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BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL EASTERN  
ZONE BENCH, KOLKATA

ORIGINAL APPLICATION NO. 73/2024/EZ

**IN THE MATTER OF:**

MANTU DAS

... APPLICANT

VERSUS

STATE OF ODISHA & ORS.

...RESPONDENT (S)

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Through

Place: Kolkata

Date:- 14/07/25



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BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL  
EASTERN ZONE BENCH, KOLKATA

**NOTARISED**

ORIGINAL APPLICATION NO. 73/2024/EZ

**10 JUL 2025**

IN THE MATTER OF:

Mantu Das

.....Applicant(s)

Versus

State of Odisha & Ors.

.....Respondent(s)



Affidavit on behalf of Central Water Board, Bhubaneswar for the compliance of order dated 08.04.2025 by Hon'ble NGT/EZ, Kolkata.

, **BIKRAM KUMAR SAHOO**, aged about 53 years, working as Regional Director in the office of the Central Ground Water Board, Govt. Of India, Ministry of Jal Shakti, Department of River Development Ganga Rejuvenation, South Eastern Region, Bhujal Bhawan, Khandagiri, Bhubaneswar – 751030, do hereby solemnly affirm and declare as under: -

*Bikram Kumar Sahoo*



1. That I, am duly authorised and competent to swear this affidavit on behalf of Central Ground Water Board, South Eastern Region, Bhubaneswar in the above matter.
2. That I have read and understood the order passed by the Hon'ble NGT dated 08.04.2025 and filing this affidavit in compliance of direction passed by the Hon'ble Tribunal.



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3. That the Deponent is fully conversant with the facts of the case on the basis of the official record and duly authorised and competent to swear this present affidavit on behalf of Central Ground Water Board, South Eastern Region, Bhubaneswar. That as per direction of the Hon'ble Tribunal vide solemn order dated 04.07.2024, Ld. Tribunal directed "we wonder whether the Central Ground Water Board, which was a member of the Joint Committee, does not consider itself a competent agency to investigate. The Central Ground Water Board should have further investigated the matter on its own."

A copy of the Study Report on "Ground Water Quality in Sukinda Valley, Jajpur District, Odisha" is annexed herewith and Marked as Annexure-R-1.

*Bikram Kumar Sahoo*  
**DEPONENT**

**VERIFICATION**

I, **BIKRAM KUMAR SAHOO** the above-named deponent do hereby verify that, the contents of the above affidavit are true and correct to my knowledge based on official records, no part of it is false and nothing material has been concealed there from.

Signed and verified on this 10<sup>th</sup> Day of July, 2025 at Bhubaneswar.

*Bikram Kumar Sahoo*  
**DEPONENT**



Identified by Me  
 Advocate

(The above named deponent(s) being duly identified by Sri..... Advocate, Bhubaneswar Appears before me on ..... 10 JULY 2025 at ..... A.M./P.M. .... on oath the contents of this affidavit are true to the best of his / her / their knowledge and belief

Deponent(s) Notary, Bhubaneswar

*Janmejaya Rautray*  
**JANMEJAYA RAUTRAY**  
 NOTARY, GOVT. OF ODISHA  
 BHUBANESWAR  
 REGD. NO-ON-86/2012  
 Mob No. - 9337121273



R-1

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**Government of India**  
**Ministry of Jal Shakti**  
**D/O Water Resources, River Development & Ganga Rejuvenation**

**REPORT ON**

**Ground Water Quality in Sukinda Valley**  
**Jajpur District, Odisha**

**For Submission before the**

**Hon'ble National Green Tribunal, Eastern Zone Bench, Kolkata**



**Central Ground Water Board**  
**South Eastern Region, Bhubaneswar**  
**June 2025**



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**Central Ground Water Board  
South Eastern Region, Bhubaneswar**

**Ground Water Quality in Sukinda Valley, Jajpur District, Odisha**

**Report Preparation  
by**

**Smt. Mausumi Sahoo, Scientist-D  
Sh. Bibhuti Bhushan Sahoo, Scientist-C  
Sh. Sinosh P K, Scientist-B**

**Supervision & Guidance  
Dr. B K Sahoo, Regional Director**

**June 2025**



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## GROUND WATER QUALITY IN SUKINDA VALLEY, JAJPUR DISTRICT, ODISHA

### 1.0 Introduction

In pursuant to the OA No.73/2024/EZ filed before the Hon'ble National Green Tribunal (NGT), Eastern Zone Bench, Kolkata; the Hon'ble NGT has constituted a joint committee vide its hearing dated 21.03.2024 comprising of the following members to enquire into the allegations made in the said OA related to water pollution in Sukinda Valley and submit a fact finding report:-

- i. Senior Scientist, Odisha Pollution Control Board,
- ii. Senior Scientist, Central Pollution Control Board,
- iii. Senior Officer, Central Ground Water Board, and
- iv. Collector & District Magistrate, Jajpur, or his representative not below the rank of Additional District Magistrate.

The joint committee has submitted the fact finding report before the Hon'ble NGT with finding of the Chromium (VI) contamination at nine sampling points and also gave the suggestion that the extent of contamination of ground water in the different regions of Sukinda Valley and surrounding area is a matter of further investigation by the competent agency. The Hon'ble NGT vide its hearing dated 04.07.2024 directed the Central Ground Water Board to further investigate the matter on its own and to file affidavit showing what action has been taken on the Report of the Joint Inspection Committee.

Following the directions of the Hon'ble NGT, the Central Ground Water Board, Bhubaneswar has taken up a study to establish the extent of Cr (VI) contamination in ground water in Sukinda Valley area. The study area covers the Sukinda Chromite Valley along with its buffers having a geographical area of around 180 square kilometres and is located in Sukinda block, Jajpur district of Odisha state. The area falls between north latitudes 21.0540 & 21.1120 and east longitudes 85.9000 & 85.6860 (Plate-1). The area receives good amount of rainfall with an annual average precipitation of 1800 mm.

