

A Report
of
Joint Committee constituted by
Hon'ble National Green Tribunal
in the matter of OA No. 169 / 2021
H.C. Arora Vs State of Punjab &
Ors.

Report of the Joint Committee in the matter of O.A. No. 169/2021; H.C. Arora vs. State of Punjab & Ors, in compliance of Hon'ble National Green Tribunal order dated 20/07/2021.

1. Background and the Directions of Hon'ble NGT:

The matter relates to plea w.r.t chemically contaminated colored water coming out of the tube-wells in village Aloarakh, Block Bhawanigarh, District Sangrur, Punjab as highlighted in the media report dated 08.07.2021 published in Hindustan Times titled 'Sangrur tube-well spews out polluted water; PPCB blames dismantled factory'. This colored water has the potential for damage to the public health & the problem has been existing for more than 10 years.

PPCB has stated that a private factory which was closed more than 15 years ago, is responsible for contamination. It has also been reported that Hon'ble NGT has imposed a compensation of Rs. 2 Crore on the said factory & its directors vide order dated 23/09/2015 in OA 35 of 2013 for restoration of the environment but the amount has not been recovered yet.

The Hon'ble National Green Tribunal during hearing on 20.07.2021 observed that:

"If the report is correct, the polluted water has potential for adversely affecting the inhabitants. In such a situation, it is the responsibility of the state to take remedial measures to enforce the right of the citizens to clean water"

Thereafter, the Hon'ble Tribunal vide order dated 20.7.2021 directed as under (copy annexed as **Annexure-1**):

"Accordingly, we direct 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 report may be furnished within two months by e-mail at judicialngt@gov.in preferably in the form of searchable PDF/ OCR Support PDF and not in the form of Image PDF. The Committee may 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. It may suggest short and long-term basis considering agronomy and public health, remediation plan, 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 CPCB and State PCB will be the nodal agency for coordination and compliance. First meeting of the committee may be convened within two weeks."

In compliance of aforesaid order, the following steps were required to be taken:

- i. Constitution of a five-member Joint Committee and to convene the first meeting of the Joint Committee within two weeks.
- ii. Site visit and interaction with the stakeholders.

- iii. 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 intermediates.
- iv. Study the effect on agricultural crops.
- v. Study the bio- magnification in agro products.
- vi. To suggest short and long-term remediation plan considering agronomy and public health and the cost of such remediation.
- vii. The report be forwarded to the Chief Secretary, Punjab for ensuring remedial measures, based on the facts found.

2. Compliance of the Directions issued by Hon'ble NGT in order dated 20.07.2021:

2.1. Constitution of the Joint Committee and the 1st meeting of the Committee:

A Joint Committee comprising the following members was constituted:

- i. District Magistrate, Sangrur.
- ii. Sh. Saurabh Gupta, IFS, Director, Directorate of Environment & Climate Change (DECC), Punjab at Chandigarh (Nominated by Principal Secretary, Department of Science, Technology and Environment) / Sh. Charchil Kumar, IFS, Director, DECC (w.e.f Dec 27, 2021).
- iii. Dr. Vimal Kumar Hatwal, Scientist - E, Ministry of Environment, Forest & Climate Change (MoEF&CC), Integrated Regional Office, Chandigarh.
- iv. Dr. Narender Sharma, Additional Director, CPCB, Regional Directorate, Chandigarh.
- v. Dr. Rajeev Gupta, Regional Officer, PPCB, Sangrur.

1st meeting of Joint Committee was held in the office of District Magistrate, Sangrur on 17/8/2021, wherein it was proposed and decided as follows:

- Sh. S.K. Mohiddin, Senior Hydro-geologist, Central Ground Water Board, Sector-26, Bhujal Bhawan, Chandigarh be co-opted as member to assist the committee w.r.t. ground water issues.
- M/s Ramky Enviro Engineers Ltd, Unit - PWMP, Village- Nimbua, PO-Rampur Sanian, Teh-Derabassi, Distt-Mohali (Punjab) be requested to supply the data w.r.t. lifting of hazardous waste by the industrial units namely M/s Matharu Chemical Industries (old name), M/s Mahaluxmi Orgochem (new name), Village Aloarakh, Tehsil Bhawanigarh, Distt. Sangrur, so that illegal disposal of hazardous waste by the said industrial units can be estimated.

- PPCB, Regional Office, Sangrur to arrange analysis report of the ground water prepared by Department of Agriculture, Sangrur based on which it was concluded that the ground water under reference is fit for irrigation.
- PPCB, Regional Office, Sangrur to provide copies of i) Application of CTE/CTO and Copy of the CTE/CTOs issued to the unit; ii) Violation done/recorded by the unit and action taken thereof by the PPCB and iii) Qualitative data/annual returns/records of Hazardous Waste Generation submitted by the unit under Hazardous Waste Management Rule.
- The site visit of Joint Committee alongwith CGWB Expert, to be conducted within two weeks, to prepare further plan of action, to conclude the matter, as per time-line given by Hon'ble National Green Tribunal.

Besides above, the Joint Committee also referred to previous reports / studies conducted by CPCB, Thapar Centre for Industrial Research & Development (TCIRD), Thapar University, Patiala, CSIR-NEERI and PPCB, on the same issue.

The approach followed by the Joint Committee for arriving at conclusion in this matter included:

- 1) **Site visit and interaction** with the local farmers to determine the affected area.
- 2) **Ground water sampling** from various bore-wells/ tube-wells located up-stream and down-stream of the closed Matharu Chemical Industries by involving CGWB expert, to establish the number of affected tube wells, depth/aquifer status, movement of contaminants and affected area.
- 3) **Sampling of agriculture Soil** of the affected area established from the above Point No. 2, to determine the accumulation of contaminants in the soil over a period of time, by irrigation with contaminated water.
- 4) **Sampling of agriculture crops and the produce (grains)**, to estimate the bio-magnification of contaminants in plant (fodder) and produce (seeds).
- 5) **Calculation of Transfer Factor (TF)**, for determining the bio-accumulation of metals/contaminants in plants and seeds from soil and **Health Risk Index (HRI)** by considering daily intake and reference oral dose.
- 6) **Findings of report given by Thapar Center for Industrial Research & Development (TCIRD)**, in year 2010 w.r.t Assessment of Length, Breadth & Depth of Ground water contamination by Matharu Chemical Industries, Bhawanigarh. The aforesaid report has already been taken on record by the Hon'ble NGT in OA no. 35/2013 titled as Parminder Singh vs PPCB & Others.
- 7) **Preparation of short term and long-term remediation plan** and cost involved, considering agronomy and public health in the affected area. The control samples in all the above cases (Point no. 2 - 4) were also taken from the area which is not affected

with contamination water to establish the impact of contamination. Further, the report of TCIRD has also been considered by the Joint Committee w.r.t. the extent of contamination / proposed remediation and accordingly, the Joint Committee prepared short and long term remediation plan.

2.2. Report of Joint Committee:

The findings of the Joint Committee in compliance of the Hon'ble NGT order dated 20.07.2021, in the above matter, are as follows:

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

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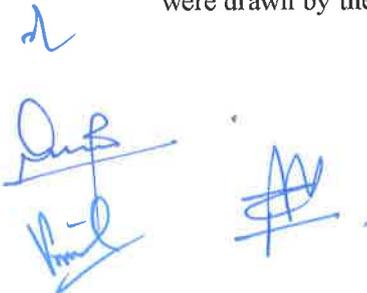
concentration of Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD), whereas, the rest three tubewells were found having high nitrate concentration, hence, confirming contamination of ground water in these five tube-wells. Six tubewells were also found having high value of Electrical conductivity, 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 m 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 tube-wells, 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

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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	30.28166, 76.07773	30.2806, 76.0772	30.2834, 76.075	30.28341, 76.0796	30.2791, 76.07623	
1	pH	6.86	7.04	7.34	7.23	7.18	7.24	
2	Total Organic Carbon (TOC), %	0.55	0.37	0.49	0.71	0.44	0.48	
3	Total Kjeldahi Nitrogen (TKN), mg/Kg	813	925	1065	897	841	1149	
4	Phosphorus, mg/Kg	8.3	92	134	118	148	136	
5	Cation Exchange Capacity, Meq/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)	BDL (MDL20)	BDL (MDL20)	BDL (MDL20)	BDL (MDL20)	BDL (MDL20)	
11	Phenolic Compounds, mg/Kg	BDL (MDL20)	BDL (MDL20)	BDL (MDL20)	BDL (MDL20)	BDL (MDL20)	BDL (MDL20)	
12	Potassium (K ₂ O), mg/Kg	109	60	172	509	245	178	
13	Magnesium (as Mg), mg/Kg	510	291	146	388	291	170	
14	Zinc (as Zn), mg/Kg	53.4	37.6	39.3	74.3	38.7	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 (MDL 0.5)	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 (MDL 0.5)	BDL (MDL 0.5)	BDL (MDL 0.5)	BDL (MDL 0.5)	0.8
20	Chromium (as Cr), mg/Kg	6	4.2	6.6	13.4	3.4	8.1	100
21	Nickel (Ni), mg/Kg	12.4	9.9	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 0.5)	BDL (MDL 0.5)	BDL (MDL 0.5)	BDL (MDL 0.5)	
24	Arsenic (As), mg/Kg	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 (MDL 0.5)	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.

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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 in Plant, mg/Kg, WHO
		Sh. Kulwinder Singh S/o Sh. Jang Singh, Village Aloarkh (In front of M/s Matharu 30.28238, 76.07803)	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	30.28166, 76.07773	30.2806, 76.0772	30.2834, 76.075	30.28341, 76.0786	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	0.11	1072	727	897	408	1130	
3	Zinc (as Zn), mg/Kg	3.9	3.9	7.5	7.8	8.7	14.9	0.6
4	Manganese (as Mn), mg/Kg	36.5	29.4	42.5	35	8.1	52.7	
5	Iron (as Fe), %	13.41	9.9	31.7	14.97	10.9	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), 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)	
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 (as 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 in 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. 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	30.28166, 76.07773	30.2806, 76.0772	30.2834, 76.075	30.28341, 76.0786	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	Zinc (as Zn), mg/Kg	12.5	19.1	17.9	16.4	15.6	19	0.6
4	Manganese (as Mn), mg/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), mg/Kg	0.5	0.5	0.4	0.4	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), 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)	

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 in Plant, mg/kg, WHO		
		Sh. Kulwinder Singh S/o Sh. Jang Singh, Village Alorakh (In front of M/s Matharu Chemical), 30.28238 & 76.07803		Village Alorakh (Dept of Tubewell)- Sh. Amrit Pal Singh S/o Sh. Rajwant Singh, 30.28166 & 76.07773		Village Alorakh (Sh. Amrit Pal Singh S/o Sh. Rajwant Singh), 30.2806 & 76.0772		Village Alorakh (Tubewell of Farmer Sh. Kulwinder Singh S/o Balvir Singh), 30.2834 & 76.075		Kulwinder Singh S/o Gurnam Singh, Village Majhi, Bhawanigarh, 30.28341 & 76.0796		Village Alorakh (From Tubewell of Sh. Dibragh Singh S/o Jagar Singh), 30.2791 & 76.07623				
		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)	BDL (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)	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
3	Zinc (as Zn), mg/Kg	3.9	12.5	16.4	3.9	19.1	23	7.5	17.9	25.4	7.8	16.4	24.2	8.7	15.6	24.3
4	Manganese (as Mn), mg/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
5	Iron (as Fe), %	13.41	26.3	39.71	9.9	29.6	39.5	31.7	24.5	56.2	14.97	23.9	38.87	10.9	511	521.9
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
7	Molybdenum (as Mo), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	
8	Cadmium (as Cd), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	
9	Chromium (as Cr), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	
10	Nickel (Ni), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	
11	Lead (Pb), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	
12	Mercury (as Hg), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	
13	Arsenic (As), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	
14	Selenium (as Se), mg/Kg	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	BDL (MDL: 0.1)	BDL (MDL: 0.2)	BDL (MDL: 0.1)	

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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 in 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. 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	30.28166, 76.07773	30.2806, 76.0772	30.2834, 76.075	30.28341, 76.0796	30.2791, 76.07823	
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	29.6	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: Cplant/Csoil)							
	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	0.71	
	Chromium (as Cr)	0.08	0.12	0.06	0.03	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)	0.03	0.04	0.03	0.03	0.04	0.06	
	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	1.40	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	1.41	1.13	1.13	2.54	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 Alimentarius 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 m² spread in about 4400 m² area were used for disposal of waste waters by the industry. Some portion of these ponds (800 m²) 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

2




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 (1133mg/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 leaching of contaminants 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 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:



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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

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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, 0.20-0.71 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. 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:

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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

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 m² (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 to be remediated based on TCIRD Study excavation/study conducted by Joint Committee	4,047 m ² (Approx. 1 Acres)
2.	Tentative depth of 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
5.	Estimated Cost of Direct landfill disposal Charges at TSDF (Assuming that no	Rs. 3,600/- per ton 33994.8 x 3600/- = Rs. 1,22,381,280/- (Rs. 12.24 Crores)

	further treatment at TSDF is required)	
6.	Estimated Excavation Cost @ Rs. 99/m ³ (as per common schedule of Rates of Pb. PWD (B&R)	24,282 x 99 = Rs. 24,03,918/- (Rs. 24.00 lac)
7.	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 cr + 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.

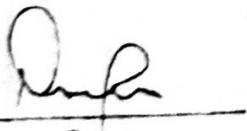
3. Submissions:

- 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.
- 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

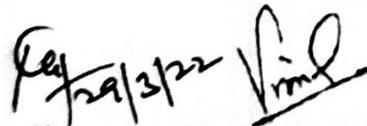
was referred to the District and Session Judge, Sangrur. However, the Judgement Debtors have not paid any amount to the State Pollution Control Board and the matter is being adjourned from one date to another without any concrete action. Directions are required to issue to the Court of District and Session Judge, Sangrur for early decision in the Execution, so that the amount of penalty recovered from the judgment debtors shall be utilized for initial remediation cost. The owners and directors of M/s Matharu 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 Committee 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.



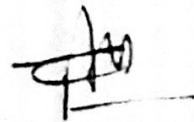
Dr. Rajeev Gupta
PPCB



Dr. Narender Sharma
CPCB



Dr. Vimal K. Hatwal
MoEF&CC



Charchill Kumar, IFS
DECC



Ramvir, IAS
DC, Sangrur

Signed with
additional comments
as Annexure-3 of
this report

Dated: March 29, 2022

(Representative
of Secretary
Environment
Punjab.)

Item No. 01

(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: 20.07.2021

**CORAM: HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON
HON'BLE MR. JUSTICE SUDHIR AGARWAL, JUDICIAL MEMBER
HON'BLE MR. JUSTICE M. SATHYANARAYANAN, JUDICIAL MEMBER
HON'BLE MR. JUSTICE BRIJESH SETHI, JUDICIAL MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER**

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

ORDER

1. Grievance in this application is against failure 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. If the report is correct, polluted water has potential for adversely affecting the inhabitants. In such a situation, it is the responsibility of the State to take remedial measures to enforce the right of the citizens to clean water.

3. Accordingly, we direct 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 report may be furnished within two months by e-mail at judicial-ngt@gov.in preferably in the form of searchable PDF/ OCR Support PDF and not in the form of Image PDF. The Committee may 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. It may suggest short and long-term basis considering agronomy and public health, remediation plan, 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 CPCB and State PCB will be the nodal agency for coordination and compliance. First meeting of the committee may be convened within two weeks.

A copy of this order be forwarded to the Chief Secretary, Punjab CPCB, State PCB, Secretary Environment Department, Punjab, Regional Officer, MoEF&CC, Chandigarh and District Magistrate, Sangrur by email for compliance.

The applicant may serve a set of papers on the CPCB, State PCB, Secretary Environment Department, Punjab, Regional Officer, MoEF&CC, Chandigarh and District Magistrate, Sangrur and file affidavit of service within one week.

List for further consideration on 12.11.2021.

Adarsh Kumar Goel, CP

Sudhir Agarwal, JM

M. Sathyanarayanan, JM

Brijesh Sethi, JM

Dr. Nagin Nanda, EM

July 20, 2021
Original Application No. 169/2021
A

Final Report on Ground Water Contamination around Matharu Industries, Alorakh, Bhawanigarh Block, Sangrur district as per Hon'ble NGT Order dated 20/07/2021 in OA No.169/2021, in the matter of H.C. Arora Vs State of Punjab & others

A complaint has been filed by Sh. H.C. Arora in the Hon'ble NGT regarding failure to take remedial measures against contamination of ground water in village Alorakh, Block Bhawanigarh, Dist.. Sangrur (OA No. 169/2021). The Hon'ble tribunal vide order dated 20-07-2021 has constituted five member Joint committee comprising CPCB, Regional Officer, MoEF & CC, Chandigarh, SPCB, a nominee of Secretary, Environment Department and Punjab 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 Hon'ble NGT ordered that the Committee may ascertain the number of tubewells 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 i.e dyes and dye intermediate, effect on agricultural crops, bio-magnification in agro products.

The five member committee has co-opted CGWB as Expert Member in the Joint Committee for concluding the matter scientifically and as per the order of Hon'ble NGT. Sh. S. K Mohiddin, Sr.Hg (Sc C) and Sh. Rishi Raj, Assistant Chemist have been deputed to carry out the studies around the area of Matharu Chemical Industry and to prepare the report. This report embodies the findings of the studies carried out during September, 2021.

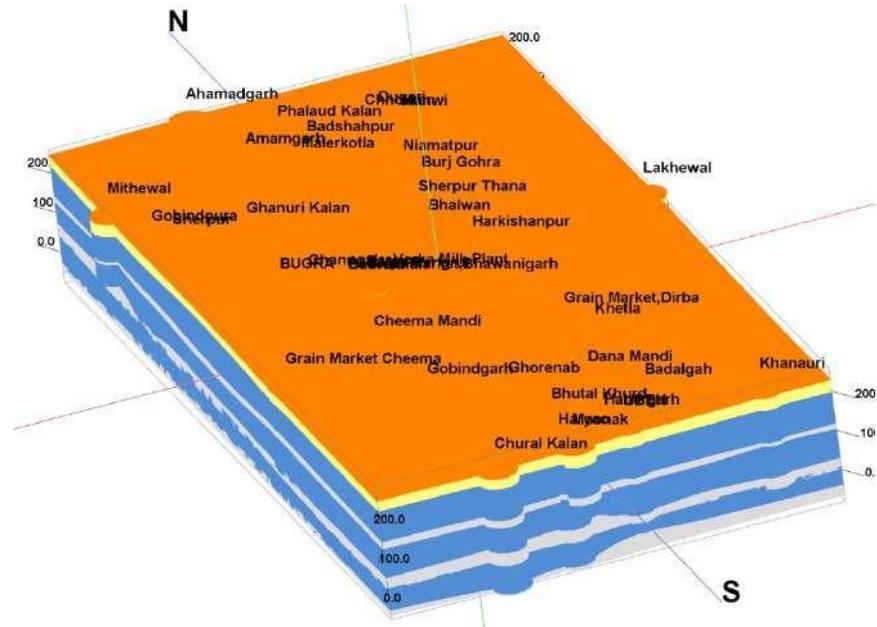
CGWB has takenup the detailed study around the Refinery and collected 22 ground water samples around the Matharu Chemical Industry to assess the ground water contamination. Groundwater sampling for 15 major elements, heavy metals and Total Organic Carbon (TOC) and analysis was done by Sh. Rishi Raj, Assistant Chemist CGWB during September, 2021 for 15 major elements and Total Organic Carbon (TOC). Apart from these parameters samples were collected by PSPCB from the same locations for getting them analysed for BOD, COD, Phenolic compounds and SAR. To study the Heavy metal contamination, the heavy metal analysis has been got done in the in Punjab

Biotechnology Incubator, Department of Science, Technology and Environment, Government of Punjab (An NABL Accredited Lab).

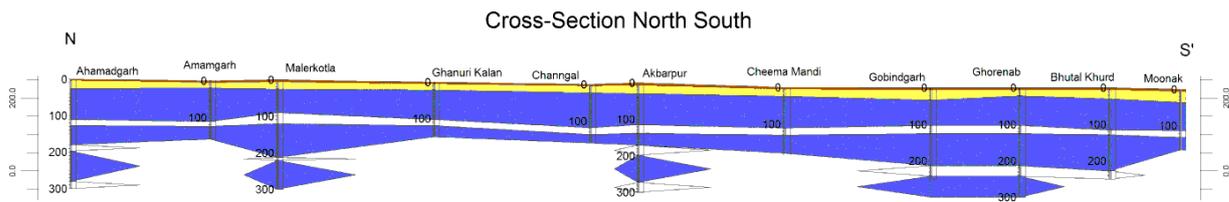
Hydrogeological condition around the Matharu Chemical Industry: The area is flat alluvial plain underlain by arid brown soil. The ground water occurs in alluvium formations comprising fine to coarse sand, which forms the potential aquifers. In the shallow aquifer (up to 50m) ground water occurs under unconfined/water table conditions, where as in deeper aquifer, semi-confined/confined conditions exist. In Sangrur district, CGWB has drilled 3 exploratory boreholes, 4 Piezometers to delineate and determine potential aquifer zones, evaluation of aquifer characteristics. The permeable granular zones comprising fine to medium grained sand and occasionally coarse sand and gravel. Ground water in the district occurs in the alluvium under water table and semi confined to confined conditions. The discharge of deep tube well in the area varies between 2400 and 2680 lpm. The tranmissivity values ranges from 1670 m²/day and storativity ranges from 7.5×10^{-2} .

The depth to water level ranges in the surrounding area is very deep i.e. about 40 to 42 m bgl. The long-term water levels trends in the Sangrur district indicates average fall of 0.50 m/year.

To know the broad picture of the aquifer disposition, inter-relationship of granular zones, nature, geometry and extension of aquifers in the Sangrur district, the aquifer grouping has been done using the sub-surface lithology and a three-dimensional aquifer model has been prepared. The first aquifer is water table aquifer and extends all over the area. The aquifer is mainly composed of fine to medium grained sand.



Three dimensional aquifer model in Sangrur district, Punjab



Cross Sections of Aquifer Map of Sangrur District

3. Ground Water Quality:

Ground water samples from 22 shallow handpumps and deep tubewells were collected for analysis. Data collected by PSPCB has also taken into consideration for pollution studies. The data and interpretation along with the maps are at Annexure-1.

4. Tubewells Contaminated: A number of parameters are considered for identification of contaminated tubewells. Important parameters considered are colour, Total Organic Carbon (TOC), Electrical Conductivity, Chemical Oxygen demand (COD), Biological Oxygen demand (BOD), Nitrate and heavy metal concentrations in this report. Presence of all the above parameters are examined against the BIS Standards prescribed for drinking water quality.

Colour of ground water from the contaminated tubewells is reddish. Ground water from the tubewells serial number 1,2,3, 5 and 8 (refer Annexure-1) is reddish in nature and thus these tubewells are contaminated.

The Electrical Conductivity: The acceptable limits of Electrical Conductivity for drinking water is 1000 ms/cm (Total Dissolved Solids – 500 mg/l) and 3000 ms/cm is permissible if any alternative source of drinking water is not available (TDS is 2000 mg/l). In general, the Electrical Conductivity values ranges between 560 ms/cm to 1995 ms/cm within the vicinity of industry. The Electrical conductivity of tubewells affected by contamination have high values of Electrical Conductivity. Thus the increased value of Electrical Conductivity within the vicinity of industry shows contamination.

Chemical Oxygen Demand (COD) is another parameter which is considered for demarcation of polluted tubewells. The water samples of two tubewells (sr. No. 1 & 2) are having COD values of 262 mg/l and 284 mg/l. In all other tubewells, the COD is below the detectable limits. In tubewell No. 14 located in the campus of Gurudwara Singh Sabha, COD is 24 which can be attributed to some other source of contamination. The data analysed by PSPCB was used for interpretation of COD.

Biological Oxygen Demand (BOD) is another parameter which is considered for demarcation of polluted tubewells. The water samples of two tubewells (Sr. No. 1 & 2) are having BOD values of 33 mg/l and 22 mg/l. In all other tubewells, the BOD is below the detectable limits. The data analysed by PSPCB was used for interpretation of BOD.

Another parameters considering for study of ground water contamination by the effluents is Total Organic Carbon due to contamination by organic products/effluents. Total Organic Carbon values range between 0.29 mg/l to 97 mg/l. Tubewells at Sr.No. 1, 2, 3, 5 and 8 have TOC in higher concentrations. All the samples collected around the industry are having the TOC but in less quantity which is less than 1 mg/l. No limit has been prescribed by BIS for TOC in drinking water. Presence of TOC shows the organic contamination of ground water.

Nitrate is another parameter considered for identification of contaminated tubewells. Nitrate concentration of tubewells at Sr. No. 1, 2 and 5 are having high concentrations.

To study the Heavy metal contamination, the following heavy metal analysis has been got done in the in Punjab Biotechnology Incubator, Department of Science, Technology and Environment, Government of Punjab (An NABL Accredited Lab).

Heavy Metal got analysed: 1. Copper, 2. Iron, 3. Manganese, 4. Selenium, 5. Silver, 6. Zinc, 7. Cadmium, 8. Lead, 9. Nickel, 10. Arsenic, 11. Total Chromium.

Out of all the metals determined, Copper, Iron, Manganese and Zinc are present in all the samples. All the other metals are present in concentrations Below detectable limits. However, the metals which are present in the samples, they are well within the permissible limits of drinking water standards (BIS, 2012) except Copper which is present above the drinking water standards in Sample No.1 which is highly contaminated in terms of ground water pollution. **Thus there is no heavy metal contamination in ground water in respect of drinking water standards are considered.**

The depth upto which the contamination has also been arrived at based on hydrogeology and presence of above parameters. The sampling has been done from the tubewells varying between shallow (46 m below ground level) to very deep (183 m bgl). It is observed that the tubewells 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. Considering the general depth of the most of the tubewells and hydrogeological conditions and aquifer disposition, it can be inferred that aquifers upto a depth of 130 m bgl are contaminated. Considering the average water levels of about 40 m bgl about 80 to 90 m thick aquifer zones have been contaminated.

5. Drinking water supply in the villages

Ground water samples from water supply tubewells in Alorakh village and Bakhtari village have been collected and analysed. All the parameters analysed are under the permissible limits of drinking water standards. The water supply in all the villages surrounding the industry are based on ground water from deeper aquifers which is being supplied by PHED Department of Government of Punjab. As the

ground water of deeper aquifers are meeting the standards prescribed by BIS (ISO10,500 of 2012) which is being supplied for drinking and domestic water requirements by piped water system.

Annexure-1**Ground Water Quality in and around Matharu Industry, Alorakh,
Bhawanigarh Block, Sangrur District.**

The quality of shallow/deep ground water in the surrounding area upto a distance of about 5km. of industry has been studied and 22 no's of water samples were collected from shallow/deep aquifers during September, 2021. All the collected samples were analyzed by adopting standard methods of analysis (APHA) in the Regional Chemical Lab of CGWB for Basic elements. The Total Organic Carbon content in the ground water samples is presented at Annexure-2. Chemical analysis data of samples are given in Annexure-3. Apart from these, analysis data of water samples collected from the PSPCB is also utilised for interpretation purpose (Annexure-5). The various maps prepared based on the chemical analysis are at Annexure-4. The heavy metal analysis of the 22 samples collected has been got done in Punjab Biotechnology Incubator, Department of Science, Technology and Environment, Government of Punjab (An NABL Accredited Lab).

pH

In the study area and surrounding area villages pH values of ground water ranges between 7.42 to 8.42.

Specific Conductance

The Electrical Conductivity varies between 560 $\mu\text{S}/\text{cm}$ at 25°C to 1995 $\mu\text{S}/\text{cm}$.

Chloride Concentration

The concentration of Chloride in all samples is less than 250 mg/l which is within the maximum permissible limit of BIS for drinking water purpose.

Fluoride Concentration

The minimum Fluoride Concentration of 0.35 mg/l and maximum concentration of 0.70 mg/l is observed. In all the samples Fluoride is within the permissible limits of drinking water standards.

Nitrate Concentration

Nitrate is another parameter considered for identification of contaminated tubewells. Nitrate concentration of tubewells at Sr. No. 1, 2 and 5 are having high concentrations.

Heavy Metal Concentrations: To study the Heavy metal contamination, the following heavy metal analysis has been got done in the in Punjab Biotechnology Incubator, Department of Science, Technology and Environment, Government of Punjab (An NABL Accredited Lab).

Heavy Metal got analysed: 1. Copper, 2. Iron, 3. Manganese, 4. Selenium, 5. Silver, 6. Zinc, 7. Cadmium, 8. Lead, 9. Nickel, 10. Arsenic, 11. Total Chromium.

Out of all the metals determined, Copper, Iron, Manganese and Zinc are present in all the samples. All the other metals are present in concentrations Below detectable limits except Lead in 4 samples, Selenium in 2 samples, Nickel in 1 sample. However, the metals which are present in the samples, they are all well within the permissible limits of drinking water standards (BIS, 2012) except Copper which is present above the drinking water standards in Sample No.1 which is highly contaminated in terms of ground water pollution. **Thus there is no heavy metal contamination in ground water in respect of drinking water standards are considered.**

Bacteriological Contamination: Chemical Oxygen Demand (COD) is another parameter which is considered for demarcation of polluted tubewells. The water samples of two tubewells (sr. No. 1 & 2) are having COD values of 262 mg/lit and 284 mg/lit. In all other tubewells, the COD is below the detectable limits. In tubewell No. 14 located in the campus of Gurudwara Singh Sabha, COD is 24 which can be attributed to some other source of contamination. The data analysed by PSPCB was used for interpretation of COD. Biological Oxygen Demand (BOD) is another parameter which is considered for demarcation of polluted tubewells. The water samples of two tubewells (Sr. No. 1 & 2) are having BOD values of 33 mg/lit and 22 mg/lit. In all other tubewells, the BOD is below the detectable limits. The data analysed by PSPCB was used for interpretation of BOD.

Total Organic carbon: Total Organic Carbon values range between 0.29 mg/lit to 97 mg/lit. Tubewells at Sr.No. 1, 2, 3, 5 and 8 have TOC in higher concentrations. All the samples collected around the industry are having the TOC but in less quantity which is less than 1 mg/lit. No limit has been prescribed by BIS for TOC in drinking water. Presence of TOC shows the organic contamination of ground water.

