Item No. 06 (Court No. 1)

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

(By Video Conferencing)

Original Application No. 169/2021

H. C. Arora Applicant

Versus

State of Punjab & Ors. Respondent(s)

Date of hearing: 31.03.2022

CORAM: HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON
HON'BLE MR. JUSTICE SUDHIR AGARWAL, JUDICIAL MEMBER
HON'BLE MS. JUSTICE PUSHPA SATHYANARAYANA, JUDICIAL MEMBER
HON'BLE PROF. A. SENTHIL VEL, EXPERT MEMBER
HON'BLE DR. VIJAY KULKARNI, EXPERT MEMBER

Applicant: Mr. H.C. Arora, Applicant in Person

Respondent: Mr. Vikrant Pachnanda, Advocate for CPCB

ORDER

1. Grievance in this application is against failure of the State authorities to take remedial measures against contamination of ground water in village Aloarakh, Block Bhiwanigarh, District Sangrur. The applicant has referred to the media report dated 08.07.2021 in Hindustan Times titled '**Sangrur tubewell spews out polluted water; PPCB blames dismantled factory'**. It is stated that the ground water is contaminated and colored water is coming out of the tubewells which has potential for damage to the public health. The problem has been existing for more than 10 years. According to the State PCB, a private factory which was closed 15 years ago, is responsible for contamination. It is also reported that this Tribunal had imposed compensation of Rs. 2

Crore on the said factory for restoration of the environment but the amount was not recovered.

2. The matter was earlier considered on 20.07.2020 and having regard to the averments in the application, the Tribunal constituted a five Member joint Committee comprising CPCB, Regional Officer, MoEF&CC, Chandigarh, State PCB, a nominee of Secretary Environment Department, Punjab, and District Magistrate, Sangrur to visit the site, interact with the stake holders, assess the ground situation and recommend the measures required to be taken. The Committee was to ascertain the number of tube wells discharging coloured water, depth of such wells, aquifer status in terms of movement and extent of contamination, characteristics of contaminated water with reference to effluent sludge disposed by the industry in question - dyes and dye intermediate, effect on agricultural crops, bio-magnification in agro products and suggest short and long-term basis considering agronomy and public health, remediation plan, cost of such remediation. A copy of the report forwarded to the Chief Secretary, Punjab for ensuring remedial measures, based on the facts found.

3. Accordingly, a report has been filed by the joint Committee on 30.03.2022 after undertaking visit to the site and studying the impact on agriculture crops and products. The Committee has suggested short term and long term remediation plan. Relevant extracts from the report are quoted below:-

> "***2.2.1. Effect on the Quality of Ground Water w.r.t no. of Tube-wells discharging Coloured Water; Depth, Aquifer Status and Extent of Contamination:***

The site visit by the Joint Committee for determining the affected area was carried out on 01/09/2021. Interaction with the local farmers were also held regarding impact of coloured water on the yield and quality of the produce in their agricultural fields. They were satisfied with the yield of crops, but were not aware of any impact of using the contaminated ground water on the quality of fodder, grains and also on human & animal health. The sampling locations were decided in consultation with CGWB Expert.

The ground water samples were collected jointly by the Officers of CGWB and PPCB in September, 2021 from 22 locations including shallow hand pumps and deep bore-wells, for analysis of water quality parameters and pollution parameters, respectively. The CGWB also carried out a survey of the area to establish the affected area and aquifer.

The Joint Committee got the analysis of ground water samples for 15 major parameters including TOC from CGWB laboratory, for pollution parameters i.e., Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Sodium Absorption Ratio (SAR) & Phenolic Compounds from PPCB laboratory and heavy metals from Punjab Biotechnology Incubator (PBTI), Mohali, since the equipment of CGWB laboratory was out of order.

The important parameters considered by Joint Committee for identification of contamination in the tube-wells & shallow hand pumps included Total Organic Carbon (TOC), Electrical Conductivity, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Nitrate and Heavy metals. The concentration of all above parameters was compared with the concentration given in the BIS Standards IS 10500:2012 prescribed for drinking water quality. Ground Water collected from five locations out of total 22 locations were found reddish in colour, indicating contamination. All these 5 tubewells were found having high Total Organic Carbon (TOC), thereby, further indicating the ground water contamination with organic compounds/industrial waste water, though there is no limit prescribed for TOC in BIS standards. Two tubewells out of the aforesaid five tubewells, were also found having significant concentration of Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD), whereas, the rest three tubewells were found having high nitrate concentration, hence, confirming contamination of ground water in these five tube-wells. Six tubewells were also found having high value of Electrical conductivity, thereby, indicating contamination within the vicinity of closed industrial site.

With regard to depth and aquifer affected with the contaminants, hydro-geology and concentration of various contaminants were considered for arriving at conclusion by CGWB Expert. The sampling has been done from the tube-wells varying between shallow (46 m below ground level) to very deep (183 m below ground level). It has been observed that the tube-wells affected by contamination are having depth of about 130 m below ground level in the vicinity of Industry. As the area is having single aquifer system upto a depth of about 200 m with a thin clay layer at around 110 m to 120 m depth bgl. Considering the general depth of the most of the tube-wells and hydro-geological conditions and aquifer disposition, it can be inferred that aquifers upto a depth of

130 m below ground level are contaminated. Considering the average water levels of about 40 m below ground level about 80 to 90 in thick aquifer zones have been contaminated. The detailed report of CGWB expert alongwith characteristics of contaminated/ground water is attached as Annexure-2.

