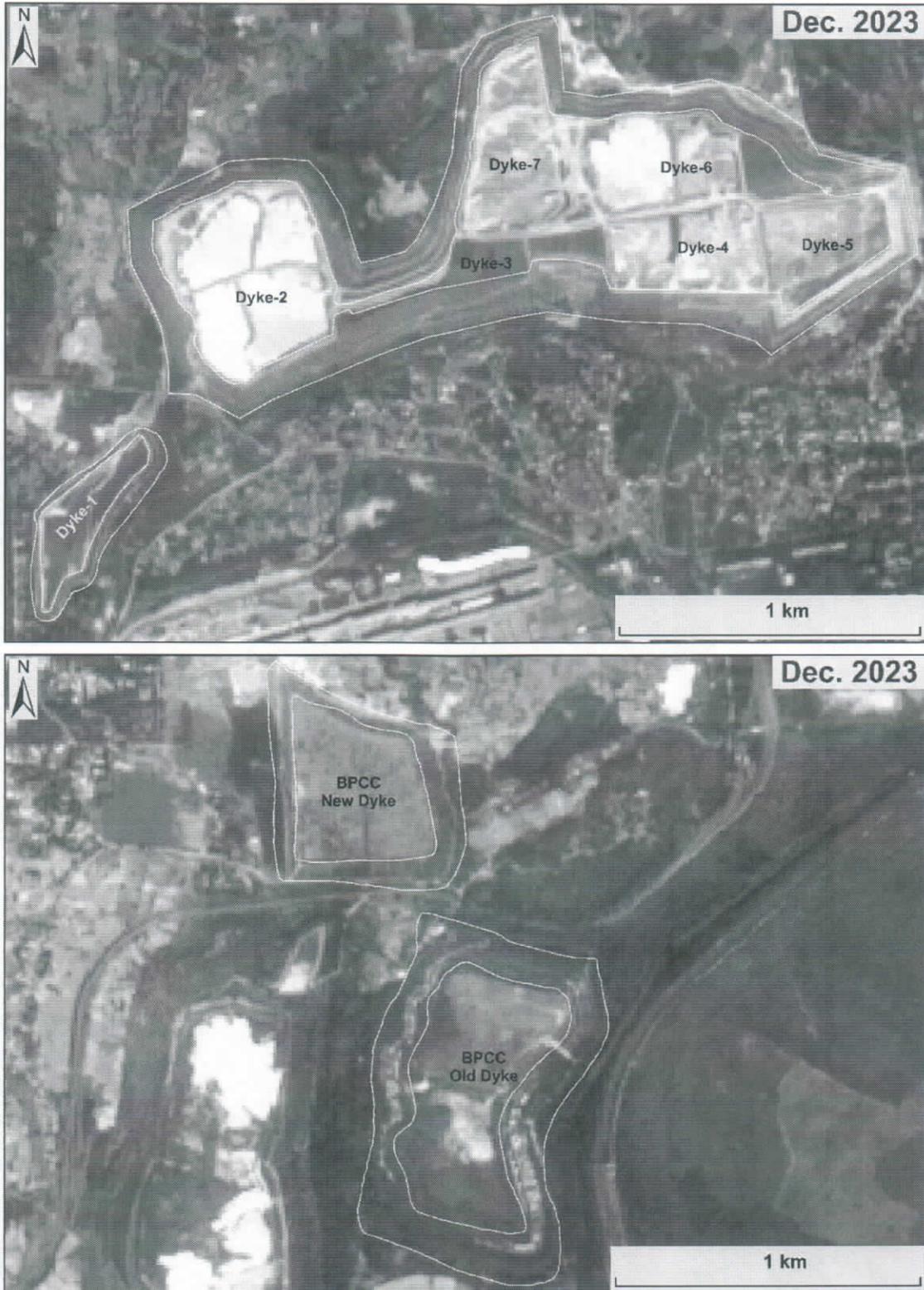


Figure 10: Sentinel-2 MSI images of December 2023 to monitor surface and land cover characteristics of ash dykes.