The area known as Sukinda ultramafic field is famous for its Chromite reserve which accounts for around 95% of the chromite reserve of the country which are associated with the ultramafic complexes. The Chromite ore is mined in the area through mostly opencast method by various private and public sector companies.

The Sukinda ultramafic field is confined to an east-west trending valley lying between the Daitari hill range in the north and the Mahagiri range in the south. The area has a width of 2 to 5 km and extends for a length of nearly 25 km in an ENE-WSW direction with general slope from north east to south west. The drainage or natural water channels in the area is towards North West and it finally joins the Damsala Nalla which is flowing NE-SW and is the main





drainage in the area. The Damsala Nala crosses the valley along the length and joins the River Brahmani that finally meets the Bay of Bengal.

## 2.0 Geology and Hydrogeology

Geologically the area is underlain by quartzites, ultramafics- mainly dunite, peridotite & pyroxenites, schists & phyllites and younger granites of Iron Ore Super Group. The Iron Ore Super Group possesses schists, phyllites and quartzites which were later intruded by ultramafic complex consisting of dunite, peridotite & pyroxenites in the Sukinda Valley. These ultramafics have been extremely weathered into a mass of talc, serpentinite and limonite which have been subsequently lateritised during quaternary period. The chromite ores occur as bands within the ultramafic body.

The occurrence and distribution of ground water in an area are governed by the underlying geological formations and hydrogeological characteristics of the surroundings. The hydrogeology of the area broadly describes the disposition of water bearing formations, occurrence of ground water and their yield potentials, ground water regime conditions in terms of depth to water levels.

Hydrogeologically the area is having two aquifers, the upper phreatic (unconfined) and the deeper semi-confined aquifer. Ground water in the area occurs both in phreatic and semi-confined conditions. The upper weathered portion of the crystalline rocks forms the phreatic aquifer. Phreatic aquifer occurs in entire area except rocky outcrops and has formed by the weathering of crystalline formations. This aquifer generally occurs down to a depth of 20 meter below ground level (mbgl) with maximum depth of up to 30 mbgl in certain areas and ground water is extracted from this aquifer mostly through dug wells (DW). The depth of the dug wells goes up to maximum of 15 mbgl.

Below the phreatic aquifer, ground water occurs in the fractures and joints within the crystalline rocks which form the semi-confined aquifer in the area. Ground water from this aquifer is extracted mainly through hand pumps (HP) and bore wells (BW). The depth of the hand pumps usually goes up to 60 mbgl and bore wells up to 120 mbgl. Ground water in the area has been extracted through dug wells, hand pumps and bore wells for both domestic as well as agricultural purpose by the local public.

To study the hydrogeology of the area, water levels in the area have been measured through 26 nos. of dug wells and 27 nos. of hand pumps during both pre-monsoon and post-monsoon seasons in the year 2024. The water levels measured through dug wells represent the phreatic aquifer and the water levels measured through hand pumps represent the deeper semi-confined aquifer in the area. The analysis of water levels measured in the area show that in the phreatic aquifer, the depth to water level during pre-monsoon season varies from 2.26 meter to 12.12 meter below ground level with an average water level of 6.8 mbgl (plate-2). Similarly depth to water level during post-monsoon season in this aquifer varies from 0.51



meter to 8.65 meter below ground level with an average water level of 4.28 mbgl (plate-3) in the area.

Similarly, in the semi-confined aquifer, the depth to water level during pre-monsoon season varies from 2.8 meter to 18.4 meter below ground level with an average water level of 9.4 mbgl (plate-4) and during post-monsoon season the depth to water level varies from 1.65 meter to 16.1 meter below ground level with an average water level of 7.1 mbgl (plate-5) in the area.

The depth to water levels in the semi-confined aquifer remain deeper as compared to the phreatic aquifer during both pre- and post-monsoon seasons. There has been a rise of water levels during post-monsoon season as compared to the pre-monsoon season in both phreatic as well as in the semi-confined aquifers as a result of recharge due to rainfall in the area. The ground water flow direction in the area is towards south-west. The Damasala Nala gets its flow from ground water system which is effluent in nature. The hydrogeology of the study area is shown in plate-6.

### 3.0 Water Sampling and Analysis

In order to study the quality of water in Sukinda Valley, 233 water samples were collected from different locations in the study area during field investigation in the year 2024. Out of 233 samples, 183 were collected during pre-monsoon season and 50 were collected during post-monsoon season. Post-monsoon sampling was primarily conducted at locations that showed elevated Cr(VI) concentrations exceeding 0.05 mg/l during the pre-monsoon season, along with a few additional sites in the surrounding areas. Spatially, the samples were collected both from areas in close proximity to the mines and from locations up to 6 km away. The samples were collected from hand pumps, bore wells, dug wells, effluent treatment plants (ETP) and mine pits of different mining companies. The location of the samples is presented in plate-7. In addition to these groundwater samples, samples were also collected from surface water bodies like pond, Damsala Nala and Bramhani River to assess the quality. Multiple samples were collected from different sources from the same village to study the quality of water during both pre- and post-monsoon seasons. The collections of samples were also carried out from both dug wells as well as from hand pumps to ascertain the quality of water in two different aquifers available in the area.

All samples were collected in accordance with the standard procedure and analysed for the parameters like, pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Hardness, Total Alkalinity, Calcium, Magnesium, Sodium, Potassium, Carbonate, Bicarbonate, Chloride, Sulphate, Nitrate and Fluoride by following the standard procedures laid down in "Standard Methods for the Examination of Water and Wastewater, 23rd Edition, American Public Health Association (APHA), 2017 in CGWB's Regional Chemical Laboratory. The samples were also analysed for concentration of chromium (VI) and were determined colorimetrically using the



diphenylcarbazine method, as per EPA Method 7196. The location and source of sampling sites are given in table-1.