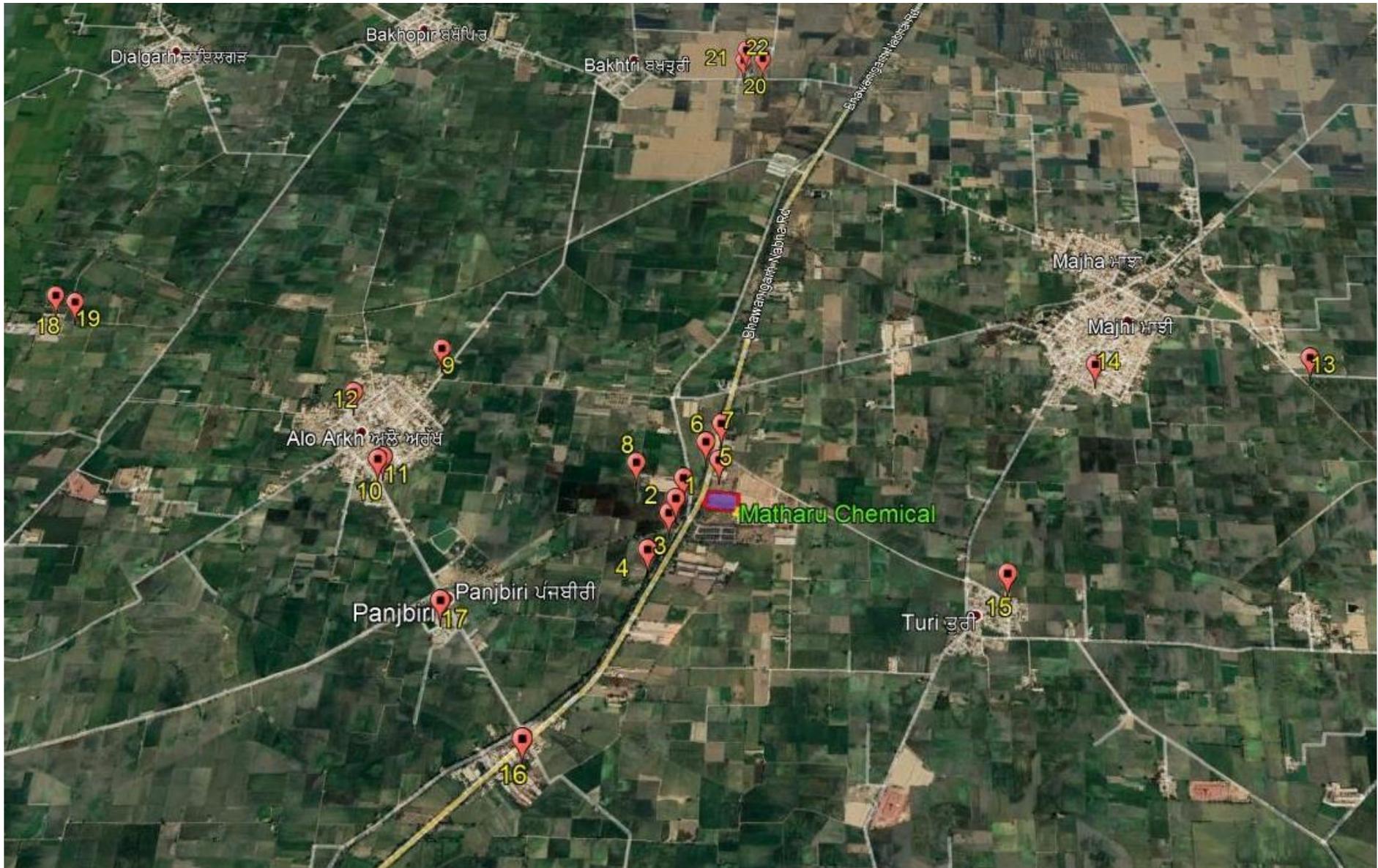
Annexure-IA			
Drinking Water Standards - BIS (IS-10500, 2012)			
S. No.	Parameters	Requirement (Acceptable limits)	Permissible limits in absence of alternative source
Organoleptic & Physical Parameters			
1	Colour, Hazen unit	5	15
2	Odour	Agreeable	Agreeable
3	Taste	Agreeable	Agreeable
4	Turbidity (NTU) Nephelometric Turbidity Unit	1	5
5	pH	6.5 - 8.5	No relaxation
6	Total Dissolved Solids, mg/l	500	2000
General parameters			
1	Aluminium (Al),mg/l	0.03	0.2
2	Ammonia(as total ammonia-N),mg/l	0.5	No relaxation
3	Anionic Detergents (as MBAS), mg/l	0.2	1.0
4	Barium, mg/l	0.7	No relaxation
5	Boron (B), mg/l	0.5	1.0
6	Calcium (Ca), mg/l	75	200
7	Chloramines(as Cl ₂), mg/l	4.0	No relaxation
8	Chloride (Cl), mg/l	250	1000
9	Copper (Cu), mg/l	0.05	1.5
10	Fluoride (F), mg/l	1	1.5
11	Free Residual Chlorine, mg/l, <i>Min</i>	0.2	1.0
12	Iron (Fe), mg/l	0.3	1.0
13	Magnesium (Mg), mg/l	30	100
14	Manganese (Mn), mg/l	0.1	0.3
15	Mineral Oil, mg/l	0.5	No relaxation
16	Nitrate (NO ₃), mg/l	45	No relaxation
17	Phenolic Compounds (as C ₆ H ₅ OH), mg/l	0.001	0.002
18	Selenium (Se), mg/l	0.01	No relaxation
19	Silver (Ag), mg/l	0.1	No relaxation
20	Sulphate (SO ₄), mg/l	200	400
21	Sulphide (as H ₂ S), mg/l	0.05	No relaxation
22	Total Alkalinity (as calcium carbonate), mg/l	200	600
23	Total Hardness (as CaCO ₃), mg/l	200	600
24	Zinc (Zn), mg/l	5	15
Parameters concerning Toxic Substances			
1	Cadmium (Cd), mg/l	0.003	No relaxation
2	Cyanide (CN)	0.05	No relaxation
3	Lead (Pb), mg/l	0.01	No relaxation
4	Mercury (Hg), mg/l	0.001	No relaxation
5	Molybdenum (Mo), mg/l	0.07	No relaxation
6	Nickel (Ni), mg/l	0.02	No relaxation
7	Polychlorinated biphenyls, mg/l	5	No relaxation
8	Polychlorinated aromatic hydrocarbons (PAH), mg/l	1	No relaxation
9	Arsenic (As), mg/l	0.01	No relaxation
10	Total Chromium (Cr), mg/l	0.05	No relaxation
11	Trihalomethanes:		
	a) Bromoform, mg/l	0.1	No relaxation
	b) Dibromochloromethane, mg/l	0.1	No relaxation
	c) Bromodichloromethane, mg/l	0.06	No relaxation
	d) Chloroform, mg/l	0.2	No relaxation

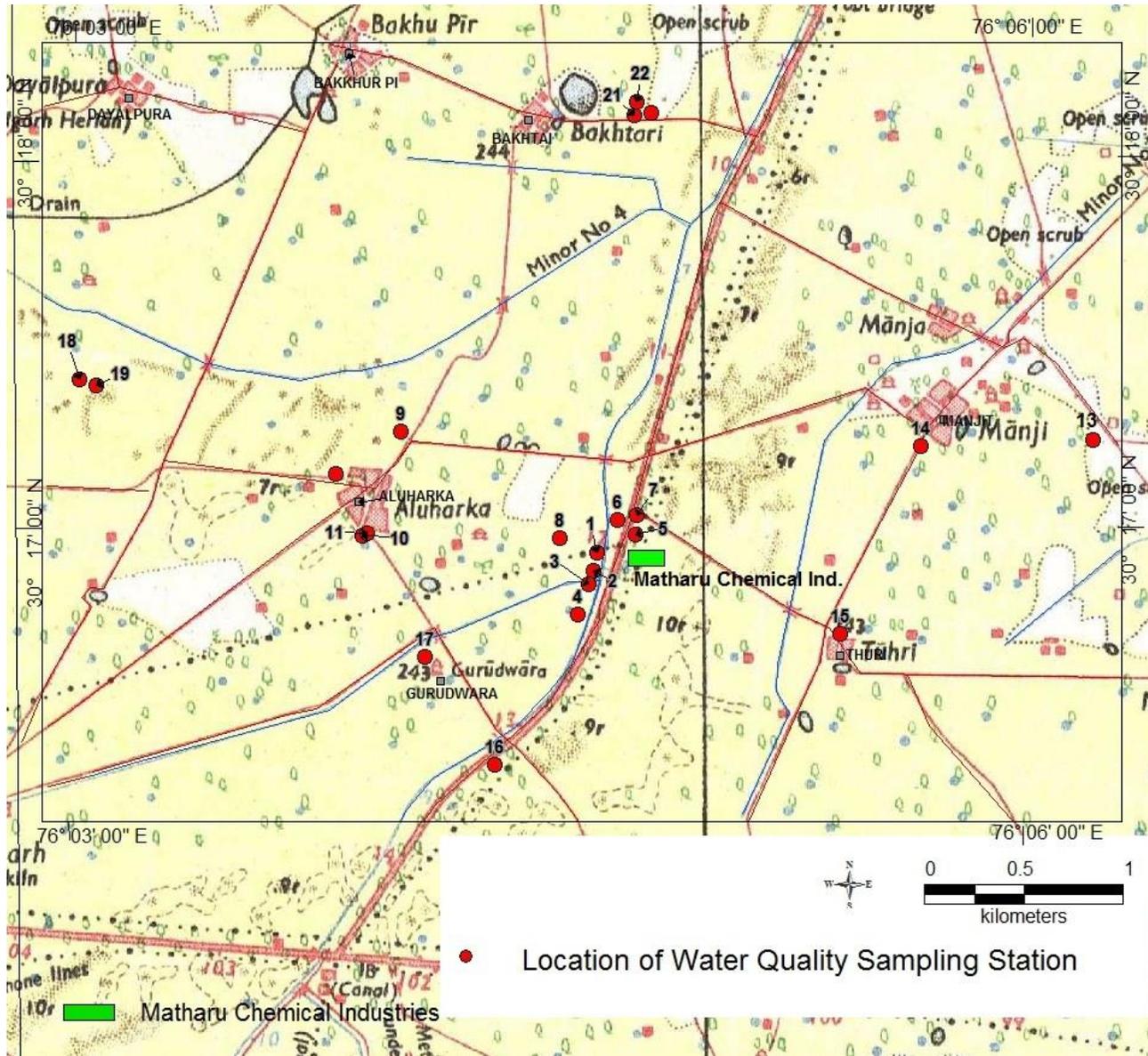
Annexure-2							
Test Report of Chemical Analysis of Ground Water Samples							
S. No	Location	Source	Longitude	Latitude	Depth in (m)	Analysis Date	TOC(NPOC) mg/l
1	Sh. Kulwinder Singh S/o Sh. Jang Singh Alowrkh	TW	76.079	30.281	116	21-Sep	97
2	Sh. Amrit Pal Singh S/o Sh. Rajwant Singh Alowrkh	TW	76.0777	30.281	83	21-Sep	29
3	Sh. Amrit Pal Singh S/o Sh. Rajwant Singh Alowrkh	TW	76.0772	30.281	131	21-Sep	7.35
4	Sh. Kulwinder Singh S/o Sh. Balbir Singh, Alowrkh	TW	76.0772	30.2806	113	21-Sep	0.38
5	M/S Super Pipes Right Side of Mathuru Chemical Industries Alowrkh	TW	76.079	30.2835	107	21-Sep	12.4
6	M/S Randhawa Filling Station Alowrkh	TW	76.0785	30.2848	54	21-Sep	0.67
7	Sh. Kulwinder Singh S/o Sh. Gurnam Singh, Alowrkh	TW	76.0796	30.2831	54	21-Sep	0.76
8	Sh. Dilbag Singh S/o Sh. Jagar Singh, Alowrkh	TW	76.0759	30.2832	61	21-Sep	3.61
9	Sh. Darsan Singh S/o Sh. Lal Singh, Alowrkh	SB	76.0675	30.2877	68	21-Sep	0.55
10	Sh. Kashmir Singh/o Sh. Joga Singh, Alowrkh	SB	76.0655	30.283	61	21-Sep	0.7
11	Water Works , Alowrkh	Water Supply TW	76.0657	30.2831	183	21-Sep	0.76
12	Sh. Devinder Singh/o Sh. Jaspal Singh, Alowrkh	SB	76.0641	30.2858	106	21-Sep	2.31
13	Water Supply Majhi Vill.	TW	76.1038	30.2873	152	21-Sep	0.33
14	Sh. Karam Singh S/o S. Sukhdev Singh, Majhi vill.	SB	76.0948	30.287	42	21-Sep	0.47

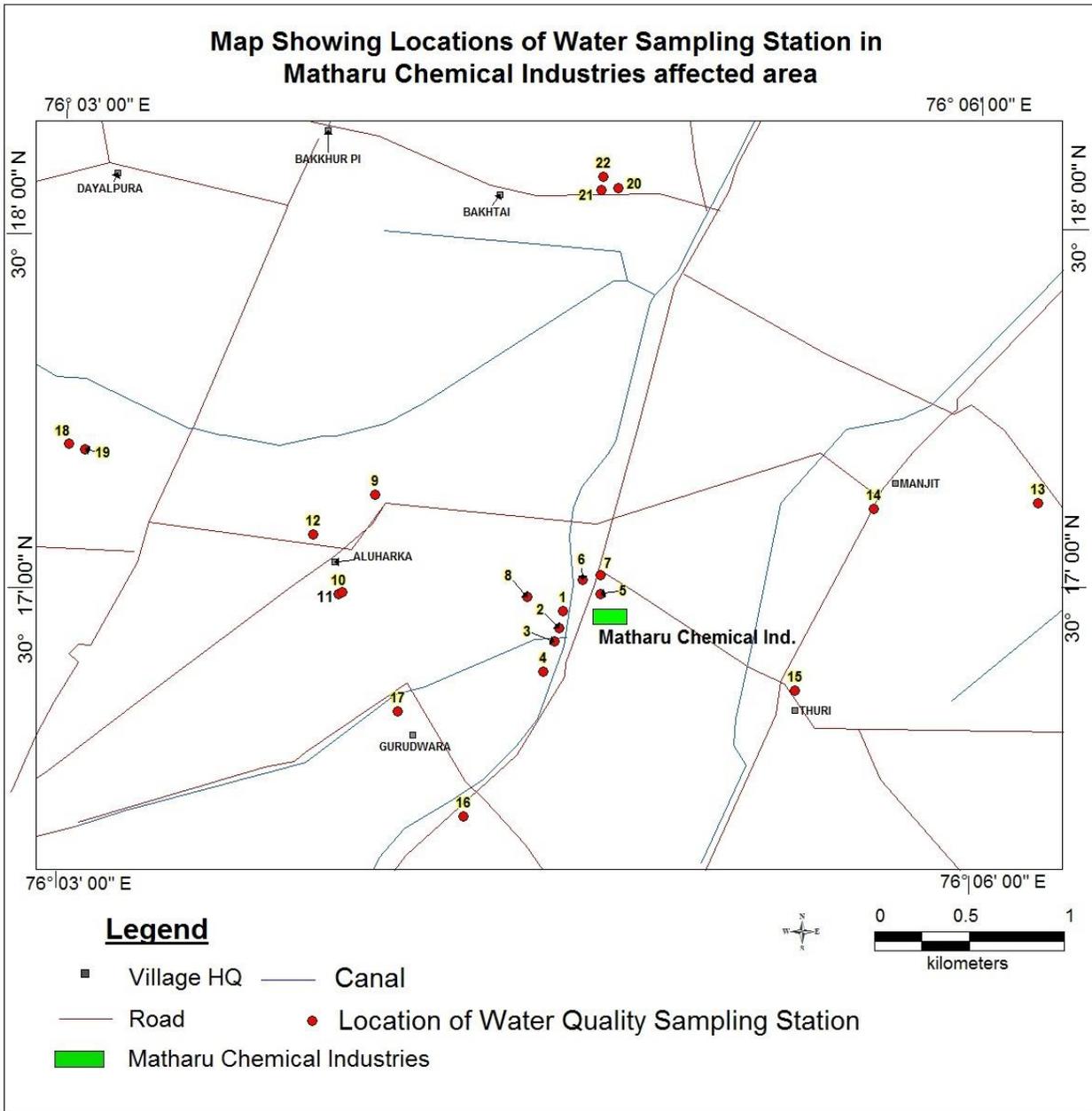
15	Singh Sabha Gurudwara Vill. Turi.	SB	76.0905	30.2785	55	21-Sep	0.58
16	M/S Gupta Interprises Filling Station Alowrkh	SB	76.0723	30.2726	49	21-Sep	0.29
17	Manji Shahib Gurudwara SahibVill. Alowrkh	TW	76.0687	30.2775	130	21-Sep	0.56
18	M/S Durga Das Poltry Farm, Vill. Dayalgarh	TW	76.0507	30.2901	61	21-Sep	2.34
19	Sh.Ajit Singh S/o Joginder Singh, Vill. DayalgarhS	SB	76.0516	30.2898	91	21-Sep	0.58
20	Water Supply Bakhtari Vill.	TW	76.0808	30.3021	137	21-Sep	0.36
21	Sh.Gurjant Singh S/o S.Bachan Singh,Bakhtari vill.	SB	76.0799	30.302	91	21-Sep	0.44
22	Smt. Asha Singh W/O S.Makand Singh,Bakhtari vill.	SB	76.08	30.3026	46	21-Sep	0.39

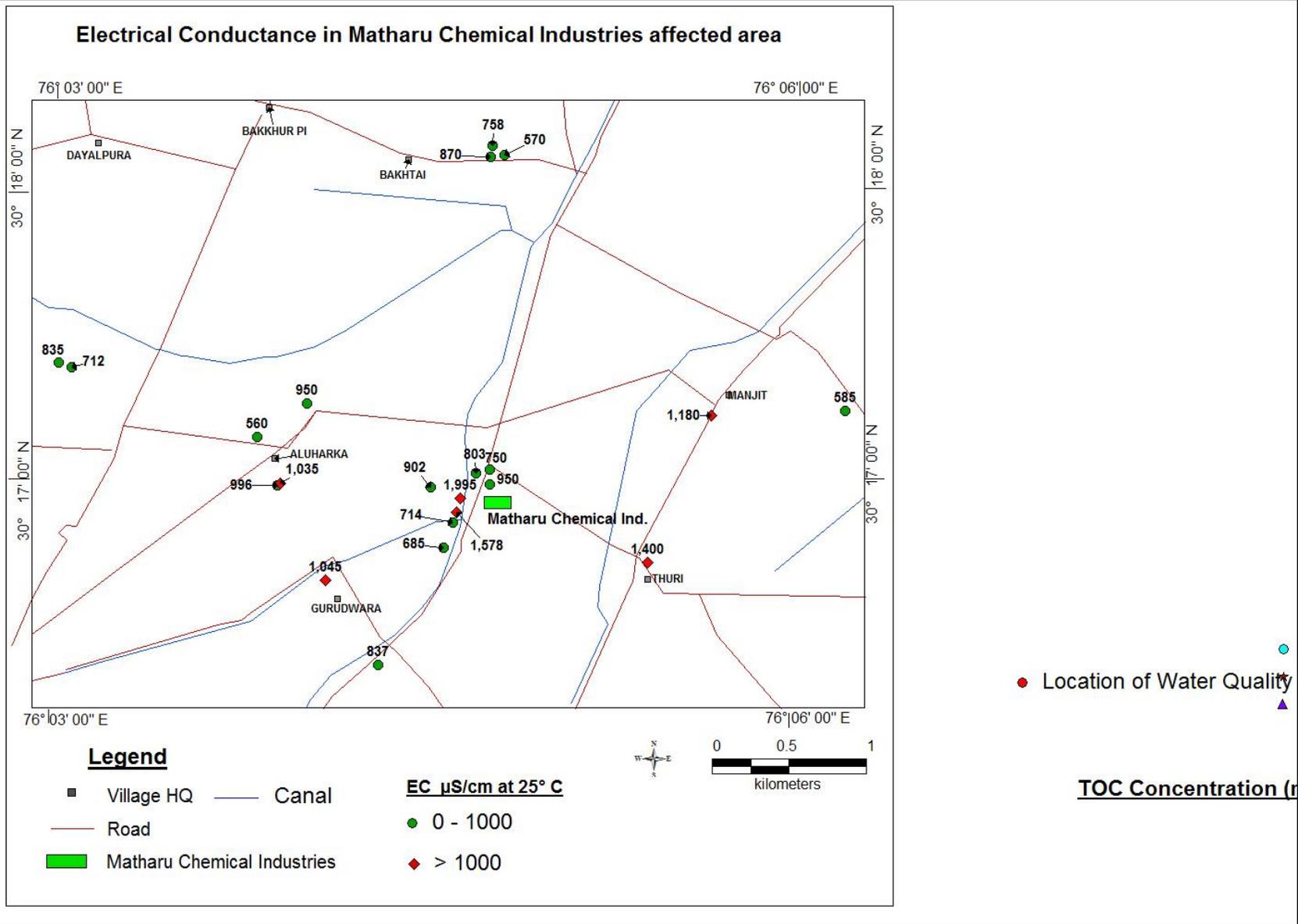
Ground Water Quality around the Matharu Industries, Alorakh, Bhawanigarh Block, Sangrur																		Annexure-3	
S. No	Location	Source	Depth	pH*	EC* in $\mu\text{S/cm}$ at 25 ^o C	CO ₃	HCO ₃	Cl*	SO ₄	NO ₃ *	F*	PO ₄	Ca*	Mg*	Na	K	SiO ₂	TH*as CaCO ₃	
						mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
1	Sh. Kulwinder Singh S/o Sh. Jang Singh Alorakh	TW	116	7.48	1995	*	*	*	*	352	0.35	*	*	*	210	9.4	*	*	
2	Sh. Amrit Pal Singh S/o Sh. Rajwant Singh Alorakh	TW	83	7.57	1578	*	*	*	*	124	0.50	*	*	*	190	9.2	*	*	
3	Sh. Amrit Pal Singh S/o Sh. Rajwant Singh Alorakh	TW	131	7.97	714	-	342	21	40	42	0.48	0.05	80	32	24	7.5	24	330	
4	Sh. Kulwinder Singh S/o Sh. Balbir Singh, Alorakh	TW	113	7.52	685	-	342	21	61	29	0.48	0.20	44	44	58	5.9	21	290	
5	M/S Super Pipes Right Side of Matharu Chemical Industries Alorakh	TW	107	8.00	950	-	464	42	74	95	0.39	B.D.L.	76	61	70	7.3	26	440	
6	M/S Randhawa Filling Station Alorakh	TW	54	7.42	803	-	464	28	B.D.L.	41	0.38	0.25	92	32	35	14	23	360	
7	Sh. Kulwinder Singh S/o Sh. Gurnam Singh, Alorakh	TW	54	7.68	750	-	403	21	5	48	0.40	0.26	60	36	38	20	23	300	
8	Sh. Dilbag Singh S/o Sh. Jagar Singh, Alorakh	TW	61	7.98	902	-	525	12	15	35	0.70	B.D.L.	48	29	108	27	22	240	
9	Sh. Darsan Singh S/o Sh. Lal Singh, Alorakh	SB	68	7.85	950	-	598	21	B.D.L.	27	0.55	0.22	60	27	128	6.6	23	260	
10	Sh. Kashmir Singh S/o Sh. Joga Singh, Alorakh	SB	61	8.00	996	-	586	42	12	28	0.55	0.25	36	27	170	6.5	24	200	

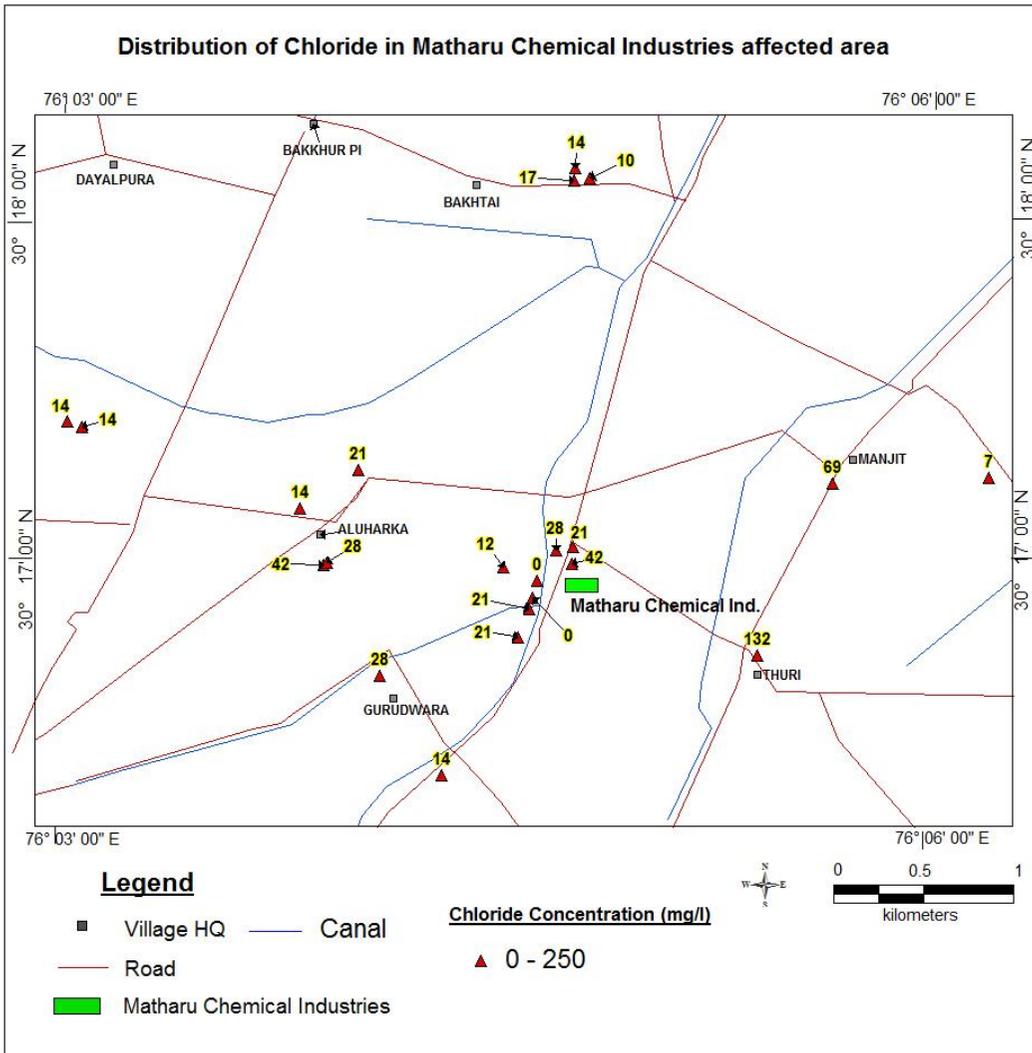
11	Water Works , Alowrkh	Water Supply TW	183	7.78	1035	-	647	28	35	22	0.60	0.22	56	29	165	6.3	23	260
12	Sh. Devinder Singh/o Sh.Jaspal Singh,Alowrkh	SB	106	8.12	560	-	391	14	B.D.L.	B.D.L.	0.58	0.18	28	24	78	4.4	20	170
13	Water Supply Majhi Vill.	TW	152	8.42	585	-	378	7	30	B.D.L.	0.60	0.20	16	24	98	2.8	17	140
14	Sh.Karam Singh S/o S.Sukhdev Singh,Majhi vill.	SB	42	7.62	1180	-	757	69	B.D.L.	17	0.58	0.25	68	34	192	7.2	25	310
15	Singh Sabha Gurudwara Vill. Turi.	SB	55	7.88	1400	-	659	132	40	30	0.55	0.26	68	39	210	7.5	25	330
16	M/S Gupta Interprises Filling Station Alowrkh	SB	49	7.68	837	-	488	14	B.D.L.	43	0.42	0.22	76	36	51	6.3	24	340
17	Manji Shahib Gurudwara SahibVill. Alowrkh	TW	130	7.32	1045	-	586	28	45	33	0.48	0.19	80	39	100	15	24	360
18	M/S Durga Das Poltry Farm, Vill. Dayalgarh	TW	61	7.38	835	-	513	14	15	55	0.48	0.23	68	56	43	7.1	24	400
19	Sh.Ajit Singh S/o Joginder Singh,. Vill. DayalgarhS	SB	91	8.00	712	-	452	14	B.D.L.	34	0.52	0.22	52	46	44	6.7	23	320
20	Water Supply Bakhtari Vill.	TW	137	8.20	570	-	403	10	B.D.L.	B.D.L.	0.55	0.18	28	27	75	4.3	19	180
21	Sh.Gurjant Singh S/o S.Bachan Singh,Bakhtari vill.	SB	91	7.85	870	-	488	17	35	41	0.70	0.15	80	39	60	6.8	19	360
22	Smt. Asha Singh W/O S.Makand Singh,Bakhtari vill.	SB	46	7.78	758	-	439	14	32	30	0.47	0.20	80	34	43	6.4	24	340

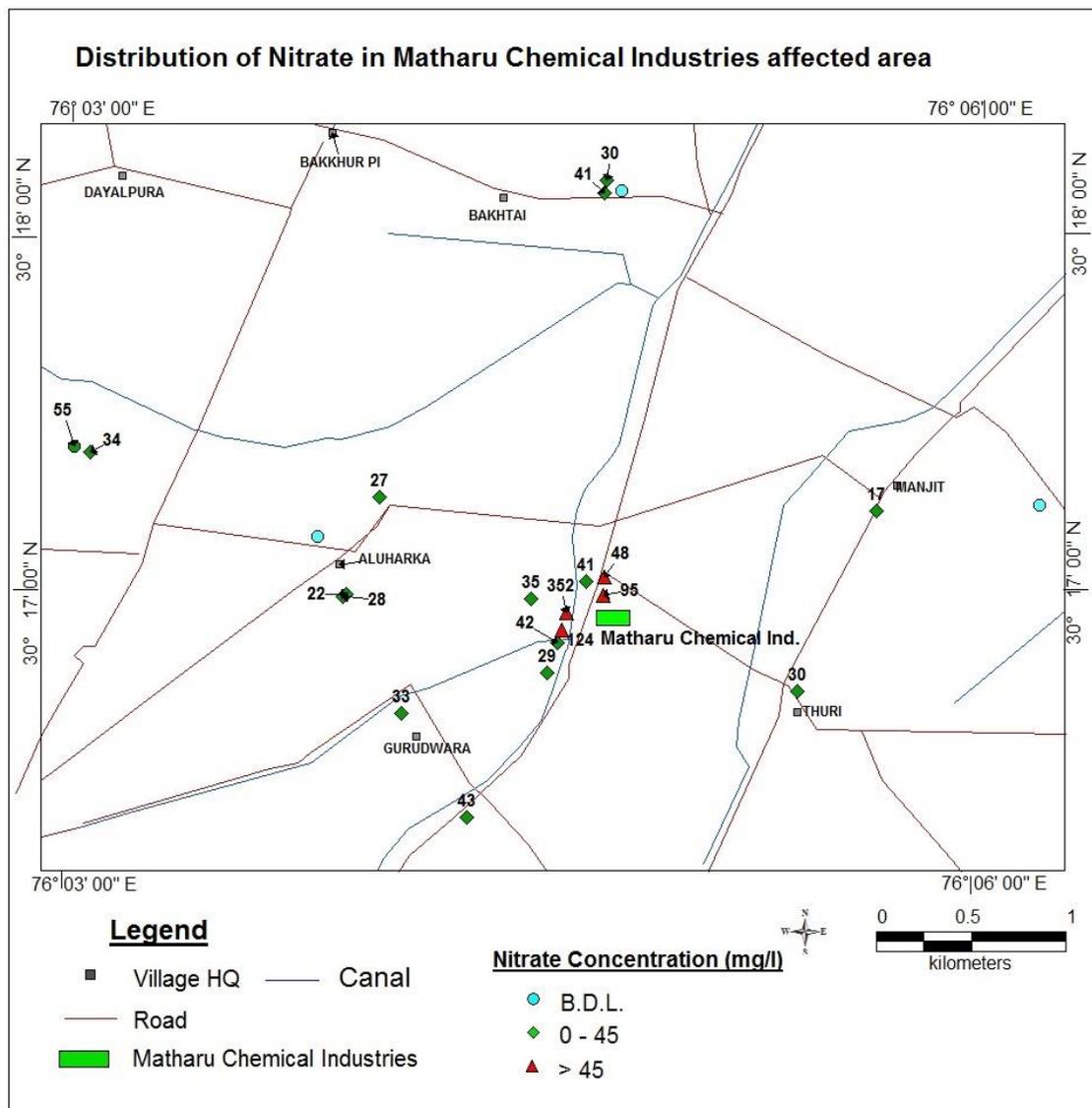


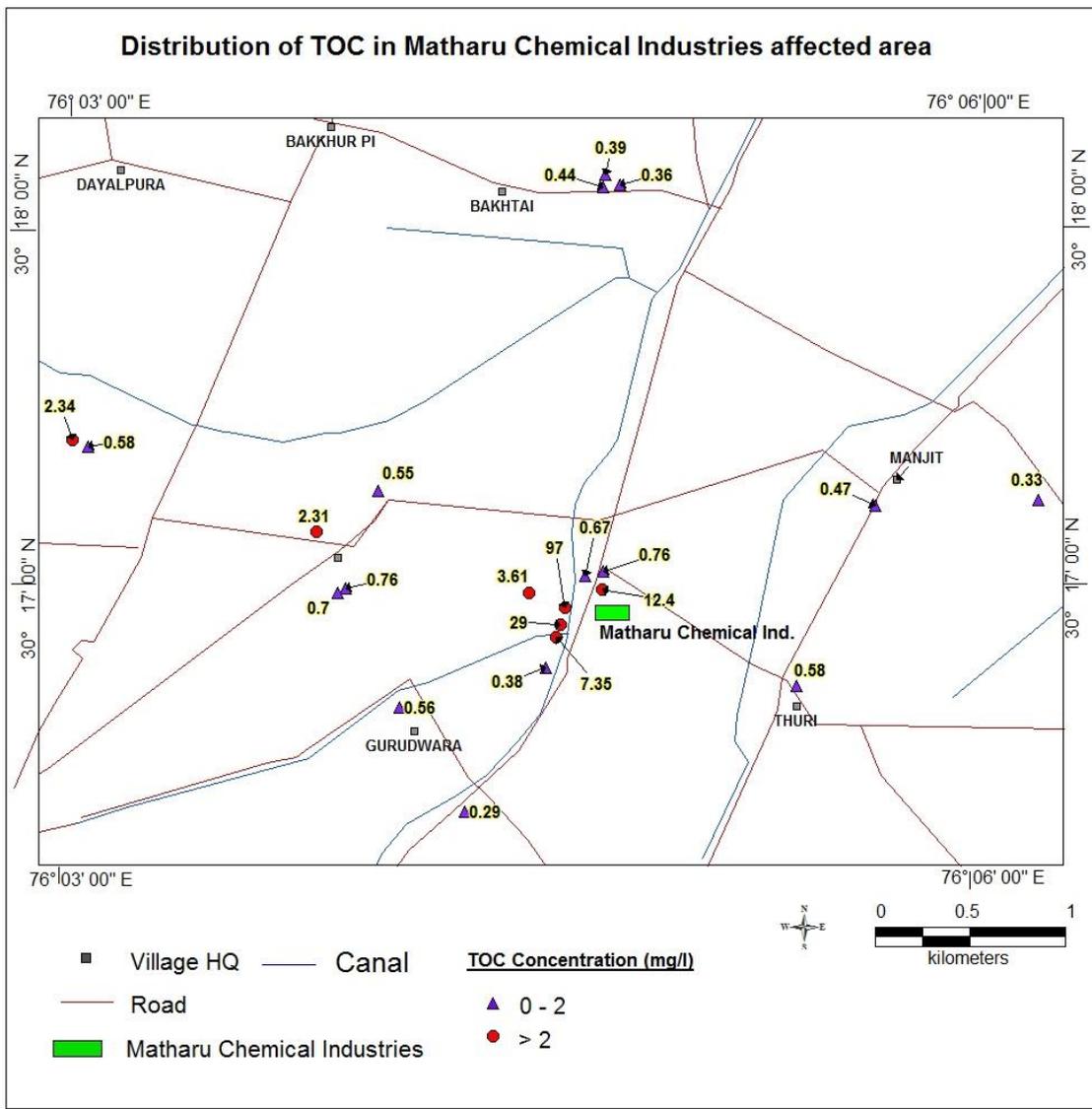












PUNJAB POLLUTION CONTROL BOARD VATAVARAN BHAVAN,
NABHA ROAD, PATIALA
GROUND WATER REPORT

1. Laboratory Sample No.	GW 872-885/H.O.Lab Monitoring/2021
2. ULR Number	ULR-TC704518000000003890
3. Name of Industry	Ground Water Samplee collected from the vicinity of M/s Matharu Chemical Industries, Bhawanigarh (Now in Dismantled Condition) Distt. Sangrur.
4. Name of Sample collecting Officer	Er. Sachin Singla, AEE
5. Designation of authorizing Test	EE, RO, Sangrur
6. Date & Time of Sample collection	09.09.2021
7. Date & Time of Sample receipt in Lab.	09.09.2021
8. Period of Analysis	09.09.2021 to 20.09.2021
9. Test Methods	As per relevant parts of IS:3025 & Methods of APHA

Results

As per Annexure-A

K. K. Singh
20/9/21

 Analyzed by

--End of Report--

Endst. No: 20714-16

Kiran Jaiswal
20/9/21

 Scientific Officer

Di
21/9/2021

- A copy of the above is forwarded to the:-
1. The Chief Environmental Engineer (Water), Punjab Pollution Control Board, Ludhiana.
 2. The Senior Environment Engineer, Punjab Pollution Control Board, Zonal Office-II, Patiala.
 - ✓ The Environment Engineer, Punjab Pollution Control Board, Regional Office, Sangrur.