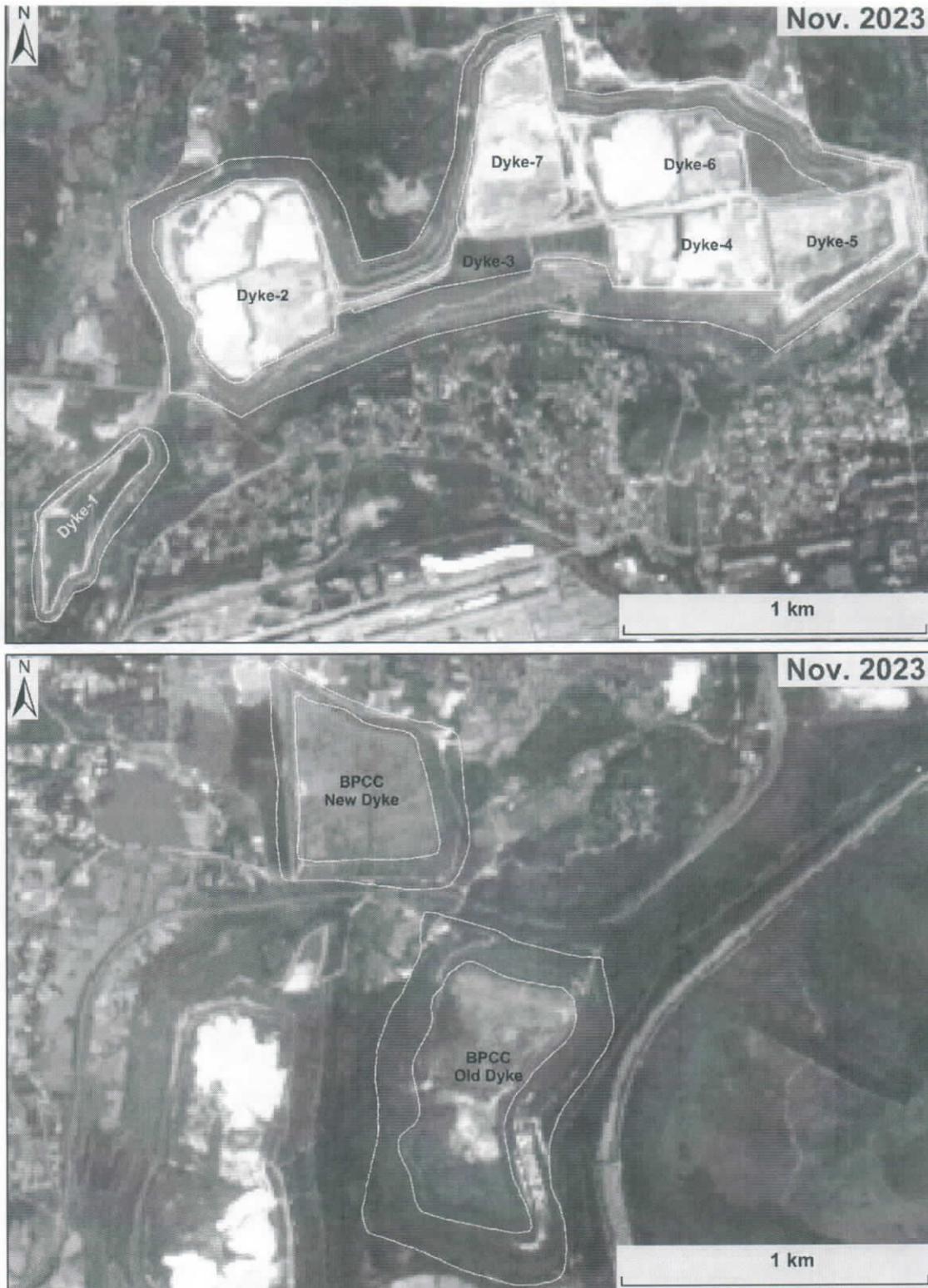


Figure 11: Sentinel-2 MSI images of November 2023 to monitor surface and land cover characteristics of ash dykes.

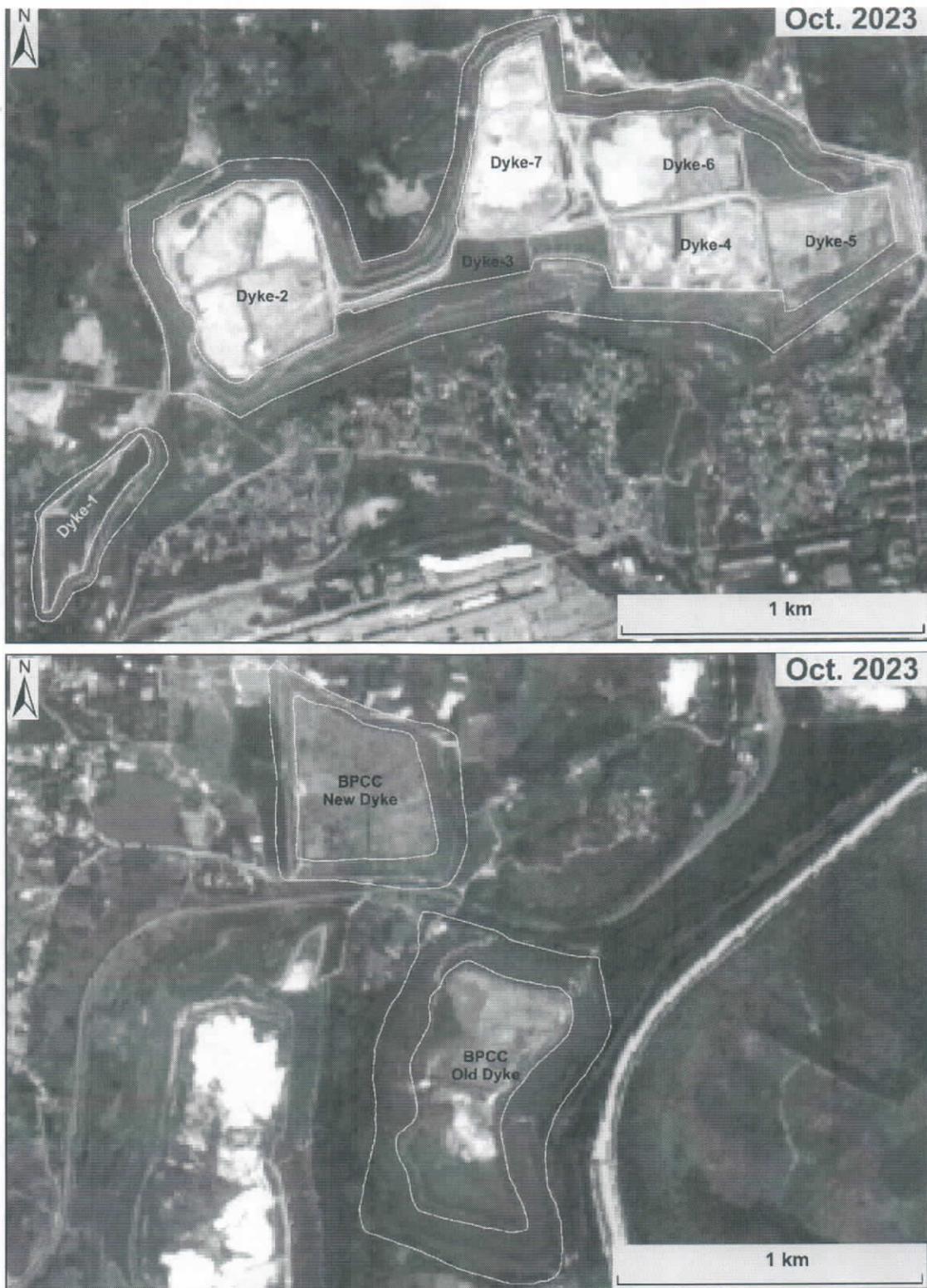


Figure 12: Sentinel-2 MSI images of October 2023 to monitor surface and land cover characteristics of ash dykes.