**Table-1: Location and source of samples collected from Sukinda Valley**

Sl. No.	Village	Number of Sources	Ground Water Source			Surface Water Source			Mine			Spring
			DW	TW/BW	HP	River	Pond	Mine Pit	ETP Inlet	ETP Outlet	WTP	
1	Aradapal	3	1		2							
2	Badakhaman	1			1							
3	Balipada	17			15	2						
4	Balipura	4			2							2
5	Benagadia	7	2		5							
6	Bhimanagar	15	1		14							
7	Chingudipal	6	2		3	1						
8	Chirgunia	5	1	1	2	1						
9	Chrome nagar	1			1							
10	Dhabahali	4	1		3							
11	Ghagiasahi	3			1	2						
12	Guakata	1			1							
13	Gurujang	3			3							
14	Gurujangpal	3	1		1	1						
15	Hatihudi	4			2	1						1
16	Kakudia	3	1		2							
17	Kalarangi	1		1								
18	Kalarangiata	6			4			2				
19	Kaliapani	18	2	2	5	2	2	2	2	1		
20	Kamarda	7		2	2				2	1		
21	Kansa	8	3	2	3							
22	Katapurti	4	1		2	1						
23	Kendubani	3	1		2							
24	Kendupura	1				1						
25	Koipasi	1			1							
26	Kuchilabanka	2				2						
27	Mahagiri	7		3					2	1	1	
28	New kamarda	2			2							
29	Ostopal	22		4	13	1	1		2	1		
30	Patna	4			4							
31	Podaora	1			1							
32	Ragada	7	1		5		1					
33	Raighat	2	1		1							
34	Rangamatia	4	2		2							
35	Sarubabil	16	2		9	2			2	1		
36	Sukinda	6		1	2				2	1		
37	Sukrunji	2	1		1							



Sl. No.	Village	Number of Sources	Ground Water Source			Surface Water Source		Mine			Spring	
			DW	TW/BW	HP	River	Pond	Mine Pit	ETP Inlet	ETP Outlet		WTP
38	Talangi	7			7							
39	Tungeisuni	6	1		3	1	1					
40	Bherubania	2	1			1						
41	Dayanabil	1				1						
42	Jaypur	1				1						
43	Koriapal	3	1		1	1						
44	Kuchilabanka	1			1							
45	Kusumaguta	3	1		1	1						
46	Mathanuagaon	2			1	1						
47	Nilakanthapur	1				1						
48	Palaspitha	1	1									
49	Purusottampur	1				1						
	<b>Total</b>	<b>233</b>	<b>29</b>	<b>16</b>	<b>131</b>	<b>26</b>	<b>5</b>	<b>4</b>	<b>12</b>	<b>6</b>	<b>1</b>	<b>3</b>

## 4.0 Results and Discussion

The groundwater quality in Sukinda Valley is assessed in accordance with test results of the physico-chemical characteristics and chromium (VI) concentration of analyzed samples and is discussed below.

### 4.1 Physico-Chemical Parameters

All analyzed samples were within the permissible limits for drinking water based on basic parameters such as pH, electrical conductivity, Sulphate, Nitrate, Chloride, Fluoride, and total dissolved solids (TDS). The TDS ranged from 19.6 to 611.1 mg/l, indicating mostly fresh to slightly mineralized water. This suggests limited mineral dissolution under natural aquifer conditions.

Notably, there were no significant water quality changes observed in the post-monsoon in comparison to pre-monsoon periods. Almost all parameters remained static without much significant variation. The minimum, maximum and mean of physico-chemical characteristics of groundwater samples, collected from the study area are presented in the table-2.

**Table-2: Minimum, maximum and mean of Physico-chemical parameters of water samples of the Sukinda Valley area**

Parameters	Permissible Limit (BIS, IS 10500:2012)	Maximum	Minimum	Mean
pH	6.5-8.5	8.34	6.3	7.4
Electrical Conductivity $\mu\text{S}/\text{cm}$ at 25°C	---	1411	32.0	283.4
Total Dissolved Solids, mg/l	2000	611.1	19.6	151.3
Hardness, as $\text{CaCO}_3$ , mg/l	600	415.7	12.3	130.9

Parameters	Permissible Limit (BIS, IS 10500:2012)	Maximum	Minimum	Mean
Total Alkalinity, as CaCO <sub>3</sub> , mg/l	600	335.3	15.0	129.4
Calcium, mg/l	200	91.19	2.5	16.9
Magnesium, mg/l	100	71.28	1.5	21.5
Sodium, mg/l	---	97.4	0.3	8.2
Potassium, mg/l	---	48.3	0.1	3.0
Carbonate, mg/l	---	0	0.0	0.0
Bicarbonate, mg/l	---	409.1	18.3	157.9
Chloride, mg/l	1000	180.5	0.8	9.6
Sulphate, mg/l	400	181.2	0.1	9.3
Nitrate, mg/l	45	40.3	0.1	5.8
Fluoride, mg/l	1.5	0.55	0.0	0.1

Perusal of the analysis results of the ground water samples show that all the physicochemical parameters are well within the maximum permissible limit for drinking water as per IS 10500:2012.

#### 4.2 Chromium (VI) concentration

Chromium mostly exists in two stable states in nature, i.e. hexavalent chromium Cr(VI) and trivalent chromium Cr(III).