Ravi
Asst. Scientific Officer
20/9/21

(GW 872-885)

(M/s Matharu Chemical Industries Bhawanigarh)

Sr. no.	Parameters	BOD mg/l	SAR	Phenolic Compound mg/l	COD
1	Village Aloarkh (In front of M/s Matharu Chemical)	33	2.04	BDL	284
2	Village Aloarkh (Dept of Tubewell) <i>280 ft</i>	22	1.77	BDL	262
3	Village Aloarkh (Sh. Amrit Pal Singh S/o Rajwant Singh)	BDL	0.68	BDL	BDL
4	Village Aloarkh (Tubewell of Farmer Sh. Kulwinder Singh)	BDL	0.75	BDL	BDL
5	M/s Super Pipes Industries, Tehsil Bhawanigarh, Sangrur	BDL	0.89	BDL	BDL
6	M/s Randhayan Transport Services, Petrol Pump, Village Majhi, Nabha Road,	BDL	0.79	BDL	BDL
7	Kulwinder Singh S/o Gurnam Singh, Vill. Majhi Bhawanigarh	BDL	0.83	BDL	BDL
8	Village Aloarkh (From Tubewell of Sh. Dilbagh Singh)	BDL	1.07	BDL	BDL
9	Residence of Darshan Singh S/o Lal Singh Village Aloarkh, Bhawanigarh	BDL	1.17	BDL	BDL
10	Residence of Sh. Kashmir Singh S/o Jaga Singh, Village Alorkh, Bhawanigarh	BDL	1.36	BDL	BDL
11	Site of Construction of Water Storage tank of Village Aloarkh	BDL	1.34	BDL	BDL
12	Residence of Sh. Davinder Singh S/o Jaspal Singh	BDL	0.86	BDL	BDL
13	Water Tank Village Majhi, Tehsil Bhawanigarh	BDL	1.05	BDL	BDL
14	Gurdwara Singh Sabha, Village Turi Bhawanigarh.	BDL	1.64	BDL	24

K. K. K.



Punjab Biotechnology Incubator

(Department of Science, Technology & Environment, GoP)

A Component of Knowledge City, Mohali

An NABL Accredited Facility



BIS Approved | FSSAI Empanelled | EIC Approved | APEDA Approved | PPCB Approved | Notified State Water Lab - GoP | Notified Under EPA - GoI



No.PBTI/FA0/131221/001950 to 1971

Dated : 15/12/2021

ULR : TC611721000000892F to 913 F

TEST REPORT

Sample Registration No. : PBTI/FA0/131221/001950 to 1971
Sample code given by customer : As per page no.2

Issued to:

Mr. S.K Mohiddin, Sr. Hg (Sc C),
Central Ground Water Board,
Department of Water Resources, RD & GR, North Western Region, Plot No. 3 B, Sector -27 A
Chandigarh
UT

SAMPLE PARTICULARS

Your Ref. No. : Letter No. 10-199/NWR/CS/OA-169/2021-708, dt. 13/12/2021
Date of Receipt : 13/12/2021
Name/Nature of sample : **Ground Water**
Sample code given by customer : As per page no.2
Condition of the sample : Intact coded sample under unrefrigerated conditions
Brand name : NM
Qty/Pkg. : 100ml each approx in plastic bottles
Batch No.: : NM
Date of Manufacture : : NA/NM
Sampling Method : : Sample not drawn by PBTI
Test Start Date : : 13/12/2021
Test Completion Date : : 15/12/2021

[Signature]
15/12/2021

Authorized Signatory
Punjab Biotechnology Incubator Lab
Employee Code: 16

- Note:**
1. The above results pertain only to the sample tested.
 2. There is no addition, deviation or exclusion from the method mentioned.
 3. The report shall not be used for advertising or any legal purpose without written permission from the Chief Executive Officer, Punjab Biotechnology Incubator.
 4. This report cannot be re-produced, except when in full, without the written permission from the Chief Executive Officer, Punjab Biotechnology Incubator.
 5. Perishable samples will be destroyed after testing, others after one month from the date of issue of the report, unless otherwise agreed with the customer or as required by the applicable regulations.

Format No : PBTI/F/7.8/02
Revision No. 00 & 25.04.2019

Page No. 1/2

National Referral Lab for LMO/GMO Detection under Seeds Act 1966 | Referral Lab under Food Safety and Standards Act 2006

C-134, Industrial Focal Point, Phase-VIII, SAS Nagar (Mohali) - 160 071, Punjab, India

Phone : +91-172-5020893, 5093595, 5020894 Tele. Fax : +91-172-5020895

E-mail : pbt2005@yahoo.com, Website : www.pbtlabs.com

ULR: TC61172100000892 F to 897 F

Sample Registration No. : PBTI/FAO/131221/001950 to 1955

Test Results

Sample Registration No.	001950	001951	001952	001953	001954	001955	Standard / Specification / Method Followed	
Sample code given by customer	Sample Code 904 - T/21 Location- Sh. Kulwinder Singh S/o Sh. Jang Singh, Alowrkh, Block - Bhawanigarh, District- Sangrur, Depth- 380feet, Source- Tubewell	Sample Code-905 T/21, Sh Amrit Pal Singh, S/o Sh. Rajwant Singh, Alowrkh, Block- Bhawanigarh, District- Sangrur, Depth- 280feet, Source- Tubewell	Sample Code-906 T/21, Sh Amrit Pal Singh, S/o Sh. Rajwant Singh, Alowrkh, Block- Bhawanigarh, District- Sangrur, Depth- 430feet, Source- Tubewell	Sample Code-907 T/21, Sh Kulwinder Singh, S/o Sh. Balbir Singh, Alowrkh, Block- Bhawanigarh, District- Sangrur, Depth- 370feet, Source- Tubewell	Sample Code-908 T/21, Ms Super Pipes, Right side of Mathuru Chemical Ind., Alowrkh, Block- Bhawanigarh, District- Sangrur, Depth- 350feet, Source- Tubewell	Sample Code-909 T/21, Ms Randhawa Filling Station, Alowrkh Block- Bhawanigarh, District- Sangrur, Depth- 180, Source- Tubewell	APHA 3125 B (By ICP-MS)	
	1. Copper, mg/l	0.07	0.03	0.01	0.006	0.01		0.008
	2. Iron, mg/l	0.22	0.10	0.09	0.07	0.12		0.04
	3. Manganese, mg/l	0.14	0.09	0.03	0.007	0.04		BDL (MDL:0.005)
	4. Selenium, mg/l	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)		0.006
	5. Silver, mg/l	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)		BDL (MDL:0.005)
	6. Zinc, mg/l	0.05	0.03	0.05	0.03	0.03		0.12
	7. Cadmium, mg/l	BDL (MDL:0.001)	BDL (MDL:0.001)	BDL (MDL:0.001)	BDL (MDL:0.001)	BDL (MDL:0.001)		BDL (MDL:0.001)
	8. Lead, mg/l	BDL (MDL:0.005)	BDL (MDL:0.005)	0.008	BDL (MDL:0.005)	BDL (MDL:0.005)		BDL (MDL:0.005)
	9. Nickel, mg/l	0.007	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)		BDL (MDL:0.005)
	10. Arsenic, mg/l	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)		BDL (MDL:0.005)
11. Total Chromium	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)		

BDL: Below Detection Limit

MDL: Method Detection Limit

Results



Authorized Signatory

[Handwritten Signature]
15/12/2021

ULR: TC61172100000898 F to 903 F

Sample Registration No. : PBTI/FAO/131221/001956 to 1961

Test Results

Sample Registration No.	001956	001957	001958	001959	001960	001961	Standard / Specification / Method Followed
Sample Code given by customer	Sample Code-910 T/21, Sh Kulwinder Singh, S/o Sh. Gurnam Singh, Alowrkh, Block-Bhawanigarh, District-Sangrur, Depth-180feet, Source-Tubewell	Sample Code-911 T/21, Sh Dilbag Singh, S/o Sh. Jagar Singh, Alowrkh, Block-Bhawanigarh, District-Sangrur, Depth-200 feet, Source-Tubewell	Sample Code-912 T/21, Sh Darshan Singh, S/o Sh. Lal Singh, Alowrkh, Block-Bhawanigarh, District-Sangrur, Depth-225 feet, Source-SB	Sample Code-913 T/21, Sh Kashmir Singh, Sh Joga Singh, Alowrkh, Block-Bhawanigarh, District-Sangrur, Depth-200feet, Source-SB	Sample Code-914 T/21, Water Works, Alowrkh, Block-Bhawanigarh, District-Sangrur, Depth-600feet, Source-Water Supply Tubewell	Sample Code-915 T/21, Sh Devinder Singh, S/o Sh. Jaspal Singh, Alowrkh, Block-Bhawanigarh, District-Sangrur, Depth-350feet Source-SB	
Sr. No	Results						
Parameter	0.006	BDL (MDL:0.005)	0.006	0.01	0.02	0.02	
1. Copper, mg/l	0.006	0.06	0.06	0.16	0.28	0.12	
2. Iron, mg/l	0.007	0.02	0.006	0.03	0.07	0.03	
3. Manganese, mg/l	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	0.006	BDL (MDL:0.005)	BDL (MDL:0.005)	
4. Selenium, mg/l	BDL (MDL:0.005)	0.02	0.03	0.03	0.03	0.05	
5. Silver, mg/l	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	
6. Zinc, mg/l	BDL (MDL:0.001)	BDL (MDL:0.001)	BDL (MDL:0.001)	BDL (MDL:0.001)	BDL (MDL:0.001)	BDL (MDL:0.001)	
7. Cadmium, mg/l	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	
8. Lead, mg/l	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	
9. Nickel, mg/l	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	
10. Arsenic, mg/l	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	
11. Total Chromium	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	

BDL: Below Detection Limit

MDL: Method Detection Limit



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15/12/2021

ULR: TC61172100000910 F to 913 F

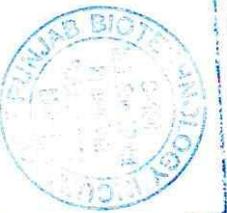
Sample Registration No. : PBT/FAO/131221/001968 to 1971

Test Results

Sample Registration No.	001968	001969	001970	001971	Standard / Specification / Method Followed
Sample code given by customer	Sample Code-922 T/21, Sh Ajit Singh, S/o Joginder Singh, Vill, Dayalgarh, Block Bhawanigarh, District- Sangrur, Depth-300ft, Source-SB	Sample Code-923 T/21, Water Supply, Bakhari Vill, Block Bhawanigarh, District- Sangrur, Depth-450ft, Source - Tubwell	Sample Code-924 T/21, Sh Gurjant Singh, S/o S. Bachan Singh, Bakhari vill, Block Bhawanigarh, District- Sangrur, Depth-300ft, Source- SB	Sample Code-925 T/21, Smt Asha Singh, W/o S. Makand Singh, Bakhari, Block - Bhawanigarh, District- Sangrur, Depth-150ft, Source- SB	APHA 3125 B (By ICP-MS)
Sr. No	Results				
1.	Copper, mg/l 0.03	BDL (MDL:0.005)	0.007	0.007	
2.	Iron, mg/l 0.10	0.47	0.11	0.17	
3.	Manganese, mg/l BDL (MDL:0.005)	0.02	BDL (MDL:0.005)	BDL (MDL:0.005)	
4.	Selenium, mg/l BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	
5.	Silver, mg/l BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	
6.	Zinc, mg/l 0.06	0.03	0.06	0.04	
7.	Cadmium, mg/l BDL (MDL:0.001)	BDL (MDL:0.001)	BDL (MDL:0.001)	BDL (MDL:0.001)	
8.	Lead, mg/l 0.007	BDL (MDL:0.005)	BDL (MDL:0.005)	0.007	
9.	Nickel, mg/l BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	
10.	Arsenic, mg/l BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	
11.	Total Chromium BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	

BDL: Below Detection Limit

MDL: Method Detection Limit



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15/12/2021

ULR: TC61172100000904 F to 909 F

Sample Registration No. : PBTI/FAO/131221/001962 to 1967

Test Results

Sample Registration No.	001962	001963	001964	001965	001966	001967	Standard / Specification / Method Followed
Sample code given by customer	Sample Code-916 T/21, Water Supply, Majni Vill, Bhawanigarh, District- Sangrur, Depth-500feet, Source- Tubewell	Sample Code-917 T/21, Sh. Karam Singh, S/o Sh. Sukhdev Singh, Majni Vill, Bhawanigarh, District- Sangrur, Depth-140 feet, Source- SB	Sample Code-918 T/21, Singh Sabha Gurudwara, Vill- Turi, Bhawanigarh, District- Sangrur, Depth-180 feet, Source- SB	Sample Code-919 T/21, M/s Gupta Enterprises Filling Station, Alowrkh, Block- Bhawanigarh, District- Sangrur, Depth-160feet, Source- SB	Sample Code-920 T/21, Manji Shahib Gurudwarah Sahib vill, Alowrkh, Block - Bhawanigarh, District- Sangrur, Depth-425ft, Source- Tubewell	Sample Code-921 T/21, M/s Durga Das, Polary Farm, Vill, Dayalgarh, Block Bhawanigarh, District- Sangrur, Depth-200ft, Source- Tubewell	
Sr. No	Results						
1.	Copper, mg/l 0.02	0.03	0.02	0.02	0.02	0.007	
2.	Iron, mg/l 0.08	0.14	0.08	0.07	0.58	0.11	
3.	Manganese, mg/l BDL (MDL:0.005)	0.03	0.02	BDL (MDL:0.005)	0.02	BDL (MDL:0.005)	
4.	Selenium, mg/l BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	
5.	Silver, mg/l BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	APHA 3125 B (By ICP-MS)
6.	Zinc, mg/l 0.04	0.04	0.06	0.04	0.04	0.04	
7.	Cadmium , mg/l BDL (MDL:0.001)	BDL (MDL:0.001)	BDL (MDL:0.001)	BDL (MDL:0.001)	BDL (MDL:0.001)	BDL (MDL:0.001)	
8.	Lead, mg/l BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	0.006	BDL (MDL:0.005)	
9.	Nickel, mg/l BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	
10.	Arsenic, mg/l BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	
11.	Total Chromium BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	BDL (MDL:0.005)	

BDL: Below Detection Limit

MDL: Method Detection Limit



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Page 4 of 5

Annexure-3

Additional Comments/Information by CPCB Member

The outcome of the studies conducted by the Joint Committee and the earlier report of investigation of the same site by PPCB through Thapar Centre of Industrial Research and Technology (TCIRD) under the directions and permission of Hon'ble High Court of Punjab and Haryana in Civil Writ Petition No. 3481/2007 were discussed in detail by the technical members of The Joint Committee representing MoEF&CC, CPCB and PPCB, in the office of PPCB, Regional Office, Sangrur on **February 21, 2022**, for inclusion in the final report. However, some of the points, which were significantly important from environment, public health and remediation point of view including output of earlier investigations, were found to be missing and not included in the final draft report circulated for comments of the members of the Joint Committee on **March 25, 2022**, followed by virtual meeting on **29/3/2022**. It was requested by CPCB member to incorporate these points in the final report, however, it was decided in the meeting that the additional details, which according to CPCB member, are significant from environment, public health and remediation point of view may also be submitted as a separate Annexure alongwith the Report of the Joint Committee, for the consideration of Hon'ble National Green Tribunal.

Accordingly, the following additional information/details are being submitted to supplement the report of the Joint Committee with an intention to only and only technically assist the Hon'ble Tribunal, in this matter:

1. The report of investigation done by PPCB at the same site through Thapar Centre for Industrial Research and Technology (TCIRD) titled “**Assessment of Length, Breadth and Depth of Ground Water Contamination**” under the directions of Hon'ble High Court of Punjab and Haryana was submitted and taken on the record by the Hon'ble High Court on 10/11/2011. According to TCIRD report, the profile of salt level in the ground water indicated that the groundwater has been contaminated by the following two sources:
 - a) Percolation and leaching of contaminants from the onsite solid/hazardous waste storage and disposal and from the solar evaporation ponds.
 - b) Direct injection of wastewater into the groundwater at 150 ft 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).

2. TCIRD also conducted assessment of groundwater contamination through peizometric sampling at various depths to establish whether the groundwater contamination was from the percolation/leaching of contaminants from the solar evaporation ponds and/or solid/hazardous waste storage tanks or from the intentional injection of wastewater into the groundwater. The results of analysis of the samples drawn through peizometer are reproduced in the following table:

Table: Quality of ground water at various depth in the peizometer installed at site.

Depth (feet)	Iron (mg/L)	Calcium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	pH	COD (mg/L)	Methanol extractable (mg/L)
105	0.25	566	202	534	47.6	85.4	7.8	132	227
120	0.40	85	341	560	47.6	99.3	7.7	161	597
130	1.17	156	538	887	85.2	141	7.7	388	767
140	0.94	1440	627	862	75.5	175	7.7	443	1060
150	1.30	196	719	1050	154	199	8.0	571	988
160	1.41	103	675	959	116	159	8.1	443	1200

3. It may be seen from the above Table that **Chemical Oxygen Demand (COD)** of the ground water from a depth of 105 ft to 160 ft was found to be ranging from 132 mg/l (105 ft) to 571 mg/l (150 ft). The higher concentration of COD at higher depth in comparison to lower depth, indicates contamination through direct injection of untreated industrial effluent upto a depth of 150-160 ft. The methanol extractables and other components were also found to be in higher concentration at higher depth in comparison to lower depth, further confirming direct injection of effluent. It may be noted that the treated effluent discharge standard for Chemical Oxygen Demand (COD) prescribed for "dye and dye intermediate industry" is 250 mg/l. Therefore, ground water contaminated with the industrial effluent and having COD 570 mg/l, can not be termed as water. The quality of this ground water (at the point where peizometer was installed and monitored by TCIRD) upto the depth of 130-160 ft having COD of 338-571 mg/l is worse than the quality of treated industrial effluent. It was estimated by TCIRD based on the material balance calculations that Industry might have injected 28000 m³ of Industrial waste water upto a depth of 140-150 ft.
4. The quantity of solid waste and hazardous waste generated and dumped unscientifically at site by the Industry was also assessed scientifically by TCIRD on the basis of production made by the industry during its existence and the material balance calculations. It was estimated that industrial unit might have generated over 17,000 tons of gypsum sludge,

over 6,000 tons of iron oxide sludge, and wastewater containing over 2,000 tons of naphthalene based organic compounds and over 40,000 tons of inorganic salts (mainly sulfates, chlorides and nitrates of sodium). Except selling out a small fraction, the industrial unit retained all the gypsum sludge and the iron oxide sludge within the premises. **The industrial unit remained zero effluent discharging unit. It discharged no wastewater and no secondary waste (organic waste and incineration ash generated from the wastewater treatment and handling) beyond its premises. The only exception is transport of 103 tons organic waste/incineration ash during dismantling after 2005 to the TSDF, Nimbua, Derabassi. Therefore, It may be concluded that a total of 65000 tons-103 (Sent to TSDF) = 64897 MT waste was unscientifically dumped at Site by the Industry.**

5. These details w.r.t. quality and quantity of industrial effluent and Solid/Hazardous waste injected and dumped available since 2010 through a scientific study conducted by TCIRD, for PPCB, were followed by studies conducted by CPCB and NEERI under the directions of Hon'ble NGT in the matter of OA No. 35/2013. The investigation of the same site through physical inspection and excavation of the site by the Joint Committee in the present matter of OA No. 169/2021, is a reconfirmation of the fact the Hazardous Waste which was found to be unscientifically dumped in 2019-10, through a study conducted by PPCB through TCIRD, is still lying there and needs immediate remediation, in the interest of environment and public health.
6. The detailed report of study conducted by PPCB through Thapar Centre for Industrial Research and Development (TCIRD) and filed before Hon'ble High Court of Punjab and Haryana in Civil Writ Petition No. 3481/2007 and considered by Hon'ble NGT in the matter of OA No. 35/2013 (THC) is enclosed herewith, as **Annexure-3(i)**. The Orders of Hon'ble National Green Tribunal in the matters, wherein this report of PPCB prepared through TCIRD was considered i.e OA No. 35/2013 (THC) dated 23/9/2015 and Review Application No. 39/2015 in OA No. 35/2013 (THC) and OA No. 2016, are also enclosed herewith as **Annexure-3 (ii)** and **Annexure-3(iii)**
7. **The quantity of solid waste and hazardous waste generated and dumped unscientifically at site by the Industry was also assessed scientifically by TCIRD for PPCB.** It was estimated that industrial unit might have generated over 17,000 tons of gypsum sludge, over 6,000 tons of iron oxide sludge, and wastewater containing over

2,000 tons of naphthalene based organic compounds and over 40,000 tons of inorganic salts (mainly sulfates, chlorides and nitrates of sodium). Except selling out a small fraction, the industrial unit retained all the gypsum sludge and the iron oxide sludge within the premises. *Therefore, it is concluded that a total of 65000 tons-103 (Sent to TSDF) = 64897 MT waste was unscientifically dumped at Site by the Industry. The Investigations by the Joint Committee in the present matter is a reconfirmation of the fact that the Hazardous Waste which was found to be unscientifically dumped, through a study conducted by PPCB through TCIRD in 2009-10, is still lying there and needs immediate remediation, in the interest of environment and public health.*

8. Short Term Remediation Plan (0-1 year) may include the following components:

● **Marking the five contaminated tube-wells as “Water not fit for drinking:**

Since, the water from the five tube-wells was found to be contaminated and yielding the , these are required to be marked as “**Water not fit for drinking**”, by the District Administration so that this water is not used for drinking purpose by human beings and animals. This is important to avoid the contaminants to become a component of food chain through use of animal products such as milk by the children. *Alternate arrangements are required to be done to provide safe drinking water to the population, currently using these bore-wells for drinking purpose, by installing deeper bore-wells after conducting analysis of the ground water.*

● **Preventing use of ground water upto 160 ft depth for irrigation/agriculture:**

The ground water was found to be heavily contaminated from a depth of 105 ft to 160 ft, having COD ranging from 132 mg/l (105 ft) to 571 mg/l (150 ft) through direct injection of untreated effluent a depth of 150-160 ft, as per the study conducted by PPCB through TCIRD in the year 2009-10 using peizometric monitoring, The methanol extractables and other components were also found to be in high concentration. *The treated effluent discharge standard for Chemical Oxygen Demand (COD) prescribed for "dye and dye intermediate industry" is 250 mg/l, which is permitted for irrigation. Therefore, ground water contaminated with the industrial effluent and having COD 570 mg/l, may not be considered as water and is not fit for irrigation/agriculture purpose.* It is therefore recommended that *no new bore-well is installed in this area upto a depth of upto 160 ft for irrigation/agriculture purpose on “Precautionary Principle”, until or unless remediation is done to remove the contamination from the ground water. The necessary directions in this regard may be given by the District Administration to the concerned agencies.*

- **Removal of Hazardous waste (Approx. 65000 MT) unscientifically dumped at site:**

It was established that a total of 65000 tons-103 (Sent to TSDF) = 64897 MT waste was unscientifically dumped at Site by the Industry in the report of PPCB (Conducted through TCIRD), **which was filed and considered by Hon'ble High Court of Punjab and Haryana in the Civil Writ Petition No. 3481/2007 and Hon'ble National Green Tribunal in the matter of OA No. 35/2013 (THC).** Further, the Joint Committee in the present matter of OA No. 169/202 has investigated and found that the Hazardous Waste which was found to be unscientifically dumped, is still lying there and needs immediate remediation, in the interest of environment and public health. **This hazardous waste is required to be removed on utmost priority for safe & scientific disposal through an expert agency, so as to eliminate this source of contamination of the ground water through leaching.**

While the area of spread of the Hazardous Waste dumped unscientifically may vary, **the quantum of 65000 MT estimated based on the production made by the Industry during its existence upto 2005 and material balance calculation is fixed,** since it is still lying there and Industry is not in existence since 2005. **The estimate for the minimum cost of remediation plan, for removal and scientific disposal of approx. 65000 MT Hazardous waste dumped unscientifically at the site may be as follows:**

S.No.	Particulars	Details
1.	Tentative quantity of the Hazardous waste to be removed/remediated	65000 MT
2.	Tentative Volume of the soil mixed with hazardous waste, to be removed/remediated considering the Sp. Gravity as 1.4	$65000/1.4 = 46429 \text{ m}^3$
3.	Estimated Cost of Direct landfill disposal Charges at TSDF assuming that no further treatment at TSDF is required (Ref: Estimated per unit cost of Rs. 3600 /per tom, as provided by TSDF, Nimbua, Derabassi, to PPCB RO, Sangrur	$65000 \times 3600 = \text{Rs. } 23.4 \text{ Crores}$
4.	Estimated Excavation Cost @ Rs. 99/m ³ (as per common schedule of Rates of Pb. PWD (B&R)	$46429 \times 99 = \text{Rs. } 0.46 \text{ Crores}$

5.	Estimated Refilling Cost @ Rs. 500/m ³ soil	46429 x 500 = Rs. 2.32 Crores
6.	Site Assessment by the agency involved in remediation (Ref: Guidelines for Implementing Liabilities for Environmental Damages due to Handling and Disposal of hazardous Waste and Penalty)	Rs. 3.5 Crores
7.	Total Tentative Estimated Cost of Remediation (Excluding Contingency and Misc. Costs)	23.4 + 0.46 + 2.32 + 3.5 = Rs. 29.68 Crores (say Rs, 30 Crores)

- **Therefore, the minimum total estimated cost of short term remediation, for removal of the hazardous waste dumped unscientifically at site and Safe/scientific disposal of the removed hazardous waste comes out to be Rs. 30 Crores.** Since the Industry under reference was operational upto the year 2005 and the estimate for the waste dumped was made based on the production made by the industry during its existence and material balance calculations, no change in the quantity of hazardous waste dumped at site is expected, **However, the volume of contaminated soil depending on area of spread may go up and accordingly the cost of remediation of the quantity in excess of 65000 MT may go up @ Rs. quantity be removed in excess of the quantity of 65000 MT hazardous waste dumped, to be assessment by the expert agency involved in the implementation of the remediation plan. The remediation cost in this case may further go up in the @ Rs. 4024/ton as estimated by the Joint Committee in its Report.**
- In this regard, Central Pollution Control Board (CPCB) has also specified “**Guidelines for Implementing Liabilities for Environmental Damages due to Handling and Disposal of hazardous Waste and Penalty**” in January, 2016, in compliance with the order dated 18/2/2014 of the Hon'ble National Green Tribunal, (Western Zone) Bench, Pune, in the matter of Application No. 87/2013(WZ), Ramubhai Kariyabhai Patel & others Versus Union of India & others (**Annexure- 3 (iv)**) **These guidelines outline the role of the responsible party and the concerned SPCB/PCC in the event of occurrence of incidences. These guidelines also provide indicative cost for assessment & remediation and guidelines for evaluating and implementing financial penalty for violation of provisions stipulated under the Hazardous Waste (Management, Handling & Transboundary Movement) Rules.**

As per above CPCB Guidelines, for dumping of hazardous waste on open grounds without secondary containment (Similar to the present matter), a cost of liability remediation has been indicated as Rs 1 Cr to Rs. 25 Cr and above. Therefore, the above

tentative cost of remediation (Rs. 30 Crores) for the remediation of the Hazardous Waste dumped unscientifically at site, is in line with the CPCB Guidelines.

This is only an indicative and estimated cost of remediation for the short term remediation plan for removal of hazardous waste, dumped unscientifically. This remediation plan should be implemented only after following the Protocol and SOP explained in the “Guidelines for Implementing Liabilities for Environmental Damages due to Handling and Disposal of hazardous Waste and Penalty” in January, 2016

- **Medium/Long Term Remediation Plan may involve the following actions:**

While the short term remediation plan proposed above, is meant for giving immediate relief to the affected villages and removal of hazardous waste dumped unscientifically and quantity of which is established, to prevent further leaching of contaminants, the following medium/long term remedial measure are necessary for ensuring access to safe water and agri-products to public.

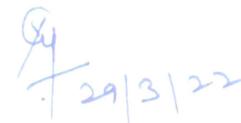
- i. Since, the Joint Committee has only conducted Bio-magnification study and estimated health risk index (HRI) based on Paddy Crop. It is recommended that local agriculture department may conduct similar studies in the area on other crops and vegetable, for taking precautionary measures in the interest of public health.
- ii. The studies conducted in this matter by PPCB through TCIRD under the directions and permission of Hon'ble High Court of Punjab and Haryana in the matter of Civil Appeal No. 3481/2007 established that untreated industrial effluent has been injected into the ground water upto a depth of 150-160 ft, leading to contamination of ground to a level (COD upto 570 mg/l and presence of methanol extractables), which make it worse than treated industrial effluent and unfit for drinking & irrigation. However, to declare this site as a contaminated site w.r.t. the presence of untreated industrial effluent in the ground water and take remediation action, the assessment is required as per protocol specified in “**Guidance document for assessment and remediation of Contaminated sites in India by MoEF&CC**”. The process for assessment of site for declaring a site as Contaminated site is a multi step process wherein, local level, district level, state level and national level agencies are involved. *Therefore, it is recommended that State Government/SPCB may initiate the process for assessment of the area w.r.t contaminated ground water due to injection of untreated industrial waste water upto a depth of 160 ft, as per protocol specified in the above MoEF&CC document as a medium term/long term remediation plan and till that time, as proposed in the short*

term remediation plan, no bore-well upto the depth of 160 ft may be installed in the area, even for drinking and irrigation purpose on "Precautionary Principle".

The remediation cost of the medium term/long term plan may be estimated only after following the above Guidance Document of MoEF&CC.

Submission:

The above additional information/details are being submitted by CPCB member just to supplement the report of the Joint Committee, which could not be incorporated while preparing the Final Report of the Committee, for some reasons, for the consideration of Hon'ble National Green Tribunal.

Handwritten signature in blue ink, followed by the date 29/3/22.

Dr. Narender Sharma
AD, CPCB, Chandigarh
Member, Joint Committee

Dated: March 29, 2022

Assessment of the Length, Breadth and Depth of Groundwater Contamination by Matharu Chemical Industries, Bhawanigarh

For
**Punjab Pollution Control Board, Patiala
Punjab (India)**



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1. Background

Matharu Chemical Industries (now Mahalakshmi Organochem Industries), Nabha Road, Bhawanigarh, Sangrur Dist., was established in 1991. It was manufacturing H-acid till 2004. Its design capacity was 580 kg H-acid per batch and 35 batches per month. Except selling of some of the iron oxide and gypsum sludge to outside parties, the industrial unit was storing the wastes, generated by it, onsite. It installed an incinerator in 1996 for the incineration of the organic waste generated by it. The industrial unit disposed the wastewater it generated in solar evaporation ponds within premises and disposed no wastewater beyond its boundaries. In the year 2005, the industrial unit reportedly dismantled the solid waste storage sheds/tanks (storing gypsum sludge, iron oxide sludge and incineration ash) and shifted the wastes present therein to the hazardous waste treatment, storage & disposal facility (TSDF), Nimbua, Dera Bassi for disposal.

Analysis of ground water samples collected during 23-11-2006 and 06-03-2009 (consequent to a CWP, No. 3481 of 2007, titled Parminder Singh v/s PPCB pending in the Honorable Punjab & Haryana High Court) revealed prima-facie of groundwater contamination. In view of this, the Punjab Pollution Control Board (PPCB), Patiala wanted detailed investigation into the length, breadth and depth of the groundwater contamination problem, and approached TCIRD/Thapar University.

TCIRD started work on the project in the 3rd week of November 2009 and completed the work in November 2010. During the study, two interim reports on the findings (one on 25-11-2009 and the other on 16-01-2010) were submitted to the Punjab Pollution Control Board (PPCB), Patiala. Now, on completion of the work, the results of the study and the findings, and the conclusions drawn from the study are presented herewith in this final report.

2. Industrial site

The industrial unit is located on the Bhawanigarh-Nabha Road at 4 kM distance from Bhawanigarh on the right side. Except for the two rice shellers, one pipe factory, one punsup godown, one petrol pump and one very small human settlement, the industrial unit is surrounded by agricultural fields. According to the records, 41 Bhigas and 13 Biswas of land was under the industrial site. Production of H-acid was commissioned at the site in July 1991 and continued production till the end of February 2005. Presently no industry exists on the site. The land has been cleared of the construction and leveled, and, at least since 2009, the land is under cultivation. Please see **figures-1 and -2** for details.

Groundwater table at the site is reported to be at >130 feet depth (pizometric well dug on-site in October 2010 indicated that the groundwater table is at 105 feet). The groundwater is heavily depended on, in the locality of the industrial site, for water supply, specially, for the irrigation of agricultural lands.



Figure-1: Industrial site location



Figure-2: Industrial site location when not under cultivation

3. H-acid Manufacturing process

Process employed for the manufacturing of H-acid from Naphthalene and presented here has been articulated from the information submitted to the SPCB for the purposes of obtaining of No Objection Certificate (NOC), Consent to Operate and Authorization to handle hazardous wastes from the SPCB, and from the review of literature on the manufacturing of H-acid.

H-acid is 1-amino, 8-naphthol, 3, 6 -disulfonic acid. It is used in the manufacturing of dyes. It is usually manufactured as a sodium salt. Its empirical formula is $C_{10}H_8NO_7S_2Na_2$. It is grey powder soluble in water, alcohol and ether. Its manufacturing involves the following steps:

1. Sulfonation of naphthalene ($C_{10}H_8$) with 65% oleum ($H_2S_2O_7$) and sulfuric acid (H_2SO_4). It might have emitted sulfur oxide fumes.
2. Nitration with 60% nitric acid (HNO_3). It might have emitted nitrogen oxide fumes.
3. Neutralization of the resultant mixture of acids and the sulfonation and nitration product with lime slurry (10%!). It might have consumed water for the lime slurry preparation.
4. Filtration of the neutralized mixer in nutch filters for separating the gypsum ($CaSO_4$) sludge (neutralization product at 70% consistency!) formed. **Gypsum sludge** (solid waste) is generated.
5. Reduction of the filtrate by iron. Involves addition of iron powder, hydrochloric acid (HCl), soda ash (Na_2CO_3) and acetic acid (CH_3COOH).
6. Filtration of the mixer, of the reduced product, the residual chemicals and the byproducts formed, in a filter press for separating the iron oxide (Fe_2O_3) sludge (at 30% consistency!). **Iron oxide sludge** (solid waste) is generated.
7. Concentration of the filtrate. Was it in a multiple effect evaporator and did it generate **foul condensate**? If a multiple effect evaporator was used then it might have demanded significant quantities of circulating cooling water.
8. Cooling the concentrated solution (circulating cooling water system might have been used), mixing with HCl and NaCl and filtering in nutch filters to obtain Koch cake. It must be generating wastewater (**mother liquor**) rich in naphthalene based compounds, sodium and chloride.
9. Charging the Koch cake with caustic lye/ caustic flakes (NaOH) and then fusing (in an autoclave!).
10. Diluting the fused mass with water, treating with sulfuric acid and boiling off to remove sulfur dioxide. Must be emitting sulfur dioxide fumes.

11. Cooling the boiled off mass and filtering through nutch filters to get the cake of sodium salt of H-acid. It must be generating wastewater (**discarded liquor**) rich in phenolic compounds and residual H-acid.
12. Washing the H-acid cake in water, centrifugal dewatering of the cake, drying and milling the cake to obtain powder of sodium salt of H-acid. It must be generating the wastewater (**product washwater**) containing H-acid and phenolic compounds.