Since, the contamination was found only in five tube-wells in the vicinity of the site under reference, it was decided by the Joint Committee to further investigate the matter, to establish the root cause of contamination in the limited number of tube-wells. Accordingly, the excavation was carried out at 04 random locations at site under study, with JCB upto a depth of about 8 to 10 feet and the layers of blackish red sludge, blackish slurry, HDPE sheets were observed in excavated pits at different levels, clearly indicating unscientific dumping of hazardous waste done by the industry during its operations/dismantling of the unit, which had resulted into leaching of contaminants into the ground water, thereby causing contamination of the aquifer over a period of time. The contamination of limited number of tube-wells in the vicinity of the site under study may be attributed to continuous pumping of ground water from the nearest tubewells, thereby limiting the transfer of contamination to other tube-wells located downstream of the site. Thus, if the pumping of ground water from these nearest tubewells is discontinued, the contamination may further spread to other tube-wells in the area.

2.2.2. Effect on agriculture Crops and Bio-magnification in agro-products:

To determine the accumulation of contaminants in the soil of the agricultural fields which are being irrigated with reddish colored water, soil samples from the six locations of the study area were drawn by the Joint Committee and got analysed for various parameters from the Punjab Biotechnology Incubator Laboratory, Mohali. The results of analysis of soil samples are summarized in Table 1.

Table 1: Analysis report w.r.t Samples of Soils irrigated with contaminated ground water

S. No.	*Parameters*	*Results of Analysis*						*Target Value of Soil, mg/Kg, WHO*
		Sh. Kulwinder Singh S/o Sh. Jang Singh, Village Aloarkh (In front of M/s Matharu Chemical)	Village Aloarkh (Dept of Tubewell)- Sh. Amrit• Pal Singh S/o Sh. Rajwant Singh	Village Aloarkh (Sh. Amrit Pal Singh S/o Sh, Rajwant Singh)	Village Aloarkh (Tubewell of Farmer Sh. Kulwinder Singh S/o Balvir Singh)	Kulwinder Singh S/o Gurnam Singh, Village Majhi, Bhawanigarh	Village Aloarkh (From Tubewell of Sh, Dilbagh Singh S/o Jagar Singh)	
		30.28238, 76.07803	3028166 , 78 07773	30.2806, 76 flP')	30_2834, 78075	30 28341, 76 0798	30 2791, 76 07623	
1	pH	6.86	704	734	7.23	7 18	7.24	
2	Total Organic Carbon (TOC), %	055	037	049	0.71	044	0.48	
3	Total Kjeldahi Nitrogen (TKN),	813	925	1065	897	841	1149	

	mg/Kg							
4	Phosphorus, mg/Kg	8 3	92	134	118	148	136	
5	Cation Exchange Capacity, Meg/100 g	214	6.3	6.3	9.8	3.9	7 6	
6	Exchangable Sodium, mg/Kg	115	19	115	16	19	18	
7	Exchangable Potassium, mg/Kg	51	35	108	437	204	128	
8	Exchangable Calcium, mg/Kg	561	701	1101	1522	420	1161	
9	Exchangable Magnesium, mg/Kg	461	274	109	349	250	160	
10	Cyanide (as CN), mg/Kg	BDL (MDL20)	BOL (MDL20)	BDL (MDL20)	BDL (MDL20)	BDL (MDL20)	BDL (MDL20)	
11	Phenolic Compounds, ma/Ka	BDL (MDL20)	BDL (MDL20)	BDL (MDL20)	BDL (MDL20)	BDL (MDL20)	BDL (MDL20)	
12	Potassium (K20), mg/Kg	109	60	172	509	245	178	
13	Magnesium (as Mg), mg/Kg	510	291	146	388	291	170	
14	Znc (as Zn), mg/Kg	534	376	393	743	387	46	50
15	Manganese (as Mn), mg/Kg	966	161	236	311	110	247	
16	Iron (as Fe), %	1 2	0 97	1 25	1.7	1 07	1.3	
17	Copper (as Cu), mg/Kg	10,9	7 9	12	16.2	7	9 5	36
18	Molybdenum (as Mo), mg/Kg	BDL (MDL 0,5)	BDL (MDL 0,5)	BDL (MDL0,5)	BDL (MDL 0,5)	BDL (MDL 0,5)	BDL (MDL 0,5)	
19	Cadmium (as Cd), mg/Kg	BDL (MDL 0 5)	BDL (MDL 0.5)	BDL (MDL0,5)	BDL (MDL 0,5)	BDL (MDL 0, 5)	BDL (MDL 0,5)	0.8
20	Chromium (as Cr), mg/Kg	6	42	6.6	134	34	81	100
21	Nickel (Ni),	124	99	13,5	20.7	9.5	14	35
22	Lead (Pb), mg/Kg	5	3 7	5 2	7 1	3.5	5	85
23	Mercury (as Hg), mg/Kg	BDL (MDL 0.5)	BDL (MDL 0 5)	BDL (MDL 05)	8DL (MDL 05)	BDL (MDL 05)	BDL (MDL 0,5)	
24	Arsenic (As), DuilKa	2 8	2 6	3 5	4.3	1 9	3 3	
25	Selenium (as Se), mg/Kg	BDL (MDL 0,5)	BDL (MDL 0 5)	BDL (MDL0,5)	BDL (MDL 0.5)	BDL (MDL 0 5)	BDL (MDL 0.5)	

The analysis of soil samples drawn from the two agricultural fields irrigated with reddish coloured ground water indicates that the concentration of zinc is on much higher side i.e. 53.4 mg/Kg and 74.3 mg/Kg, respectively, in comparison to the target values in soil i.e. 50 mg/Kg specified by WHO. It was informed by the PPCB Member that Zinc is added as supplement in the fields by the farmers for paddy crop, which might be the reason for its higher concentration in the soil despite having lower concentration in the ground water. In view of this, a detailed mass balance calculations for Zn was done by the Joint Committee, which indicated that total load of Zn in the soil is much higher than the total amount of Zn added in the soil as supplement, indicating that the source of higher concentration of Zn is other than supplementary addition of Zn. ***The upward capillary mass transfer of contaminants from the unscientifically dumped hazardous waste and untreated industrial waste water injected upto a depth of 150-160 ft may be the probable reason for the presence of higher concentration.*** *The concentration of other parameters i.e. copper, chromium, cadmium, nickel & lead is within the target values in soil i.e. 36, 100, 0.8, 35 & 85 mg/kg, respectively.*