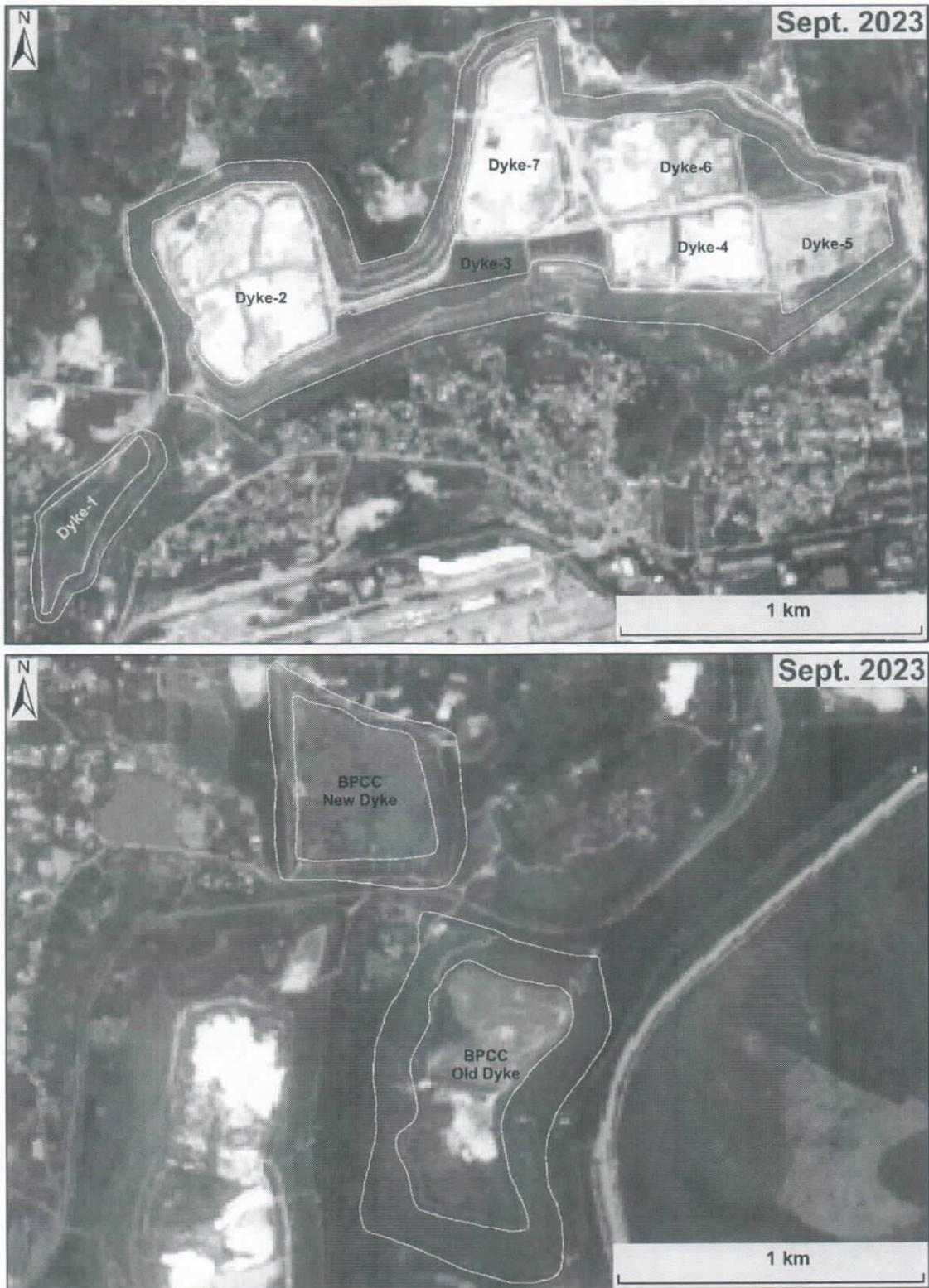


Figure 13: Sentinel-2 MSI images of September 2023 to monitor surface and land cover characteristics of ash dykes.



Figure 14: Sentinel-2 MSI images of August 2023 to monitor surface and land cover characteristics of ash dykes.



Figure 15: Sentinel-2 MSI images of June 2023 to monitor surface and land cover characteristics of ash dykes.



Figure 16: Sentinel-2 MSI images of May 2023 to monitor surface and land cover characteristics of ash dykes.

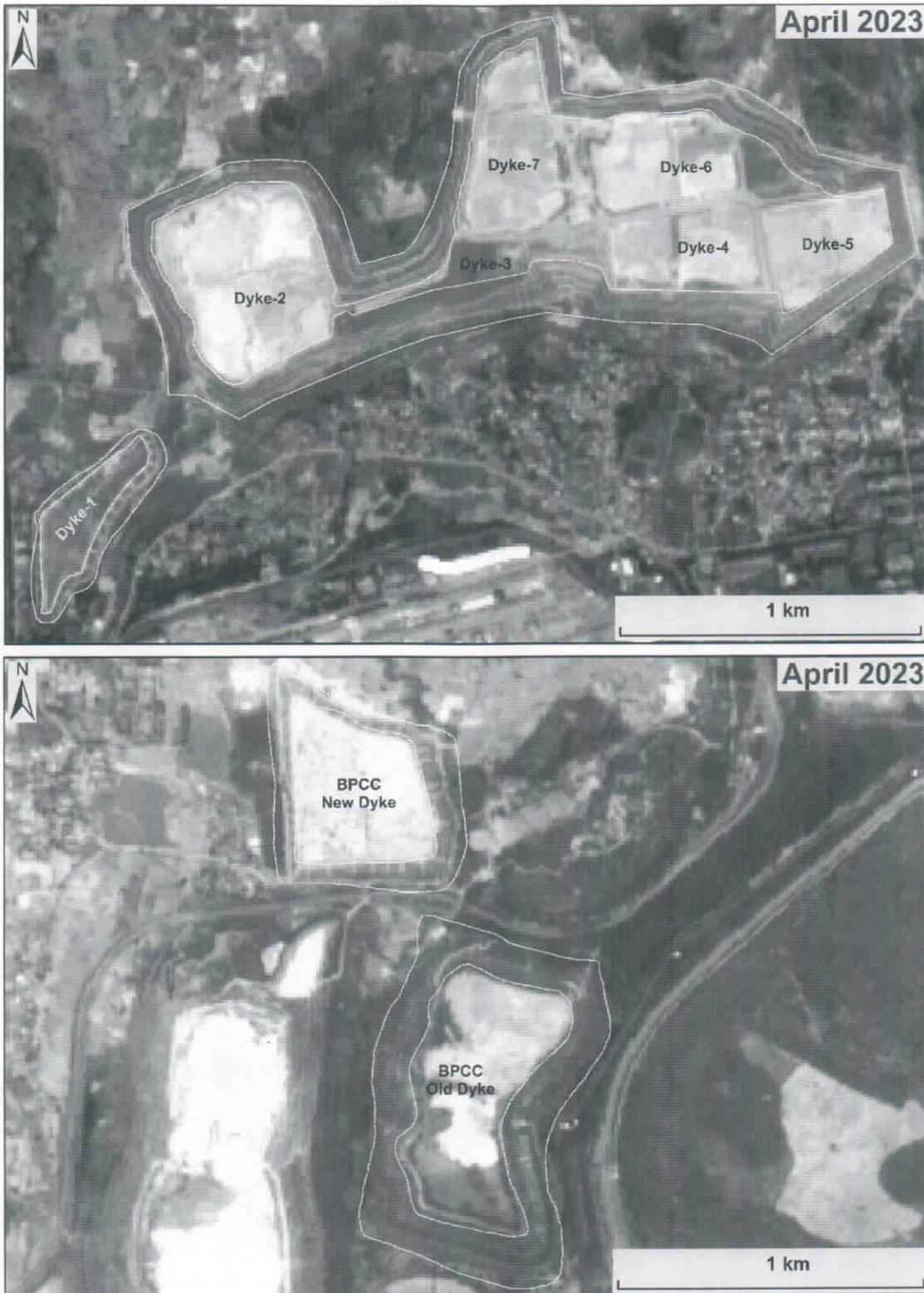


Figure 17: Sentinel-2 MSI images of April 2023 to monitor surface and land cover characteristics of ash dykes.