H-acid was manufactured in batches (35 batches per month) from naphthalene (600 kg/batch). Each batch of manufacturing produced 580 kg of sodium salt of H-acid. Raw material inputs of the manufacturing were as shown in **table-1**. The byproducts and wastes generated from the manufacturing were as indicated by the industry as shown in **table-2**.

Table-1: Material inputs of H-acid manufacturing

S.No.	Input material	Quantity (kg/batch)	Quantity (ton/year)@	Consumption for 1994-95 (tons/year)
1.	Naphthalene	600	252	345
2.	Sulfuric acid	3039	1276	1703
3.	Oleum (65%)	1790	752	1000
4.	Nitric acid	372	156	518
5.	Lime stone	1637	689	1464
6.	Hydrochloric acid (100% purity)	72	30.2	120
7.	Soda ash (sodium carbonate)	900	378	554
8.	Sodium hydroxide	860	361	560
9.	Iron powder	650	273	291
10.	Common salt	2700	1134	??
11.	Acetic acid	10.4	4.383	6

@ 35 batches of H-acid manufacturing per month for 12 months a year is assumed.

Table-2: Byproducts/wastes generated from the H-acid manufacturing

S.No.	Product/byproduct/waste	Quantity (kg/batch)	Quantity@ (ton/year)
--	Sodium salt of H-acid (product)	580 (681)*	243.6 (286)*
1.	Gypsum on dry weight basis	3082	1294
2.	Iron oxide on dry weight basis	1109	466
3.	Sodium bisulfate lost in wastewater	---	---
4.	Sodium nitrite and nitrate lost in wastewater	---	---
5.	Common salt lost in wastewater	~2750	~1155
6.	Glauber salt lost in wastewater	---	---
7.	Naphthalene lost in the wastewater	396 (360.5)*	166 (151)*

@ 35 batches of H-acid manufacturing per month for 12 months a year is assumed.

* Values given in the parentheses are for the 681 kg product recovery per batch

4. Wastes generated from the H-acid manufacturing

The industrial unit was consuming water for the following purposes:

- Preparation of the lime slurry used in step -3 for neutralization
- Washing of nutch filters and filter presses used in the filtration in steps -4, -6 and -11
- Dilution of fused mass in step -10
- Washing of H-acid cake in step -12

In addition to this, water was also used as boiler feed water in the 1 ton/hr capacity boiler and as makeup water in the cooling tower and circulating cooling water system. PPCB records indicate consumption of about 34 m³/day of water (26 m³/day in the manufacturing process, 5 m³/day in the boiler and 3 m³/day in the circulating cooling system).

The H-acid manufacturing process might have generated the following wastes:

1. **Gypsum (calcium sulfate) sludge:** Removed from the reaction mixer through filtering in step-4 of the manufacturing process.
2. **Iron oxide sludge:** Removed from the reaction mixer through filtering in step-6 of the manufacturing process.
3. **Foul condensate:** Generated (if concentrated in multiple effect evaporator) at the multiple effect evaporator in step-7 of the manufacturing process. It might have been the least polluted wastewater stream.
4. **Mother liquor:** Discarded after the filtration removal of Koch cake in step-8 of the manufacturing process. It is high strength waste and was apparently disposed off in the solar evaporation ponds (and then incinerated!).
5. **Discarded liquor:** Discarded after the filtration removal of the H-acid in step-11 of the manufacturing process (high strength wastewater).
6. **Product washwater:** Generated from the washing of the H-acid cake in step-12 of the manufacturing process (moderate strength wastewater and can be reused for dissolving the fused mass in step-10).

Material balance calculations indicate that only <40% of the naphthalene used became integral part of the product (H-acid) and the rest >60% was lost mostly in the wastewater (generated at step-8, step-11 and step-12) may be as naphthalene based compounds, sulfonated phenolic compounds and condensation products of fusion. Because of limited water solubility and higher sludge consistencies, gypsum and iron oxide sludges might have very little of these organic

substances. Because of the higher boiling point, very little of the organic matter might have been actually lost into the atmosphere as organic vapours.

The byproducts, sodium sulfate, sodium bisulfite, sodium chloride, sodium nitrite and sodium nitrate and the added sodium chloride, because of their high solubility, might have been mostly present in the wastewaters generated. Very little of these might have been lost in the gypsum and iron oxide sludges (may depend on the sludge consistency). It is not clear whether and how much of the sodium sulfate was actually recovered from the wastewater (mother liquor) during treatment (neutralization, filtration, concentration and filtration) and reused in the H-acid manufacturing process (in place of soda ash!).

Closer look at the inputs (given in **table-1**) and the outputs (given in **table-2**) reveals that of the total inputs of 12,640 kg/batch, gypsum and iron oxide sludge amount to 4,191 kg/batch and the product (H-acid) to 681 kg/batch. Rest of the material (7,768 kg/batch) might have been mostly lost into the wastewater generated and a small portion of it might have been lost into the atmosphere as sulfur oxides and nitrogen oxides.

5. Waste Management Practices

5.1 Wastewater

Wastewater generation might have been around 20 m³/batch of H-acid processed or 23 – 24 m³/day. Generation rates of different wastewaters have been assessed as following:

- Mother liquor (assessed at about 3-4 m³/batch)
- Foul condensate (assessed at about 5-6 m³/batch)
- Nutch filters' and filter presses' washwater (about 1 m³/batch)
- Discarded liquor (assessed at about 5 m³/batch)
- H-acid washwater (assessed at about 5 m³/batch)

In addition to these process wastewaters, the industrial unit might also have generated the following wastewaters:

- Steam condensate that could not be recovered and allowed to flow into the drain
- Cooling tower blow down water
- Regeneration wastewater generated from the generation of boiler feedwater plant (soft water plant!)

The industrial unit used an incinerator since late 1996 for the disposal of the mother liquor. Wastewater discharge by the industrial unit beyond its premises was zero. The industrial unit, as per the records, used lined shallow solar evaporation ponds of 200 m² area each (20 m x 10 m) for the disposal of the wastewater. For enhancing the evaporation rates, the industrial unit, according to records, used forced spray evaporation. Aerial photograph of the industrial site, obtained from Google Earth (see **figure-2** and **figure-3**), and soil core testing indicates that about 4400 m² land area was used as solar evaporation ponds. Filed information of PPCB also indicates use of 4 evaporation ponds, each of 24 m x 24 m x 1.5 m dimensions, and one tank of 50 m x 26 m x 2 m dimensions. Some part of the evaporation pond area was found, during survey of the site, to have bags of organic solid waste buried under the top soil. Crystallization and subsequent problems associated with the pumping for the forced spray evaporation might have forced the industrial unit to continually expand the evaporation ponds and shift to newer ponds.

Once usage of an evaporation pond was stopped, the residual low density crystalline organic material (the residual organic matter) present in the pond contents might have formed a thick hard crust layer on the top of the pond contents. Soil core sampling in the evaporation pond area has shown presence of a hard but water soluble layer of 3 to 5 cm and even more thickness over

the concentrated liquid (**figure-4**). This crystalline layer might have almost stopped further evaporation from the concentrated liquid of the abandoned pond. As a consequence of this the industrial unit might not have been in a position to dispose off all the wastewater in the solar evaporation ponds.

As per the information available in the PPCB records, the industrial unit had installed an incinerator in 1996 for the disposal of the mother liquor generated in step-8. Further, the records say that 100 kg/day (at certain other places indicated as 50 kg/day) of ash was generated from the incineration of the mother liquor. 100 kg/day ash is grossly understated. Almost all the chloride used in the manufacturing process, both as NaCl and as HCl, is expected to get into the mother liquor and then become part of the incineration ash. Our assessment is the mother liquor might have been almost a saturated salt solution.

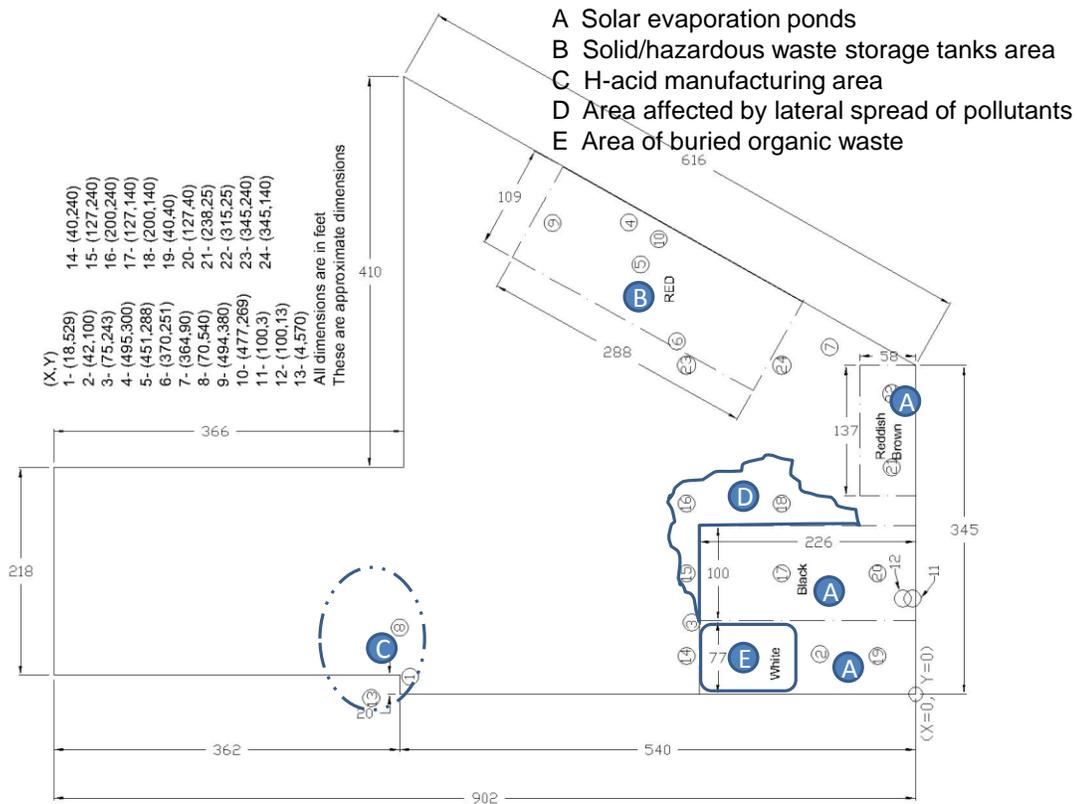


Figure-3: Industrial site showing evaporation ponds and sludge storage pits



Figure-4: Hard, water soluble crust layer material on evaporation ponds

5.2 Solid and hazardous waste

The solid and hazardous wastes generated include

- **Gypsum sludge:** 3,082 kg/batch on dry weight basis. Assuming 30% moisture about 1850 tons per year gypsum sludge was generated.
- **Iron oxide sludge:** 1,109 kg/batch on dry weight basis. Assuming 70% moisture about 466 tons per year of iron oxide sludge was generated.
- **Incineration ash:** 100 kg/batch or 30 tons per year (as informed by the industrial unit). This is grossly understated and may be possible if glauber salt can be used in place of common salt, and if the used glauber salt can be recovered from the wastewater and reused. Sodium chloride use might have generated about 2.7 tons/batch of incineration ash.

Three sludge tanks/pits, each of 20 m x 12 m x 2 m dimensions (480 m³ volume), were apparently used for the storage of the generated gypsum sludge, iron oxide sludge and incineration ash. Please see **figure -3** for the probable sludge storage tanks location. Apparently

some of the organic sludge accumulated in the solar evaporation ponds was also collected and stored in the tank meant for the incineration ash storage.

It appears that some but not exactly known quantity of the iron oxide sludge and of the gypsum sludge was billed and sold out to outside parties for reuse. Records available are not complete for accounting the amount of sludge thus sold out. During 14-10-1993 and 18-03-1994, 633 tons of iron oxide sludge, and during 03-4-1993 and 24-03-1994, 293 tons of gypsum sludge was sold out. Similarly, during 1995, 1035 tons of gypsum and 945 tons of iron sludge were sold out. After the closure of the industrial unit, 103 tons of organic sludge (incineration ash!) was reportedly lifted from the incineration ash storage tank and transported to the TSDF of Nimbua, Dera Bassi for disposal.

No records exist indicating generation, sale and disposal of any other solid waste or sludge.

6. Groundwater analysis

For reaffirming the prima-facie of groundwater contamination and assessing the spread or extent of groundwater contamination, groundwater was sampled from 9 locations from the existing tube wells both within and around the premises of the industrial unit during 22nd and 23rd November 2009. Please see **figure-2** for the groundwater sampling locations. The groundwater table during the sampling was reportedly at >130 feet. On the basis of the raw materials consumed, the manufacturing process employed and the products, byproducts and wastes generated, the groundwater samples were analyzed for the following parameters in order to establish whether any of the wastes of the industrial unit have reached and present in the groundwater:

- Iron (Fe)
- Chloride (Cl⁻)
- Sulphate (SO₄⁻²)
- Nitrate (NO₃⁻)
- Carbonate (CO₃⁻²)
- Total Kjeldahl nitrogen (TKN)
- Total dissolved solids (TDS)
- Chemical oxygen demand (COD)
- Phenolic compounds

The results obtained from the analysis of the ground water samples are shown in **table-3**. The methods of analysis followed for the analysis are indicated in **table-4**.

Table-3: Results of analysis of the ground water samples

Parameter	Groundwater samples								
	Stn.: 1	Stn.: 2	Stn.: 3	Stn.: 4	Stn.: 5	Stn.: 6	Stn.: 7	Stn.: 8	Stn.: 9
Fe (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
CO ₃ ²⁻ (mg/l)	BDL	BDL	16.86	14.45	BDL	19.27	24.09	16.86	24.09
SO ₄ ²⁻ (mg/l)	206	152	63	46	63	30	BDL	25	25
Cl ⁻ (mg/l)	190	55	14	19	18	11	18	15	20
NO ₃ ⁻ (mg/l)	6.40	3.62	2.30	3.85	15.52	6.86	8.45	7.0	9.8
COD (mg/l)	86	50	14	16	20	23	13	16	14
TDS (mg/l)	1016	647	454	429	456	310	493	388	415
TKN (mg/l)	0.28	0.17	0.50	0.56	0.34	0.11	0.22	0.22	0.39
Phenol	@	@	BDL						

@: In case of the samples from Stns -1 and -2, there are indications of presence of phenolic compounds, but, the concentrations could not be measured by the routine testing method (see table-4).

BDL: Below Detectable Limits

Table-4: Methods of analysis, and detection limits and measurement uncertainties for the parameters

Parameters	Method Used	Minimum Detection Limit	Uncertainty
Fe [mg/L]	21 st Edn. APHA, AAS Method	0.24	± 0.05 %
Carbonate (CO ₃ ²⁻) [mg/L]	21 st Edn. APHA, Titrimetric	2	± 0.5 %
Sulphate (SO ₄ ²⁻) [mg/L]	21 st Edn. APHA, Gravimetric	10	± 5%
Chloride (Cl ⁻) [mg/L]	21 st Edn. APHA, Ion Selective Electrode	1	± 5%
Nitrate (NO ₃ ⁻) [mg/L]	21 st Edn. APHA, Cd Reduction	.05	± 1 %
COD [mg/L]	21 st Edn. APHA, Open Reflux Method	10	± 5%
TDS [mg/L]	IS: 3205 Part 16, Gravimetric	10	± 5%
TKN-N [mg/L]	IS: 3205 Part 34 Titrimetric	0.10	± 10%
Phenol [mg/L]	21 st Edn. APHA, Colorimetric	0.02	± 1%

The ground water samples from at least two sampling stations (Stn -1 and Stn-2) have been found contaminated with the industrial waste. This is evident from the high sulfate, chloride, COD and TDS levels observed and from the indication of presence of phenolic compounds. Contamination of the groundwater appears to be limited in extent and apparently not spreading. Discontinuity of groundwater contamination (since 2004) and continual pumping out of ground water for irrigation at the sampling stations have apparently arrested the spread of the groundwater contamination.

The phenolic compounds however could not be measured by the routinely used standard method. The groundwater samples from these two sampling stations were reddish brown in colour and both the samples were not having any iron in them (iron can also impart reddish-brown colour to water). This led to the suspicion of presence of higher order phenolic compounds in the water samples and imparting the colour, and to the further investigation of the samples in the direction of extraction, isolation and characterization of the substances imparting colour to the water.

Evaporative concentration, methanol extraction and column chromatography (of the samples), both with 1:1 methanol and chloroform and with methanol, resulted in the isolation of two sulfonated phenolic compounds at the concentrations given in **table-5**. Analysis of the isolated compounds on FTIR indicated presence of the functional groups, N-H, O-H and S=O, in both the

compounds (see **table-6** for details). Analysis of all the other 7 groundwater samples indicated that these have the methanol extractables below detectable levels (<10 mg/L) and the two sulfonated phenolic compounds were not detected in them.

Table-5: Sulfonated phenolic compounds in the samples from Stns -1 and -2

Compound	Sample 1	Sample 2
Methanol extractables (mg/L)	149	173
Compound A (mg/L)	60	75
Compound B (mg/L)	48	32

Table-6: Results of analysis of the compounds isolated from the groundwater samples on FTIR

	IR bands observed	Remarks@
Compound A	3430, 1635, 1384, 1047 and 669 cm^{-1} .	IR bands at 3430, 1635 and 1384 cm^{-1} confirms the presence of functional groups N-H or O-H. IR bands at 1047 and 669 cm^{-1} confirms the presence of sulphonyl group.
Compound B	3416, 1089 and 630 cm^{-1}	IR bands at 3416 cm^{-1} confirms the presence of functional groups N-H and O-H. IR bands at 1089 and 630 cm^{-1} confirms the presence of sulphonyl group.

Identification of sulphonated phenolic compounds in the ground water and other circumstantial evidences (like water solubility) indicate that the the ground water in question is contaminated with the industrial wastes, specially those generated beyond the Koch cake fusion step (step-9 of the manufacturing process).

7. Top soil samples analysis

To-the-scale lay out map of the industrial unit is not available. The 'not to scale hand drawn map' obtained from the PPCB records (see **figure-5**) is not clearly indicating location of the solid and hazardous waste storage tanks, of the solar evaporation ponds, and of the manufacturing sheds. The industrial unit was long been dismantled, some of the stored solid wastes were shifted out (to the TSDF, Nimbua, Dera Bassi), the land was leveled and the land use has been changed to agricultural use. In the light of these facts, for exactly knowing the waste storage and disposal and actual manufacturing locations within the industrial site of 35000 m² area, the industrial site was physically surveyed. And, for assessing the spread of wastes, top soil was sampled on 20-01-2010 at eleven different locations from within the industrial unit premises. Locations of the sampling were chosen after proper survey of the site. Locations of the soil sample collection are shown in **figure-6**. Results of the soil samples analysis are shown in **table- 7**.

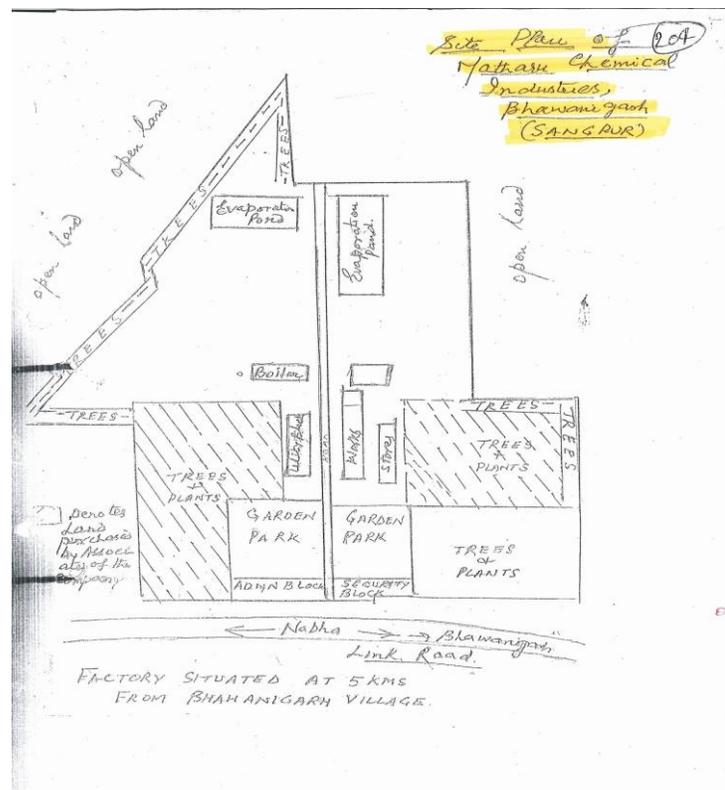


Figure-5: Layout map of the industrial unit (from PPCB records)



Locations -10 and -11 represent waste sludge and boiler ash dumped onsite
Location -9 can be treated as control site
Locations -6 and -7 are beyond the site boundaries

Figure-6: Surface soil sampling locations

Table-7: Results soil samples analysis

Location	Iron (mg/kg)	Sulfate (mg/kg)	Nitrate (mg/kg)	Chloride (mg/ kg)	pH	TOC (mg/kg)	Methanol extractable (mg/kg)	Comp. -A	Comp. -B
Loc.-1	186000	83400	4.44	151	8.09	7700	120	ND	ND
Loc.-2	14300	15400	1.06	156	8.20	2600	25	ND	ND
Loc.-3	13200	3100	7.07	165	7.94	4600	24	ND	ND
Loc.-4	121000	127000	1.68	871	8.33	4100	35	ND	ND
Loc.-5	170000	313000	9.35	1090	8.37	3300	200	ND	D
Loc.-8	19300	2410	2.14	623	7.87	3900	45	ND	ND
Loc.-9#	7010	142	0.69	634	8.20	3500	42	ND	ND
Loc.-6@	6940	302	1.49	450	8.27	2400	12	ND	ND
Loc.-7@	13700	258	0.89	155	8.12	5800	39	ND	ND
Loc.-10*	17100	398000	-	778	10.05	6400	10	ND	ND
Loc.-11**	7720	1300	3.77	124	8.18	10400	-	-	-

Comp. -A and Comp. -B are Sulphonated phenolic compounds identified in groundwater

ND refers to not detected

Sample location -9 can be treated as control

@ Sampling locations -6 and -7 are beyond the boundaries of the industrial unit

* Sampling location -10 has solid waste in bags buried under the soil

** Sampling location -11 has boiler ash spread around in the soil.

The results gave no clue about the exact locations of solid and hazardous waste disposal and of the solar evaporation ponds. The results clearly indicate that locations -1, -4 and -5 have very high levels of iron, calcium and sulfate (iron oxide and gypsum sludge constituents) and location -5 was also found to have one of the two sulfonated phenolic compounds. Further, the disposal locations of individual solid/hazardous wastes (gypsum sludge, incineration ash, iron oxide sludge) could not be identified from the results. The results only indicated that the gypsum sludge and the iron sludge were spread all around the soil in the process of leveling of land for facilitating cultivation.

Physical survey of the industrial site indicated the following:

- Industrial site was spread beyond the boundaries of the piece of land shown as the industrial site. A shallow lined pit filled with waste, many empty chemical bottles, and an abandoned tube well were found at soil core sampling location-13 (shown in **figure-3**) beyond the boundary limits of the industrial unit.
- The solid and hazardous wastes are spread all around the site. High sulfate, iron and chloride levels in the soil are indications of this (please see **table-7**).

- Crops are affected in the areas with the exposed waste (areas of visible iron oxide sludge were apparently have no damaging effects on crops). The areas affected can be clearly seen in **figure-1**.
- Solid waste packed in bags is dumped buried under the soil at least at one location. This area is found worst affected from the agriculture point of view.

8. Soil core sampling and analysis studies

With the dismantling of the civil structures, with the leveling of land and with the change of land use it has become impossible to clearly establish where actually the solid/hazardous waste storage tanks, the solar evaporation ponds, etc., were located and what was their extent. Records available with the PPCB could also not help in this regard.

The ground water table (at ~130 feet) vis-à-vis the depth of solar evaporation ponds and solid/hazardous waste storage tanks, indicates that the ground water contamination is very unlikely from the percolation/leaching from the waste storage tanks and solar evaporation ponds.

For knowing whether as per the indications the ground water contamination is not from the percolation/leaching from the waste storage tanks and solar evaporation ponds and for assessing both depth and extent of spread of solid/hazardous waste, soil core sampling on the site was planned. Aerial photograph of the site (available from the Google Earth) and physical survey of the industrial site were used as bases in deciding on the soil sampling locations. Altogether 24 locations were chosen (**figure-3** and **figure-7**).



Figure-7: Industrial site photograph showing the soil core sampling locations

No soil core samples were collected from the following locations:

- Soil core sampling location -13: This location (**figures -3 and -7**) falls beyond the boundary limits of the industrial site and the PPCB official advised not to collect the sample.
- Soil core sampling locations -12, -17, -20 and -21: These locations (**figures -3 and -7**) fall within the solar evaporation ponds area and have shown the profile and sample characteristics very similar to those of soil core sampling locations -2, -19 and -22. Hence these samples were discarded and not analyzed.

In all the cases the soil core samples were collected at 3 feet depth intervals and analyzed for

- pH
- Iron (Fe)
- Sodium (Na)
- Chloride (Cl)
- Sulphate (SO_4^{-2})
- Nitrate (NO_3^-)
- Chemical oxygen demand (COD)
- Methanol extractable content
- Sulfonated phenolic compound –A
- Sulfonated phenolic compound –B

Except in case of the sampling location -1 (**figures -3 and -7**), soil core sample collection was stopped at a depth where the soil showed no visible signs of contamination (colour). Wherever lined concrete bottom was encountered, efforts were made to break the concrete lining and go around 3 feet beyond the concrete lining, and, in cases where the concrete lining could not be broken the soil core sampling was stopped at the concrete lining depth.

The soil core sampling locations can be categorized into the following four groups:

1. Sampling locations in the suspected manufacturing shed location (soil core sampling locations -1, -8 and **-13**)
2. Sampling locations in the suspected solid/hazardous waste storage tanks area (soil core sampling locations -4, -5, -6, -7, -9, -10, -23, and -24)

3. Sampling locations in the suspected solar evaporation ponds area (soil core sampling locations -2, -19, -22, **-12, -17, -20, and -21**)
4. Sampling locations beyond the suspected solar evaporation ponds area (soil core sampling locations -14, -3, -15, -16, -18, and -11)

Sampling location -1 in the suspected manufacturing shed area (see **figures -3 and -7**) was actually dug for collecting piezometric groundwater samples and dug upto 170 feet depth. At this location, the ground water was encountered at 105 feet. Visible contamination of the soil core samples could not be seen prominently at both the sampling locations -1 and -8.

At the soil core sampling locations, -6, -7, -9 and -24 (see **figures -3 and -7**), the soil contamination was found to be superficial. At the soil core sampling locations, -4, -5 and -10 (see **figures -3 and -7**), hard concrete lining was encountered at about 18 feet depth and soil core sampling was stopped at that depth.

At the sampling locations, -2, -19, -22, -12, -17, -20 and -21 (see **figures -3 and -7**), at around 4 to 6 depth a HDPE membrane layer and a hard, water soluble crust layer (of about 3 to 5 cm and even greater thickness) were encountered (please see **figure -4**). Below this, there was thick black liquor. Pumping out of this liquid was found resulting in the subsidence of the surrounding soil (please see **figure-8**). At the soil core sampling locations -12, -17, -20 and -21, when the thick black liquor was encountered the sampling was stopped, assuming the sample similarities to the soil core samplings at locations -2, -19 and -22. At the soil sampling location -2, weak concrete lining was encountered at about 15 feet depth. At the soil core sampling locations -19 and -22, the sampling was abandoned much before reaching the concrete lined bottom because of the difficulties encountered in the manual soil core sampling.

At the sampling locations -14, -3, -15, -16, -18 and -11 (see **figures -3 and -7**), HDPE membrane, hard, water soluble crust layer, thick black liquor pond and concrete lining were not encountered. This indicates that the area was not actually part of the designated solid/hazardous waste storage tanks or of the solar evaporation ponds. The area being outside the industry site, excepting the sampling location -11, no soil core samples were collected on the rice sheller side. Three of the 6 sampling locations (locations -14, -3 and 15) are on the downstream side of the solar evaporation ponds (on the suspected manufacturing shed side). Two sampling locations (locations -16 and -18) are on the solid/hazardous waste storage side.



Figure-8: Photograph showing subsidence of soil at the sampling location -2

The sampling locations -3 and -11 in the area surrounding the suspected solar evaporation ponds (see **figures -3 and -7**), were found to have no visible contamination. All the other sampling locations (locations -14, -15, -16 and -18) were found to have visible contamination. But at these sampling locations the thick black liquor, the hard water soluble crust layer and the bottom concrete lining were not found. This indicates that these sampling locations are outside the solar evaporations but having the waste spread even into this area.

8.1 Suspected manufacturing shed area

Results obtained from the analysis of the soil core samples collected from the suspected manufacturing shed area are shown in **table-8**. The results indicate that the soil is contaminated with the industrial waste. This is evident from the higher levels of iron, sodium, sulfate, chloride, and also nitrate. It is also evident from the relatively higher levels of methane extractables and organic matter (measured as COD). The results however are not consistent between the sampling locations -1 and -8. At the sampling location-1, the organic contaminants are mostly confined to the top layers, while the inorganic species (iron, sodium, sulfate, chloride and nitrate) are found increasing upto certain depth and then decreasing. Relatively lesser mobility of the organic

contaminants and relatively higher mobility of the inorganic contaminants could be responsible for this.

At the sampling location-8, the surface soil contamination is apparently lesser and probably the top soil from this location might have been moved away in the process of leveling of the land. At this site, iron sludge contamination is apparently lower when compared with the gypsum sludge and organic contamination (specially the methanol extractables and sulphonated phenolic compounds). The organic contamination in this location is rather subsurface in the top 15 feet. Concentration of methanol extractable organic matter is found decreasing with depth (at 15 feet it was 1060 mg/kg, while at 17 feet it was 932 mg/kg) beyond 15 feet depth. At 15 feet depth only sulphonated phenolic compound –A was detected but not the compound –B. Soil core sampling for some more depth (> 17 feet) might have revealed the mobility of organic contaminants in the soil. Among the two sulphonated phenolic compounds, mobility of compound –B appears to be greater than that of compound –A.

Table-8: Soil core samples from the suspected manufacturing shed area

Depth (feet)	Iron (g/kg)	Sodium (g/kg)	Sulfate (g/kg)	Nitrate (mg/kg)	Chloride (g/kg)	pH	COD (g/kg)	Comp A	Comp B	Methanol extractable (mg/kg)@
Soil core Sampling location-1										
1	120.2	0.851	64.1	29.6	0.484	7.90	16.10	ND	ND	41
6	16.17	1.810	6.27	29.6	0.554	8.90	2.640	ND	ND	40
9	19.96	6.850	17.2	32.5	0.531	8.70	3.490	ND	ND	<10
12	16.82	5.200	16.4	17.3	0.599	8.80	2.950	ND	ND	<10
15	6.910	3.740	6.30	24.4	0.476	9.00	1.980	ND	ND	<10
20	10.90	1.030	< 2.00	70.8	0.467	8.90	---	ND	ND	<10
60	7.300	0.482	< 2.00	< 1.25	0.314	7.40	1.560	ND	ND	<10
100	10.70	0.382	< 2.00	< 1.25	0.428	8.30	1.820	ND	ND	<10
160	10.00	0.511	< 2.00	< 1.25	0.421	8.80	2.390	ND	ND	<10
Soil core Sampling location-8										
0.6	0.257	1.660	444	< 1.25	0.426	6.70	1.380	ND	ND	120
6	16.82	4.400	20	475	0.359	7.70	---	ND	ND	131
10	33.70	6.710	11	378	0.647	8.60	---	D	ND	659
15	24.70	6.850	39	1080	0.675	7.20	---	D*	ND*	1060
17	9.500	4.100	<2.00	1120	0.560	6.90	---	D	D	932

@ Methane extractables are believed to include Naphthalene, intermediate aromatic organic compounds, and sulphonated phenolic compounds.

* 'ND' indicates 'Not Detected' and 'D' indicates 'Detected'.

8.2 Suspected solid/hazardous wastes storage area

Results obtained from the analysis of the soil core samples collected from the suspected solid/hazardous waste storage tanks area (soil core sampling locations -4, -5, -6, -7, -9, -10, -23 and -24) are given in **table-9**.

Sampling locations -6, -7 and -24 were actually found to be visibly contaminated only in the surface layers (<6 feet).

Contamination by sulphonated phenolic compounds was detected only at the sampling locations -6 and -7. Sampling location -23 (all through the depth upto 21 feet), and also the sampling location -4 (only upto 9 feet depth), have been found to have methanol extractable organic contaminants but not the sulphonated phenolic compounds. Highest level of methanol extractable organic compounds (4.83 g/kg) have been found at the sampling location -6.

Soil core samples from all the sampling locations of the suspected solid/hazardous waste storage tanks area have been found to have higher levels of iron oxide sludge. At all the sampling locations, excepting the locations -6, -10 and -23, the iron sludge levels are relatively lower (iron in the range of 0.69 to 7.85 g/kg) in the surface layers. And, in the subsurface layers, upto 18 feet depth, the concentrations are higher (in the range of 9.84 to 24.7 g/kg). At the sampling location -23, the iron sludge levels are almost similar and higher upto 9 feet depth (~14 g/kg of iron), and, beyond this depth, the iron sludge concentration was found decreasing (to 11.7 g/kg at 21 feet depth). Sampling locations -6 and -10 have the highest concentrations of mostly wet iron oxide sludge (208 g/kg and 316 g/kg of iron respectively) in the surface layers.

Lower sulfate levels at all the sampling locations of this area (<0.002 to 0.228 g/kg) indicate that the suspected solid/hazardous waste storage tanks area has relatively lower levels of gypsum sludge. The gypsum sludge might have been shifted out and sold to outside parties for reuse.

Moderate sodium and chloride levels (0.41 to 2.94 g/kg and 0.303 to 2.59 g/kg respectively) at all the sampling locations, excepting at the sampling location -7, could be from the disposal of sodium and chloride rich incineration ash or evaporation pond sludge in this area. Sodium level at the sampling location -7 is relatively higher (14.8 g/kg). This sampling location is adjacent to one of the suspected solar evaporation ponds and this might have contributed higher sodium salts.