The samples of paddy plant and seed grown on the soils were also collected by the Joint Committee for analysis of various parameters to study effect on agriculture crops and the bio-magnification of contaminants in agro-products. The results of analysis are presented in ***Table 2, Table 3 and Table 4.*** *Out of various parameters tested*

in the Crop (Paddy) and Grain (Edible Part), Zinc was found to be in much higher concentration both in crop and grain (edible part). Zinc was found to be varying between 3.9 to 14.9 mg/Kg in Crop (Non edible part) against the WHO target value of 0.6 mg/kg. Similarly, it was found to be varying between 12.5 to 19.1 mg/Kg in the grain (edible part) against WHO target value of 0.6 mg/Kg. To summarize, Zinc was observed to be varying between 16.4 to 33.9 mg/Kg in the whole plant against the target value of 0.6 mg/Kg. In general, heavy metal contamination is the first level indicator of food safety and quality. High level of TOC observed in the ground water might be resulting in an increase in low molecular weight organic complexing molecules, which as per literature, may serve the carriers of heavy metals, resulting in increased uptake of heavy metals. Zn is an essential nutrient for human health, but at the same time, it can be toxic in higher concentrations leading to various health complications including reduction in immune function and levels of high density lipo-proteins besides affecting the absorption of copper and iron.

Table 2: Analysis Report w.r.t Samples of Crop (Paddy) produced in the fields irrigated with contaminated water.

S. No.	*Parameters*	*Results of Analysis*						*Target Value of Plant, mg/Kg, WHO*
		Sh Kulwinder Singh, S/o Sh. Jang Singh, Village Aloarkh (in front of M/s. Matharu Chemical)	Village Aloarkh (Dept of Tubewell)- Sh. Amrit Pal Singh S/o Sh Rajwant Singh	Village Aloarkh (Sh. Amrit Pal Singh S/o Sh. Rajwant Singh)	Village Aloarkh (Tubewell of Farmer Sh Kulwin der Singh Edo Balvir Singh)	Kulwinder Singh S/o Gurnam Singh, Village Majhi, Bhawanigarh	Village Aloarkh (From Tubewell of Sh Dilbagh Singh S/o Jagar Singh)	
		30.28238. 76.07603	30 28166. 78.07773	30.2806, 76.0772	30.2834, 76.075	3020341, 78.0796	30 2781, 76,07623	
1	Cyanide (as C)4), mg/Kg	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0 1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	
2	Magnesium (as Mg), mg/Kg	0.11	1072	727	897	408	1130	
3	Zinc (as Zn), mg/Kg	3,9	3 9	7 5	7 8	6.7	14.9	0.6
4	Manganese (as Mn), ma/Ks	36 5	29 4	42,5	35	8.1	52 7	
5	Iron (as Fe), %	1341	99	31,7	14.97	109	29.17	
6	Copper (as Cu), mg/Kg	0,3	0.2	0 5	0.5	1 4	1.4	10
7	Molybdenum (as Mo), Ma/KR	BDL (MDL: 0.2)	BDL (MDL: 0.2)	BDL (MDL: 0 2)	BDL (MDL: 0.2)	BDL (MDL: 0 2)	BDL (MDL: 0.2)	
8	Cadmium (as Cd), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0.2)	BDL (MDL: 0 2)	BDL (MDL: 0.2)	BDL (MDL: 0.2)	BDL (MDL: 0.2)	0 02
9	Chromium (as Cr), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0 2)	BDL (MDL: 0 2)	BDL (MDL: 0 2)	BDL (MDL: 0 2)	BDL (MDL: 0 2)	1.3
10	Nickel (Ni), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0.2)	BDL (MDL: 0 2)	BDL (MDL: 0.2)	BDL (MDL: 0 2)	BDL (MDL: 0 2)	10
11	Lead (Pb), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0.2)	BDL (MDL: 0.2)	BDL (MDL: 0 2)	BDL (MDL: 0.2)	BDL (MDL: 0 2)	2
12	Mercury (as Hg), mg/Kg	BDL (MDL: 0 2)	BDL (MDL: 0 2)	BDL (MDL: 0.2)	BDL (MDL: 0.2)	BDL (MDL: 0.2)	BDL (MDL: 0.2)	
13	Arsenic (As), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0 2)	BDL (MDL: 0 2)	BDL (MDL: 0.2)	BDL (MDL: 0 2)	BDL (MDL: 0 2)	
14	Selenium (aa Se), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0.2)	BDL (MDL: 0 2)	BDL (MDL: 0.2)	BDL (MDL: 0 2)	BDL (MDL: 0 2)	

Table 3: Analysis Report w.r.t Samples of Grain (Edible Part) produced in the fields irrigated with contaminated water.