In natural water systems, Cr(III) usually appears as Cr<sup>3+</sup>, Cr(OH)<sup>2+</sup>, Cr(OH)<sub>2</sub><sup>+</sup>, or Cr(OH)<sub>4</sub><sup>-</sup>. It is poorly soluble and tends to precipitate as Cr(OH)<sub>3</sub>, especially at pH values between 6 and 12, limiting its mobility (Rai et al., 1987).

Cr(VI) is more hazardous. It exists in forms like HCrO<sub>4</sub><sup>-</sup>, CrO<sub>4</sub><sup>2-</sup>, and Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup>, depending on pH and redox conditions. Cr(VI) is highly soluble, mobile, and toxic, and although often associated with industries like tanning and electroplating, it can also form naturally via oxidation of Cr(III) by manganese oxides (Godgul & Sahu, 1995). Laboratory experiments confirm that alkaline and oxidizing conditions, which are common in Sukinda's lateritic overburden, favour the conversion of Cr(III) to Cr(VI) (Godgul, 1994; Godgul & Sahu, 1995).

The toxicity and mobility of Cr depends on its speciation. The Cr(III) is mostly immobile; however, Cr(VI) is highly toxic as it is easily soluble and mobile and adversely affect the environment beyond its permissible limit. The permissible limit of Cr(VI) has been set by different organizations for different media viz. soil, drinking water, industrial sewage etc. According to Bureau of Indian standards (BIS) permissible limit of Cr(VI), for drinking water is 0.05 mg/l.

Sukinda Valley receives an annual rainfall of around 1,800 mm, with nearly 80% occurring during the monsoon (June–September). When rainwater interacts with exposed chromite ore, hexavalent chromium [Cr(VI)] can leach into open mine pits. Cr(VI) concentrations in



these mine pits water generally shows value, which is well above the safe limit of 0.05 mg/litre for drinking water set by the BIS.

A total of 233 water samples, collected from various sources during both pre- and post-monsoon seasons, were analyzed for hexavalent chromium [Cr(VI)]. Of these, 39 samples showed Cr(VI) concentrations exceeding 0.05 mg/l in at least one of the seasons. The test results of samples with chromium (VI) above 0.05 mg/l, collected from the Sukinda Valley are given in the Table-3. All the ground water samples collected from dug wells in the area have Cr (VI) concentration below detection limit (BDL).

**Table-3: Location of samples showing concentration of Cr(VI) more than 0.05 mg/l**

Sl. No.	District	Block	Village	Source	Longitude	Latitude	Concentration of Cr(VI) in mg/l	
							Pre-monsoon	Post-Monsoon
1	Jajpur	Sukinda	Kamarda Mines Inlet	ETP Inlet	85.82639	21.06333	0.079	0.1247
2	Jajpur	Danagadi	Mahagiri Inlet	ETP Inlet	85.77588	21.03115	0.1022	0.111
3	Jajpur	Sukinda	Ostopal Inlet	ETP Inlet	85.79042	21.05996	1.861	0.7217
4	Jajpur	Sukinda	S. Kaliapani mine Inlet	ETP Inlet	85.77843	21.04663	0.601	0.3058
5	Jajpur	Sukinda	Saruabil Inlet	ETP Inlet	85.82075	21.05867	0.875	0.4608
6	Jajpur	Sukinda	Sukinda Mine TATA Inlet	ETP Inlet	85.74322	21.02156	0.91	0.7915
7	Jajpur	Sukinda	Balipada 3	HP	85.83184	21.06969	0.0705	0.0601
8	Jajpur	Sukinda	Balipada 4	HP	85.82621	21.06893	0.2921	0.0456
9	Jajpur	Sukinda	Balipada 5	HP	85.82558	21.06732	0.0809	0.0601
10	Jajpur	Sukinda	Balipada 6	HP	85.82574	21.06763	0.133	0.1194
11	Jajpur	Sukinda	Balipura Village	HP	85.83441	21.06996	0.0734	0.0553
12	Jajpur	Sukinda	Bhingtangar	HP	85.73725	21.01972	0.139	0.1522
13	Jajpur	Sukinda	Bhingtangar 4	HP	85.73688	21.01974	0.0445	0.094
14	Jajpur	Sukinda	Bhingtangar 5	HP	85.73718	21.0206	0.0423	0.1404
15	Jajpur	Sukinda	Bhingtangar 1	HP	85.73825	21.01975	0.1568	0.0116
16	Jajpur	Sukinda	Bhingtangar 2	HP	85.73582	21.01974	0.085	0.0648
17	Jajpur	Sukinda	Bhingtangar 3	HP	85.73535	21.02021	0.094	0.0648
18	Jajpur	Sukinda	Bhingtangar 6	HP	85.73656	21.02009	0.0804	0.0744
19	Jajpur	Sukinda	Bhingtangar 7	HP	85.73656	21.02009	0.0862	0.0812
20	Jajpur	Sukinda	Bhingtangar 8	HP	85.73578	21.02001	0.112	0.0841
21	Jajpur	Sukinda	Kamarda	HP	85.83567	21.06035	0.1551	0.1404
22	Jajpur	Sukinda	New kamarda	HP	85.83798	21.0612	0.0815	0.0965
23	Jajpur	Sukinda	Ostopal	HP	85.79572	21.06553	0.688	0.6715
24	Jajpur	Sukinda	Ostopal 2	HP	85.7876	21.0579	0.3545	0.3122
25	Jajpur	Sukinda	Ostopal 3	HP	85.80096	21.06154	0.3546	0.2765
26	Jajpur	Sukinda	Patna 2	HP	85.7695	21.06582	0.4105	0.3993
27	Jajpur	Sukinda	Saruabil	HP	85.81069	21.05721	0.1365	0.0482
28	Jajpur	Sukinda	Saruabil	HP	85.81056	21.05806	0.0962	0.0466
29	Jajpur	Sukinda	Kalarangiatta Mine Pit	Mine Pit	85.74167	21.01892	0.6037	0.59
30	Jajpur	Sukinda	S Kaliapani Quarry F	Mine Pit	85.79981	21.0412	0.6543	0.6205