Table-9: Soil core samples from solid waste disposal tanks area

Depth (feet)	Iron (g/kg)	Sodium (g/kg)	Sulfate (g/kg)	Nitrate (mg/kg)	Chloride (g/kg)	pH	COD (g/kg)	Methanol extractable (mg/kg)	Comp.-A	Comp.-B
Soil core sampling location -4										
3	3.780	0.491	0.228	< 1.25	0.481	7.5	---	110	ND	ND
6	16.20	0.408	0.099	11.0	0.303	7.5	3.870	25	ND	ND
9	16.50	0.553	0.011	7.92	0.520	7.8	2.300	37	ND	ND
15	10.90	0.594	0.011	5.47	0.476	7.4	1.770	<10	ND	ND
18	14.60	0.571	<0.002	6.59	0.395	8.6	2.150	<10	ND	ND
Soil core sampling location -5										
3	3.430	2.030	0.193	112.0	0.989	7.2	2.640	<10	ND	ND
6	24.70	2.940	0.021	96.80	1.330	8.0	3.940	<10	ND	ND
9	14.70	2.340	<0.002	1.360	0.870	7.5	4.010	<10	ND	ND
12	11.30	2.020	0.012	178.0	0.707	7.4	2.720	<10	ND	ND
18	16.40	0.852	<0.002	6.780	0.515	8.4	2.240	<10	ND	ND
Soil core sampling location -6										
5	208.0	2.090	0.079	8100	2.590	8.20	---	4830	D	D
Soil core sampling location -7										
3	6.250	14.80	0.045	1020	1.230	8.00	---	280	D	D
Soil core sampling location -9										
0.3	0.699	0.456	0.534	< 1.25	0.290	6.70	1.230	<10	ND	ND
3	9.840	0.755	0.004	18.7	0.590	7.90	1.680	<10	ND	ND
9	11.90	1.840	<0.002	24.3	0.880	7.60	5.480	<10	ND	ND
Soil core sampling location -10										
3	316.0	2.100	0.037	< 1.25	0.811	8.00	---	<10	ND	ND
6	13.30	1.130	0.004	23.3	1.300	7.60	3.260	<10	ND	ND
18	14.80	0.555	<0.002	< 1.25	0.530	7.30	1.860	<10	ND	ND
Soil core sampling location -23										
3	14.50	1.580	0.038	14.8	0.344	7.6	3.727	210	ND	ND
9	14.20	6.220	0.005	147	0.905	7.4	6.695	52	ND	ND
15	12.30	6.880	0.006	216	0.779	8.4	4.323	41	ND	ND
21	11.70	5.050	0.005	338	0.622	8.0	3.919	63	ND	ND
Soil core sampling location -24										
3	7.850	1.50	<0.002	114	0.494	7.4	4.693	<10	ND	ND

8.3 Suspected solar evaporation ponds area

A HDPE membrane has been encountered at around 4 to 6 depth in the suspected solar evaporation ponds area during the soil core sampling. At most of the sampling locations, a hard, water soluble crust layer (of about 3 to 5 cm and even greater thickness) was also found below the HDPE membrane. Below this, there was thick black liquor. At the soil sampling location -2, a weak concrete lining was encountered at about 15 feet depth.

Results obtained from the analysis of the soil core samples from the suspected solar evaporation ponds area are presented in **table-10**.

Contaminant concentrations are not that high in the top 3 to 5 feet depth at the sampling locations -2 and -19. But at the sampling location -22, even the top layer has higher levels of specially sodium and sulfate. These results indicate import of soil and use of solid/hazardous waste (iron oxide sludge and gypsum sludge) to form the top 3 to 5 feet deep soil layer during leveling of the land.

The results indicate that the suspected solar evaporation ponds area actually has more than one (many) ponds. Otherwise, composition of the liquid found in all the three locations at depths >5 feet and <15 feet might have been similar.

At least some of the solar evaporation ponds had also been used for the disposal of specially iron oxide sludge, in addition to for the disposal of mother liquor. Otherwise very high iron level (142.6 g/kg) at the sampling location -22 is inexplicable.

Methanol extractable organic compounds levels at the sampling location-2 have been found decreasing with increasing depth (93.5 g/kg at 10 feet depth and 33.5 g/kg at 15 feet depth). This indicates that may be due to relatively lower specific gravity the methanol extractable organic compounds (including the sulphonated phenolic compounds) have the tendency to accumulate in the top liquid layer.

Relatively lower levels of specially COD and methanol extractable organic compounds (61.29 g/kg and 4.98 g/kg respectively) at 18 feet depth at the sampling location -2 indicate that downward movement of the organic contaminants was lesser and solar evaporation ponds apparently contributed relatively lesser to the ground water contamination.

The results of analysis (increasing sodium and sulfate levels with depth) indicate accumulation of sodium sulfate at the bottom of the solar evaporation pond at least at the sampling location-2.

Table-10: Solar evaporation pond area

Depth (ft)	Iron (g/kg)	Sodium (g/kg)	Sulphate (g/kg)	Nitrate (mg/kg)	Chloride (g/kg)	pH	COD (g/kg)	Methanol Extractable (g/kg)	Comp A	Comp B
Soil core sampling location-2										
5	16.91	3.100	44.3	24.2	0.464	8.6	5.948	0.110	ND	ND
10	0.533	68.67	151	3930	27.40	8.3	125.7	93.50	D	D
15	0.470	72.44	252	4660	24.30	8.4	286.5	33.50	D	D
18	1.920	127.6	285	2090	1.700	8.7	61.29	4.980	D	D
Soil core sampling location-19										
3	4.547	44.19	83	398	0.566	8.4	3.957	0.120	ND	ND
9	12.20	105.6	358	12010	3.400	9.6	23.10	14.70	D	D
Soil core sampling location-22										
3	13.00	387.3	433	1756	4.412	9.2	19.04	0.026	ND	ND
12	142.6	274.9	401	142600	8.360	7.8	583.5	22.35	D	D

8.4 Area surrounding the suspected solar evaporation ponds

Intention of the soil core sampling at locations -14, -3, -15, -16, -18, and -11 (see **figure -3 and -7**) from the area surrounding the suspected solar evaporation ponds was to check whether the waste present in the suspected solar evaporation ponds has been spreading laterally and downwards. HDPE membrane cover, water soluble hard crust layer, thick black liquor ponding and concrete lining have not been encountered at all these locations of soil core sampling. The soil was found sandy beyond 20 feet depth at these locations.

Results obtained from the analysis of the soil core samples collected from the above sampling locations are presented in **table-11**. These results indicate that there is both lateral and downward spread of contaminants from the solar evaporation ponds into the surrounding areas. The sandy soil at 4 to 6 feet depth below the solar evaporation ponds could intensify the spread of contaminants further in future.

The spread of contaminants was found as the least at the sampling location-11. Methanol extractable organic compounds level was <10 mg/kg at 13 feet and greater depths. Sulphonated phenolic compounds were not detected at this sampling location. Even iron levels were very low at 25 feet.

Contaminant levels were very high at the sampling locations -16 and -18, specially in the subsurface layers. Sodium, sulfate, nitrate, chloride, COD and methanol extractable organic compounds levels were 183-229 g/kg, 334-415 g/kg, 72.9-99.2 g/kg, 17.6-30.3 g/kg, 177-231 g/kg and 12.3-26.4 g/kg respectively. This indicates that this area was used by the industrial unit

may be for the open disposal of the mother liquor and other wastewater. Even lateral spread of contaminants from the solar evaporation ponds might have contributed to the high contaminant levels.

At the sampling locations -3, -14 and -15, the soil is moderately contaminated and at greater depths (>9 feet) sulphonated phenolic compounds are detected indicating lateral spread of contamination from the solar evaporation ponds. Iron, sodium, sulfate, nitrate, chloride, COD and methanol extractable organic compounds levels at these locations are 5.12-21.6 g/kg, 2.51-16.7 g/kg, 2.9-44.3 g/kg, 0.034-2.66 g/kg, 0.2-1.8 g/kg, 0.9-14.5 g/kg and 0.049-1.7 g/kg respectively. Top layers of the soil are relatively less contaminated, indicating that the area was filled with iron rich soil brought in during leveling of the land.

Table-11: Soil core samples from area surrounding the solar evaporation ponds

Depth (ft)	Iron (g/kg)	Sodium (g/kg)	Sulphate (g/kg)	Nitrate (mg/kg)	Chloride (g/kg)	pH	COD (g/kg)	Methonal Extractable (mg/kg)	Comp -A	Comp -B
Soil core sampling location-14										
3	12.10	1.420	2.08	10.5	0.515	8.0	4.211	<10	ND	ND
9	18.50	12.50	15.6	77.3	1.134	7.1	8.658	200	D	D
15	20.80	4.060	10.0	34.8	0.950	7.5	6.311	1210	D	D
21	21.60	4.260	5.0	48.0	0.802	7.2	4.902	49	D	ND
24	16.40	3.360	7.91	33.7	0.924	7.9	3.895	979	D	D
Soil core sampling location-3										
3	18.83	3.460	<2.00	53	0.437	7.2	3.668	98	ND	ND
6	6.750	10.41	18.6	40.7	0.422	8.0	0.591	112	ND	ND
9	10.23	2.510	2.78	108	0.430	7.9	7.118	88	ND	ND
12	5.120	16.79	44.3	255	0.466	8.6	3.839	657	D	ND
14	17.02	5.596	26.1	2660	0.203	8.3	10.27	771	D	D
Soil core sampling location-15										
3	9.700	3.180	4.81	101	0.481	7.3	4.523	212	ND	ND
9	12.80	12.70	14.7	1618	1.575	6.3	14.48	1710	D	D
15	12.30	11.10	18.6	1116	1.776	7.7	10.31	923	D	D
21	9.500	8.440	6.13	827	1.144	8.3	7.124	776	D	D
24	8.500	2.980	5.72	498	0.363	7.6	4.580	370	D	D
Soil core sampling location-16										
3	7.700	2.170	6.24	120	0.681	7.5	2.554	<10	ND	ND
12	3.100	229.4	415	83500	30.30	9.2	231.1	12300	D	D
Soil core sampling location-18										
3	8.290	4.080	24.8	116	0.771	7.7	3.899	<10	ND	ND
9	2.210	184.5	397	99200	26.90	11	154.2	25400	D	D
15	5.490	183.0	334	72900	17.60	9.4	177.4	26375	D	D
Soil core sampling location-11										
1	7.770	1.300	7.69	147	0.501	8.4	1.804	110	ND	ND
7	15.07	0.727	6.22	6.16	0.576	8.3	1.686	78	ND	ND
13	8.980	1.570	12.9	106	0.463	8.2	1.955	<10	ND	ND
19	8.840	1.430	13.3	176	0.711	7.8	1.904	<10	ND	ND
22	9.320	1.330	6.55	51.4	0.582	8.6	1.379	<10	ND	ND
25	0.601	1.090	9.28	49.1	0.365	8.5	1.700	<10	ND	ND

9. Pizometric water contamination assessment studies

Pizometric groundwater sampling was planned at the suspected H-acid manufacturing shed location. Intention of the pizometric groundwater sampling was to know whether the groundwater contamination was from the percolation/leaching of contaminants from the solar evaporation ponds and/or solid/hazardous waste storage tanks or it was from the intentional injection of wastewater into the groundwater.

During digging of the tube well, for the pizometric sampling, the groundwater was encountered at 105 feet depth. From 105 feet depth, the groundwater samples (along with the solid material samples) were collected at regular depths and analysed. The results obtained from the analysis of both the groundwater samples and the solid material samples are given in **tables -12 and -14**.

All the anticipated contaminants (iron, calcium, sodium, sulfate, chloride, nitrate, organic matter, methanol extractable organic matter and sulfonated phenolic compounds) were found in the groundwater samples. Levels of all the contaminants were found increasing with depth upto certain depth and beyond that decreasing with depth. This indicates that the contaminants were apparently loaded into the groundwater at certain depth and from their diffusing in all directions and moving in the groundwater flow direction.

The contaminant levels in the groundwater have been much higher than those found in the groundwater samples collected from the nine groundwater sampling locations (see **table -12, -3 and -15**). This indicates that the contamination levels in the groundwater is increasing as one moves from the groundwater sampling stations -1 and -2 towards the pizometric well and epicenter for the ground water pollution lies somewhere around the pizometric well.

Higher ratios of methanol extractable organic compounds to nitrates, chlorides and COD in the groundwater samples in comparison to those in the liquor samples of the solar evaporation ponds (**tables -10 and -12**) indicate that the wastewater contaminating the groundwater is different from the liquor that is present in the solar evaporation ponds. The solar evaporation ponds appear to predominantly have the mother liquor while the wastewater contaminating the groundwater is predominantly the filtrate/liquor discarded during filtration of the diluted fused mass in step-11 of the H-acid manufacturing process.

Profile of the total salt level (sum of iron, sodium, sulfate, nitrate and chloride) in the groundwater given in **table -13** indicates that the groundwater has been contaminated by the following two different sources:

- Percolation and leaching of contaminants from the onsite solid/hazardous waste storage and disposal and from the solar evaporation ponds.

- Direct injection of wastewater into the groundwater at 150 feet 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)

As on now contribution made 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 ground water (which was apparently discontinued by 2005) . Total salt level in the top layer of the ground water (1435 mg/L at 105 feet depth) is higher than that at 120 feet depth (1133 mg/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 120 feet depth, the total salt levels are increasing up to 140 feet depth (to 3178 mg/L) and then decreasing (2012 mg/L at 160 feet depth)). The latter might be from the direct injection of the wastewater might be at 140-150 feet depth.

Results given in **table-14** indicate that methanol extractable contaminants including the sulfonated phenolic compounds have very little affinity with the solid material of the aquifer. This is evident from the <10 mg/kg of methanol extractable organic compounds in the solid material samples obtained from the aquifer zone of the piezometric well. The sulfonated phenolic compounds have not been detected in the solid material of the aquifer. Most of the iron content of the added wastewater is apparently accumulating in the solid material of the aquifer. While the ground water is having just 0.25-1.41 mg/L of iron, the solid material is having 10-28.5 g/kg of iron.

Table-12: Groundwater quality at the piezometric hole created

Depth (feet)	Iron (mg/L)	Calcium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	pH	COD (mg/L)	Methanol extractable (mg/L)	Comp. -A (mg/L)	Comp. -B (mg/L)
105	0.25	566	202	534	47.6	85.4	7.8	132	227	D	D
120	0.40	85	341	560	47.6	99.3	7.7	161	597	D	D
130	1.17	156	538	887	85.2	141	7.7	388	767	D	D
140	0.94	1440	627	862	75.5	175	7.7	443	1060	D	D
150	1.30	196	719	1050	154	199	8.0	571	988	D	D
160	1.41	103	675	959	116	159	8.1	443	1200	D	D

Table-13: Profile of total salt levels in the groundwater

Depth (feet)	Iron (mg/L)	Calcium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Total salts level (mg/L)@
105	0.25	566	202	534	47.6	85.4	1435
120	0.40	85	341	560	47.6	99.3	1133
130	1.17	156	538	887	85.2	141	1808
140	0.94	1440	627	862	75.5	175	3180
150	1.30	196	719	1050	154	199	2319
160	1.41	103	675	959	116	159	2013

@ Here total salt level refers to the sum of concentration of Iron, Calcium, Sodium, Sulfate, Nitrate and Chloride

Table-14: Results of analysis of the solid material samples obtained during pizometric groundwater sampling

Depth (feet)	Iron (g/kg)	Sodium (g/kg)	Sulfate (g/kg)	Nitrate (mg/kg)	Chloride (g/kg)	pH	COD (g/kg)	Methanol extractable (mg/kg)	Comp -A	Comp -B
100	10.72	0.382	< 2.00	< 1.25	0.428	8.30	1.822	<10	ND	ND
130	16.80	0.576	< 2.00	< 1.25	0.384	7.60	2.929	<10	ND	ND
150	28.49	1.693	< 2.00	< 1.25	0.771	8.40	3.842	<10	ND	ND
160	10.01	0.511	< 2.00	< 1.25	0.421	8.80	2.385	<10	ND	ND

Table-15: Concentration of contaminants in the groundwater samples

Contaminant	Concentration in the groundwater samples (mg/L)		Concentration in the pizometric well (mg/L)	
	Minimum	Maximum	Minimum	Maximum
Iron	BDL	BDL	0.25 (105)**	1.41 (160)**
Sulfate	BDL (-7)*	206 (-1)*	534 (105)**	1050 (150)**
Chloride	11 (-6)*	190 (-1)*	85.4 (105)**	199 (150)**
Nitrate	2.3 (-3)*	15.5 (-5)*	47.6 (105)**	154 (150)**
COD	13 (-7)*	86 (-1)*	132 (105)**	571 (150)**
Methanol extractable organic compounds	149	173	227 (105)**	1200 (160)**

* Sampling station of the groundwater samples are given in the parentheses

** Depth of pizometric groundwater samples are given in the parentheses

10. Conclusions Drawn

Matharu Chemical Industries, Bhawanigarh was in operation and manufactured H-acid between July 1991 and February 2005. During this period, at the rate of 580 kg/batch and 35 batches per month, the industrial unit might have manufactured over 3000 tons of H-acid. From this the industrial unit might have generated over 17,000 tons of gypsum sludge, over 6,000 tons of iron oxide sludge, and wastewater containing over 2,000 tons of naphthalene based organic compounds and over 40,000 tons of inorganic salts (mainly sulfates, chlorides and nitrates of sodium). Please refer to **tables -1 and -2** for details.

Except selling out a small fraction, the industrial unit retained all the gypsum sludge and the iron oxide sludge within the premises. The industrial unit remained zero effluent discharging unit. It discharged no wastewater and no secondary waste (organic waste and incineration ash generated from the wastewater treatment and handling) beyond its premises. The only exception is transport of 103 tons organic waste/incineration ash during dismantling after 2005 to the TSDF of Nimbua, Dera Bassi.

It appears that the industrial unit segregated the filtrate (discarded liquor) of the H-acid manufacturing step-11 (and even the H-acid washwater of the H-acid manufacturing step-12, if not reused) and disposed off through injecting into the groundwater at about 140-150 feet depth. Over the 14 years period the industrial unit might have injected about 28000 m³ of wastewater into the groundwater. This has heavily polluted the local groundwater. Declining groundwater table and continual pumping out of groundwater for irrigational use, specially, at the groundwater sampling stations (wells) -1 and -2, apparently are not allowing spread of the groundwater pollution. The observed groundwater pollution is mainly from this wastewater injection. Contribution by the soild/hazardous waste storage tanks and by the solar evaporation ponds as of now appears to be there but not very significant. Total salt level (iron, calcium, sodium, sulfate, nitrate and nitrate) observed in the top layer of the groundwater (at 105 feet depth) is higher than that observed at 120 feet depth (1435 mg/L). This could be from the percolation/leaching of contaminants from above. Beyond 120 feet depth the total salt level was increasing upto 140 feet depth and beyond that it is decreasing. The latter could be because of the injected wastewater.

All the other wastewaters (the mother liquor of step-8, the washwater of the nutch filters and filter presses, the foul condensate of H-acid manufacturing step-7, if any, and even the wastewater from the utilities and services, if any), amounting to 28000-57000 m³, were apparently disposed off by the industrial unit into the solar evaporation ponds.

Solar evaporation ponds of 3600 m² area spread in about 4400 m² land area were used for the disposal of the wastewaters. Some portion of the solar evaporation ponds area (about 800 m²)

was apparently used for the burying disposal of organic solid waste packed in gunny bags. The solar evaporation ponds are found to still hold the disposed wastewater in the form of thick black liquor from about 6 feet depth to about 15 feet 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 about 10,000 m³. This thick black liquor is percolating downwards and it will ultimately reach the ground water and pollute it. Being a low lying area, both storm water and applied flood irrigation water accumulate in the solar evaporation pond area and will enhance the percolation and leaching of the pond contents into the groundwater.

Confinements of the solar evaporation ponds appear to be not that leak proof. The thick black liquor is percolating/leaching both vertically and laterally. Lateral spread of the solar evaporation pond contents have already heavily contaminated about 600 m² land on the northern side (figures -3 and -9).



Figure-9: Photographs showing contaminated soil core samples adjacent to solar evaporation ponds

Gypsum sludge, iron oxide sludge and incineration ash (and even the organic sludge) were supposedly stored in three sludge storage tanks, each of about 480 m³ sludge storage capacity. During dismantling of the sludge storage tanks, only about 103 tons of incineration ash/organic sludge was reportedly transported to the TSDF of Nimbua, Dera Bassi for disposal, and no gypsum sludge and no iron oxide sludge were transported to the TSDF for disposal.

Assuming consistency and bulk density of the gypsum sludge as 70% and 3.0 respectively, total volume of the gypsum sludge generated might have been above 8000 m³ while the storage

capacity available was just 480 m³. Similarly, assuming consistency and bulk density of the iron oxide sludge as <30% and <3.0 respectively, total volume of the iron oxide generated might have been >6500 m³ while the storage capacity available was just 480 m³.

Unknown but significant quantities of both gypsum sludge and iron oxide sludge were reportedly disposed off through selling to outside parties. Rest of the gypsum sludge and the iron oxide sludge were, both before and during the dismantling of the industrial unit (and the sludge storage tanks) and leveling of land, disposed and spread on the land within the industrial unit premises. This might have been responsible for the higher levels of iron, sulfate, chloride and nitrate in the top soil of the industrial unit (**table-7**). Significant quantities of specially the wet low consistency (<30%) iron oxide sludge was disposed in the northern corner of the industrial plot (please see **figure –10**), which was not actually designated for the solid/hazardous waste storage.



Figure-10: Photographs showing disposed iron oxide sludge core samples from the north-eastern corner of the site

Incinerator was commissioned in 1996. Before 1996, no organic waste was incinerated. Even after the commissioning in 1996, the incinerator was not effectively used. The mother liquor was supposedly neutralized with quick lime and filtered to remove gypsum, then it was concentrated and filtered to remove glauber salt (sodium sulfate), and then it was supposedly incinerated. Incineration of the treated mother liquor was supposed to generate about 30 tons/year of incineration ash. Despite this, at the time of dismantling, the incineration ash storage tank was (instead of 250-400 tons) was having only 103 tons of ash.

Use of sodium chloride (common salt) and hydrochloric acid (in the H-acid manufacturing step - 8) might have proved the mother liquor treatment very difficult and might have resulted in the generation much larger quantities of incineration ash, when incinerated. Ineffective use of the incinerator might have forced the industrial unit to maintain the mother liquor (concentrated to different levels) in the solar evaporation ponds. some of the sludge settled to the bottom of the solar evaporation ponds on concentrating might have been dredged, sun dried and packed in gunny bags and disposed in the solar evaporation ponds area (please see **figure-3**).

11. Remedial actions recommended

The study clearly showed the following:

1. Localized contamination of groundwater through injection of about 28000 m³ of industrial wastewater at about 140-150 depth.
2. Presence of about 10,000 m³ of industrial waste concentrated to different levels in the solar evaporation ponds (a potential source of groundwater contamination)
3. Heavy contamination of about 600 m² land with the thick black liquor of the solar evaporation ponds on the northern side
4. Presence of iron oxide sludge in the north-eastern corner of the industrial site and buried organic waste on the south-western side of the solar evaporation ponds
5. Contamination of the top soil within the industrial unit premises specially with iron oxide and gypsum sludge

The contaminated groundwater needs treatment at the least to remove the methanol extractable organic compounds (including the sulphonated phenolic compounds). For this the ground water may be pumped out from the epicenter of contamination (which lays at 140-150 feet depth closer the manufacturing shed on the western side), treated for the removal of methanol extractable organic matter and then, if found suitable, used for irrigation in the nearby agricultural fields.

The treatment can include

- raising pH to >11 with lime to precipitate the colour imparting methanol extractable organic matter
- settling/clarification to remove the precipitated organic matter
- neutralizing the clarified water with sulfuric acid to about 7 pH

The treated (heavily polluted) groundwater is suspected to have higher TDS and may not prove fit for irrigation at least during initial stages. Amount of ground water to be pumped out and treated may be quite large (can be around 1,00,000 m³ or even more). The sludge generated from the treatment needs handling as hazardous waste. After dewatering and drying it may be sent to the TSDF for disposal or incinerated.

The thick black liquor and other waste present in the solar evaporation ponds may be treated as hazardous waste. It may be lifted and transported as it is or after sufficient treatment (neutralization, concentration and filtration!) to TSDF for disposal. All the secondary wastes generated during such treatment may also be considered as hazardous waste and handled. The solar evaporation ponds may contain upto 10,000 m³ of waste.

The heavily contaminated soil (with the thick black liquor of the solar evaporation ponds) of about 600 m² land area upto 20 feet on the northern side may also be handled as hazardous waste. This waste may amount to 2700 m³. It may be lifted and shifted to the TSDF for disposal. Further, the iron oxide sludge in the north-eastern corner of the industrial site and the buried organic waste on the south-western side of the solar evaporation ponds may also be lifted and transported to the TSDF for disposal as hazardous waste. Actual quantity of this waste to be handled could not be assessed.

Contamination of the top soil within the premises of the industrial unit, specially with iron oxide and gypsum sludge, may be taken care off through the following steps:

1. Avoid run on of storm water from the surrounding areas through creating berms/barriers and diverting the storm water specially on the eastern and southern sides.
2. Avoid flood irrigation of the land within the industrial unit premises and impose restrictions on the crops to be grown. Fiber and energy plantation crops may be most the appropriate. Food and fodder yielding crops may be avoided.

**BEFORE THE NATIONAL GREEN TRIBUNAL,
PRINCIPAL BENCH, NEW DELHI
ORIGINAL APPLICATION NO. 35/2013 (THC)**

In the matter of:

1. Parminder Singh, s/o Pritam Singh
Balad Kalan Village, Bhawanigarh Tehsil,
Sangrur District.
2. Hoshiar Singh, s/o Harbhajan Singh
Toori Village, Bhawanigarh Tehsil,
Sangrur District.
3. Narindre Singh, s/o Inder Singh
Balad Kalan Village, Bhawanigarh Village,
Sangrur District.
4. Surjit Singh, s/o Harnek Singh
Bhavangarh, Sangur District.
5. Ranjit Singh, s/o Satpal Singh
Balad Kooti Village, Bhavangarh Tehsil,
Sangur District.
6. Angrej Singh, s/o Surjir Singh
Toori Village, Bhavanigarh Tehsil,
Sangrur District.
7. Harnek Singh, s/oGujjar Singh
Sarpanch, Gram Panchayat Toori,
Toori Village, Bhavanigarh Tehsil,
Sangrur District.
8. Jagnahar Singh, s/o Nikka Singh
Toori Village, Bhavanigarh Tehsil,
Singrur District.
9. Paramjit Singh, s/oSharan Singh
Toori Village, Bhavanigarh Tehsil,
Singrur District.
10. Sukhwinder Singh, s/oMohinder Singh
Toori Village, Bhavangarh Tehsil,
Singrur District.

---- Applicants

Versus

1. Punjab Pollution Control Board through its
Chairman, Vatavaran Bhawan, Nabha Road, Patila.

2. Environmental Engineer, Punjab Pollution Control Board, Through its Regional Office, Sanrur District, Sangrur.
3. Assistant Environmental Engineer, Punjab Pollution Control Board, through its Regional Office, Sangrur District, Sangrur.
4. M/S Matharu Steel Pvt. Limited having its Registered Office at Plot No. 4, Near Airport, Jhalanpur Road, Kota Rajasthan thru. Its Director Shri. Chander Shekhar Dhawan.
5. M/S Mahalaxmi Orgochem Industries, c/o Matharu Steels Pvt. Limited, Nabha Road, Tehsil Bhavanigarh, Distict Sangrur, Through Shri. Chander Shekhar Dhawan.
6. Chander Shekhar Dhawan, Director, M/S Matharu Steels Pvt. Limited, resident of 110-A, Sarabha Nagar, Ludhiana.
7. Sunil Ahuja, Director of M/S Matharu Steels Pvt. Limited, Resident of E-14, Sector-14, Noida, U.P.
8. Tara Singh, S/o Swaran Singh. Village Nauhra, Nabha, Patiala Distict.
9. Gurcharan Singh Matharu s/o Surjit Singh Matharu Director, Matharu Chemicals Industries Nabha Road, Bhawangarh Tehsil Sangrur District.
10. Central Pollution Control Board represented by The Member- Secretary, New Delhi.

--- Respondents

Counsel for Applicants:

Mr. Ritwick Dutta, Amicus Curie

Counsel for the Respondents:

Counsel for Respondent 1, 2 &3: Mr. A.R Takkar, Ms. Gurinderjit, Mr. Ankur Sharma, Advocates Ms. Garima Huda and Mr. Rajkumar, Advocate

Counsel for Respondent 4 to 6: Mr. Jeevesh Nagrath, Mr. Nitheesh Kr. Sharma and Mr.V. Kashvap Advocate

Counsel for Respondent 7: Mr. Rajat Navet and Mr.Ritwick Navet, Advocates

Counsel for Respondent 9: Mr. Sunil Gupta, Advocate

Counsel for Respondent 10: Mr. Rajkumar, Advocate with Mr. S.L.Gundli, S.L.O, C.P.C.B.

Present:**HON'BLE MR. JUSTICE DR. P. JYOTHIMANI (JUDICIAL MEMBER)****HON'BLE MR. JUSTICE U. D. SALVI (JUDICIAL MEMBER)****HON'BLE PROF. A. R. YOUSUF (EXPERT MEMBER)****HON'BLE MR. BIKRAM SINGH SAJWAN (EXPERT MEMBER)****ORDER****Reserved on: 27th February, 2015****Pronounced on: 23rd September, 2015**

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- 1.) Whether the Judgment is allowed to be published on the net?
 - 2.) Whether the Judgment is allowed to be published in the NGT reporter?

Prof. A. R. Yousuf (EM)

1. The applicants have filed Civil Writ Petition no. 3481/ 2007 on the file of the High Court of Punjab & Haryana, alleging that Respondents 4 to 7 were polluting the environment by not complying with the provisions of Hazardous Wastes (Management and Handling) Rules 1989, affecting their Fundamental Rights guaranteed under article 14 and 21 of the Constitution of India. All the ten petitioners are residents of different villages in Tehsil Bhawanigarh, Dist. Sangrur (PB), which are in the proximity of 1-2 kilometres from the area where the industrial unit "M/S Matharu Chemical Industries" (later on renamed as M/S Mahalaxmi Orgochem Industries) of respondents No. 4 and 5 was situated.
2. According to the petitioners the said unit was manufacturing H-acid, i.e. Sodium Salt, which is highly toxic in nature and the waste material, from the process of manufacturing is highly hazardous to the environment. The petitioners are

aggrieved from the fact that the said respondents did not dispose of the waste material from the manufacturing process, including by-products, all of which is hazardous in nature in accordance with the provisions of 'the Environment (Protection) Act, 1986', 'Hazardous Wastes (Management and Handling) Rules, 1989' as amended in May 2003, The Water (Prevention and Control of Pollution) Act, 1974 and 'The Air (Prevention and Control of Pollution) Act, 1981 and dumped the same at the site in violation of the said rules.

3. According to petitioners Respondent No. 4, viz., M/S Matharu Steel Pvt. Ltd., having its registered office in Rajasthan, set up the Industrial unit by the name "M/s Matharu Chemical Industries" in a piece of land measuring 41 bighas 13 biswas in Village Toori, Tehsil Bhawanigarh, District Sangrur and started manufacturing H-acid (Sodium Salt) in 1997. Later on, name of the unit was changed to M/s Mahalaxmi Orgochem Industries i.e. Respondent No. 5. As per the petitioners, Respondent No. 6 and 7 are the directors and occupiers of respondent No. 4 and 5 respectively and were therefore, responsible for the safe custody, storage, handling etc. of the hazardous waste material lying at the premises of respondent No. 5. As per the complaint these respondents continued manufacturing H-Acid till March, 2005, after which the unit was closed. According to the petitioners following raw material inputs are used for the manufacturing process of H-acid.

1.	Naphthalene	600 kg
2.	Sulphuric Acid	3039 kg
3.	Oleum	1790 kg
4.	Nitric Acid	372 kg
5.	Calcium hydroxide (Calcium Carbonate)	1637 kg
6.	Hydrochloric Acid	751 kg
7.	Soda Ash	900 kg
8.	Caustic Soda	860 kg
9.	Iron powder	650 kg
10.	Common Salt	2700 kg

4. According to them the above mentioned quantity of the raw materials (listed as items 1-10 in Para 3 supra) was used to produce 580 kg of Sodium Salt of H-acid and during the manufacturing process following 06 by-products, besides waste material, were also produced.

1.	Gypsum	3503 kg
2.	Iron Oxide	852 kg
3.	Sodium Bisulphite	550 kg
4.	Sodium Nitrite and Nitrate	110 kg
5.	Common Salt	3005 kg
6.	Glaubers Salt	1636 kg

5. The contention of the petitioners was that the waste material from the above said manufacturing process, which remained unused, was highly toxic and contained acid content, is harmful to the life of the inhabitants of the surrounding areas. The said waste material also caused wide spread pollution of ground water, air, etc. According to them it was the duty and responsibility of these respondents to keep such hazardous

waste under safe custody till it was not disposed of as per the provisions contained in Environmental rules.

6. The petitioners alleged that the said H-Acid manufacturing unit was closed on 01.03.2005 and the respondents dismantled the over ground portion including the roof of the hazardous waste storage facility and the hazardous wastes were lying in the open in violation of the concerned environmental rules. According to them, as the waste material was lying in open area it had started showing its impact on the environment and the ground water of the nearby area got polluted and had already turned dark red in colour which is unfit to be used by human being. The seepage of rain water through this highly hazardous waste material had also been polluting the ground water thus rendering the same unfit for human consumption. Further, the soil of the nearby area had turned dark brown in colour and the cultivation in the surrounding areas, if consumed by the human being would cause risk to their life and liberty.

7. In this backdrop the petitioners prayed that:

- i) Directions be issued to the respondents to store, dispose of the hazardous waste material lying in the premises of respondent No. 5 in an environmentally safe manner.
- ii) That the provisions of the Environment (Protection) Act 1986, Hazardous Wastes (Management and Handling) Rules, 1989 as amended in May 2003, The Water

(Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) act, 1981 be complied with so as to protect the health of the petitioners and the inhabitants of the nearby areas.

iii) Respondents 1 – 3 be directed to take water samples of the nearby area.

8. The above writ petition was being heard by the Hon'ble High Court of Punjab & Haryana at Chandigarh till 2013, when it was transferred to the NGT vide HC order dated 29.01.2013 and was registered in NGT as Application No. 35/2013 (THC).
9. After hearing the parties, the Hon'ble High Court on 2nd April, 2009 directed the Punjab Pollution Control Board to inspect the site and analyse the samples taken from there and submit the status report to it.