S. No.	*Parameters*	*Results of Analysis*						*Target Value of Plant, mg/Kg, WHO*
		Sh Kulwinder Singh, S/o Sh. Jang Singh, Village Aloarkh (in front of M/s. Matharu Chemical)	Village Aloarkh (Dept of Tubewell)- Sh. Amrit Pal Singh S/o Sh Rajwant Singh	Village Aloarkh (Sh. Amrit Pal Singh S/o Sh. Rajwant Singh)	Village Aloarkh (Tubewell of Farmer Sh Kulwin der Singh Edo Balvir Singh)	Kulwinder Singh S/o Gurnam Singh, Village Majhi, Bhawanigarh	Village Aloarkh (From Tubewell of Sh Dilbagh Singh S/o Jagar Singh)	
		30 28238, 76.07803	3028166, 78.07773	30 2806, 76.0772	30,2834, 76.075	30 28341, 76.0798	30.2791, 76.07623	
1	Cyanide (as CN), mg/Kg	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	
2	Magnesium (as Mg), mg/Kg	873	732	781	782	735	855	
3	lint (as Zn), mg/Kg	12.5	19.1	17.9	16.4	15.6	19	0.6
4	Manganese (as Mn), rn g/Kg	13.8	26.3	23.2	22.6	17.4	30.6	
5	Iron (as Fe), %	26.3	29.6	24.5	23.9	511	28.2	
6	Copper (as Cu), mg/Kg	3.3	4.2	3.8	3.5	4.7	6.7	10
7	Molybdenum (as Mo), mg/Kg	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	
8	Cadmium (as Cd), mg/Kg	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	0.02
9	Chromium (as Cr), m g/Kg	0.5	0.5	0.4	04	0.9	0.3	1.3
10	Nickel (Ni), mg/Kg	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	10
11	Lead (Pb), mg/Kg	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	2
12	Mercury (as Hg), mg/Kg	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	
13	Arsenic (As), mg/Kg	BDL (MDL: 0.1)	BDL (MDL: 0 1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	
14	Selenium (as Se), M g/Kg	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	

Table 4: Analysis Report w.r.t Samples of Crop and Edible Part (Combined) produced in the fields irrigated with contaminated water.

S. No.	Parameters	Results of Analysis																		Target Value of Plant, mg/Kg, WHO
		Sh Kulwinder Singh, S/o Sh. Jang Singh, Village Aloarkh (in front of M/s. Matharu Chemical)			Village Aloarkh (Dept of Tubewell)- Sh. Amrit Pal Singh S/o Sh Rajwant Singh			Village Aloarkh (Sh. Amrit Pal Singh S/o Sh. Rajwant Singh)			Village Aloarkh (Tubewell of Farmer Sh Kulwin der Singh Edo Balvir Singh)			Kulwinder Singh S/o Gurnam Singh, Village Majhi, Bhawanigarh			Village Aloarkh (From Tubewell of Sh Dilbagh Singh S/o Jagar Singh)			
		Crop	Grain	Whole Plant	Crop	Grain	Whole Plant	Crop	Grain	Whole Plant	Crop	Grain	Whole Plant	Crop	Grain	Whole Plant	Crop	Grain	Whole Plant	
1	Cyanide (as CN), mg/Kg	BDL (MDL: 0.1)	BDL (MDL: 0.1)		BDL (MDL: 0 1)	BDL (MDL: 0 1)		BDL (MDL: 0.1)	IBDL (MDL: 0 1)		BDL (MDL: 0 1)	BDL (MDL: 0.1)		BDL (MDL: 0 1)	BDL (MDL: 0 1)		BDL (MDL: 0.1)	BDL (MDL: 0.1)		
2	Magnesium (as Mg), mg/Kg	0.11	873	873 11	1072	732	1804	727	781	1508	897	782	1679	408	735	1143	1130	855	1985	
3	lint (as Zn), mg/Kg	39	12.5	16.4	3.9	19 1	23	75	17 9	254	78	16 4	242	87	15.6	24,3	14 9	19	33.9	0.6
4	Manganese (as Mn), rn g/Kg	36 5	13 8	50 3	29.4	26 3	55 7	42 5	23 2	65 7	35	22 6	57 6	8 1	17 4	25.5	52 7	30 6	83.3	
5	Iron (as Fe), %	13 41	26.3	39.71	29 6	39 5	31 7	24 5	56 2	14 97	23 9	38 87	10 9	511	521 9	29 17	28 2	57.37		
6	Copper (as Cu), mg/Kg	0.3	3.3	3.6	0.2	4 2	4.4	0.5	3 8	4.3	0 5	3 5	4	1 4	4 7	6 1	1 4	6,7	8.1	10
7	Molybdenum (as Mo), mg/Kg	BDL (MDL: 0 2)	BDL (MDL: 0 1)		BDL (MDL: 0 2)	BDL (MDL: 0 1)		BDL (MDL: 0 2)	BDL (MDL: 0 I)		BDL (MDL:0.2)	BDL (MDL: 0 1)		BDL (MDL:0.2)	BDL (MDL: 0 I)		BDL (MDL:0.2)	13DL (MDL: 0.1)		
8	Cadmium (as Cd), mg/Kg	BDL (MDL: 0 2)	BDL (MDL: 0.1)		BDL (MDL: 0.2)	;BDL (MDL: 0 1)		BDL (MDL: 0.2)	BDL (MDL: 0.1)		BDL (MDL: 0 2)	BDL (MDL: 0.1)		BDL (MDL: 0.2)	BDL (MDL: 0 1)		BDL (MDL: 0.2)	BDL (MDL: 0.1)		0.02
9	Chromium (as Cr), m g/Kg	BDL (MDL: 0.2)	'0.5		BDL (MDL: 0.2)	0 5		BDL (MDL: 0 2)	0.4		BDL (MDL: 0.2)	0.4		BDL (MDL: 0.2)	0 9		BDL (MDL: 0.2)	0 3		1.3
10	Nickel (Ni), mg/Kg	BDL (MDL: 0 2)	BDL (MDL: 0 1)		BDL (MDL: 0 2)	BDL (MDL: 0 1)		BDL (MDL: 0 2)	BDL (MDL: 0.1)		BDL (MDL: 0 2)	BDL (MDL: 0_1)		BDL (MDL: 0 2)	BDL (MDL: 0 1)		BDL (MDL:0.2)	BDL (MDL: 0 1)		10
11	Lead (Pb), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0.1)		BDL (MDL: 0 2)	BDL (MDL: 0.1)		BDL (MDL:02)	BDL (MDL: 0.1)		BDL (MDL: 0 2)	BDL (MDL: 0 1)		BDL (MDL:02)	BDL (MDL: 0.1)		BDL (MDL:0.2)	BDL (MDL: 0.1)		2
12	Mercury (as Hg), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0 1)		BDL (MDL: 0.2)	BDL (MDL: 0 1)		BDL (MDL: 0.2)	BDL (MDL: 0 1)		BDL (MDL: 0.2)	BDL (MDL: 0.1)		BDL (MDL: 0 2)	BDL (MDL: 0,1)		8DL (MDL: 0.2)	BDL (MDL: 0 1)		
13	Arsenic (As), mg/Kg	BDL (MDL: 0 2)	BDL (MDL: 0.1)		BDL (MDL: 0.2)	BDL (MDL: 0.1)		BDL (MDL: 0.2)	13DL (MDL: 0 1)		BDL (MDL: 0.2)	BDL (MDL: 03)		BDL (MDL: 0.2)	BDL (MDL: 0,1)		BDL (MDL: 0.2)	BDL (MDL: 0.1)		
14	Selenium (as Se), M g/Kg	BDL (MDL: 0 2)	BDL (MDL: 0.1))	BDL (MDL: 0 2)	BDL MDL:0.1		BDL (MDL:02)	BDL (MDL: 0 1)		BDL (M)L: 0,2)	BDL (MDL:01)		SOL (MDL: 0 2)	BDL (MDL:0.l)		BDL (MDL:02)	BDL (MDL: 0.1)			