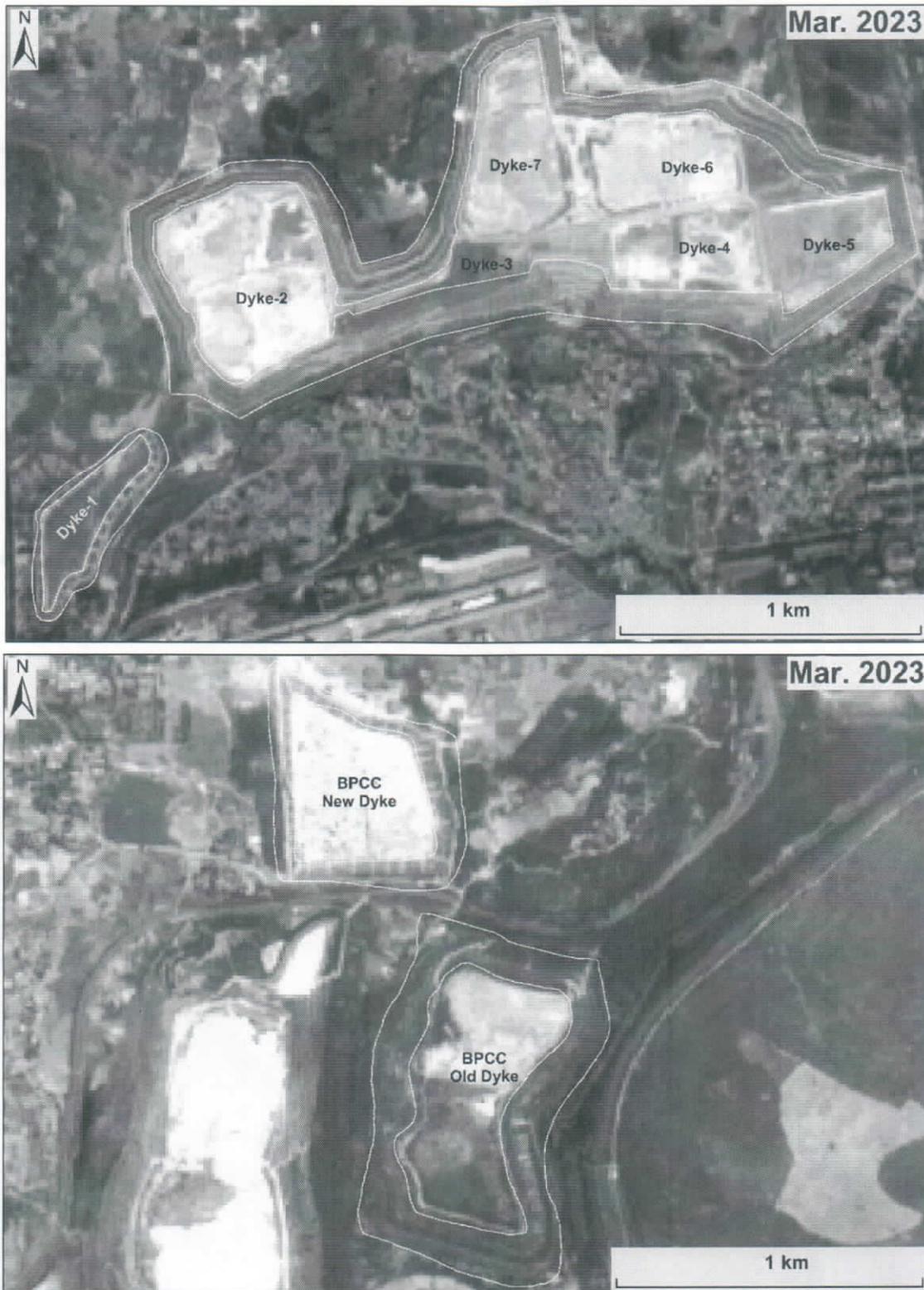


Figure 18: Sentinel-2 MSI images of March 2023 to monitor surface and land cover characteristics of ash dykes.



Figure 19: Sentinel-2 MSI images of February 2023 to monitor surface and land cover characteristics of ash dykes.



Figure 20: Sentinel-2 MSI images of January 2023 to monitor surface and land cover characteristics of ash dykes.