“In the circumstances, therefore, we direct that the Punjab Pollution Control Board shall depute a team for inspection of the site and for taking samples and also for examining whether any dump of hazardous waste material is lying concealed under the surface. The team shall visit the site on 26.04.2009 at 10:00 a.m. One of the petitioners and respondent no. 6 shall remain personally present at the spot on the date and the time given above. Respondent nos. 4 to 6 shall also deposit with the Punjab Pollution Control Board a sum of Rs. 2 lacs towards testing charges. The Punjab Pollution Control Board shall file a status report along with test reports received in the meantime, on or before the next date of hearing.”

10. As per Status Report-Affidavit submitted by Sh. A.K. Kalsi, Environmental Engineer, Punjab Pollution Control Board, Regional Office, Sangrur dated 15.07.2009, in compliance to the Hon'ble Punjab & Haryana High Court orders dated

2/4/2009, the Punjab Pollution Control Board constituted a team comprising of following officers for inspection of the site and for taking samples and also for examining whether any dump of hazardous waste material was lying concealed under the surface.

- i) Er. A. K. Kalsi, Environmental Engineer, Regional Office, Sangrur.
- ii) Er. S. S. Matharu, Asstt. Environmental Engineer, Zonal Office-II, Patiala.
- iii) Er. Om Parkash, Asstt. Environmental Engineer, Regional Office, Sangrur.
- iv) Dr. Sat Pal Verma, Asstt. Scientific Officer, Head Office Laboratory, Patiala.

The team inspected the site in question on 26/4/2009 at 10.00a.m. onwards along with Sh. Narinder Singh S/o Sh. Bhinder Singh resident of Village Baladkalan (Petitioner) and Sh. C. S. Dhawan, Director of M/s Mahalaxmi Orgochem Industries, Nabha Road, Bhawanigarh. Soon after starting the inspection, Sh. Tara Singh, present owner of the land in question came there. The team made the following observations:

- i. It was observed by the team that the site of the industry had been levelled mechanically by the present owner of the land S. Tara Singh. Sh. Narinder Singh S/o Sh. Bhinder Singh resident of Village Baladkalan (Petitioner) showed three sites (S-1, S-2 & S-3) within the premises of the

previous industrial unit, where he apprehended that the waste generated by the industry has been dumped. After digging out about 2-3 feet at site S-1, red coloured waste was found dumped. At site 2, after digging out about 2-3 feet, black coloured waste was found dumped.

- ii. When the digging at site S-3 started, the soil cover on this site was observed in loose state up to 4-5 feet, this may probably be due to recent levelling of the said land area. After digging out about 4-5 feet of this spot, black coloured waste was found dumped. A sample of this waste was collected in the presence of petitioner as well as the then occupier of the industry, which was sealed after packing into polythene bag. The petitioner claimed that the industry has dumped waste in huge quantity beyond 10' from the top level of the area at this site and he emphasized that JCB is required to dig out up to the aforesaid required depth for taking samples of waste. However, the present owner of the land S. Tara Singh raised the objection that he has made heavy expenditure to level the site and he restrained the team to dig out at spot S-3 with the help of any mechanical excavator (JCB) to take the sample of waste as apprehended by the petitioner. He suggested that the samples of waste may be taken with the help of any kind of boring machine, but the petitioner denied to do so.

- iii. The petitioner also showed a site outside the premises of the previous industry, where he apprehended that the waste has been dumped. This site has been marked as S-4 in the site plan, when this site started digging out, light brown coloured waste was found dumped at this site after removing soil cover 5-6". A sample of this waste was collected in the presence of petitioner as well as the then occupier of the industry, which was sealed after packing into a polythene bag.
- iv. All the aforesaid samples collected from the site in question, were sent to M/s Shri Ram Institute for Industrial Research, Delhi for analysis, the analysis results of which have been received from the said laboratory on 21.5.2009. The waste constituents such as nitrates and nitrites belong to class 'C' of the Schedule-II appended to the Hazardous Waste (Management, Handling & Trans-boundary Movement) Rules, 2008, but the concentration of these parameters in all the four samples i.e. S-1, S-2, S-3 & S-4 is much less than the prescribed concentration of class 'C'. However, as per analysis results of waste sample marked as S-3, this sample is not free from acute toxicity, as such the said waste is covered under class 'E' of Schedule-II appended to the said Rules. Thus, the waste dumped at site S-3 is hazardous in nature and is required to be disposed off in an environmentally sound manner.

- v. During the said visit and inspection of the site on 26/4/2009, seven ground water samples from various tube wells/bore wells, marked as G-1 to G-7 on the site plan, were also collected from the surrounding vicinity of the industry.
- a. The results of above parameters show that ground water sample G-1 & G-2 are affected with reference to the parameters viz Colour, TDS, Chloride & Sulphate.
- vi. In the affidavit the said PPCB officer also informed the Hon'ble High Court that the Board has already engaged Thapar University vide letter no. 11604 dated 1.4.2009 to carry out a detailed investigation regarding the length, breadth and depth of ground water contamination as well as hazardous waste. The study is likely to be completed within 3 months.
11. On 17.8.2009 the Hon'ble High Court, after perusing the proposal of Thapar Centre for Industrial Research & Development for preparation of a comprehensive report on the pollution related angle of the said industrial unit and remedial measures thereof, allowed the PPCB to go ahead with the proposed 3 month long study. Further, Mr. Tara Singh S/O Mr. Swaran Singh R/O Nauhra (Nabha), the present owner of the said industrial unit site, was impleaded as a party respondent No, 8.
12. Respondent No. 9 submitted, through reply affidavit dated 19.11.2013, that he was associated with the said industrial

unit as one of the directors of the unit only up to March, 2003 and during this period (1991 – 2003) he was meticulous to ensure that all the relevant approvals and consents relating to the various environmental laws, particularly under the Water (Prevention & Control of Pollution) Act, 1974 (“Water Act”), the Air (Prevention and Control of Pollution) Act, 1981 (“Air Act”) and the Hazardous Waste (Management & Handling) Rules 1989 (“HW Rules”) were valid at all times and were renewed from time to time after official inspections of all the concerned Departments. It is submitted that all compliances were made and, amongst others the following valid approvals/ consents were obtained and got renewed to ensure that the said company was in compliance with all applicable environmental legislation/ requirements to the satisfaction of the Punjab Pollution Control Board, the Regulatory Authority.

Legislation	Approval/NOC No.	Date of Approval/ NOC	Period of validity of Approval/ NOC
Water Act	1.)SGR/WPC/ETP/1993-94/F-91	7.10.1993	30.09.1994
	2.)SGR/ETA/95-10/F-173	18.10.1995	17.10.2010
Air Act	1.)SGR/APC/ECD/93-94/R-75	02.02.1994	30.06.1994
	2.)SGR/APC/97-09/R-157	08.10.1997	30.06.2009
HW Rules	Letter No. 4580 renewed periodically last by Letter No. 16987 DT. 09.08.2004	06.05.1997	18.03.1999
		23.04.2002	22.04.2004
		05.08.2004	04.08.2005

13. It was pointed out by Respondent No. 9 that he was involved in the affairs of the company only till 28.03.2003 and at the time of transfer of the said Company all the records including the licences/NOCs under the relevant environmental laws were handed over to the new owners/ Management of the said manufacturing unit for the smooth running of their unit and for necessary action including renewals thereof by the persons who had taken over the said Company and who are impleaded as Respondent Nos. 6 and 7 in the Writ Petition.
14. In his letter to the Member Secretary, PPCB vide No. 593 dated 4.3.2002 in respect of the application of **M/s Matharu Chemical Industries, Nabha Road, Bhawanigarh, Distt, Sangrur** for renewal of **authorisation under the Hazardous wastes (Management & Handling) Rules 1989 as amended in 1/2000**, the concerned Environmental Engineer has commented thus “The Industry generates gypsum @1500TPA from filtration ii) and iron oxide @400TPA from reduction process. These both are by-products of the industry and are sold in the market. As per hazardous Waste (Management & Handling) amended Rules, 2000 both these bye-products are not hazardous in nature. The industry generates mother liquor from filtration iii) which is incinerated in the incinerator and thereby generating ash @50kg/day. This ash is hazardous in nature and is covered under waste stream no. 41.1 of Schedule I appended with said rules. The

industry is maintaining the record of ash generated from incineration of Gypsum & Iron Oxide. As per record, the industry has stored 76.63Tonnes ash inside the storage pit after packing into H.D.P.E bags. The industry was visited by AEE on 22.2.2002 and during visit it was observed that the industry has constructed an impervious pit made of (R.C.C) having size 20mX12mX5m for the storage of incinerator ash. Thus the total volume of storage pit is 1200m³ and hence 1200 Tonnes of ash can be stored in the pit. The industry is producing 15 T of ash in a year and hence the balance capacity of storage pit is sufficient more than five years. The industry has constructed 2 no pits having size 20mx12mx5m in addition of above to store Gypsum & Iron oxide before selling it outside. The industry has fixed danger sign outside the pit & fenced the pit with fencing wire.”

15. The Industrial Unit in question was issued a show cause notice on 5th April, 2004 by Environmental Engineer, PPCB, for Violation of the provision of Water (Prevention & Control of Pollution) Act, 1974 and Air (Prevention & Control of Pollution) Act, 1981. The deficiencies /violations observed included particularly:

- i. The effluent from the lab section is discharged on to land for stagnation without any treatment.
- ii. The cooling water from the fusion process and the boiler blow down was also being discharged onto land for stagnation.

- iii. The scrubber water from scrubbers attached to boiler furnace & thermopac was not being completely re-circulated and a part of that was being discharged onto land for stagnation. The scrubber water from the scrubbers attached to control SO_x & NO_x emissions is discharged onto land for stagnation.
- iv. The house-keeping of the industry was very poor and there is no proper system for drainage of waste water from different sections. Although the quantity of waste water generated from different sections is small, but it is going for stagnation from most of the section. The Industry has not provided any facility for measurement of its effluent.
- v. The gypsum sludge and the iron sludge generated from the process was lying in the open in the form of heaps and it was not stored under the shed.
- vi. The industry has added the fusion process without obtaining any NOC from the Board. The representative of the industry told that this process has been added only about 3 months back and with the help of this process, they can use lesser quantity of raw material for producing a particular quantity of their product.
- vii. The industry has not provided the sampling facilities for collection of NO_x & SO_x emission samples.
- viii. The industry was using rice husk as fuel in its non-fluidized bed boiler furnace & thermopac furnace.

- ix. The main stack of the boiler and thermopac was found broken along with the ladder.
- x. The duct connecting the exhaust from thermopac furnace to the stack was found broken.
- xi. The industry has not provided proper stack height on its two no. D.G. sets of 125 KVA each.

16. The said industry was visited by the officials of the PPCB on 24.5.2004 in connection with the renewal of authorisation under the H.W. (M& H) Rules. During the visit "It has been observed that the H.W. is being stored in the H.W pit after packing in gunny bags. The bags are being replaced with fresh bags and much of the work remains to be done. The H.W pit is covered with AC sheets from top & two sides, third side of this pit is a storage shed where gypsum was stored. The fourth side is not covered with AC sheets. The fencing around the H.W. pit has not been done. The incinerator is not operational. As per representative of the industry it is not required to be used as sodium sulphate is extracted from the mother liquor by the cold process and reused in the process, the remaining mother liquor is re-used in process. As per the industry, the concentrated mother liquor requires to be incinerated after 2-3 months. However as per record of the H.W maintained by the industry, no H.W has been shown as generated after 27.12.2003. The final record on 27.12.2003 shows 1973 bags containing 98.650 MT of H.W. As per the representative of the industry the manufacturing process has

been changed from earlier but detailed changed process yet to be submitted.”

17. As is apparent from the letter No. HMC/2005/SGR/2235 Dt. 16.2.06 issued by Member Secretary, Punjab Pollution Control Board to M/S Maha Laxmi Orgochem Industries (Prop. Matharu Steel (P) Ltd.), formerly known as M/s Matharu Chemical Industries, Nabha Road, Distt. Sangrur, the over ground parts of the Industrial unit were dismantled right during 2005. This is clearly evident from the contents of this notice.

“And whereas the industry was visited by officer of the Board on 10.1.2006 and observed that the industry has dismantled the over ground portion including the roof of the hazardous waste storage facility and hazardous waste was lying in the open.

And whereas the industry has violated the provisions of the rule 5 of the Hazardous Waste (Management & Handling) Rules, 1989 as amended in May, 2003.

Now, therefore, the Chairman, Punjab Pollution Control Board in exercise of the power conferred upon the Board u/s 5 of the Environment (Protection) Act, 1986, after going through the details of the case, has decided to direct as follows:-

The industry will not dispose of its hazardous waste lying in the premises and will store the same in environmentally

sound manner till the same is disposed in common treatment, storage and disposal facility.

In case you fail to comply with the above said directions, the industry and its Managing Director/Directors and officer concerned/responsible to comply with the provisions of the Hazardous Waste (Management & Handling) Rules, 1989 as amended in May 2003 shall be liable for action under Section 15 & 16 of the Environment (Protection) Act, 1986.”

18. As per No. HMC/SGR/2004-2005/R-2060 Sh. C.L. Dhawan of M/s Mahalaxmi Orgochem Industries (Prop. Matharu Chemical Steel Pvt. Ltd.) previously known as M/s Matharu Chemical Industries was granted an authorization by the PPCB under Rule 5 of the Hazardous Wastes (Management & Handling) Amendment Rules, 1989 as amended in 2003 of Environment (Protection) Act, 1986 to operate a facility for collection and storage of hazardous waste on the premises situated at Nabha Road, Bhawanigarh, Distt. Sangrur for a period of one year from 05.08.2004, the date of issue of the authorization. The Terms and Conditions of Authorization included, besides many other things, in particular the following conditions.

- i. The person authorised shall not rent, lend, sell, dispose, transfer or otherwise transport the hazardous waste without obtaining prior permission of the Board.
- ii. Any unauthorized change in personnel, equipment and working conditions as mentioned in the application by

the person authorized shall constitute a breach of his authorization.

- iii. It is the duty of the authorized person to take prior permission of the state Pollution Control Board to close down the facility.
- iv. The occupier generating hazardous waste/operate of a facility for collection and storage of hazardous waste shall maintain records of such operations in Form-3.
- v. An occupier who is generating hazardous waste shall store his waste category wise on site in environmentally sound manner.
- vi. An occupier/generator shall not store hazardous wastes in open ground. It must be stored in an isolated site away from plant operational area.
- vii. The storage tank/container of the hazardous waste should be in good condition and made of (or lined with) an appropriate material which does not react with the waste contained in it and can withstand the physical and environmental conditions during storage and handling.
- viii. The occupier generating hazardous waste shall mark each container holding hazardous waste with the marking "HAZARDOUS WASTE" both in English and Punjabi.
- ix. The storage area should be fenced properly and a sign Board indicating "DANGER" and "HAZARDOUS

WASTE” sign & nature of the waste shall be placed at storage site.

- x. The industry shall store the hazardous waste in environmentally sound manner and pack the hazardous waste sludge in impervious bags/containers strong enough to sustain rigour of handling, storage, transportation and weather conditions. The storage facility must be covered from upper side.
- xi. The occupier and operator of a facility shall also be liable to reinstate or restore damaged or destroyed elements of the environment at his cost, failing which the occupier or the operator of a facility, as the case may be, shall be liable to pay the entire cost of remediation or restoration and pay in advance an amount equal to the cost estimated by the State Pollution Control Board.

19. It may be pointed out that Respondent 3 (Assistant Environmental Engineer, PPCB, Regional Office, Sangrur, has stated in his reply affidavit dated 7th August, 2007 on behalf of Respondent 1 – 3, that “the respondent industry no. 5 vide letter dated 18.3.2005 informed the answering respondents that due to adverse market condition they have stopped production temporarily and also added that as and when the production will start they will inform the Board. The fact was verified by the answering respondents when the

industrial unit was found closed during visit by the officers of respondents on 21.3.2005..... The Industrial unit was again visited by the officers of the answering respondents on 2.1.2006 and it was found that the industry has dismantled the plant up to plinth level. But the hazardous waste was lying in bags in the storage pit.”

20. Respondent 1 – 3 in the aforementioned affidavit also state that the premises of the respondent 5 (Industrial unit site) were visited by respondent no. 3 on 26.2.2007 on the directions of the Hon’ble Court of Sh. Harash Mehta, PCS, Addl. Civil Judge (Senior Division), Sangrur in a civil case During inspection, no chemical/raw material/product of the industry was found lying within the premises and the hazardous waste was found stored in storage pit in safe manner by the visiting officers.” However, they are silent about the manner of storing of the iron oxide and gypsum on the site.

21. During its pendency in the Honble HC, the PPCB asked the Thapar Centre for Industrial Research & Development (TCIRD), Thapar University, Patiala (Pb) to have a detailed investigation into the length, breadth and depth of the ground water contamination problem of the concerned unit. The said centre completed the job during the course of one year, November, 2009 – November, 2010. The final report was submitted and taken on the record by the Hon’ble High Court on 10.01.2011.

22. The TCIRD Report spread over 44 pages and titled “Assessment of the Length, Breadth and Depth of groundwater Contamination by Matharu Chemical Industries, Bhawanigarh” indicated that M/S Matharu Chemical Industries (later on Mahalakshmi Organochem Industries), Nabha Road, Bhawantigarh, Sangrur, Dist., Punjab was established in 1991. The industrial unit is located on the Bhawanigarh-Nabha Road at 4 km distance from Bhawanigarh on the right side. Except for the two rice shellers, one pipe factory, one punsup godown, one petrol pump and one very small human settlement, the industrial unit is surrounded by agricultural fields. As per the TCIRD Report 41 Bhiga and 13 Biswa of land was under the industrial site. It was manufacturing H-acid and its design capacity was 580 kg H-acid per batch and 35 batches per month. The production of H-Acid was commissioned at the site in July 1991 and continued till the end of February 2005.

23. The TCIRD Report has provided details about the process employed by the concerned industrial unit for the manufacturing of H-acid from Naphthalene. The details have been (as mentioned in the report) based on the information submitted by the proponents of the said industrial unit to the Punjab Pollution Control Board for the purposes of obtaining of No Objection Certificate (NOC), Consent to Operate and

authorization to handle hazardous, supplemented by review of literature on the manufacturing of H-acid.

24. According to the report the H-acid is 1-amino, 8-naphthol, 3, 6-disulfonic acid with empirical formula $C_{10}H_8NO_7S_2Na_2$. It is used in the manufacturing of dyes. It is usually manufactured as a sodium salt. It is grey powder soluble in water, alcohol and ether. Its manufacturing involves the following steps:

- i. Sulfonation of naphthalene ($C_{10}H_8$) with 65% oleum ($H_2S_2O_7$) and sulphuric acid (H_2SO_4). It might have emitted sulphur oxide fumes.
- ii. Nitration with 60% nitric acid (HNO_3). It might have emitted nitrogen oxide fumes.
- iii. Neutralization of the resultant mixture of acids and the sulfonation and nitration product with lime slurry (10%). It might have consumed water for the lime slurry preparation.
- iv. Filtration of the neutralized mixer in nutch filters for separating the gypsum ($CaSO_4$) sludge (neutralization product at 70% consistency!) formed. Gypsum sludge (solid waste) is generated.
- v. Reduction of the filtrate by Iron. Involves addition of iron powder, hydrochloric acid (HCl), soda ash (Na_2CO_3) and acetic acid (CH_3COOH).
- vi. Filtration of the mixer, of the reduced product, the residual chemicals and the by-products formed, in a

filter press for separating the iron oxide (Fe_2O_3) sludge (at 30% consistency). Iron oxide sludge (solid waste) is generated.

- vii. Concentration of the filtrate. Was it in a multiple effect evaporator and did it generate foul condensate? If a multiple effect evaporator was used then it might have demanded significant quantities of circulating cooling water.
- viii. Cooling the concentrated solution (circulating cooling water system might have been used), mixing with HCl and NaCl and filtering in nutch filters to obtain Koch cake. It must be generating wastewater (mother liquor) rich in naphthalene based compounds, sodium and chloride.
- ix. Charging the Koch cake with caustic lye/caustic flakes (NaOH) and then fusing (in an autoclave!).
- x. Diluting the fused mass with water, treating with sulphuric acid and boiling off to remove sulphur dioxide. Must be emitting sulphur dioxide fumes.
- xi. Cooling the boiled off mass and filtering through nutch filters to get the cake of sodium salt of H-acid. It must be generating wastewater (discarded liquor) rich in phenolic compounds and residual H-acid.
- xii. Washing the H-acid cake in water, centrifugal dewatering of the cake, drying and milling the cake to obtain powder of sodium salt of H-acid. It must be

generating the wastewater (product wash water) containing H-acid and phenolic compounds.

25. H-acid was manufactured in batches (35 batches per month) from naphthalene (600 kg/batch). Each batch of manufacturing produced 580 kg of sodium salt of H-acid. Raw material inputs of the manufacturing were as shown in Table 1. The by-products and wastes generated from the manufacturing were as indicated by the industry as presented in Table 2.

Table 1: Material inputs of H-acid manufacturing

S. No.	Input material	Quantity (kg/batch)	Quantity (ton/year)*	Consumption for 1994-95 tons/year)
1.	Naphthalene	600	252	345
2.	Sulphuric acid	3039	1276	1703
3.	Oleum (65%)	1790	752	1000
4.	Nitric Acid	372	156	518
5.	Lime stone	1637	689	1464
6.	Hydrochloric acid (100% purity)	72	30.2	120
7.	Soda ash(sodium carbonate)	900	378	554
8.	Sodium hydroxide	860	361	560
9.	Iron powder	650	273	291
10.	Common salt	2700	1134	??
11.	Acetic acid	10.4	4.383	6

* 35 batches of H-acid manufacturing per month for 12 months a year is assumed.

Table 2: By-products/wastes generated from the H-acid manufacturing

S. No.	Product/by-product/waste	Quantity (kg/batch)	Quantity (ton/year)[@]
--	Sodium salt of H-acid (product)	580 (681)*	243.6(286)*
1.	Gypsum on dry weight basis	3082	1294
2.	Iron oxide on dry weight basis	1109	466
3.	Sodium bisulphate lost in wastewater	----	---
4.	Sodium nitrite and nitrate lost in wastewater	----	---
5.	Common salt lost in wastewater	~ 2750	~1155
6.	Glauber salt lost in wastewater	----	---
7.	Naphthalene lost in the wastewater	396 (360.5)*	166 (151)*

@ 35 batches of H-acid manufacturing per month for 12 months a year is assumed

* values given in the parentheses are for the 681 kg product recovery per batch.

26. The industrial unit was consuming water for the following purposes:

- i. Preparation of the lime slurry used in step-3 for neutralization.
- ii. Washing of nutch filters and filter presses used in the filtration in steps 4, 6 and 11.
- iii. Dilution of fused mass in step 10.
- iv. Washing of H-acid cake in step 12.

v. In addition to this, water was also used as boiler feed water in the 1 ton/hr capacity boiler and as makeup water in the cooling tower and circulating cooling water system. PPCB records indicate consumption of about 34 m³/day of water.

27. The H-acid manufacturing process might have generated the flowing wastes:

- i. **Gypsum (calcium sulphate) sludge:** Removed from the reaction mixer through filtering in step-4 of the manufacturing process.
- ii. **Iron oxide sludge:** Removed from the reaction mixer through filtering in step-6 of the manufacturing process.
- iii. **Foul condensate:** Generated (if concentrated in multiple effect evaporator) at the multiple effect evaporator in step-7 of the manufacturing process. It might have been the least polluted wastewater stream.
- iv. **Mother liquor:** Discarded after the filtration removal of Koch cake in step-8 of the manufacturing process. It is high strength waste and was apparently disposed off in the solar evaporation ponds (and then incinerated).
- v. **Discarded liquor:** Discarded after the filtration removal of the H-acid in step-11 of the manufacturing process (high strength wastewater).

- vi. **Product washwater:** Generated from the washing of the H-acid cake in step-12 of the manufacturing process (moderate strength waste and can be reused for dissolving the fused mass in step-10).

28. Material balance calculations by the TCIRD/Thapar University team (TCIRD Report) indicate that only <40% of the naphthalene used in manufacturing process became integral part of the product (H-acid) and the rest >60% was lost mostly in the waste water (generated at step-8, step-11 and step-12) may be as naphthalene based compounds, sulfonated phenolic compounds and condensation products of fusion. The report points out that “because of limited water solubility and higher sludge consistencies, gypsum and iron oxide sludges might have very little of these organic substances”. At the same time it also notes that “because of the higher boiling point, very little of the organic matter might have been actually lost into the atmosphere as organic vapours.’
29. This report further observes that “the by-products, sodium sulphate, sodium bisulfite, sodium chloride, sodium nitrite and the added sodium chloride, because of their high solubility, might have been mostly present in the wastewaters generated. Very little of these might have been lost in the gypsum and iron oxide sludges (may depend on the sludge consistency). It also notes that “it is not clear whether and how much of the sodium sulphate was actually recovered from the wastewater (mother liquor) during

treatment (neutralization, filtration, concentration and filtration) and reused in the H-acid manufacturing process (in place of soda ash!).”

30. By quantifying the raw material used and the products and by-products obtained from the manufacturing process, the TCIRD team concluded that the total input of the unit was 12,640 kg/batch. There was a total production of 681 kg/batch of H-acid, besides Iron oxide and gypsum sludge generated was 4,191kg/batch. According to them rest of the material, i.e., 7,768 kg/batch might have been mostly lost into the wastewater generated and a small portion of it might have been lost into the atmosphere as sulphur oxides and nitrogen oxides.
31. According to the TCIRD team the Wastewater generation might have been around 20 m³/batch of H-acid processed or 23-24 m³/day. Generation rates of different wastewaters per batch have been assessed as follows:
- i. Mother liquor (assessed at about 3-4 m³/batch)
 - ii. Foul condensate (assessed at about 5-6 m³/batch)
 - iii. Nutch filters’ and filter presses’ washwater (about 1 m³/batch)
 - iv. Discarded liquor (assessed at about 5 m³/ batch)
 - v. H-acid washwater (assessed at about 5 m³/batch)
32. In addition to these process wastewaters, the industrial unit might also have generated the following wastewaters:

- i. Steam condensate that could not be recovered and allowed to flow into the drain
 - ii. Cooling tower blow down water
 - iii. Regeneration wastewater from the boiler feed water plant (soft water plant!)
33. The industrial unit used an incinerator since late 1996 for the disposal of the mother liquor. Waste water discharge by the industrial unit beyond its premises was zero. The industrial unit, as per the records, used lined shallow solar evaporation ponds of 200 m² area each (20 m x 10 m) for the disposal of the wastewater. For enhancing the evaporation rates, the industrial unit, according to records, used forced spray evaporation. Information furnished by the PPCB also indicates use of 4 evaporation ponds, each of 24 m x 24 m x 1.5 m, and one tank of 50 m x 26 m x 2m.
- i. Crystallization and subsequent problems associated with the pumping for the forced spray evaporation might have forced the industrial unit to continually expand the evaporation ponds and shift to newer ponds.
 - ii. Once usage of an evaporation pond was stopped, the residual low density crystalline organic material (the residual organic matter) present in the pond content might have formed a thick hard crust layer on the top of the pond contents.
 - iii. Soil core sampling by the TCIRD team in the evaporation pond area showed presence of a hard but water soluble

layer of 3 to 5cm and even more thickness over the concentrated liquid. It is pointed out that this crystalline layer might have almost stopped further evaporation from the concentrated liquid of the abandoned pond. As a consequence the industrial unit might not have been in a position to dispose off all the wastewater in the solar evaporation ponds.

- iv. As per the information available in the PPCB records, the industrial unit had installed an incinerator in 1996 for the disposal of the mother liquor generated in step-8.
- v. Further, the records say that 100 kg/day (at certain other places indicated as 50 kg/day) of ash was generated from the incineration of the mother liquor. 100 kg/day ash is grossly understated. Almost all the chloride used in the manufacturing process, both as NaCl and HCl, is expected to get into the mother liquor and then become part of the incineration ash. The assessment is that the mother liquor might have been almost a saturated salt solution.

34. The solid and hazardous waste generated by the said industrial unit has been stated to include:

- i. **Gypsum sludge:** 3,082 kg/batch on dry weight basis. About 1850 tons per year (dry weight basis) of gypsum sludge was generated. It was assumed to contain 30% moisture.

- ii. **Iron oxide sludge:** 1,109 kg/batch on dry weight basis. About 466 tons per year (dry weight basis) of iron oxide sludge was generated. It was assumed to contain 70% moisture.
- iii. **Incineration ash:** 100 kg/batch or 30 tons per year. This is grossly understated and may be possible if Glauber salt can be used in place of common salt, and if the used Glauber salt can be recovered from the wastewater and reused. Sodium chloride use might have generated about 2.7 tons/batch of incineration ash.
35. Three sludge tanks/pits, each of 20 m x 12 m x 2 m dimensions (480 m³ volume), were apparently used for the storage of the generated gypsum sludge, iron oxide sludge and incineration ash. Apparently some of the organic sludge accumulated in the solar evaporation ponds was also collected and stored in the tank meant for the incineration ash storage.
36. The unit was storing all the wastes, generated by it, on-site except for selling of some iron oxide and gypsum sludge to outside parties. The unit installed an incinerator in 1996 for incinerating of the organic waste. The unit disposed the waste water it generated in solar evaporation ponds within premises and disposed no wastewater beyond its boundaries.
37. According to the TCIRD report the profile of the salt level (sum of iron, sodium, sulphate, nitrate and chloride) in the

groundwater indicates that the groundwater has been contaminated by the following two sources.

- i. Percolation and leaching of contaminants from the onsite solid/hazardous waste storage and disposal and from the solar evaporation ponds.
 - ii. 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).
38. It is stated that as of now contribution made 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 by 2005). Total salt level in the top layer of the groundwater (1435mg/L at 105ft depth) is higher than that at 120ft depth (1133mg/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.

39. The TCIRD team reported the presence of the Sulfonated Phenolic compounds in two groundwater samples collected from two sampling stations located just outside the premises of the industrial unit. According to them the phenolic compounds however, could not be measured by routine Colorimetric method for phenols given in 21st Edition of APHA. As these samples were reddish brown in colour in spite of the absence of iron in them, presence of higher order phenolic compounds in these samples was suspected. The evaporative concentration, methanol extraction and chromatography of all the groundwater samples collected by the team with 1:1 methanol and chloroform and with methanol resulted in the isolation of two sulfonated phenolic compounds in samples from st.1 and st.2 (see Table No. 5 and 6 of TCIRD Report reproduced below). Analysis of the isolated sulfonated compounds on FTIR indicated the presence of functional groups N-H, O-H and S=O in both the compounds. Analysis of all the other 7 groundwater samples indicated that these have the methanol extractables below detectable levels.

Table No. 5: Sulfonated phenolic compounds in the samples from Stn. 1 and stn. 2

Compound	Sample 1	Sample 2
Methanol extractables (mg/L)	149	173

Compound A (mg/L)	60	75
Compound B (mg/L)	48	32

Table 6: Characterization of Ground Water Samples for presence of Sulfonated Phenolic Compounds by FTIR

Sample	IR bands observed	Remarks@
Compound A	3430, 1635, 1384, 1047 and 669 cm ⁻¹	IR bands at 3430, 1635 and 1384 cm ⁻¹ confirms the presence of functional groups N-H or O-H. IR bands at 1047 and 669 cm ⁻¹ confirms the presence of sulphonyl group.
Compound B	3416, 1089 and 630 cm ⁻¹	IR bands at 3416 cm ⁻¹ confirms the presence of functional groups N-H or O-H. IR bands at 1089 and 630 cm ⁻¹ confirms the presence of sulphonyl group.

40. TCIRD report maintained that the presence of sulfonated phenolic compounds in the ground water together with other circumstantial evidences (like water solubility) indicated that the ground water in question was contaminated with the industrial wastes, specially those generated beyond the Koch cake fusion step (step-9 of the manufacturing process). ”

41. In response to the TCIRD Report, the Respondents 4 – 7 presented before the Hon’ble High Court the comments offered

on this Report (on their request) by Prof. Barun Kumar Guha (Retired) Chemical Engineering Department, Environmental Engineering Group Indian Institute of Technology, Delhi dated September, 2012, which is on the record at pages 445 – 461. Prof. Guha's review is titled "Comments on the Report on Assessment of Ground Water Contamination at the Plant Site of M/S Mahalaxmi Organochem Industries Thapar Center for Industrial Research and Development". In the said review Prof. Guha has commented not only on the Report prepared by TCIRD but also on the Analysis of water samples done by M/S Eco-Laboratories & Consultants Pvt. Ltd.

42. In case of solid wastes he states "The solid wastes generated within the plant mostly from process steps and they included, gypsum sludge, iron sludge and incinerator ash". According to Prof. Guha "the first two types of sludge (gypsum sludge and iron sludge), from the manufacturing process for H – Acid, were produced directly from the process steps involving filtration and were quite wet. These were dewatered and then further dried by exposing to sun. All these sludge are classified as hazardous in nature because of the contamination of toxic organic compounds." He further states about gypsum sludge that "the product after drying was not of pure white colour and free of these matters, as is desired by these users. Hence it was difficult to sell it to such users. He talks about the use of iron sludge in brick kilns as well as agriculture lands. He also states that the gypsum was taken by brick kiln owners free of

cost and even transportation charges were borne by M/s Mahalaxmi Organochem Industries. In case of solar evaporation ponds, the said expert notes that these were lined and “whatever small amount that might have percolated was due to the drift loss occurring from the spraying of the liquid within the pond to enhance the evaporation rate. The drift loss gets deposited on the surrounding areas and subsequent rainfall or irrigation for the crop cultivation has resulted in its percolation to the soil.” A perusal of Prof. Guha’s review, however, indicates that he has not questioned any details given by the TCIRD about the manufacturing process, including the quantity of raw material used, quantities of by-products (gypsum and iron sludge) and waste material (mother liquor) generated and the quantum of the final commercial product (H-Acid) produced. Therefore the reliance placed by respondent 4 to 6, on the comments made by Prof. Guha is of no help to them in dispelling the strong view expressed by the TCIRD in its report.

43. According to the learned counsel appearing for the said respondents, there are number of inconsistencies with regard to soil and ground water analysis in TCIRD study. There is no balance between the anion (SO₄ and Cl) and cation (Na) concentration in soil. The soil samples collected from the solid waste dumping area show no sign of any contamination with the level of sulphate, nitrate, chloride, sodium and others

which show that they are within the limits which are normal for many of the soils.

44. Prof. Guha questions the necessity of testing the water samples for the methanol extract value. According to him “it is quite strange that the soluble components needed the methanol extraction. Particularly the COD values should have been the indicator of the presence of organic components. However, there is no clear relationship between the methanol extract and COD values”.