The health risks posed by contaminated ground water were assessed by Joint Committee using different approaches viz. Transfer Factor (TF), Daily Intake of Metal (DIM) and Health Risk Index (HRI) w.r.t heavy metals viz. Zinc (Zn), Manganese (Mn), Copper ***(Cu)*** *and Chromium* ***(Cr).*** *The results are presented in* ***Table 5:***

Table 5: Results of Analysis w.r.t Transfer Factor, Daily Intake of metals and Health Risk Index w.r.t heavy metals viz. Zinc, Manganese, Copper and Chromium observed in Soil.

S. No.	*Parameters*	*Results of Analysis*						*Target Value of Plant, mg/Kg, WHO*
		Sh Kulwinder Singh, S/o Sh. Jang Singh, Village Aloarkh (in front of M/s. Matharu Chemical)	Village Aloarkh (Dept of Tubewell)- Sh. Amrit Pal Singh S/o Sh Rajwant Singh	Village Aloarkh (Sh. Amrit Pal Singh S/o Sh. Rajwant Singh)	Village Aloarkh (Tubewell of Farmer Sh Kulwin der Singh Edo Balvir Singh)	Kulwinder Singh S/o Gurnam Singh, Village Majhi, Bhawanigarh	Village Aloarkh (From Tubewell of Sh Dilbagh Singh S/o Jagar Singh)	
		30 28238, 76.07803	3028166, 78.07773	30 2806, 76.0772	30,2834, 76.075	30 28341, 76.0798	30.2791, 76.07623	
A	**Soil**							
	Zinc (as Zn), mg/Kg	53.4	37 6	39.3	74.3	38.7	46	50
	Manganese (as Mn), mg/Kg	966	161	236	311	110	247	
	Copper (as Cu), mg/Kg	10 9	7.9	12	16 2	7	9.5	36
	Chromium (as Cr), mg/Kg	6	4.2	6.6	13 4	3.4	8.1	100
B	**Grain**							
	Zinc (as Zn), mg/Kg	12.5	19.1	17.9	16.4	15.6	19	0.6
	Manganese (as Mn), mg/Kg	13.8	26.3	23.2	22.6	17.4	30.6	
	Iron (as Fe), %	26.3	298	24.5	23.9	511	28.2	
	Copper (as Cu), mg/Kg	3.3	4.2	3.8	3.5	4.7	6.7	10
	Chromium (as Cr), mg/Kg	0.5	0.5	0.4	0.4	0.9	0.3	1.3
C	**Transfer Factor (TF: C plant/C soil)**							
	Zinc (as Zn)	0.23	0.51	0.46	0.22	0.40	0.41	
	Manganese (as Mn)	0.01	0.16	0.10	0.07	0.16	0.12	
	Copper (as Cu)	0.30	0.53	0.32	0.22	0.67	071	
	Chromium (as Cr)	0.08	0.12	0.06	003	0.26	0.04	
	DIM							
	Zinc (as Zn)	0.11	0,16	0.15	0.14	0.13	0.16	
	Manganese (as Mn)	0.12	0.22	0.20	0,19	0.15	0.26	
	Copper (as Cu)	0.30	0.53	0.03	0.22	0.67	0.71	
	Chromium as Cr)	0.004	0.004	0.003	0.003	0.008	0.003	
	Health Risk Index (HRI); HRI: DIM/RFD							
	Zinc (as Zn)	0.35	0.54	0.50	0.46	0.44	0.54	
	Manganese (as Mn)	0.83	1.59	140	1.37	1.05	1.85	
	Copper (as Cu)	0.70	0.89	0 80	0.74	0.99	1.42	
	Chromium (as Cr)	1.41	141	1.13	1.13	0.54	0.85	

The results of analysis w.r.t bio-accumulation of Zn, Mn, Cu and Cr from soil to crop i.e. Transfer factor varies between 0.23-0.51,0.01-0.16, 0.20-0.71 and 0.003-0.008 respectively, in the samples collected from 06 locations, clearly indicating the higher transfer of heavy metals at some locations in comparison to others. The Joint Committee determined transfer factor for only one crop i.e. paddy, which was found to be grown during the study period (September-November 2021) and it may vary for other crops and vegetable if grown in the same area irrigated with contaminated ground water, depending on the seasonal variation w.r.t temperature., humidity and absorbing capacity of a particular crop.