CHAPTER-4

UAV 3-D Data Acquisition and Processing

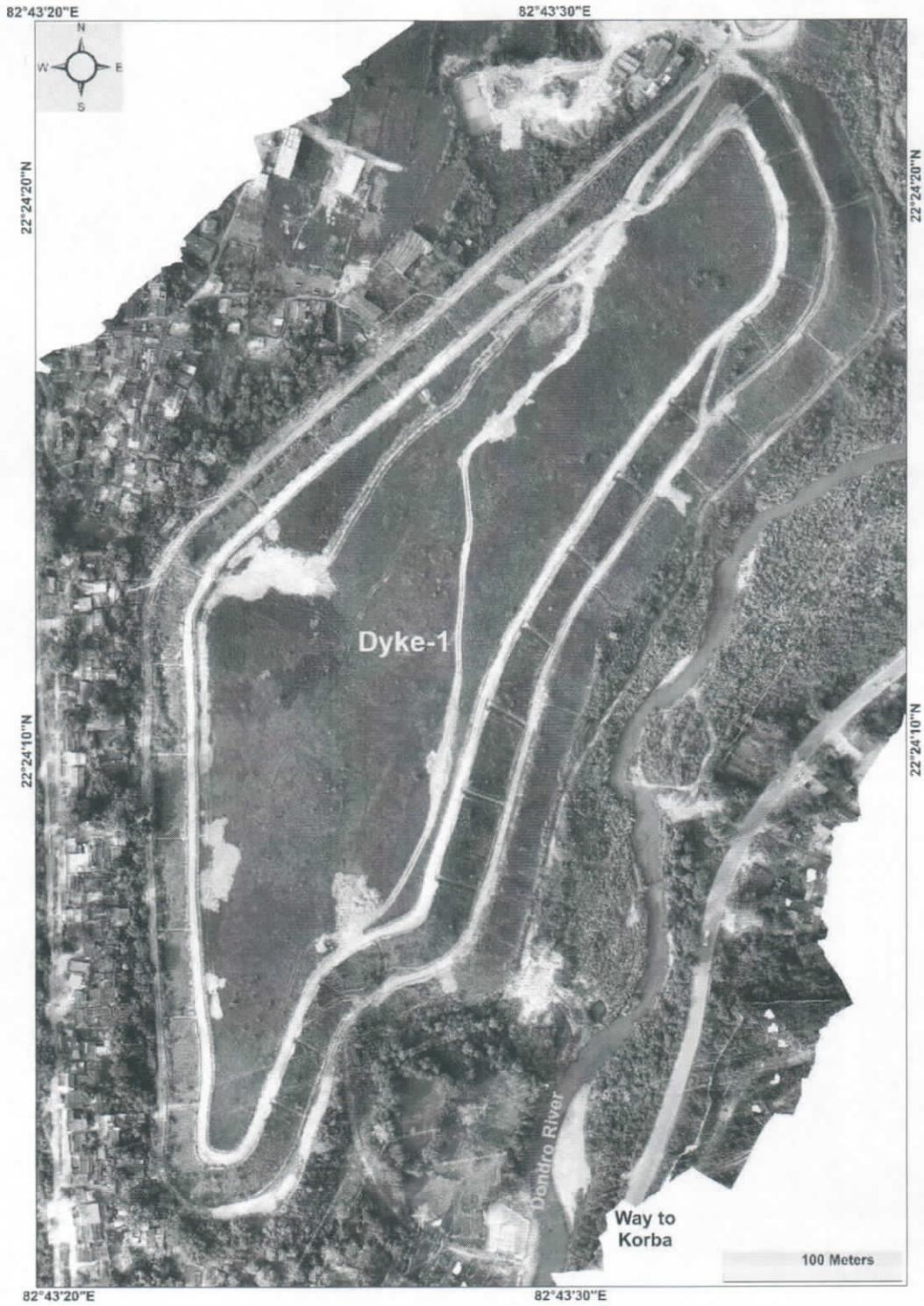


Figure 11: The very high-resolution image (25 cm) UAV data for Dyke-1

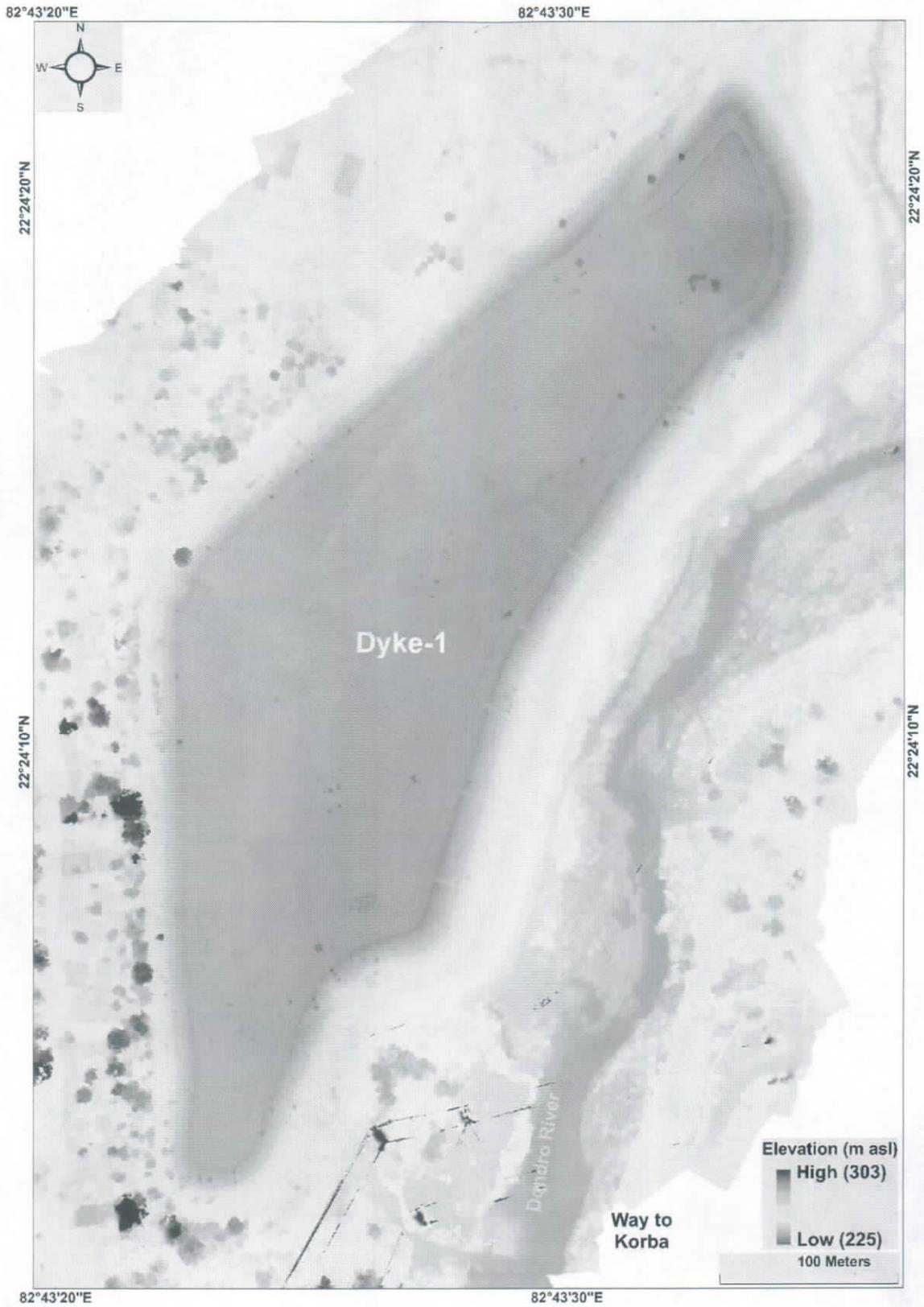


Figure 12: The very high-resolution Digital elevation model constructed from (25 cm) UAV data for Dyke-1



Figure 13: The 3-D representation of Dyke-1 from different directions. The data doesn't show any significant change in 3-Dimensional characteristics of the Dyke-1



Figure 14: The 3-D representation of Dyke-1 from different direction. The data doesn't show any significant change in 3-Dimensional chrematistics of the Dyke-1