Sl. No.	District	Block	Village	Source	Longitude	Latitude	Concentration of Cr(VI) in mg/l	
							Pre-monsoon	Post-Monsoon
31	Jajpur	Sukinda	Chingudipal	Damsala Nala	85.77329	21.05104	0.7313	0.0417
32	Jajpur	Sukinda	Chirgunia	Damsala Nala	85.75855	21.0434	0.09	0.0302
33	Jajpur	Sukinda	Ghagiasahi	Damsala Nala	85.74094	21.03551	0.067	0.19
34	Jajpur	Sukinda	Kallapani	Damsala Nala	85.77226	21.04578	0.1984	0.032
35	Jajpur	Sukinda	Kaliapani	Damsala Nala	85.77229	21.04584	0.1986	0.0374
36	Jajpur	Sukinda	Katapurti	Damsala Nala	85.73861	21.03059	0.4502	0.035
37	Dhenkanal	Kankadahada	Kuchilabanka	Damsala Nala	85.72455	21.01722	0.06	0.0703
38	Dhenkanal	Kankadahada	Kusumaguta	Damsala Nala	85.72075	21.00532	0.12	0.0383
39	Jajpur	Sukinda	Oastapal	Damsala Nala	85.7841	21.05401	0.0884	0.0442

Out of 183 samples collected during pre-monsoon period from different sources, 37 samples have Cr (VI) concentration more than 0.05 mg/l. Out of these 37 samples having Cr (VI) above permissible limit (>0.05 mg/litre), 20 are from hand pumps (HPs), 6 are from effluent treatment plant (ETP) inlets, 2 are from mine pits and 9 are from Damsala river. Similarly out of 50 samples collected from different sources during post-monsoon period, 28 samples have Cr (VI) concentration more than 0.05 mg/l. Out of these 28 samples having Cr (VI) above permissible limit (>0.05 mg/litre), 18 number are from hand pumps (HPs), 6 number are from ETP inlets, 2 number are from mine pits and 2 number are from Damsala river. The samples collected from surface water source (Damsala river) show concentration of Cr (VI) > 0.05 mg/l during pre-monsoon season, whereas the concentration in most of the samples is within the permissible limit during post-monsoon season.

**Table-4: Source wise samples analysed vs samples with Cr(VI)>0.05 mg/l**

Sl. No.	Source	Pre-monsoon		Post-monsoon	
		No. of Samples Analysed	Samples with Cr(VI)>0.05 mg/l	No. of Samples Analysed	Samples with Cr(VI)>0.05 mg/l
1	DW	28	0	1	0
2	BW	11	0	5	0
3	HP	99	20	31	18
4	Damsala Nala	23	9	4	2
5	Mine pit	2	2	2	2
6	Pond	5	0	0	0
7	ETP-Inlet	6	6	6	6
8	ETP-outlet	6	0	0	0
9	WTP	1	0	0	0
10	Spring	2	0	1	0
	<b>Total</b>	<b>183</b>	<b>37</b>	<b>50</b>	<b>28</b>

The water collected in the mine pits through rainfall and seepage of ground water is pumped out for facilitation of mining activities. These pumped water have been treated in ETPs of different mining companies before release in the Damsala Nala. The Cr (VI) concentration in water samples collected from the outlets of these ETPs is below detection limit (BDL).

The Damsala Nala, the stream draining the valley, receives treated effluent from the Effluent Treatment Plants (ETPs) and is frequently used by local villagers for purposes other than drinking like bathing and recreational activities. Water samples were collected from various locations during the study period revealed that chromium concentration was exceeding 0.05mg/l in many places there by exceeding the Bureau of Indian Standards acceptable limit (0.05mg/l). However, elevated chromium concentrations exceeding 0.05 mg/l in Damsala Nala are restricted to its stretch within the Sukinda Valley area. Beyond the valley, both at upstream and downstream, the concentration does not exceed the permissible limit. The samples collected from Brahmani River downstream the valley area show total Chromium concentration below detection limit (BDL).

At most monitoring sites, chromium levels in groundwater remained relatively stable across both daily and seasonal timescales. In locations where consecutive-day sampling was carried out, no significant variations were detected. Overall, the fluctuations observed were minimal. This consistent pattern in chromium concentration suggests the presence of a steady, naturally occurring (geogenic) source.

Chromium (VI) contamination was absent in shallow, unconfined (phreatic) aquifers, indicating that the phreatic zone remain relatively free from contaminations. This suggests that deeper semi-confined aquifers in the area are more vulnerable due to longer residence time and deeper oxidation mechanisms.

## 5.0 Conclusion and Recommendations

The Sukinda Valley area has phreatic aquifer up to a depth of 30 meter below ground level followed by fractured deeper aquifer. A total number of 233 samples were collected from the study area and analysed. The samples were collected from hand pumps, dug wells, Effluent Treatment Plant (ETP) mine pits, Damsala Nala and Brahmani River. In addition to these groundwater samples, samples were also collected from surface water body (pond, spring and river), to assess the quality. Out of 233 samples, 37 samples have shown higher concentration of chromium (VI) above 0.05 mg/l during pre-monsoon and 28 locations have shown chromium (VI) above 0.05 mg/l during post-monsoon season.

The findings and recommendations to prevent the ground water contaminations in the area are as follows.

1. The upper phreatic aquifer (up to 30 mbgl) is free from Cr (VI) contamination, this zone may be tapped for drinking and domestic water supply purpose after ensuring quality of every individual source.