Health Risk Index was also determined by Joint Committee, considering the daily intake of grains as 410g/person/day and vegetables & fruits @ 450 g/person/day. A factor of 0.085 was used to convert the fresh weight of vegetable/fruits to dry weight. Average body weight was considered as 53 Kg, for determining the Health Risk Index (HRI). The Oral Reference Dose of Zn, Mn, Cu and Cr was taken as 0.30 mg/kg/day, 0.14 mg/kg/day, 0.04 mg/kg/day and 0.003 mg/kg/day (Ref: FAO/WHO; Codex Alimentarious Commission, 2013; IRIS). The Health Risk Index (HRI) was found to be varying from 0.35 - 0.54, 0.83 - 1.85, 0.70 - 1.42 and 0.85 - 2.54 for Zn, Mn, Cu and Cr respectively, in the samples drawn by the Joint Committee from 06 locations. The values of HRI less than 1 (< 1) is considered safe for intake of food/vegetables. However, the values in the present case were found to be > 1 for Mn (04 Locations), Cu (01 Location) and Cr (05 Locations) in the area under reference, this may pose health risk over a passage of time, if the remediation is not done w.r.t ground water contamination caused due to direct injection of the untreated industrial effluent and the hazardous waste dumped unscientifically at the industrial site.

2.2.3 Findings of TCIRD Report and visit of Joint Committee

The findings w.r.t. contamination of groundwater made by TCIRD in its report are reproduced

as under:

a) Percolation and leaching of contaminants from the onsite solid/hazardous waste storage and disposal and from the solar evaporation ponds. Solar Evaporation ponds of 3600 m^2 spread in about 4400 m^2 area were used for disposal of waste waters by the industry. Some portion of these ponds (800 m^2) was apparently used for burying the disposal of solid waste (gypsum sludge, iron oxide sludge and incineration ash) packed in gunny bags. The Solar Evaporation Ponds are still holding the disposed waste water in form of thick black liquor from about 6 ft depth to 15 ft depth. This liquor layer is confined at the top by a hard, water-soluble crust layer and a HDPE membrane, and by a concrete lining at the bottom. Volume of this liquid amounts to 10,000 m3 and is percolating both vertically ***and*** *laterally into the ground* ***polluting the aquifer.***

b) Direct injection of wastewater into the groundwater at 150ft depth (liquor discarded in the H-acid manufacturing step 11

after filtration recovery of the sodium salt of H-acid appears to be the wastewater discharged into the groundwater through direct injection).

TCIRD concluded that the contribution to the ground water pollution by the percolation/leaching from the solid /hazardous waste storage tanks and from the solar evaporation ponds is relatively lesser and the ground water pollution is mainly from the direct injection of wastewater into the groundwater (which was apparently discontinued in 2005). Total salt level in the top layer of the groundwater (1435mg /L at 105ft depth) is higher than that at 120ft depth (1 I 33mg/L). This could be because of the contributions through percolation and leaching from the overburden soil, the solar evaporation ponds and from the solid/hazardous waste storage. Beyond 120ft depth, the total salt levels are increasing up to 140ft depth (to 3178mg/L) and then decreasing (2012mg/L at 160ft). The latter might be from the direct injection of the wastewater might be at 140 — 150ft depth.

On the basis of the findings of TICRD in its report and the observations made by the Joint Committee of the site under consideration, a site visit was again carried out on 30.11.2021 and 4 locations were selected based on the information obtained from local residents. At the said locations, excavation was carried out with JCB upto a depth of about 8 to 10 feet. During excavation, a layer of blackish sludge, slurry, HDPE sheets, pits containing blackish slurry were observed at different levels in the excavated site, clearly indicating unscientific dumping of hazardous waste, which is resulting into leachting of contaminants and thus causing contamination of the aquifier. However, in order to ascertain the exact area including depth upto which hazardous waste had been dumped by the industry into ground illegally during its operations / dismantling of the unit, a detailed study from expert agency is required to carried out. On the basis of the outcome of the study, a volume of hazardous waste/ contaminated soil lying in the ground will be calculated and thereafter remedial plan will be prepared accordingly.

The photographs showing dumping of hazardous waste dumped unscientifically as observed by Joint Committee during site visit and excavation are as follows:

2.2.4. Remediation Plan:

In this regard, the Joint Committee was directed by Hon'ble NGT as follows:

"It may suggest short term and long-term basis considering agronomy and public health, remediation plan, cost of such remediation, cost of such remediation. A copy of the report be forwarded to the Chief Secretary, Punjab for ensuring remedial measures, based on the facts found"

The Joint Committee considered the following conclusions of the study carried out in this matter, while preparing the remediation action plan:

- *Five tube-wells were found to be contaminated in the study conducted by Joint Committee and yielding coloured water. The water from these tube-wells is not fit for drinking purpose.*