Figure 15: The very high-resolution image (25 cm) of UAV data for Dyke-2 to 7



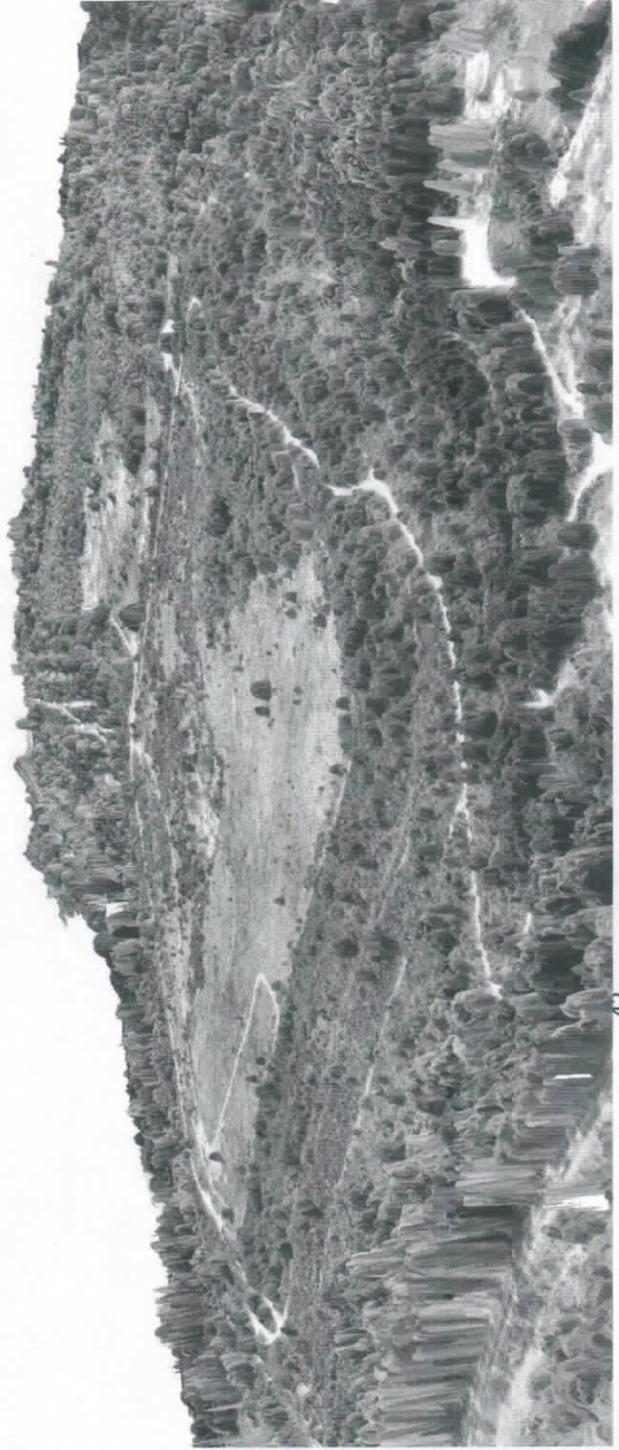
Figure 16: The very high-resolution Digital elevation model constructed from (25 cm) UAV data for Dyke-2 to 7



Figure 17: The very high-resolution image (25 cm) of UAV data for BCPP Old Dyke (Dganiakhar)



Figure 17: The very high-resolution Digital elevation model constructed from (25 cm) UAV data for BCPP Old Dyke (Dganiakhar)



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Figure 18: The 3-D representation of BCPP Old Dyke (Dganiakhar) from different direction. The data doesn't show any significant change in 3-Dimensional chromaticities of the BCPP Old Dyke (Dganiakhar)



Figure 19: The 3-D representation of BCPP Old Dyke (Dganiakhar) from different direction. The data doesn't show any significant change in 3-Dimensional chrematistics of the BCPP Old Dyke (Dganiakhar)

Figure 20: The very high-resolution image (25 cm) of UAV data for BCPP New Dyke (Balgikhar)

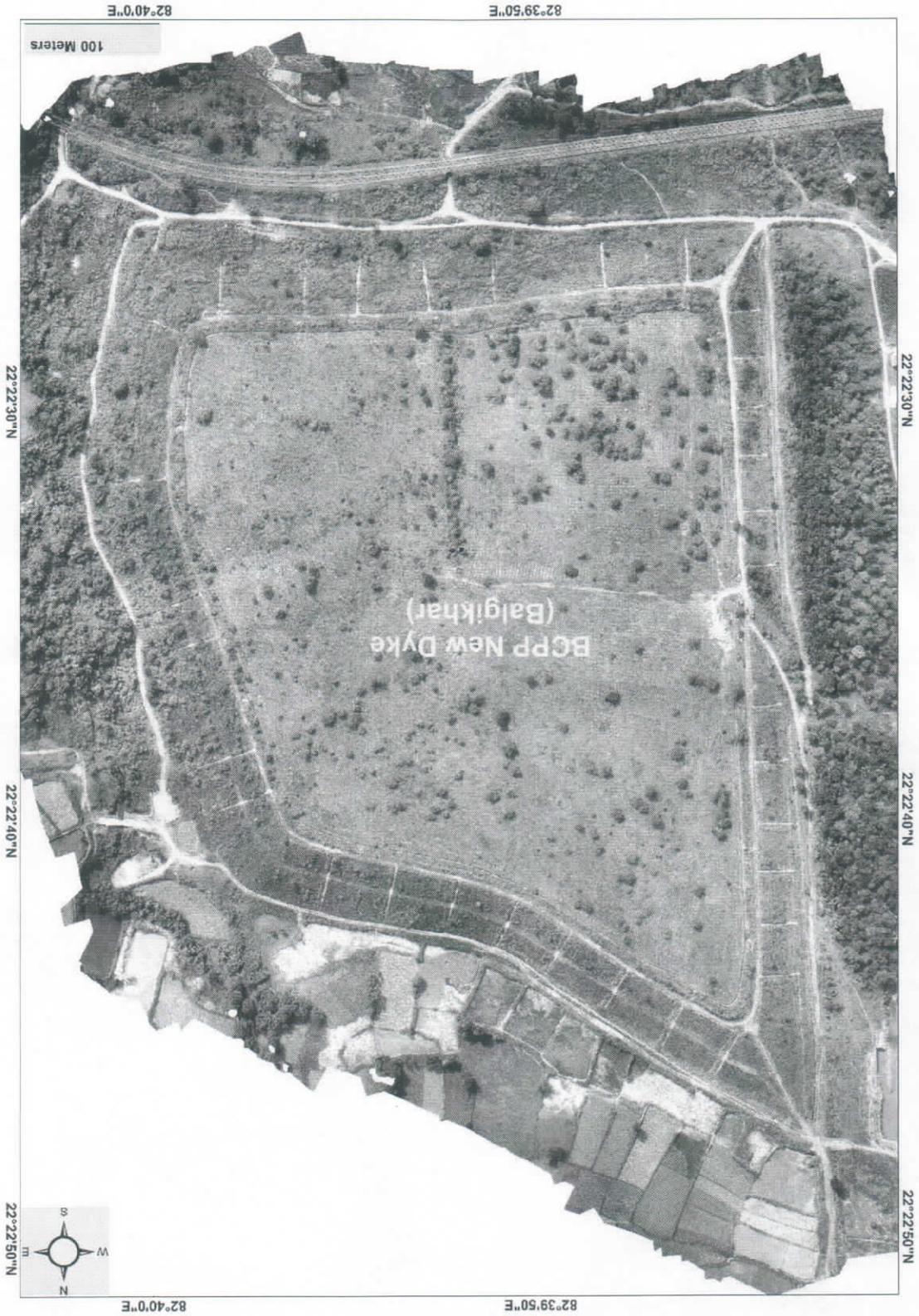


Figure 21: The very high-resolution image (25 cm) of UAV data for BCPP New Dyke (Balgikhar)