2. While the shallow phreatic aquifers are free from chromium contamination, determining the precise extent of contamination in the deeper aquifers remains challenging. Wells drilled to similar depths in close proximity exhibiting vastly different levels of Cr(VI) results in an unpredictable spatial pattern. This variability, coupled with the absence of consistent anthropogenic sources, suggests that the natural oxidative mobilization of Cr(VI) from chromite-bearing strata is the primary mechanism driving the contamination and is suggestive of the geogenic origin.
3. It is essential to expand and strengthen the safe drinking water supply schemes to ensure the provision of safe water to the local population.
4. Contaminated wells should be permanently closed to prevent public exposure to unsafe water sources.
5. If new wells are constructed, they must be subject to periodic water quality monitoring to ensure the safe quality of the water.
6. The Cr (VI) concentration in water samples collected from the outlets of the ETPs of different mining companies is below detection limit (BDL).
7. Effluent treatment systems in the mining areas must be strictly maintained to ensure effective treatment and compliance with discharge standards. This is crucial to prevent contamination of nearby surface water bodies.
8. Elevated chromium concentrations exceeding 0.05 mg/l in Damsala Nala are restricted to its stretch within the Sukinda Valley area. Beyond the valley, both at upstream and downstream, the concentration of Cr (VI) does not exceed the permissible limit. Samples collected from Bramhani River downstream the Sukinda Valley area show Chromium concentration below detection limit (BDL).
9. Ultramafic, chromite-rich regions like the Sukinda Valley require rigorous and continuous water quality management to mitigate environmental degradation and associated public health risks.



Plate-1: Location map of Sukinda valley, District-Jajpur, Odisha

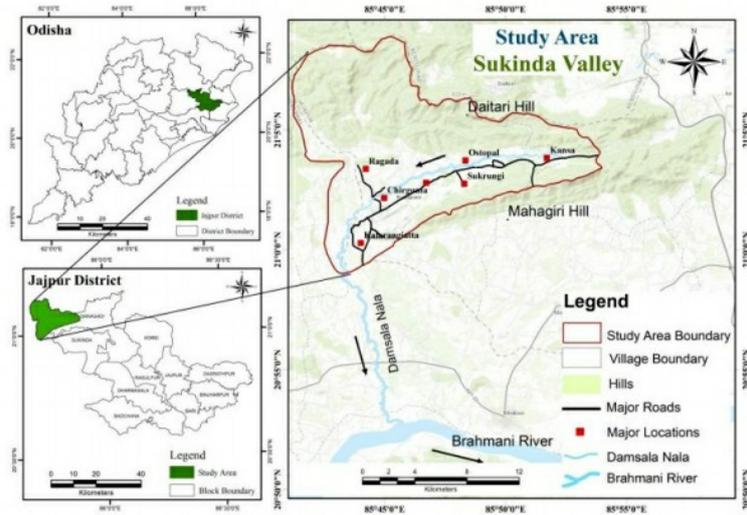


Plate-2: Depth to water level map (Pre-monsoon, 2024) of phreatic aquifer of Sukinda Valley, District-Jajpur, Odisha

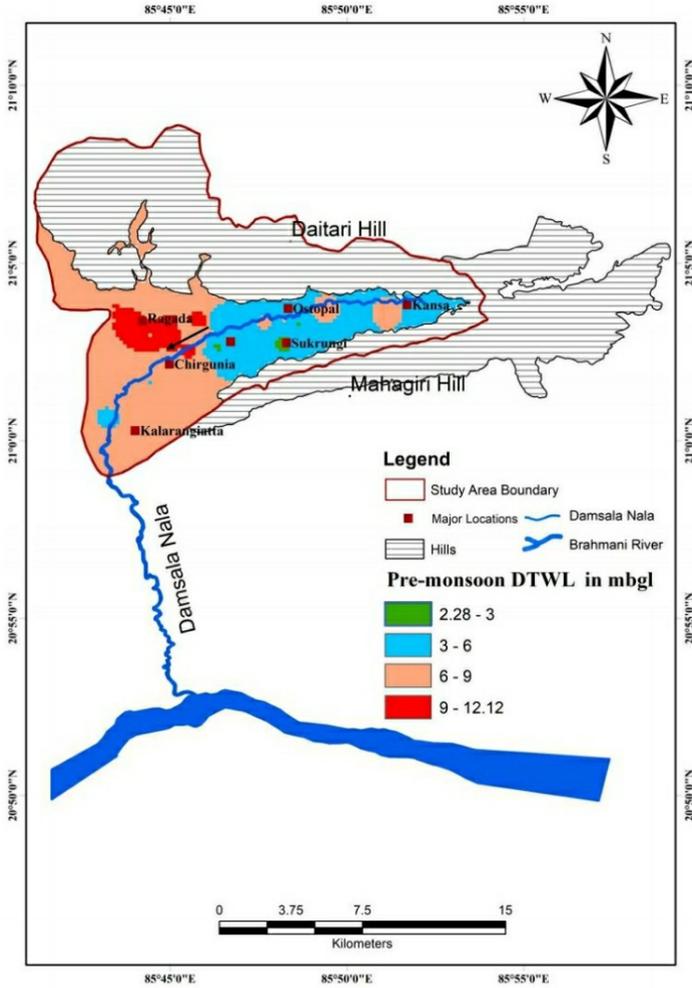


Plate-3: Depth to water level map (Post-monsoon, 2024) of phreatic aquifer of Sukinda Valley, District-Jajpur, Odisha