45. In Civil Misc. No. 14527 of 2012 in CWP No. 3481 of 2007, Mr. Om Parkash, Environmental Engineer, PPCB, filed a counter affidavit on behalf of R1 – 3 on the comments of Prof. B. Guha as submitted by R 4 – 6 . The main contention of R 1 – 3 was that Prof. Guha never visited the site in question and his comments were based only on the perusal of the TCIRD report.

46. In the said affidavit of Mr. Om Parkash, rebuttal of Dr. Akepati S. Reddy, author of the TCIRD Report on Prof. Guha’s comments was also reflected as under. “Ground water pollution, by polycyclic aromatic organic compounds of naphthalene origin, under the industrial site and presence of highly concentrated effluents in the then evaporation ponds (presently covered by about 6 feet thick layer of soil), as reported in the TCIRD report, are the ground realities and proven beyond any doubt. And these ground realities cannot be doubted either by the respondents 4 – 6 or by the report of

Prof. B. K. Guha.” Dr. Reddy reiterates the stand that the “ground water pollution in the concerned area is most likely due to intentional injection of the effluent in to the ground water. The ground water pollution problem and the concentrated effluent in the solar evaporation ponds should be treated as two unrelated problems.”

47. The comments given by Dr. Reddy were negated by Mr. C. S. Dhawan, R6 on behalf of R 4 – 6 vide Reply Affidavit file in Civil Misc. No. 17279 of 2012. In this affidavit even the expertise of TCIRD with respect to the study conducted was challenged on the premise that the main scope of working of TCIRD relates to Paper Industry and that the said Center stands derecognized by the PCB itself in the year 2009, inferring there from that they are not competent to submit the report.

48. On 4th July, 2013 the NGT Bench directed the CPCB to depute an expert or a team of experts to examine the locations of the sites and to give a report on the following points:

- a. Whether the water is contaminated/ polluted at the place shown in the Application?
- b. Whether the characteristics of the soil are affected due to the dumping of the chemical wastes at the place in question?
- c. Whether the ground water is polluted due to the effluent discharge or the discharge in to the bore wells?

- d. Whether the crops or orchards in the proximity of the sites have been damaged due to the pollution allegedly caused due to the effluent discharged.
- e. The expert team of CPCB may suggest the methodology for restoration/ reclamation of the contaminated environment.
49. In compliance to the directions of NGT, the CPCB team collected samples of groundwater and soil in the affected area (near M/S Mahalakshmi Organochem Industry, Nabha Road) in Sangrur during 24 – 26 July, 2013. The Final report of the survey was submitted by the CPCB in September, 2013. A perusal of the said report reveals that in respect of the groundwater the CPCB focused its attention on the parameters:
- pH, conductivity, TDS, Ca, Mg, K, total Hardness, Na, F, Cl, SO₄, Nitrate, total alkalinity, COD, BOD, heavy metals, TC and FC,
- While in case of soil the parameters analysed included:
- pH, conductivity, organic carbon, organic matter, Na, K, Mg, CEC, Cl, Heavy metals.
50. The team mentioned in the report that production of H-acid commenced at the site in July 1991 and continued till end of February 2005. Presently there was no industrial activity at the site as the plant has been dismantled and cultivation is

being done at the site by the purchaser Sh. Tara Singh S/o Sh. Subaran Singh R/s Village Nauhra (Nabha), District Patiala.

51. As per the CPCB report, during the field survey, it was observed that the colour of surface soil was red at many places within the premises of the closed industrial unit. Soil of black colour was found at 4 feet depth near the so called solar evaporation pond. **The report further observed that coloured water was pumped out of the tube well installed in the premises of the unit (Depth of the tube well 280 feet) even after continuous flow for 105 minutes.** The report inferred that the groundwater quality exceeds the desirable limits of drinking water with respect to TDS, total alkalinity, total hardness, colour, calcium and iron. It further reported that black liquor was found at the depth of 5 feet near the site of solar evaporation pond which depicts that leftover industrial process waste is still lying. On the basis of the above findings, the CPCB suggested that:

- i. the leftover industrial process waste lying at the depth of 4 feet should be removed and disposed to approved Treatment, Storage and Disposal Facility.
- ii. The voids be filled with clayey soil.
- iii. Use of land for any other purposes including cultivation should be avoided till remediation is completed.
- iv. Access to the site be restricted with the help of fencing.

- v. The leaching from site may be minimized by laying a compacted clay layer of 30-60cm depth with proper slope.

52. Prof. B. K. Guha (Retired), IIT, New Delhi, engaged by Respondent Industry, gave his “Comments on the Report on Assessment of Groundwater Contamination at the Plant site of M/S Mahalakshmi Organochem Industries by Central Pollution Control Board, Delhi” on 25.09.2013. His main objection to the report is regarding the non-existence of background water quality. Further, he points out the absence of details about agricultural activities being carried out on the land in question. In reference to “the soils samples were black at depth of 6 inches to 4 feet. At the site of solar evaporation pond is not very clear. As there was no quantification to indicate whether the colour intensity was increasing or decreasing with depth.”

53. Respondent 9 through his counter affidavit dated 31.7,2013, besides other facts, inter alia submitted that

“8. that the annual report also gives the details of the by-products lying at the site as on 31st March, 2003 and as per the said report only the following quantities appear in the same :-

Gypsum:	26023 kg	
Iron sludge:	21242 kg.	_____ Rs. 47,264.00

Both these commodities constitute only about 2 truck loads each and these figures confirm the fact that the by-products generated till March, 2003 were being regularly disposed off”.

It may be noted that the quantity reflected above by the said respondent are actually wrongly reported as is evident from the details presented in the Balance Sheet at page 628. The

figures reflected above in kilograms are actually amount in Rupees, the total amount on account of Industrial wastes being Rs. 47,264.00 with the break up:

3. Industrial Wastes

(a) Gypsum	Rs. 26,023.00	
(b) Iron Sludge	Rs. 21,241.00	Rs. 47,264.00

54. On 8th May, 2014, while pleading on behalf of the Punjab Pollution Control Board (PPCB), Mr. A.R. Takkar, learned Counsel pointed out that earlier a report was submitted before the Hon'ble Punjab and Haryana High Court by Thapar Center for Industrial Research & Development (TCIRD) and the said report showed that between July 1991 and February 2005 the industrial unit manufactured over 3000 tons of H-acid and generated over 17,000 tons of gypsum sludge, over 6,000 tons of iron oxide sludge and over 40,000 tons of inorganic salts, together with wastewater containing over 2,000 tons of naphthalene based organic compounds. Except for selling out a small fraction, the industrial unit retained all the gypsum sludge and the iron oxide sludge within the premises.

55. The TCIRD report prepared by Dr. A. S. Reddy further inferred as under "it appears that the industrial unit segregated the filtrate (discarded liquor) of the H-acid manufacturing step-11 (and even the H-acid wash-water of the H-acid manufacturing step-12, if not reused) and

disposed off through injecting into the groundwater at about 140-150 feet depth. Over the 14 years period the industrial unit might have injected about 28,000 m³ of wastewater into the groundwater. This has heavily polluted the local groundwater.” In support of this inference it was pointed out that “the groundwater samples from at least two sampling stations (Stn. 1 and Stn. 2) have been found contaminated with the industrial waste. This is evident from the high sulphate, chloride, COD and TDS levels observed and from the indication of presence of phenolic compounds. Contamination of the ground water appears to be limited in extent and apparently not spreading. Discontinuity of groundwater contamination (since 2004) and continual pumping out of ground water for irrigation at the sampling stations have apparently arrested the speed of the groundwater contamination.”

56. The samples from station 1 and 2 (which were located in the plot of land adjacent to the Unit on its eastern side) showed the concentration of Methanol extractables as 149 mg/L and 173 mg/L respectively. The report indicates that “the phenolic compounds however could not be measured by the routinely used standard method. The groundwater samples from these two sampling stations (1 & 2) were reddish brown in colour and both the samples were not having any iron in them (iron can also impart reddish-brown colour to water). This led to the suspicion of presence of higher order phenolic

compounds in the water samples and imparting the colour, and to the further investigation of the samples in the direction of extraction, isolation and characterisation of the substances imparting colour to the water. Evaporative concentration, methanol extraction and column chromatography (of the samples), both with 1:1 methanol and chloroform and with methanol resulted in the isolation of two sulphonated phenolic compounds... Analysis of the isolated compounds on FTIR indicated presence of functional groups N-H, O-H and S-O, in both the compounds.”

57. From these findings it was inferred by Dr. Reddy that “Identification of sulphonated phenolic compounds in the ground water and other circumstantial evidences (like water solubility) indicate that the ground water in question is contaminated with the industrial wastes, especially those generated beyond the Koch cake fusion step (step 9 of the manufacturing process).”

58. It was further pointed out by the Learned Counsel that the Central Pollution Control Board (CPCB) did not conduct any test to identify the presence of sulfonated phenolic compounds and as such the CPCB Report is incomplete. In view of this deficiency the CPCB was directed vide NGT order dated 8th May, 2014 to conduct test for identifying the presence of sulfonated phenolic compounds in the groundwater and for assessment and also to suggest

methodology for restitution/remediation of the contaminated water.

59. In response to this direction, the CPCB filed a report titled “Report on Assessment of groundwater Contamination (near erstwhile M/S Mahalaxmi Organochem Industry, Nabha Road) District Sangrur, Punjab” dated June, 2014. The report reveals that the CPCB team visited the site on 24.06.2014 and collected ground water samples from 8 locations, which were analyzed for following parameters.

“pH, conductivity, TDS, Ca, Mg, K, Total Hardness, Na, K, F, Cl, SO₄, Total alkalinity, Total Phenols, COD, Heavy metals (As, Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn)”

60. The said CPCB report reveals that “phenolic compounds were analyzed based on 5530-D, direct photometric method (after distillation) of Standard Method for Examination of Water and wastewater” 22nd edition published by American public health Association (APHA) and is adopted by National Accreditation Board for Laboratories (NABL)”. Based on analytical results it was observed that samples are found within prescribed limits of BIS drinking water standards IS 10500:2012 (desirable limit) with respect to phenolic compounds, pH, Total Dissolved Solids, Calcium, Sulphate, cadmium, Copper, Nickel and total Chromium. Iron concentration was found exceeding the prescribed limits in

tube well installed in industrial premises. Groundwater quality exceeds the desirable limits of drinking water with respect to total alkalinity and total hardness.” Accordingly it was concluded from the study and analytical results that the impact of erstwhile M/S Mahalakshmi Organochem Industries unit was not found in the 8 tube wells of the area.

61. Learned Counsel appearing for the industry disputed the findings in TCIRD report and according to him the report of the CPCB clearly shows that the Sulfonated Phenolic compounds were below the detection limits. However, the Learned Counsel for the PPCB disagreed with this view and submitted that the CPCB carried out analysis by APHA method which is less sensitive than FTIR method and, therefore, if the findings of the CPCB are to be comfortably relied upon then the findings ought to have been arrived by the sensitive FTIR method and not by APHA method alone. He, therefore, suggested carrying out of the fresh sampling and analysis of the ground water from the sources collected from the same sites as those collected by the CPCB at the hands of reputed specialised institution like NEERI (National Environmental Engineering Research Institute) by employing FTIR method for analysis of the ground water to assess the presence of sulfonated phenolic compounds.
62. After hearing the rival contention, the NGT Bench directed the NEERI to undertake the analysis of the ground water at the disputed site. Accordingly it was directed thus:

- i. NEERI shall depute a team of Experts to collect the underground water samples from the same locations from where the earlier water samples were collected by CPCB and to analyse those samples for ascertaining the presence of Sulfonated Phenolic compounds by APHA as well as FTIR methods and any other better method that may be available with NEERI. Quantitative analysis of the sulfonated phenolic compounds shall also be undertaken by NEERI.
 - ii. NEERI shall also give its opinion as regards the possible sources of such Sulfonated Phenolic compounds, if detected in the samples, at the said locations.
 - iii. NEERI shall also suggest the methodology for remediation of the underground water if found contaminated with Sulfonated Phenolic compounds.
63. NEERI filed its report titled “Assessment of Ground Water Contamination in and Around Mahalaxmi Organochem Industries, Bhawanigarh” in the NGT on 13.11.2014. As per the report the CSIR-NEERI team collected ground water samples on 17th October, 2014 from the same tube wells wherefrom CPCB had collected samples earlier in June, 2014. The NEERI report reveals that “However, during sampling it was observed that the original tube well GW-1 was blocked and a newly drilled tube well was noticed about 100 to 150 ft away from GW-1 located in the same premises.

Hence, water sample was collected from the newly drilled tube well considering it as GW-1.”

64. The team analyzed the samples for Iron, Carbonate, Sulphate, Chloride, Nitrate and Phenolic compounds. According to the data collected by the team, concentrations of carbonates, sulphates, chlorides and nitrates were found to be within the acceptable limits of IS:10500 2012. Iron concentrations were observed to be below the detectable limits. The phenolic compounds, however, could not be measured by the routinely used standard APHA method.
65. According to the NEERI team, the presence of reddish brown colour in the two groundwater samples collected by the TCIRD team (in the absence of any iron) had led them to suspect the presence of higher order phenolic compounds in the water samples. However, the water sample collected by NEERI team at GW-1 was observed to be muddy, while all others were colourless and odourless. The team observed that the concentration of sulfonated phenolic compounds in the ground water sources, especially GW-1 and GW-2, where their presence was expected in view of possible contamination, could not be measured by the routine testing method for phenols, i.e. Spectrophotometric method (21st Edn. APHA). Accordingly in view of non-availability of reference standards for sulfonated phenolic compounds, extraction of ground water samples was carried out by the team by chloroform followed by characterisation of the

extract using FTIR for its determination as total sulfonated phenolic compounds, present if any. Analysis of the chloroform extract on FTIR indicated presence of the functional groups N-H, O-H and S=O in samples GW-1 and GW-2 which confirmed presence of sulfonated phenolic compounds (see Table 6 of the NEERI report on page 905; reproduced below). In the remaining 6 samples the level of the functional groups N-H, O-H and S=O in the chloroform extract was insignificant.

Table 6: Characterization of Ground Water Samples for presence of Sulfonated Phenolic Compounds by FTIR (NEERI Report p/13)

Sample	IR bands observed	Remarks *
GW-1	3430, 1635, 1384, 1047 and 669 cm ⁻¹	IR bands at 3430, 1635 and 1384 cm ⁻¹ confirms the presence of functional groups N-H or O-H. IR bands at 1047, 669 cm ⁻¹ confirms the presence of sulphonyl group.
GW-2	3416, 1635, 1089 and 630 cm ⁻¹	IR bands at 3416, 1635 cm ⁻¹ confirms the presence of functional groups N-H or O-H. IT bands at 1089 and 630 cm ⁻¹ confirms the presence of sulphonyl group.

66. The NEERI report concluded that “Identification of sulfonated phenolic compounds in the ground water indicate that the

ground water in question is contaminated with the industrial wastes, especially those generated beyond the Koch cake fusion step i.e. step-9 of the manufacturing process.” This conclusion drawn by the NEERI Report was objected to by the learned Counsel appearing for the project proponent on the ground that the NEERI has not found in the entire report any fault on the part of project proponent in support of the conclusion drawn. This argument was countered by the learned Counsel for the applicant on the ground that different tests are carried out.

67. On 19.12.2014 a scientist from CPCB was asked by the NGT Bench to explain the basis on which CPCB team had termed the ground water not to be contaminated. The said scientist stated that they had arrived at the conclusion “that the water was not contaminated” on the basis of APHA method. According to him the said APHA method is the most modern one and CPCB does not have any other facility, except APHA method.

68. On the direction of the Bench, three scientists from NEERI, who prepared the NEERI Report of November, 2014, also appeared before the Tribunal on 7th January, 2015 and explained that their study had been able to establish conclusively the presence of sulfonated phenolic compounds in the ground water samples by the FTIR method, although only qualitatively.

69. It may be pointed out that “the analytical procedure **5530 D. Direct Photometric Method** uses the 4-aminoantipyrine colorimetric method that determines phenol, ortho- and meta-substituted phenols, and, under proper pH conditions, those para-substituted phenols in which the substitution is a carboxyl, halogen, methoxyl, or sulfonic acid group. This method, however, does not determine those para-substituted phenols where the substitution is an alkyl, aryl, nitro, benzoyl, nitroso, or aldehyde group. The 4-aminoantipyrine method is given in APHA (1999) in two forms: Method C, for extreme sensitivity, is adaptable for use in water samples containing less than 1 mg phenol/L. It concentrates the color in a non-aqueous solution. Method D retains the color in the aqueous solution. Because the relative amounts of various phenolic compounds in a given sample are unpredictable, it is not possible to provide a universal standard containing a mixture of phenols. For this reason, phenol (C₆H₅OH) itself has been selected as a standard for colorimetric procedures and any color produced by the reaction of other phenolic compounds is reported as phenol. Because substitution generally reduces response, this value represents the minimum concentration of phenolic compounds.

5530 D. Direct Photometric Method

- i. Principle:* Steam-distillable phenolic compounds react with 4-aminoantipyrine at pH 7.9 ± 0.1 in the presence of potassium ferricyanide to form a colored antipyrine

dye. This dye is kept in aqueous solution and the absorbance is measured at 500 nm.

ii. Interference: Interferences are eliminated or reduced to a minimum by using the distillate from the preliminary distillation procedure.

iii. Minimum detectable quantity: This method has less sensitivity than Method C. The minimum detectable quantity is 10 µg phenol when a 5-cm cell and 100 mL distillate are used.

70. The learned counsel for respondents 4 – 6 and Respondent 9 contend that as per BIS, the testing methodology to be applied for analysing phenolic compounds is IS 3025 (Part 43). This testing method also been adopted by National Accreditation Board for Laboratories (NABL). According to them the test conducted by CPCB and its report filed along with the affidavit dated 18.07.2014 is as per this very method and based on this method it was observed that samples are within prescribed limits of BIS drinking water standards IS 10500:2012 (desirable limit) with respect to phenolic compounds. According to these respondents the study has concluded that “the impact of erstwhile M/s Mahalakshmi Orgochem Industries unit was not found in existing 08 tube wells. They further submit that three independent laboratories, namely M/S Skylab Analytical laboratory, M/S ITL Labs Pvt. Ltd. And M/S Shriram Institute of Industrial Research, all approved by the Ministry of

Environment and Forests have confirmed that the test method to be used for quantitative analyses of phenolic compounds in water sample is IS 3025 (part 43) and the minimum detectable limit of the said method is 0.001mg/l.

71. The learned counsel for Respondent No. 4-6 further contend that FTIR method is not the method prescribed by the Bureau of Indian Standards, Furthermore, by applying the FTIR method the quantitative analysis cannot be done. They allege that the report of NEERI is the repetition of the contents of the report by Thapar Institute. In fact the mistakes contained in the report of Thapar Institute are also contained in the report by NEERI. It is contended that in Table 5 of NEERI's report they have wrongly stated that the minimum detection limit for phenols by application of 22nd APHA spectrophotometric method is 0.02mg/l. It is submitted that as is clear from IS 3025 (part 43) by applying 5530D direct photometric method which is based on standard method for examination of water and wastewater 22nd Edition published by APHA and adopted by NABL, the desirable limit of phenolic compound in water is 0.001mg/l is to be tested by applying this method.

72. It is also contended on behalf of the said respondents that the FTIR method is sensitive only for the qualitative assessment. Furthermore, the FTIR method for GW-1 sample mentions the following IR bands

3430, 1635, 1089, 1047 and 669.

And for GW-2 it mentions the following IR bands

3416, 1635, 1089 and 630.

According to them band 3430 and 3416 are for alcohol and phenols. Band 1635 is for amines. Bands 1047 and 1089 are for aliphatic amines. Bands 669 and 630 are for alkyl halides. They submit that FTIR method itself uses methanol, which itself contains alcohol. The conclusion in NEERI's report alleging contamination is only because presence of phenols have been detected by FTIR method. However, NEERI's report does not state that there is any contamination which is beyond the desirable or prescribed limit of drinking water as specified by BIS.

73. In this context we are not impressed by the reasoning forwarded by the respondent Industry. It is true that the CPCB has prescribed 5530D direct photometric method (based on standard method for examination of water and wastewater 22nd Edition published by APHA) for the determination of phenols in the water samples, but in the preamble of the said method it is clearly mentioned that "This method, however, does not determine those para-substituted phenols where the substitution is an alkyl, aryl, nitro, benzoyl, nitroso, or aldehyde group" and the minimum quantity that can be detected through this method is 0.01mg/L, which is far higher than the desirable limit set by the BIS, that is 0.002mg/L. Further, it may be pointed out that the FTIR method used by TCIRD and NEERI has been reported to be far more sensitive

and advanced than the simple “5530D direct photometric method” adopted by BIS.

74. **Fourier Transform infrared spectroscopy (FTIR)** is a technique which is used to obtain an infrared spectrum of absorption, emission, photoconductivity or Raman scattering of a solid, liquid or gas. An FTIR spectrometer simultaneously collects high spectral resolution data over a wide spectral range. This confers a significant advantage over a dispersive spectrometer which measures intensity over a narrow range of wavelengths at a time [Griffiths, P. & de Hasseth, J.A. (2007) *Fourier Transform Infrared Spectrometry* (2nd ed.), Wiley-Blackwell]. As per the introductory note published in 2001 by Thermo-Nicolet Corp. (USA), the manufacturers of FT-IR spectrometers, FT-IR stands for Fourier Transform Infra-Red, the preferred method of infrared spectroscopy. In infrared spectroscopy, IR radiation is passed through a sample. Some of the infrared radiation is absorbed by the sample and some of it is passed through (transmitted). The resulting spectrum represents the molecular absorption and transmission, creating a molecular fingerprint of the sample. Like a fingerprint no two unique molecular structures produce the same infrared spectrum. This makes infrared spectroscopy useful for several types of analysis.

- It can identify unknown materials

- It can determine the quality or consistency of a sample
- It can determine the amount of components in a mixture

Why Infrared Spectroscopy? An infrared spectrum represents a fingerprint of a sample with absorption peaks which correspond to the frequencies of vibrations between the bonds of the atoms making up the material. Because each different material is a unique combination of atoms, no two compounds produce the exact same infrared spectrum. Therefore, infrared spectroscopy can result in a positive identification (qualitative analysis) of every different kind of material. In addition, the size of the peaks in the spectrum is a direct indication of the amount of material present. With modern software algorithms, infrared is an excellent tool for quantitative analysis.

75. The objection raised by the Expert engaged by the Respondents that the TCIRD has used methanol, which is an alcohol and as such must have interfered with the results also does not hold the ground. Had this been the case then the FTIR would have shown similar values in all the water samples tested by this (TCIRD) team as the methanol was used as the solvent in all of them. Further, the presence of the sulfonated phenolic substances has also been confirmed by the FTIR test done by the NEERI although they used chloroform in place of methanol. It may also be noted that CPCB have accepted that

the facility available with them is only for “5530D direct photometric method”.

76. A perusal of the four study reports, i.e., TCIRD Report of 2011, CPCB Report of 2013, CPCB Report of 2014 and CSIR-NEERI Report of 2014 and submissions made by rival parties at different stages of the case first in the Hon’ble High Court of Punjab & Haryana at Chandigarh and later on before the NGT Principal Bench at New Delhi, would clearly lead to the following facts.

- a. The industrial Unit was running for almost fourteen years (to be precise, 13 years and 8 months, i.e., from July 1991 to February 2005) at the site.
- b. The unit had obtained the requisite permission for the establishment of the said industrial unit. However, NOCs/Consent to operate were not obtained for the whole period and for some period the unit was run without proper consents.
- c. The unit was using naphthalene as the raw material for the production of the H-acid.
- d. The unit was storing the iron oxide slurry as well as gypsum slurry on the site itself.
- e. The unit had constructed a pond for storing of the final waste material generated in the manufacturing process, i.e., mother liquor.
- f. The unit didn’t have any incineration process for the first five years of manufacturing and the mother liquor

was simply stored in the pond and passed through the evaporation process only.

- g. The solid waste left over after incineration process was stored in a tank covered by tin shed.
- h. Except for a small quantity of gypsum, which was sold to some third party, gypsum as well as iron oxide remained dumped on the site. There is no record to show that the gypsum and iron oxide has been disposed off properly or shifted to any other place when the unit was dismantled and the land previously occupied by the unit was put to agriculture.
- i. The industrial unit closed in March, 2005 and later on dismantled completely and even the shed covering the hazardous waste was dismantled, leaving the hazardous wastes exposed to the vagaries of the weather at least for four years (March, 2005 – August 9, 2009).
- j. The estimate provided by the TCIRD regarding the quantum of raw materials used, product and by-products as well as waste materials produced have not been questioned by any party, including the expert engaged by Respondents 4 - 7.
- k. The calculations made by the TCIRD have revealed the utilization of less than 40% of the naphthalene processed for the manufacture of H-acid. This leads to the inference that about 60% of the unutilized naphthalene remained either in the mother liquor

and/or got mixed with the iron oxide and gypsum slurry.

1. The incinerated ash, which was stored in the ash pond got ultimately shifted to TSDF facility at Nimbua during 7th – 9th August, 2008 and as such remained without any cover for the period January, 2006 – August, 2008, as the dismantling of the sheds was first noticed on 2nd January, 2006 by PPCB.
77. Based on the above narration of facts, contentions of the learned counsel on both the side, perusal of the entire records including various reports and on application of mind we frame the following issues and answer them.
- a. Did the Respondents 4 - 7 have necessary approvals of competent authorities to establish and operate the said unit as mandated under various Environment related acts?
 - b. If the unit was having the consent to operate, did it run as per the conditions set in the consent to operate?
 - c. Was the unit producing any hazardous substances? If so, was the disposal of such wastes as per the Hazardous Wastes (Management and Handling) Rules, 1989 as amended in 2003?
 - d. Did the environment get affected by the said acts of the respondents and to what extent? What is the relief ?

78. Issues:

a. Did Respondents 4 - 7 have necessary approvals of competent authorities to establish and operate the said unit as mandated under various Environment related acts?

The answer to this question is given in the reply affidavit filed by Respondent 9 on 19.11.2013. According to him M/S Matharu Chemical Industries was given the No Objection Certificate by the Punjab Pollution Control Board vide letter No. 16708 dated 12.07.1990 for the manufacture of H - Acid @ 600kg per day. This would mean that the respondents had the consent to establish. As per his reply affidavit the following valid approvals/ consents were obtained and got renewed from time to time to ensure that the said company was in compliance with all applicable environmental legislation/requirements to the satisfaction of the Punjab Pollution Control Board, the Regulatory Authority.

Legislation	Approval/NOC No.	Date of Approval/ NOC	Period of validity of Approval/ NOC
Water Act	1.)SGR/WPC/ETP/1993-94/F-91	7.10.1993	30.09.1994
	2.)SGR/ETA/95-10/F-173	18.10.1995	17.10.2010
Air Act	1.)SGR/APC/ECD/93-94/R-75	02.02.1994	30.06.1994

	2.)SGR/APC/97-09/R- 157	08.10.1997	30.06.2009
HW Rules	Letter No. 4580 renewed periodically last by Letter No. 16987 DT. 09.08.2004	06.05.1997 23.04.2002 05.08.2004	18.03.1999 22.04.2004 04.08.2005

A perusal of the above tabulated list reveals that although the unit had obtained the requisite permissions under the Water and Air Act at different points of time, the unit didn't have NOC/consent to operate for the period from July, 1991 (start of manufacture) to 6.10.1993 and again from 1.10.1994 to 17.10.1995 under Water Act. Similarly it didn't have permission for the period from July, 1991 to 1.2.1994 and again from 1.7.1994 to 7.10.1997 under Air Act. The unit didn't have permission to store the Hazardous wastes for the period from July, 1991 to 5.5.1997, from 19.3.1999 to 22.4.2002, from 23.4.2004 to 4.8.2004 and from 5.8.2005 to 7.8.2008 under Hazardous Wastes Rules. So, it is quite evident that the industrial unit violated the Air Act, Water Act as well as Environment Protection Act during the periods mentioned above. The issue is answered accordingly.

b. If the unit was having the consent to operate, did it run as per the conditions set in the consent to operate?

As is revealed by the details given in the above issue, the unit didn't have Consent to operate for a considerable period of time under both Air Act and Water Act. The unit worked without any consent under Air Act for 05 years and 10 months (July, 1991 to 1.2.1994 and 1.7.1994 to 7.10.1997) and under Water Act for a period of 3 years and 3 months (July, 1991 (start of manufacture) to 6.10.1993 and 1.10.1994 to 17.10.1995).

Even when the consents were in place, the Industrial Unit in question violated the conditions of the consent as is amply clear from the following two facts. The Unit was issued a show cause notice on 5th April, 2004 by PPCB for Violation of the provision of Water (Prevention & Control of Pollution) Act, 1974 and Air (Prevention & Control of Pollution) Act, 1981. The deficiencies/violations observed included particularly:

- i. The effluent from the lab section is discharged on to land for stagnation without any treatment.
- ii. The cooling water from the fusion process and the boiler blow down was also being discharged onto land for stagnation.
- iii. The scrubber water from scrubbers attached to boiler furnace & thermopac was not being completely re-circulated and a part of that was being discharged onto land for stagnation. The scrubber water from the scrubbers attached to control SO_x &

NOx emissions is discharged onto land for stagnation.

- iv. The house-keeping of the industry was very poor and there is no proper system for drainage of waste water from different sections. Although the quantity of waste water generated from different sections is small, but it is going for stagnation from most of the section. The Industry has not provided any facility for measurement of its effluent.
- v. The gypsum sludge and the iron sludge generated from the process was lying in the open in the form of heaps and it was not stored under the shed.
- vi. The industry has added the fusion process without obtaining any NOC from the Board. The representative of the industry told that this process has been added only about 3 months back and with the help of this process, they can use lesser quantity or raw material for producing a particular quantity of their product.
- vii. The industry has not provided the sampling facilities for collection of NOx & SOx emission samples.
- viii. The industry was using rice husk as fuel in its non-fluidized bed boiler furnace & thermopac furnace.
- ix. The main stack of the boiler and thermopac was found broken along with the ladder.

- x. The ducting connecting the exhaust from thermopac furnace to the stack was found broken.
- xi. The industry has not provided proper stack height on its two no. D.G. sets of 125 KVA each.

The points raised in this show cause notice bring to fore two important deficiencies, which had remained unattended by the said industrial unit and the unit was violating the norms and was continuously polluting the environment. First, as per the conditions set in the Consent to Operate granted to the Industrial Unit under section 25/26 of Water (Prevention and Control of Pollution) Act, 1974 all trade effluents was mandated to be disposed off through solar incineration only. However, as indicated in (i) and (ii) above the effluent from the lab section as well as the cooling water from the fusion process and the boiler blow down was simply discharged onto land for stagnation. Second, the industry did not provide the sampling facilities for collection of NO_x & SO_x emission samples and had been polluting the air throughout its existence at the site. These facts amply prove that the project proponent, even during the short period of consent has not complied with the conditions.

c. Was the concerned industrial unit producing any hazardous substances? If so, was the disposal of such wastes as per the Hazardous Waste

(Management and Handling) Rules, 1989 as amended in 2003?

As per the Hazardous Wastes (Management and Handling) Rules, 1989 (as amended in May, 2003) "Hazardous Waste" is defined as any waste which by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances, and shall include- (a) wastes listed in column (3) of Schedule-1; (b) wastes having constituents listed in Schedule-2 if their concentration is equal to or more than the limit indicated in the said Schedule; and (c) wastes listed in Lists 'A' and 'B' of Schedule-3 (Part-A) applicable only in case(s) of import or export of hazardous wastes in accordance with rules 12, 13 and 14 if they possess any of the hazardous characteristics listed in Part-B of Schedule-3.

Explanation: For the purposes of this clause- (i) all wastes mentioned in column (3) of Schedule-1 are hazardous wastes irrespective of concentration limits given in Schedule-2 except as otherwise indicated and Schedule-2 shall be applicable only for wastes or waste constituents not covered under column (3) of Schedule-1; (ii) Schedule-3 shall be applicable only in case(s) of import or export."

The TCIRD Report points out that the following by-products/waste materials were generated during the production of H-Acid in the said industrial unit.

1.	Gypsum on dry weight basis
2.	Iron oxide on dry weight basis
3.	Sodium bisulphate lost in wastewater
4.	Sodium nitrite and nitrate lost in wastewater
5.	Common salt lost in wastewater
6.	Glauber salt lost in wastewater
7.	<i>Naphthalene lost in the wastewater</i>
8.	<i>Mother liquor</i>
9.	<i>Incinerated ash</i>

Item No. 7, 8 and 9 readily fall under the hazardous waste category and none of the parties in the present dispute question the inclusion of these three items as hazardous wastes.

Although gypsum and iron oxide in their pure form are not treated as hazardous in nature, but in the manufacture of H-acid they are formed as by-products and are not in pure form and contain a significant quantity of naphthalene based intermediate compounds as impurities. This is explained by Venkatesan & Saksena (1995) very clearly. According to them “in order to separate the nitro naphthalene sulphonic acid from sulphuric acid, lime and soda ash were used to precipitate the sulphuric acid as calcium and sodium sulphate respectively. This resulted in

11-12 tonnes of gypsum sludge generation per tonne of H-acid manufactured. **Gypsum sludge contained 0.5-1 per cent nitro naphthalene compounds.** **The nitro naphthalene compounds are toxic in nature.** Their study further indicates that “Iron powder and HCl were used for the reduction of nitro to amino group, resulting in the generation of 3 – 3.5 tonnes of iron sludge (Fe₂O₃, sludge) per tonne of H-acid. **The concentration of amino compound in iron sludge was analysed to be about 4 – 5 per cent. The amino naphthalene compounds are toxic and carcinogenic in nature.** *Venkatesan, N & Saksena, A. K. (1995). Pollution prevention strategy at an H-acid manufacturing unit. UNEP Industry and Environment January - March 1995: 51 – 53.]*

The study conducted by Venkatesan & Saksena (1995) leaves no doubt in treating the gypsum sludge as well as iron oxide sludge produced as by-product in the manufacture of H - Acid to be hazardous waste as a significant quantity of naphthalene intermediate compounds is present in them. The hazardous nature of these by-products has also been confirmed by Prof. Guha, the expert engaged by respondents 4 to 7. In his comments on the TCIRD Report Prof. Guha states thus “*the first two types of sludge (gypsum sludge and iron sludge), from the manufacturing process for H – Acid, were produced directly from the process steps involving filtration*

and were quite wet. These were dewatered and then further dried by exposing to sun. All these sludge are classified as hazardous in nature because of the contamination of toxic organic compounds.” He further states about gypsum sludge that “the product after drying was not of pure white colour and free of these matters (sic organic matters), as is desired by these users. Hence it was difficult to sell it to such users. The intermediate compounds formed during the manufacture of H-Acid include Naphthalene-di,-tri- and tetra sulphonic acids, nitronaphthalene-mono,di and tri-sulphonic acids, naphthylamine-mono and di-sulphonic acids eg. 1-naphthylamine-3,6- and 5,7-disulphonic acid, and dinaphthylsulphone-sulphonic acid and their amino and nitro derivatives. All these by- products are non-biodegradable [**Schossler et al (1979), United States patent US4166826; 1979 for discovery of H Acid manufacturing process**]. Any or all of these intermediate compounds could find its way in to the environment along with the waste products Gypsum (calcium sulphate), Iron oxide and mother liquor.