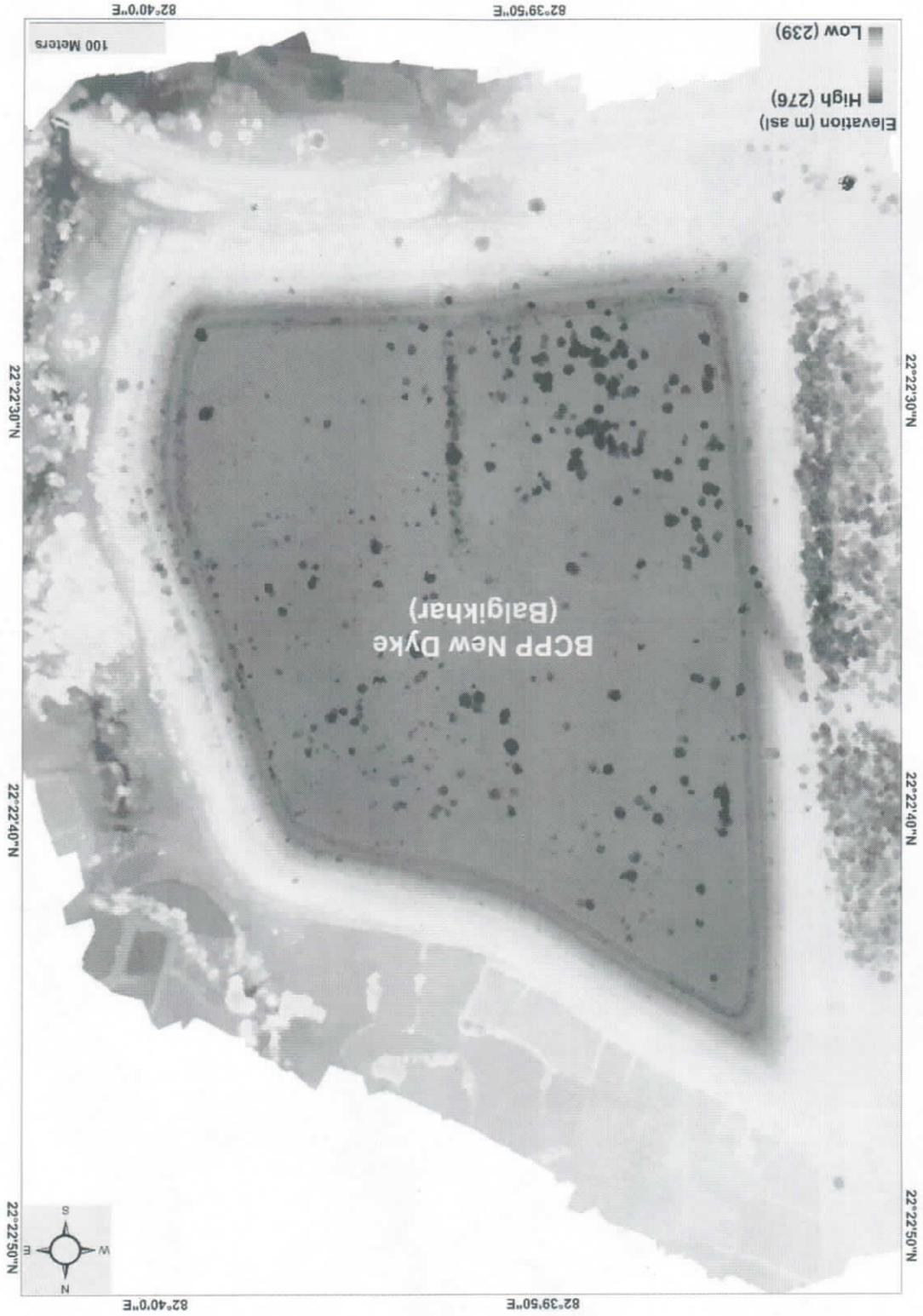




Figure 22: The 3-D representation of BCPP New Dyke (Balgikhar) from different direction. The data doesn't show any significant change in 3-Dimensional characteristics of the BCPP New Dyke (Balgikhar)



Figure 23: The 3-D representation of BCPP New Dyke (Balgikhar) from different direction. The data doesn't show any significant change in 3-Dimensional chrematistics of the BCPP New Dyke (Balgikhar)

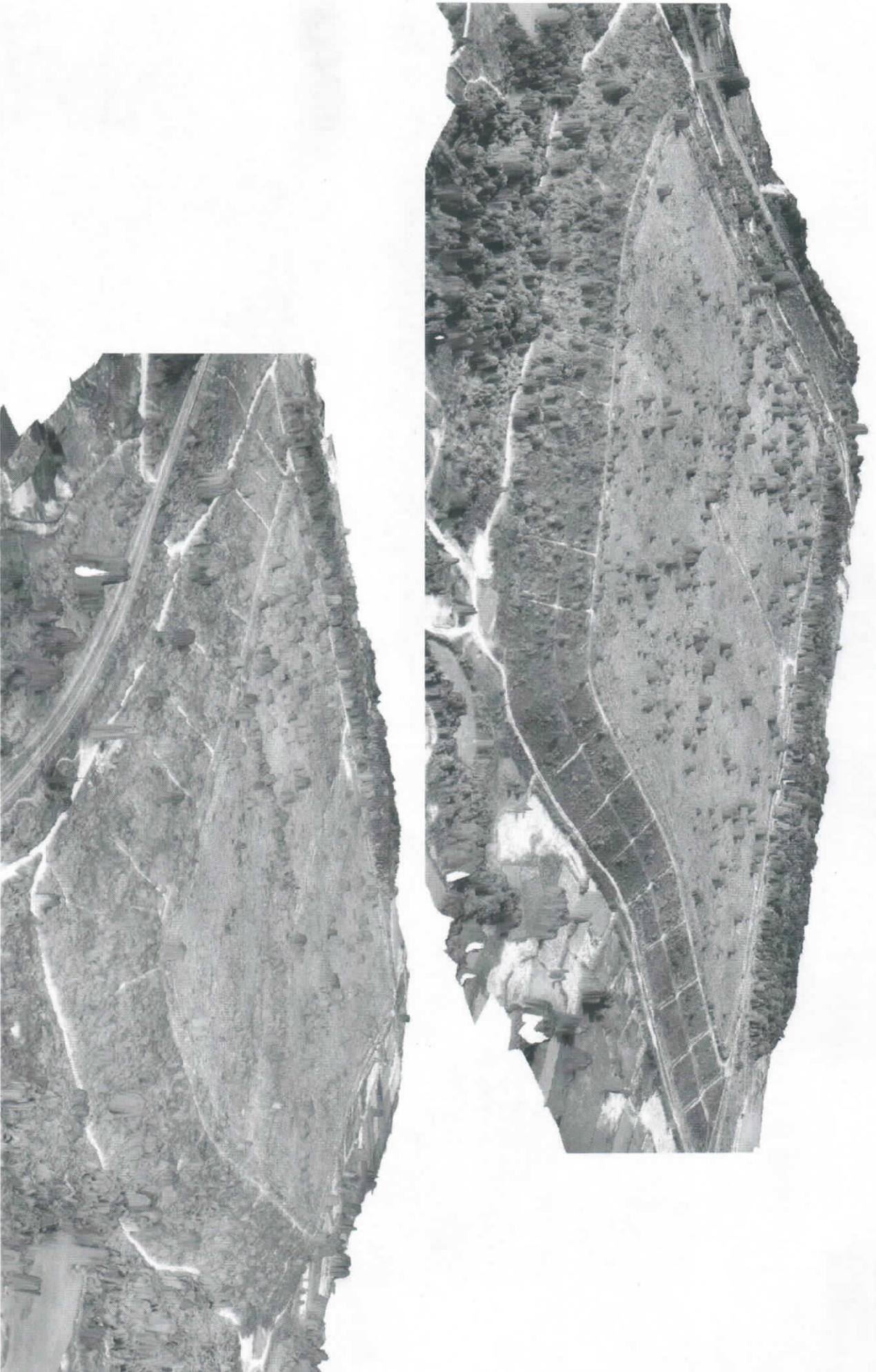


Figure 24: The 3-D representation of BCPP New Dyke (Balgikhar) from different directions. The data doesn't show any significant change in 3-Dimensional chrematistics of the BCPP New Dyke (Balgikhar)