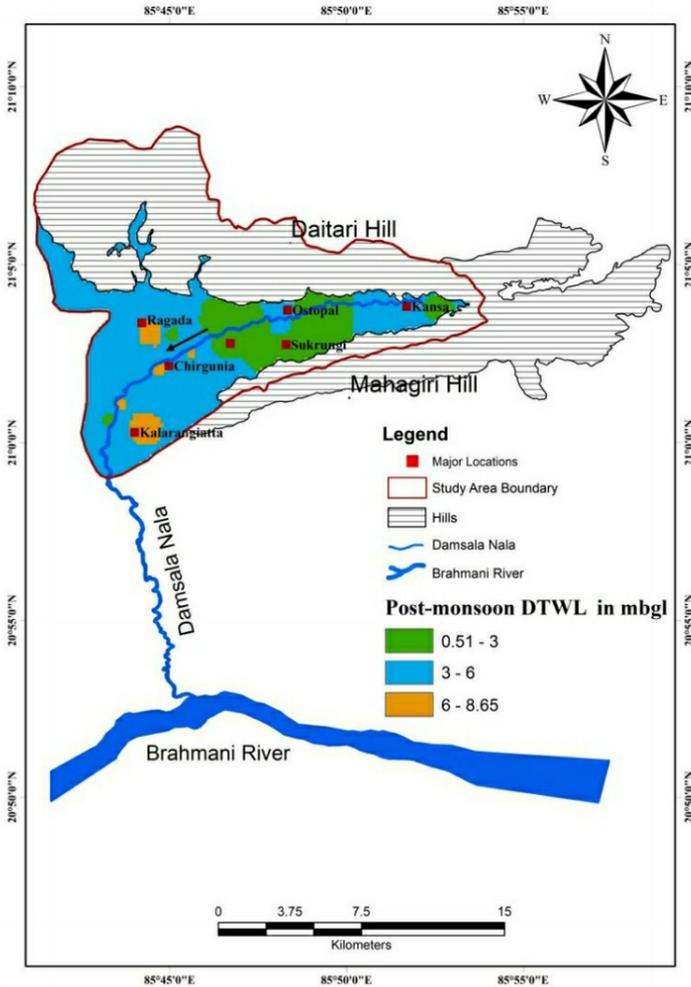




Plate-4: Depth to water level map (Pre-monsoon, 2024) of deeper aquifer of Sukinda Valley, District-Jajpur, Odisha

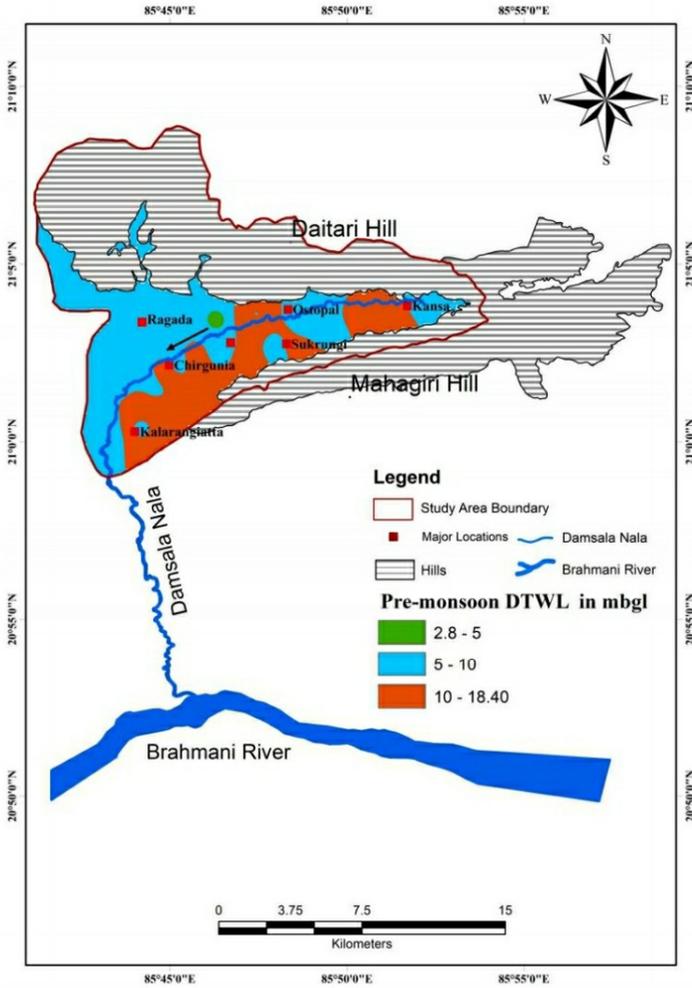


Plate-5: Depth to water level map (Post-monsoon, 2024) of deeper aquifer of Sukinda Valley, District-Jajpur, Odisha