- *The five tube-wells affected by contamination are having depth of about 130 m below ground level in the vicinity of Industry. As per survey carried out by CGWB Expert, "The area is having single aquifer system upto a depth of about 200 m with a thin clay layer at around 110 m to 120 m depth. Considering the general depth of the most of the tube-wells and hydro-geological conditions and aquifer disposition, it can be inferred that aquifers upto a depth of 130 m below ground level are contaminated. Considering the average water levels of about 40 m below ground level about 80 to 90 m thick aquifer zones have been contaminated."*
- *Unscientific dumping of hazardous waste was observed by the Joint Committee during excavation from 04 random locations at site, which is resulting into leachinG of hazardous waste and thus causing contamination of the aquifer. However, in order to ascertain the exact area including depth upto which hazardous waste had been dumped by the industry into ground illegally during its operations / dismantling, of the unit, a detailed study from expert agency is required to be carried out. On the basis of the outcome of the study by an agency, a volume of hazardous waste dumped / contaminated soil lying at site bgl will be calculated and thereafter, the remediation can be planned accordingly.*
- *The analysis of soil samples drawn from the two agricultural fields irrigated with reddish coloured ground water indicated that the concentration of zinc is on much higher side i.e. 53.4 mg/Kg and 74.3 mg/Kg in comparison to the target values in soil i.e. 50 mg/Kg specified by WHO.* ***Zinc was found to be in much higher concentration both in crop and grain (edible part) as well i.e. 16.4 to 33.9 mg/Kg in the whole plant against the target value of 0.6 mg/Kg.*** *Zn is an essential nutrient for human health, but at the same time, it can be toxic in higher concentrations leading to various health complications including reduction in immune function and levels of high density lipo-proteins besides affecting the* ***absorption of*** *copper* ***and iron.***
- *The results of analysis w.r.t bio-accumulation of Zn, Mn, Cu and Cr from soil to crop i.e. Transfer factor was found to be varied between 0.23-0.51,0.01-0.16, 0.200.71 and 0.003-0.008 respectively, in the samples collected from 06 locations,* ***clearly indicating the higher transfer of heavy metals at some locations in*** *comparison to others. Health Risk Index was also determined by Joint Committee for heavy metals viz. Zn, Mn, Cu and Cr.* ***The Health Risk Index (HRI) was found to be varying from 0.35 - 0.54, 0.83 -1.85, 0.70 -1.42 and 0.85 - 2.54 for Zn, Mn, Cu and Cr respectively,*** *in the samples drawn by the Joint Committee from 06 locations.* ***The values of HRI less than 1 (< 1) is considered safe for intake of food/vegetables. However, the values in the present case were found to be > 1 for Mn (04 Locations), Cu (01 Location) and Cr (05 Locations) in the area under reference,*** *which may pose health risk over a passage of time,* ***if the remediation is not done w.r.t ground water contamination caused due to direct injection of the untreated industrial effluent and the***

hazardous waste dumped unscientifically at the industry site.

Keeping in view of the above, the Joint Committee has prepared the short term and the long term ***remediation plan as follows:***

2.2.4.1. Short Term Remediation Plan:

a) Marking the contaminated tube-wells as "Water not fit for Drinking:

Since, the water from the five tube-wells was found to be contaminated, these are required to be marked as ***"Water not fit for drinking",*** *so that this water is not used for drinking purpose by District Administration. All these five tube-wells are primarily being used for agriculture purpose and are not source of drinking water supply to any residential area.*

b) Declaration of the Site as "Contaminated Site":

Based on the earlier studies conducted by TCIRD, Patiala, CPCB, Delhi, NEERI, Nagpur and present study carried out by Joint Committee in this matter, it has been emerged that the hazardous waste had been dumped unscientifically at the site under reference and the leaching of contaminants had caused the contamination of the aquifer upto 130 m depth bgl. Therefore, the site under reference may be declared as ***"Contaminated Site" as per the Guidelines on Implementing Liabilities for Environmental Damages due to Handling & Disposal of Hazardous Waste and Penalty" published by CPCB in 2016.***

c) Remediation of the "Contaminated Site" under reference:

Since, it has been established that ground water has been contaminated in the vicinity of the contaminated site due to leaching of contaminants into the aquifer, the remediation of this contaminated site is important w.r.t risks to public health and environmental quality. Further, the pumping of ground water from these tube-wells may not be discontinued, as there is continuous risk of spread of contamination to other tube-wells laterally. Thus, two solutions are being proposed for remediation of the contaminated site:

- ✓ ***Off-site Solution***

This can be carried out by excavating the hazardous waste unscientifically dumped at site and transferring the same to TSDF, by involving the agency having expertise in handling the hazardous waste. The remediation of this contaminated site may not only result in restoration of ground water quality of the five tube-wells, which are yielding coloured water but at the same time, will prevent further movement of contaminants to other tube-wells laterally, besides improvement in soil ***quality as well as*** *avoid* ***the transfer of contaminants from soil to*** *Crops/agro-products.*

- ✓ ***On-site Solution***

An alternative solution is on-site remediation, which reduces the production of leachate and lessens the chance of groundwater contamination. On-site remediation may include temporary removal of the hazardous waste/contaminated soil already dumped during

operation / dismantling of the unit, construction of a secure landfill on the same site i.e., full containment containment of the waste. This can be done through expert agency which will make trenches by removing the already dumped hazardous waste / contaminated soil at the site in scientific manner up to the depth of contamination, placing an impermeable cover in the horizontal as well as in vertical direction in the trenches and thereafter, re-fill the excavated hazardous waste/contaminated soil into the trenches. Further, before refilling, the said excavated waste can be mixed with some binding material for solidification of the waste which will not only reduce the volume of hazardous waste but also rule out the future leaching and the same will act as impermeable barrier. In order to implement this technique, an expert agency is required to be engaged to submit its proposal w.r.t. cost and timelines.

Remediation cost.

The tentative remediation cost as estimated by the Joint Committee is as follows:

The excavation was carried out at 04 random locations at site under study, with JCB upto about 8 to 10 feet and the layers of blackish red sludge, blackish slurry, HDPE sheets were observed in excavated pits at different levels, clearly indicating unscientific dumping of hazardous waste done by the industry during its operations / dismantling of the unit, which has slowly resulted into leaching of contaminants into the ground water, thereby causing contamination of the aquifer over a period of time. However, based on the previous reports/ studies conducted by TCIRD, CPCB, PPCB and present study conducted by the Joint Committee, remedial cost plan for an area of 4047 m^2 (1.0 Acre) of land with depth of 6 m has been calculated in case of off-site solution. Further, this is a tentative cost which excludes treatment, contingency, other Misc cost & may increase depending upon the market dynamics at the time of implementation of this remediation plan viz a viz the volume of hazardous waste / contaminated soil excavated.