Annexure Table-1:
Subsidence and Displacement rates along the Dyke-2,3,4,5,6 and 7

Displacement value Along the dykes	Uncertainty Values (\pm)
0.0074	0.0014800
0.008	0.0016000
-0.003	-0.0006000
-0.0011	-0.0002200
-0.0011	-0.0002200
0.0064	0.0012800
0.0026	0.0005200
-0.0014	-0.0002800
-0.0021	-0.0004200
-0.0004	-0.0000800
-0.0059	-0.0011800
-0.0072	-0.0014400
-0.0081	-0.0016200
-0.0152	-0.0030400
-0.0215	-0.0043000
-0.0259	-0.0051800
-0.028	-0.0056000
-0.0322	-0.0064400
-0.0408	-0.0081600
-0.0336	-0.0067200
-0.0258	-0.0051600
-0.0271	-0.0054200
-0.0201	-0.0040200
-0.0157	-0.0031400
-0.0149	-0.0029800
-0.0192	-0.0038400
-0.0245	-0.0049000
-0.0209	-0.0041800
-0.0219	-0.0043800
-0.0248	-0.0049600

-0.0245	-0.0049000
-0.0223	-0.0044600
-0.0224	-0.0044800
-0.0246	-0.0049200
-0.0255	-0.0051000
-0.0261	-0.0052200
-0.0236	-0.0047200
-0.0131	-0.0026200
-0.0381	-0.0076200
-0.0248	-0.0049600
-0.0243	-0.0048600
-0.0316	-0.0063200
-0.0352	-0.0070400
-0.0335	-0.0067000
-0.0436	-0.0087200
-0.0467	-0.0093400
-0.0434	-0.0086800
-0.0455	-0.0091000
-0.0271	-0.0054200
-0.0269	-0.0053800
-0.0267	-0.0053400
-0.0311	-0.0062200
-0.0315	-0.0063000
-0.0305	-0.0061000
-0.0334	-0.0066800
-0.028	-0.0056000
-0.0251	-0.0050200
-0.0246	-0.0049200
-0.0354	-0.0070800
-0.035	-0.0070000
-0.0275	-0.0055000
-0.0241	-0.0048200
-0.02	-0.0040000
-0.0186	-0.0037200

-0.0264	-0.0052800
-0.0251	-0.0050200
-0.0266	-0.0053200
-0.0196	-0.0039200
-0.0219	-0.0043800
-0.0262	-0.0052400
-0.0317	-0.0063400
-0.0312	-0.0062400
-0.0367	-0.0073400
-0.0357	-0.0071400
-0.0263	-0.0052600
-0.0255	-0.0051000
-0.0258	-0.0051600
-0.0255	-0.0051000
-0.0219	-0.0043800
-0.0233	-0.0046600
-0.0197	-0.0039400
-0.0163	-0.0032600
-0.0046	-0.0009200
0.0024	0.0004800
0.0037	0.0007400
0.0028	0.0005600
0.0031	0.0006200
0.0059	0.0011800

Annexure Table-2:
Subsidence and Displacement rates along the Dyke-1

Displacement value Along the dykes	Uncertainty Values (\pm)
-0.0124	-0.0024800
-0.0069	-0.0013800
-0.004	-0.0008000
-0.0077	-0.0015400
-0.0117	-0.0023400
-0.0092	-0.0018400
-0.0025	-0.0005000
-0.0107	-0.0021400
-0.0067	-0.0013400
-0.0016	-0.0003200
-0.0045	-0.0009000
-0.0177	-0.0035400
-0.0212	-0.0042400
-0.0188	-0.0037600
-0.0243	-0.0048600
-0.0274	-0.0054800
-0.0252	-0.0050400
-0.0267	-0.0053400
-0.0294	-0.0058800
-0.0277	-0.0055400
-0.022	-0.0044000
-0.023	-0.0046000
-0.0146	-0.0029200

Annexure Table-3:
Subsidence and Displacement rates along the BCPP New Dyke
(Balgikhar)

Displacement value Along the dykes	Uncertainty Values (\pm)
0.0416	0.0083200
0.0332	0.0066400
0.0365	0.0073000
0.0362	0.0072400
0.0347	0.0069400
0.0359	0.0071800
0.0281	0.0056200
0.0254	0.0050800
0.024	0.0048000
0.0235	0.0047000
0.0322	0.0064400
0.0465	0.0093000
0.0463	0.0092600
0.0439	0.0087800
0.0443	0.0088600
0.0469	0.0093800
0.0468	0.0093600
0.0524	0.0104800
0.0485	0.0097000
0.0471	0.0094200
0.0457	0.0091400
0.0464	0.0092800
0.0493	0.0098600
0.0459	0.0091800
0.0394	0.0078800

Annexure Table-4:
Subsidence and Displacement rates along the BCPP Old Dyke
(Daganiakhar)

Displacement value Along the dykes	Uncertainty Values (\pm)
0.0383	0.0076600
0.0282	0.0056400
0.0206	0.0041200
0.0089	0.0017800
0.0114	0.0022800
0.0096	0.0019200
0.011	0.0022000
0.0199	0.0039800
0.017	0.0034000
0.0156	0.0031200
0.0174	0.0034800
0.0246	0.0049200
0.0318	0.0063600
0.0237	0.0047400
0.0203	0.0040600
0.0228	0.0045600
0.023	0.0046000
0.0255	0.0051000
0.0181	0.0036200
0.0004	0.0000800
-0.0014	-0.0002800
-0.005	-0.0010000
-0.0092	-0.0018400
-0.0121	-0.0024200
-0.015	-0.0030000
-0.0181	-0.0036200
-0.0194	-0.0038800
-0.0168	-0.0033600
-0.0077	-0.0015400

0.0039	0.0007800
0.0086	0.0017200
0.0131	0.0026200
0.017	0.0034000
0.0215	0.0043000
0.0267	0.0053400
0.0384	0.0076800