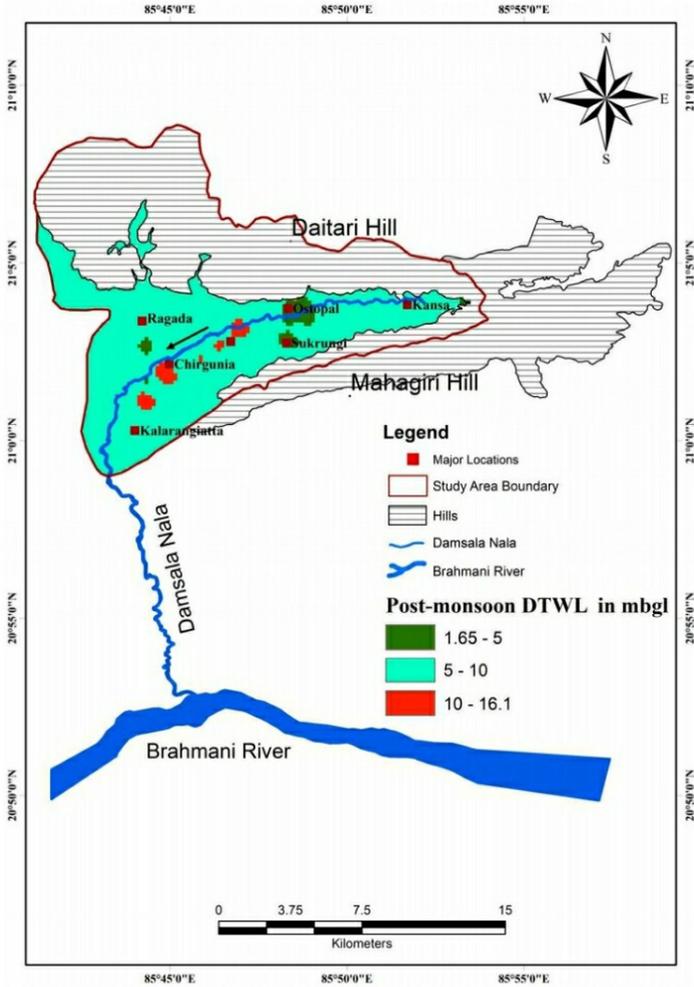


Plate-6: Hydrogeological map of Sukinda Valley, District-Jajpur, Odisha

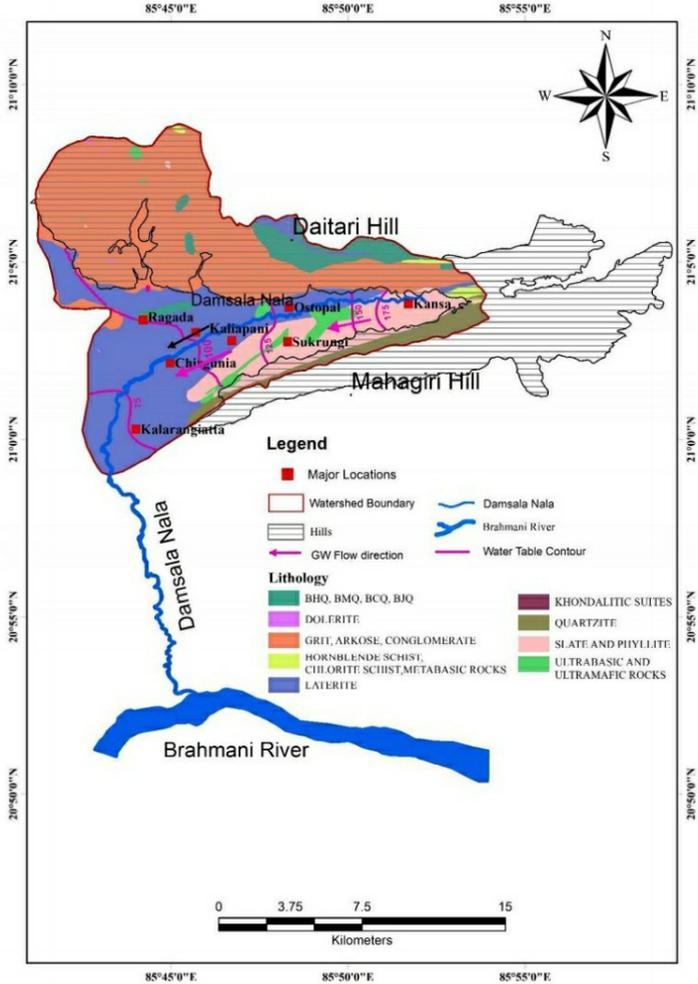




Plate-7: Sample location map of Sukinda Valley, District-Jajpur, Odisha

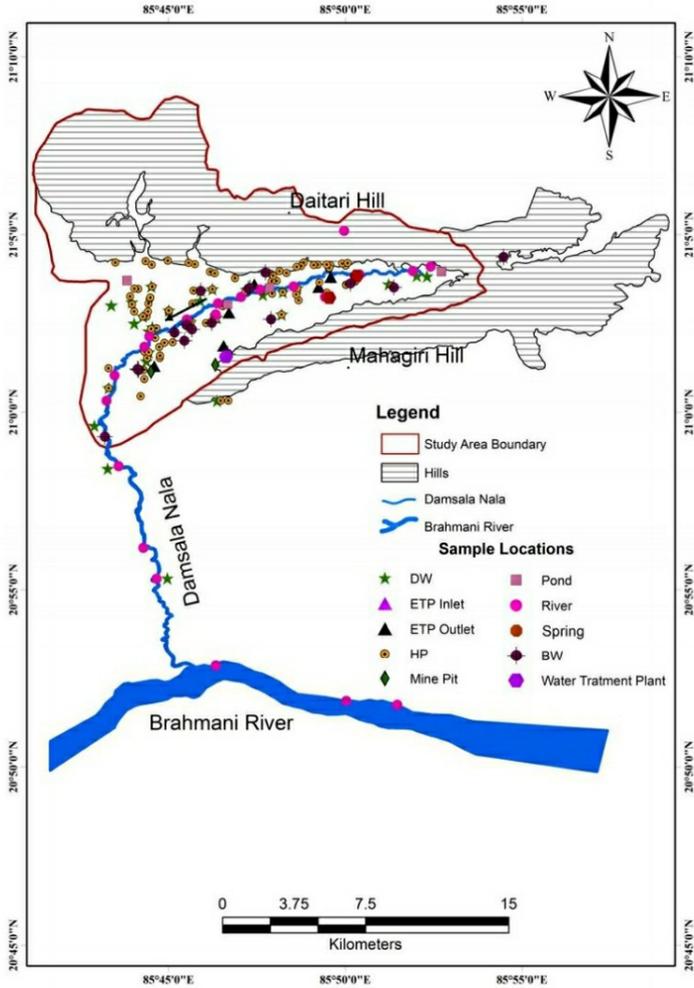


Plate-8: Spatial distribution of samples with Chromium (VI) above permissible limit