Sr. No.	***Particulars***	***Details***
1.	*Tentative Area tobe remediated based on TCIRD Stud excavation/study conducted by Joint Committee*	*4,047 m^2 (Approx. 1 Acres)*
2	*Tentative depthof Contamination, to be remediated.*	*6 mtr (may vary once actual remediation process starts)*
3.	*Total Volume/Wt of Soil /Sludge to excavated and disposed off to TSDF.*	*4,047 x 6 = 24,282 m^3* *Specify gravity of Sandy Clay Soil: 1.4* *24,282 x 1.4* *=33,994.8 Ton*
4	*Estimated Cost of Direct land fill disposal Charges at TSDF (Assuming that no further treatment at TSDF is required)*	*Rs. 3,600/- per ton* *33994.8 x 3600/- = Rs. 1,22,381,280/- (Rs. 12.24 Crores)*
5	*Estimated Excavation Cost @Rs. 99/m^3 (as per common schedule of Rates of Pb. PWD*	*24,282 x 99 = Rs. 24,03,918/- (Rs.*

	(B&R)	*24.00 lac)*
6.	*Estimated Refilling Cost @ Rs. 500/m^3 soil*	*24,282 x 500 = Rs. 1,21,41,000 (Rs. 1.21 Crores)*
	*Total **Initial Tentative Estimated Cost** (Excluding Contingency and Misc. Costs)*	*Rs. (12.23 cr + 0.240 or + 1.21) cr = Rs. 13.68 Crore*

In order to ascertain the exact area including depth upto which hazardous waste had been dumped by the industry into ground illegally during its operations / dismantling of the unit, a detailed study from an expert agency is required to be carried out. On the basis of the outcome of the said study, exact volume of hazardous waste dumped / contaminated soil lying at site below ground level (bgl) will be calculated and thereafter, the remediation plan will be implemented as per the options available

2.2.4.2. Long Term Remediation Plan for Ground Water, if required.

The need for implementation of any long-term remediation plan is not expected, if the short-term remediation plan, as proposed above is religiously implemented. However, if required, the long-term remediation of Ground Water based on "Pump Out and Pump In" or Pump Out, Treat and Pump In" approach may be implemented, after evaluating the outcome of the Short-term plan. The Estimated cost of long-term plan may require Rs. 200/- per m3 to more than Rs. 5000/-per m3 depending on the approach followed.

3. Submissions:

a) The minimum tentative Cost for initial remediation of one-acre area (upto depth of 6 m) of the contaminated site in case of short-term remediation plan estimated by the Joint Committee is Rs. 13.68 Cr, which may vary based on outcome of the actual remediation, once started.

b) The Joint Committee has deliberated the matter with regard to availability of funds to carry out the remediation work at the site and who will bear the remediation cost. After examination of the matter, it is stated that the Hon'ble NGT was pleased to dispose of a connected matter in OA No. 35 of 2013 vide order dated 23.09.2015, wherein Rs. 2.0 crore penalty was imposed upon M/s Matharu Chemical & its responsible persons on the basis of Polluter Pay Principle for restoration of Environment. Execution Application no. 23 of 2020 was disposed of vide order dated 03.11.2020 and the matter was referred to the District and Session Judge, Sangrur. However, the Judgment debtors have not paid any amount to the State Pollution Control Board and the matter is being adjourned from one date to another without any concrete action. Directions are required to Issue to the Court of District and Session Judge. Sangrur for early decision in the Execution so that the amount of penalty recovered from the judgment debtor shall be utilized for initial remediation cost. The owners and directors of M/s Manard Chemical who were party in OA No. 35 of 2013 and Execution Application no. 23/2020 be strictly directed by the Hon'ble NGT to bear the entire cost of remediation of the site

c) A detailed study from an expert agency is required to be carried out in order to ascertain the exact area of contamination including depth upto which hazardous waste had been dumped by the industry into the ground illegally during its operation.

d) On the basis of the outcome of the said detailed study, exact volume of hazardous waste dumped/contamination of soil lying beneath the land will be calculated for the purpose of implementing the remediation plan as per the best options available.

The above report of the Joint Committed is being submitted for the consideration of Hon'ble National Green Tribunal. Further, ***a copy of the above report including remediation plan and annexures, is also being forwarded to Chief Secretary, Government of Punjab, through Nodal Agency (PPCB)/Principal Secretary, Department of Science, Technology and Environment as directed by Hon'ble NGT, for taking further remedial action, in compliance of the Hon'ble NGT Order dated 20/7/2021*** *The Joint Committee will abide by further directions of Hon'ble NGT, in this matter.***"**

4. We note that additional comments/information has been given by the CPCB Member on the subject of ground water contamination and also certain other issues. There are additional suggestions with regard to short, medium and long term remediation plan and other measure required to be adopted. The same is part of the report as Annexure–3.

5. Having regard to the composition of the Committee and the material considered in the report and also in absence of any opposition by the State inspite of copy of report having been served on it, we accept the report of the Committee and issue directions in terms thereof. The Chief Secretary, Punjab, in coordination with the concerned authorities may ensure remedial action speedily to effectuate the guaranteed right of the citizens to clean potable water. The Chief Secretary may also take into account the suggestions in the additional report referred to above. The cost of remediation has to be borne by the State in the first instance without prejudice to the recovery of the amount later from the violators/erring officers. Area in question be treated as 'contaminated site' and remediation plan as per the Report of the Joint Committee may

be executed within six months. If it becomes necessary, the Plan may be suitably modified in consultation with CPCB and any other Institution. Chief Secretary may constitute a credible executing/ monitoring Committee to get the remediation plan executed and to monitor its timely and proper execution. Status report of compliance as on 31.8.2022 may be forwarded to Registrar General, NGT on or before September 30, 2022 by email. District Magistrate, Sangrur may place the information in public domain and appropriately caution the inhabitants about contaminated water in the interest of public health. PPCB and State GWB may regularly monitor the quality of contaminated water.

The application is disposed of.

A copy of this order be forwarded to the Chief Secretary, Punjab and District Magistrate, Sangrur, State PCB and State GWB by e-mail for compliance.

Adarsh Kumar Goel, CP

Sudhir Agarwal, JM

Pushpa Sathyanarayana, JM

Prof. A. Senthil Vel, EM

Dr. Vijay Kulkarni, EM

March 31, 2022
Original Application No. 169/2021
A