The simple answer to the consequential question as to whether the project proponent disposed of such waste as per the rules is no. The Industrial Unit didn't follow the norms set for the collection and ultimate disposal of the hazardous wastes although the unit produced a large

quantity of such material. First of all it may be pointed out that the industrial unit did not even apply for the requisite NOC for the handling of hazardous wastes for six long years of H-Acid production, i.e., July, 1991 to May, 1997. And when they did apply and were given the permission to store the hazardous wastes as per the norms, the Industry just dumped the gypsum and iron oxide within the premises in a very casual manner. Only the Incinerator ash was kept in a shed covered on three sides and having a roof of sheets. However, this shed was completely dismantled in 2005 by the respondent industry and the hazardous wastes were left unattended in the open. The respondent 8, later on levelled the said land with the help of mechanized equipment (as has been clearly shown through several photographs by the petitioners. During this process the whole quantity of contaminated gypsum and iron oxide was spread on the concerned land and covered by several feet of soil used for the levelling process. This resulted in the complete exposure of the toxic naphthalene intermediates mixed with these two by-products to the rain and irrigation water as the land was put to agriculture by the respondent 8.

The incinerated ash was left open in the ash pond without any proper rain cover. It may be pointed out here that the incinerated ash could be disposed off from the

site only on 7th – 9th August, 2008. This is revealed by the affidavit of Col. (Er.) Surinder Jit Singh Sandhu (Retd.) D. G. M Ramky Enviro Enginners Ltd. Opp. Vardhman Chemtech Ltd., Vill Nimbua, , Tehsil Dera Bassi Distt, Mohali, dated 29.04.2009 which is placed on record . In his affidavit, Col. Sandhu submits that he is operating the Treatment Storage Disposal Facility (TSDF) Nimbua on behalf of Nimbua Greenfield Punjab Ltd. as operator and that the waste from the site of the Mahaluxmi Orgochemicals Industries was collected by his own transport i.e. Ramky Enviro Engineers Ltd. In all, 7 trips were made for collecting 101.830 M.T. of waste from 7th to 9th August, 2008 as per details given below.

S. No.	Manifest No.	Qty. of Waste lifted & transported to TSDF, Nimbua
i)	2245	10.30 MT
ii)	2246	9.610 MT
iii)	2247	16.065MT
iv)	2248	19.290MT
v)	2249	18.545MT
vi)	2250	15.500MT
vii)	2251	12.520MT
	Total	101.830MT

Accordingly this leads to the conclusion that the said toxic ash was there in the uncovered ash pond for at least two years and seven months [at least, from first week of January, 2006 (PPCB official noticed it on 10.01.2006) to 7th August, 2008]. During this period the ash passed three monsoons and many of the toxic ingredients must have dissolved in rain and got dispersed to the adjoining areas.

As per No. HMC/SGR/2004-2005/R-2060 Sh. C. L. Dhawan of M/s Mahaluxmi Orgochem Industries previously known as M/s Matharu Chemical Industries was granted an authorization by the PPCB under Rule 5 of the Hazardous Wastes (Management & Handling) Amendment Rules, 1989 as amended in 2003 to operate a facility for collection and storage of hazardous waste on the premises on the Terms and Conditions, which inter alia included, the following conditions.

- i. ----
- ii.
- iii. The person authorised shall not rent, lend, sell, dispose, transfer or otherwise transport the hazardous waste without obtaining prior permission of the Board.
- iv. Any unauthorized change in personnel, equipment and working conditions as mentioned in the

application by the person authorized shall constitute a breach of his authorization.

- v. It is the duty of the authorized person to take prior permission of the state Pollution Control Board to close down the facility.
- vi. The occupier generating hazardous waste/operate of a facility for collection and storage of hazardous waste shall maintain records of such operations in Form-3.
- vii.
- viii.
- ix. An occupier who is generating hazardous waste shall store his waste category wise on site in environmentally sound manner.
- x. An occupier/generator shall not store hazardous wastes in open ground. It must be stored in an isolated site away from plant operational area.
- xi. The storage tank/container of the hazardous waste should be in good condition and made of (or lined with) an appropriate material which does not react with the waste contained in it and can withstand the physical and environmental conditions during storage and handling.
- xii. The occupier generating hazardous waste shall mark each container holding hazardous waste with

the marking “HAZARDOUS WASTE” both in English and Punjabi.

xiii. The storage area should be fenced properly and a sign Board indicating “DANGER” and “HAZARDOUS WASTE” sign & nature of the waste shall be placed at storage site.

xiv.

xv.

xvi. The industry shall store the hazardous waste in environmentally sound manner and pack the hazardous waste sludge in impervious bags/containers strong enough to sustain rigour of handling, storage, transportation and weather conditions. The storage facility must be covered from upper side.

xvii.

xviii.

xix. The occupier and operator of a facility shall also be liable to reinstate or restore damaged or destroyed elements of the environment at his cost, failing which the occupier or the operator of a facility, as the case may be, shall be liable to pay the entire cost of remediation or restoration and pay in advance an amount equal to the cost estimated by the State Pollution Control Board.

xx.

xxi.

xxii.

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xxv.

xxvi.

xxvii.

The Industry in question violated all the above mentioned terms and conditions, more or less for the whole period of its operation at the site. No record was maintained in respect of Gypsum and Iron oxide, which because of the presence of quantities of naphthalene based compounds qualified to be treated as hazardous wastes and neither of these materials was stored properly and laid on the premises in a scattered manner without proper cover. Even the most hazardous incinerated ash was kept in the open for more than two years.

The land on which the industry-produced hazardous wastes were lying was sold without proper permission of the PPCB as was mandated by the terms and conditions governing the consent to store hazardous wastes. The issue is answered accordingly.

d. Did the environment get affected by the said acts of the respondents and to what extent? What is the relief?

According to the TCIRD report the profile of the salt level (sum of iron, sodium, sulphate, nitrate and chloride) in the

groundwater indicates that the groundwater has been contaminated by the following two sources.

- i. Percolation and leaching of contaminants from the onsite solid/hazardous waste storage and disposal and from the solar evaporation ponds.
- ii. 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 by 2005). Total salt level in the top layer of the groundwater (1435mg/L at 105ft depth) is higher than that at 120ft depth (1133mg/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.

As per the CPCB July 2013 report, during the field survey, it was observed that the colour of surface soil was red at many places within the premises of the closed industrial unit. Soil of black colour was found at 4 feet depth near the so called solar evaporation pond. It was found that black liquor was present at the depth of 5 feet near the site of solar evaporation pond which depicts that leftover industrial process waste is still lying there.

The report further observed that coloured water was pumped out of the tube well installed in the premises of the unit (Depth of the tube well 280 feet) even after continuous flow for 105 minutes. The report inferred that the groundwater quality exceeds the desirable limits of drinking water with respect to TDS, total alkalinity, total hardness, colour, calcium and iron. Therefore it is crystal clear that the environment got affected grossly by the lethargic attitude of the project proponents.

79. As we have concluded that the project proponents have not obtained consent for a considerable number of years and even during the period of consent they have not acted as per the terms contained therein and that there is a clear breach in respect of handling of hazardous waste, we have to decide about the relief which includes remediation process. The first step that requires to be done is the removal of hazardous

waste stored in the form of sludge created during the manufacturing process. Then comes the purification of water in the area surrounding the unit with all precautionary steps to be taken in the meantime.

80. The Central Pollution Control Board, in its report of August 2013, while assessing the ground water contamination near M/S Mahalaxmi Organochem Industry, namely the 5th respondent, arrived at a conclusion that the coloured ground water was observed from the deep tube well within the premises of the unit in the depth of 280 ft and the ground water quality exceeded the desirable limit of drinking water with respect to TDS, total alkalinity, total hardness, colour, calcium and iron, and suggested the following recommendations:

A. Ground water and soil sampling of erstwhile unit were conducted during monsoon season i.e July, 2013. There is need to carry out post monsoon monitoring preferably during November in order to have representative sample.

B. Immediate measures and controls

- i. The leftover industrial process waste lying at the depth of 4ft should be removed and disposed to approved Treatment, Storage and Disposal facility.
- ii. The voids filled with clayey soil.

- iii. Use of land for any other purposes including cultivation should be avoided till remediation is completed.
- iv. Access to the site be restricted with the help of fencing.
- v. The leaching from site may be minimized by laying a compacted clay layer of 30- 60 cm depth with proper slope.

C. Remediation of contaminated site

The following methodology shall be followed for remediation of contaminated site of M/S Mahalaxmi Organochem Industries, Nabha Road, Bhawanigarh, Sangrur District Punjab.

- i. Preliminary site verification supported with data/ background information of contaminated site and development of conceptual plan with monitoring protocol for detailed site investigation.
- ii. Undertaking detailed site investigation by conducting studies which include-
 - drilling of sampling borewells in & around the site for assessment of soil & ground water quality
 - conducting geo-technical studies comprising hydro- geological investigations

- delineate the boundaries of contaminated site and quantification of contaminated soil.
- Evaluation of the results to identify potential Sources, pathways and receptors
- iii. Risk assessment study of the site based on socio- economic and environmental assessment of contaminated area by using appropriate risk assessment model.
- iv. Identification of remediation goals/ objectives based on reduction of risk and also the intended future land use and selection of remedial option.
- v. Design of remediation plan for the approved remediation option.
- vi. Preparation of DPR for selective remediation based on the investigation details.
- vii. Execution of actual remediation work.
- viii. Assessment and validation of remediation work.
- ix. Future monitoring of the remediated work.'

81. The Thapar Center for Industrial Research and Development (TCIRD) in its report dated 04-01-2011, concluded that there was (1) localised contamination of ground water through injection of about 28000 m³ of industrial wastewater at about 140-150 depth, (2) the

presence of about 10000 m³ industrial waste was found concentrated to different levels in the solar evaporation ponds, (3) heavy contamination of about 600 m² land with the thick black liquor of the solar evaporation ponds on the northern side (4) presence of iron oxide sludge in the north – eastern corner of the industrial site and buried organic waste on the south- western side of the solar evaporation pond and (5) contamination of top soil within the industrial premises specially with iron oxide and gypsum sludge, has opined that the contaminated water needs treatment atleast to remove the methanol extractable organic compounds. According to the said Center, the treatment can include

- raising pH to > 11 with lime to precipitate the colour imparting methanol extractable organic matter
- settling/ clarification to remove the precipitated organic matter
- neutralizing the clarified water with sulphuric acid to about 7 pH.

82. It is also observed by the Center that the liquor and other waste present in the solar evaporation ponds may be treated as hazardous waste and lifted and transported as it is or after sufficient treatment like neutralization, concentration and filtration to TSDF for disposal. It is also stated that contamination of top soil within the premises of the unit,

specially with iron oxide and gypsum sludge may be taken care of by steps like:

- Avoid run on of the storm water from the surrounding areas through creating berms/barriers and diverting the storm water specially on the eastern and southern sides.
- Avoid flood irrigation of the land within the industrial unit premises and impose restrictions on the crops to be grown. Fiber and energy plantation crops may be most the appropriate. Food and fodder yielding crops may be avoided.

83. The CERD Instruments and Consultants, Noida, who appears to have been consulted by the PPCB to effect a study regarding the remediation of ground water contamination has submitted a report in the form of an offer in July 2012, stating that a detailed analysis would be carried out and inference would be drawn on the basis of scientific results. While explaining the data required for such study, the said consultant has also stated that the remediation work can be completed in a period of seven months as per the schedule annexed. They have also given the schedule of payments for undertaking the work stating that the expenses may be around Rs.29,89,000/ with Service Tax. Therefore it is clear from the above particulars that remediation is possible and the hazardous waste lying in the form of sludge in the premises of the unit must be removed. Further, the unit which is found to have not only committed breach but also caused

environmental disaster is liable to be penalised under the principle of 'Polluter Pays'.

84. It is to be noted that the 8th respondent, Tara Singh, who is a resident of the village was impleaded in the Hon'ble High Court on 17-08-2009 to assist the court. He is the purchaser of the land of the company, the 4th respondent through the 6th respondent on 28-02-2007. The Hon'ble High Court in the order dated 29-08-2011 has directed the 8th respondent to deposit the expenses for restoration of damages. The said 8th respondent filed C.M.P. No.12551/2011 for discharging him from the liability, as he was a bonafide purchaser. By an order dated 20-12-2011, the Hon'ble High Court, while discharging the said 8th respondent, directed the 4th to 7th respondents to deposit the said amount. Therefore, it is clear that the High Court has also found him as a bonafide purchaser. Therefore, we hold that the said 8th respondent cannot be made responsible for the pollution caused by the other respondents.

85. The 9th respondent Shri. Gurcharan Singh Matharu who was impleaded subsequently, was a director of Matharu Steel Private Ltd, the 4th respondent, till 2003. He also acted as a director of Matharu Chemical Industries since 1991 till 2003. Even though he takes a stand that he sold his rights in the company to the 6th respondent under an agreement dated 28-03-2003 and therefore the vendee should take up the responsibility, in our view, he cannot disown his obligation by merely transferring his interest in the unit. The respondents

who have polluted the ground water ever since the date of their industrial activities from 1991 till 2005 and even now continuously, as it has been found by the experts that traces of phenolic compounds, carbonate, sulphate and nitrate are found in the lands and water around the 5th respondent unit, are liable to compensate under 'Polluter pays' principle. Taking note of the fact that the pollution caused has serious implication on the living condition of the people and that the process of remediation will take some more years, we are of the view that they should be directed to pay at least an amount of Rs. Two crores to be used for providing safe drinking water and better solid waste management facilities to the people of the petitioner's villages.

86. Accordingly, we pass the following order:

1. The Application No. 35/2013 stands allowed.
2. It is declared that the Respondent 4, 5 units also represented by Respondent 6 & 7 as the directors of the 4th and 5th respondent company and respondent 9, by their industrial activities have polluted the air, land and water including the ground water and produced and stored hazardous waste unauthorisedly and without any proper disposal.
3. The Respondent 4 to 7 and 9 shall remove all hazardous waste still lying in the premises of M/S Mahalaxmi Orgchem Industries under the joint supervision of the Central Pollution Control Board and the Punjab State

Pollution Control Board at their cost and within a period of three months from today. To effect such speedy removal both the Boards shall do all necessary assistance, guidance both expertise and otherwise and shall also be entitled to obtain any further opinion/ opinions at the cost of the 5th respondent and its Directors.

4. The Respondent 4 to 7 and 9 shall effect remediation of water contamination in the premises of the unit and all the surrounding areas polluted by the activities of the unit at their cost. This shall be done under the joint supervision of the CPCB and PPCB, who shall suggest the suitable method through appropriate agency/agencies. The steps shall include prevention of agricultural activities in the surrounding area as suggested by the Boards and all other precautionary methods. The said process shall be completed in a period of eight months from today.
5. The CPCB and PPCB shall file periodical report about the progress in the Registry of the Principal Bench of the NGT, once in a month commencing from 01- 11- 2015.
6. That apart, the Respondents 4 and 5 along with their Directors Respondent no. 6 and 7 and 9 shall pay an amount of Rs. Two crores under the principles of 'Polluter Pays' in the following proportion i.e Respondent no. 4 along with all its Directors including Respondent no. 6

and 7 to the extent of 40% jointly, Respondent no. 5 and all its Directors to the extent of 30% jointly and the remaining 30% by the 9th Respondent. The said amount shall be deposited within 8 weeks from today with the Principal Secretary, Ministry Environment, State of Punjab, who shall keep the said amount in a separate account and spend for providing safe drinking water and better solid waste management facilities to the people of Village Toori, BaladKalan and BaladKooti, Tehsil Bhawanigarh, District Sangrur with prior approval of the N.G.T.

7. The Respondents 4 to 7 and 9 shall be liable to pay cost of Rs. 25000/ to be payable to the learned counsel for the applicant/Amicus and another amount of Rs.50000/ to the applicants as cost.
8. M.A. No. 21 of 2014 does not survive as the main application No. 35/2013 (THC) has been finally disposed of.

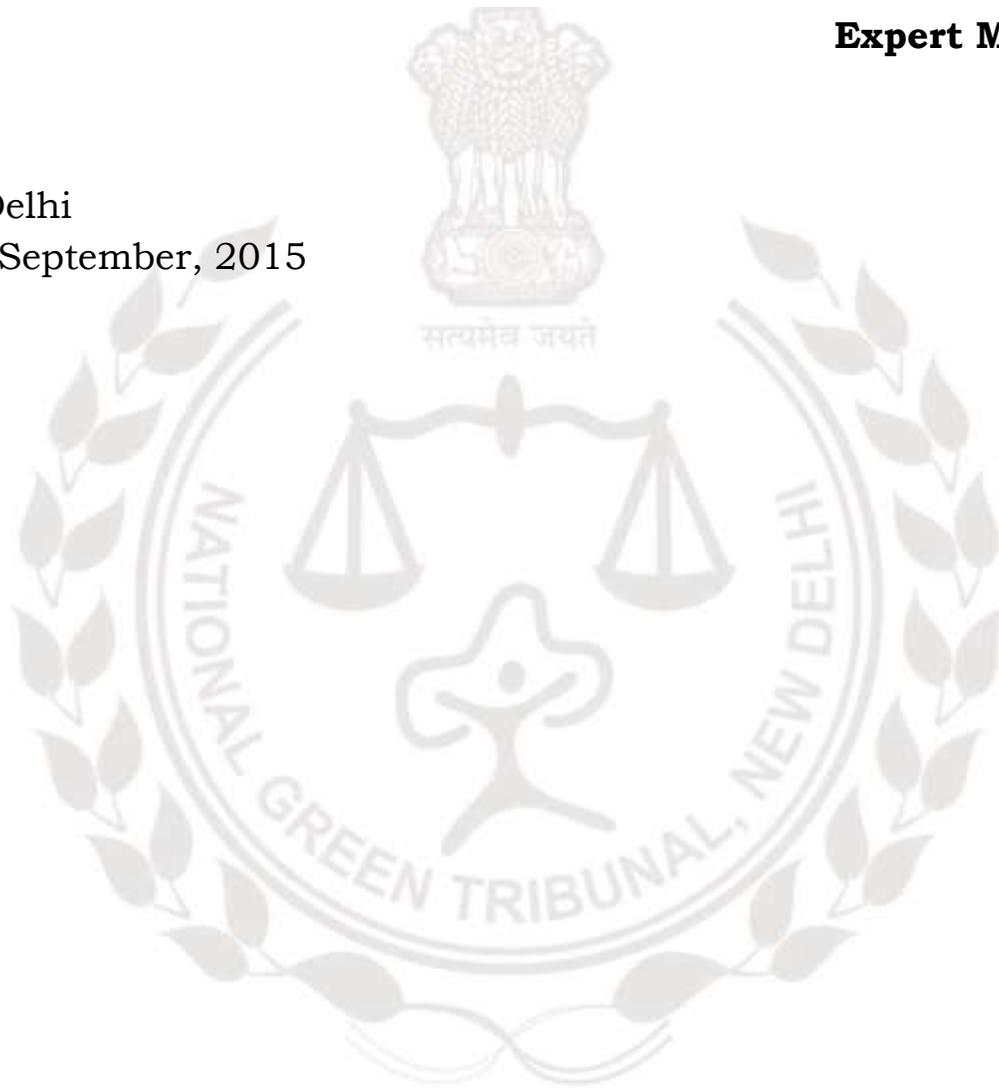
Justice Dr. P. Jyothimani
Judicial Member

Justice U. D. Salvi
Judicial Member

Prof. A. R. Yousuf
Expert Member

Mr. Bikram Singh Sajwan
Expert Member

New Delhi
23rd September, 2015



NGT

**BEFORE THE NATIONAL GREEN TRIBUNAL,
PRINCIPAL BENCH, NEW DELHI ORIGINAL**

**REVIEW APPLICATION NO. 39/2015
IN
APPLICATION NO. 35/2013 (THC)
AND
ORIGINAL APPLICATION NO. 70/2016**

In the matter of:

GURCHARAN SINGH MATHARU

435, Rajiv Gandhi Nagar,
Kota, Rajasthan.



----- **APPLICANTS**

Versus

- 1. PARMINDER SINGH, S/O PRITAM SINGH**
Balad Kalan Village, Bhawanigarh
Tehsil, Sangrur District.
- 2. HOSHIAR SINGH, S/O HARBHAJAN SINGH**
Toori Village, Bhawanigarh Tehsil,
Sangrur District.
- 3. NARINDRE SINGH, S/O INDER SINGH**
Balad Kalan Village,
Bhawanigarh Village, Sangrur District.
- 4. SURJIT SINGH, S/O HARNEK SINGH**
Bhavangarh, Sangur District.
- 5. RANJIT SINGH, S/O SATPAL SINGH**
BaladKooti Village, Bhavangarh Tehsil,
Sangur District.
- 6. ANGREJ SINGH, S/O SURJIR SINGH**
Toori Village, Bhavanigarh Tehsil,
Sangrur District.
- 7. HARNEK SINGH, S/O GUJJAR SINGH**
Sarpanch, Gram Panchayat Toori,
Toori Village, Bhavanigarh Tehsil,
Sangrur District.
- 8. JAGNAHAR SINGH, S/O NIKKA SINGH**
Toori Village, Bhavanigarh Tehsil,
Sangrur District.

- 9. PARAMJIT SINGH, S/O SHARAN SINGH**
Toori Village, Bhavanigarh Tehsil,
Singrur District.
- 10. SUKHWINDER SINGH, S/O MOHINDER SINGH**
Toori Village, Bhavangarh Tehsil,
Singrur District.
- 11. PUNJAB POLLUTION CONTROL BOARD**
through its Chairman, VatavaranBhawan,
Nabha Road, Patila.
- 12. ENVIRONMENTAL ENGINEER,**
Punjab Pollution Control Board,
Through its Regional Office,
Sanrur District, Sangrur.
- 13. ASSISTANT ENVIRONMENTAL ENGINEER,**
Punjab Pollution Control Board,
through its Regional Office, Sangrur District, Sangrur.
- 14. M/S MAHALAXMI ORGANOCEM INDUSTRIES**
Nabha Road, Teshil Bhanvanigarh, District Sangrur
Thru. Shri. Chander Shekhar Dhawan.
- 15. CHANDER SHEKHAR DHAWAN,**
Director, M/S MatharuSteels Pvt. Limited,
Resident of 110-A, Sarabha Nagar, Ludhiana.
- 16. SUNIL AHUJA,**
Director of M/S Matharu Steels Pvt. Limited,
Resident of E-14, Sector-14, Noida, U.P.
- 17. TARA SINGH, S/O SWARAN SINGH.**
Village Nauhra, Nabha, Patiala Distict.
- 18. CENTRAL POLLUTION CONTROL BOARD**
Represented by the Member- Secretary,
New Delhi.

--- **RESPONDENTS**

AND

1. PARMINDER SINGH & ORS

--- **APPLICANTS**

VERUS

1. PUNJAB POLLUTION CONTROL BOARD & ORS

-----**RESPONDENTS**

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Menon and Mr. Sunil Gupta Advs.

Counsel for the Respondents:

Counsel for C.P.C.B. Mr. Raj Kumar Adv. With Mr. Bhupinder Kr. L.A.

Counsel for PPCB: Mr. Narnder Benipal, Adv. With Mr. Harjeet Singh Environmental Engineer

Present:

HON'BLE MR. JUSTICE SWATANTER KUMAR (CHAIRPERSON)

HON'BLE MR. JUSTICE U. D. SALVI (JUDICIAL MEMBER)

HON'BLE MR. BIKRAM SINGH SAJWAN (EXPERT MEMBER)

O R D E R

Reserved on: 20TH December, 2016

Pronounced on: 6th July, 2017

1. This Review Application has been Preferred against the Judgment and Order dated 23rd September, 2015 passed in O.A.No.35 of 2013 whereby the Respondent No-9 Gurucharan Singh Matharu, Director of Matharu Chemical Industries along with other Respondent industrial units and their Directors have been declared to have polluted the air, land and water including groundwater by their industrial activities and produced and stored hazardous waste unauthorizedly without any proper disposal, and were further directed to contribute towards the cost of remediation of the problem in addition to cost.

2. We have heard the parties to the Review Application and considered the record of the case.

3. Broadly, the Applicant contends that the Tribunal ignored the fact that no case has been made out against the Review Applicant Gurucharan Singh Matharu as entire right, title, interest was transferred to new management vide an

agreement dated 28-03-2003; and he was only one Director of the Company from 1991 to 2003 during which the industry has operated in accordance with the consent to operate granted by Punjab Pollution Control Board.

4. Perusal of the Judgment reveals that we did consider the submissions made by the Review applicant particularly, his contention vide reply affidavit dated 19th November, 2013 that he was associated with the industrial unit as one of the Director of the unit only upto March, 2003 and during this period (1999-2003) he was meticulous to ensure that all the relevant approvals and consents relating to the various environmental laws were valid at all times and were renewed from time to time after final inspection of the concerned Department and at the time of transfer of the said company all the records including licenses/NOCs under the relevant environmental laws were handed over to the new owners/management of the said manufacturing unit. We also took into consideration various analysis reports, particularly, in relation to the groundwater and four Status Reports, TCIRD Report of 2011, CPCB Report of 2013, CPCB Report of 2014 and CSIR-NEERI Report of 2014 and submissions made by the rival parties at different stages of the case first before the Hon'ble High Court of Punjab and Haryana at Chandigarh and later before us and could arrive at composite collation of the facts as follows:

- a.** The industrial Unit was running for almost fourteen years (to be precise, 13 years and 8 months, i.e., from July 1991 to February 2005) at the site.
- b.** The unit had obtained the requisite permission for the establishment of the said industrial unit. However, NOCs/Consent to operate were not obtained for the whole period and for some period the unit was run without proper consents.
- c.** The unit was using naphthalene as the raw material for the production of the H-acid.
- d.** The unit was storing the iron oxide slurry as well as gypsum slurry on the site itself.
- e.** The unit had constructed a pond for storing of the final waste material generated in the manufacturing process, i.e., mother liquor.
- f.** The unit didn't have any incineration process for the first five years of manufacturing and the mother liquor was simply stored in the pond and passed through the evaporation process only.
- g.** The solid waste left over after incineration process was stored in a tank covered by tin shed.
- h.** Except for a small quantity of gypsum, which was sold to some third party, gypsum as well as iron oxide remained dumped on the site. There is no record to

show that the gypsum and iron oxide has been disposed of properly or shifted to any other place when the unit was dismantled and the land previously occupied by the unit was put to agriculture.

- i.** The industrial unit closed in March, 2005 and later on dismantled completely and even the shed covering the hazardous waste was dismantled, leaving the hazardous wastes exposed to the vagaries of the weather at least for four years (March, 2005 – August 9, 2009).
- j.** The estimate provided by the TCIRD regarding the quantum of raw materials used, product and by-products as well as waste materials produced have not been questioned by any party, including the expert engaged by Respondents 4 - 7.
- k.** The calculations made by the TCIRD have revealed the utilization of less than 40% of the naphthalene processed for the manufacture of H-acid. This leads to the inference that about 60% of the unutilized naphthalene remained either in the mother liquor and/or got mixed with the iron oxide and gypsum slurry.
- l.** The incinerated ash, which was stored in the ash pond got ultimately shifted to TSDF facility at Nimbua during 7th – 9th August, 2008 and as such remained without any cover for the period January, 2006 –

August, 2008, as the dismantling of the sheds was first noticed on 2nd January, 2006 by PPCB.

5. We noticed that:

“the unit didn’t have NOC/consent to operate for the period from July, 1991 (start of manufacture) to 6.10.1993 and again from 1.10.1994 to 17.10.1995 under Water Act. Similarly it didn’t have permission for the period from July, 1991 to 1.2.1994 and again from 1.7.1994 to 7.10.1997 under Air Act. The unit didn’t have permission to store the Hazardous wastes for the period from July, 1991 to 5.5.1997, from 19.3.1999 to 22.4.2002, from 23.4.2004 to 4.8.2004 and from 5.8.2005 to 7.8.2008 under Hazardous Wastes Rules. So, it is quite evident that the industrial unit violated the Air Act, Water Act as well as Environment Protection Act during the periods mentioned above.

It was also noticed that even when the consent was placed before the Authority concerned the Industrial Unit in question was issued a show cause notice on 5th April, 2004 by Environmental Engineer, PPCB.

6. According the TCIRD report, the profile of the salt level (sum of iron, sodium, sulphate, nitrate and chloride) in the groundwater indicates that the groundwater has been contaminated by the following two sources.

i. Percolation and leaching of contaminants from the onsite solid/hazardous waste storage and disposal and from the solar evaporation ponds.

ii. 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 by 2005). Total salt level in the top layer of the groundwater (1435mg /L at 105ft depth) is higher than that at 120ft depth (1133mg/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. As per the CPCB July 2013 report, during the field survey, it was observed that the

colour of surface soil was red at many places within the premises of the closed industrial unit. Soil of black colour was found at 4 feet depth near the so called solar evaporation pond. It was found that black liquor was present at the depth of 5 feet near the site of solar evaporation pond which depicts that leftover industrial process waste is still lying there.

7. We, therefore, recorded the finding that the environment got affected grossly by the lethargic attitude of the Project Proponent and on account of an approach in respect of handling of hazardous waste in face of the facts noticed by us.

8. The Review Applicant Gurucharan Singh Matharu mainly contends that his role as a Director of the Company came to an end in the year 2003 and the manufacturing activity during his tenure as a director was conducted with due consents/approvals, the copies of which he seeks to produce now; and there was nothing to point out any action/inaction on his part which could have led to any pollution as alleged.

9. Pertinently, we had taken into consideration the role of the Review-Applicant Mr. Gurucharan Singh Matharu, director of Matharu Steel Pvt. Ltd till 2003 and as a director of Matharu Chemical Industries since 1991. We had also considered his specific contentions that he had sold his rights in the Company to 6th Respondent under an agreement dated 28.3.2003 and, therefore, the vendee should take up the responsibility. We

categorically observed that the Review Applicant cannot disown his obligations by merely transferring his right in the unit, and the groundwater was continued to be polluted ever since the date of their industrial activities from 1991 onwards. We had given a thought to sensitivity of FTIR method in detection of sulphonated phenolic compounds as compared to routine APHA method and to the fact that sulphonated phenolic compounds imparted reddish brown colour to water pumped out of the tube well installed in the premises of the unit in absence of any iron therein.

10. Assuming that the industry duly enjoyed consents/approvals during the tenure of the Review Applicant as a director of the said Company and the consents showed that the periodic test of groundwater carried out by the Pollution Control Board were found to be in order, nowhere do we find any whisper about the groundwater being tested during the said period by a sensitive test like FTIR method, which could give clear answer and explain reddish brown colour of the groundwater pumped out through the tube well in the premises of the said industry in absence of iron therein. Needless to state that, increase or decrease of contaminants in the groundwater is gradual over a passage of time and its presence became manifest with the sensitive FTIR method. The fact remains that presence of contaminant like sulphonated phenolic compounds in the groundwater can be attributed to Koch cake fusion stage in manufacturing of H-Acid (Pg. 56-57) and the responsibility lies

on all those responsible for the operation of industry to show that their activity was/is benign to the environment.

11. No mistake or error apparent on the face of record so as to enable the conclusions as solicited by the Review Applicant can therefore be perceived in passing of impugned order from the record before us and we will have to traverse beyond the jurisdiction conferred upon us by law as a Revisional Forum and exercise the appellate jurisdiction, which we are not ordained by law to do while exploring any mistake or error in the present case.

We, therefore, reject this Application with no order as to costs.

Justice Swatanter Kumar
Chairperson

Justice U. D. Salvi
Judicial Member

Mr. Bikram Singh Sajwan
Expert Member

New Delhi
6th July, 2017

hkk

Annexure- 3 (iv)

Guidelines on Implementing Liabilities for Environmental Damages due to Handling & Disposal of Hazardous Waste and Penalty



CPCB

January 2016

Central Pollution Control Board
(Ministry of Environment, Forest & Climate Change, Government of India)
Parivesh Bhawan, East Arjun Nagar,
Shahdara, Delhi - 110032

Guidelines on Implementing Liabilities for Environmental Damages due to Handling & Disposal of Hazardous Waste and Penalty



CPCB

January 2016

Central Pollution Control Board
(Ministry of Environment, Forest & Climate Change, Government of India)
Parivesh Bhawan, East Arjun Nagar,
Shahdara, Delhi - 110032

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अरुण कुमार मेहता, भा.प्र.से.
 संयुक्त सचिव
 (पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय)
ARUN KUMAR MEHTA, I.A.S.
 Joint Secretary
 (Ministry of Environment, Forest & Climate Change)
 &
 अध्यक्ष
 केन्द्रीय प्रदूषण नियंत्रण बोर्ड
 Chairman
CENTRAL POLLUTION CONTROL BOARD



भारत सरकार
 पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
 नई दिल्ली - 110003
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT, FOREST &
CLIMATE CHANGE
NEW DELHI-110003

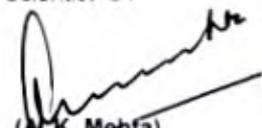
FOREWORD

Hazardous waste is required to be stored, packaged, transported or recycled/utilized/disposed in an environmentally sound manner in compliance with the provisions stipulated under the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, notified under the Environment (Protection) Act, 1986. Improper handling or disposal of hazardous waste may lead to environmental damages and violations of provisions laid down under the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008. Rule 25 of the said Rules lays down provisions for liability of occupier, transporter, operator of a facility and importer. The Rule 25(1) stipulates that the occupier, importer, transporter and operator of the facility shall be liable for all damages caused to the environment or third party due to improper handling of the hazardous wastes or disposal of the hazardous wastes. Further, Rule 25(2) stipulates that the occupier and the operator of the facility shall be liable to pay financial penalties as levied for any violation of the provisions under these Rules by the State Pollution Control Board with the prior approval of the Central Pollution Control Board.

Incidences of fire, spillage, illegal disposal, etc. of hazardous waste are being noticed regularly which necessitates systematic imposition of liability on occupier, importer, transporter and operator of the facility, as the case may be, for damages caused to the environment or third party as well as levy financial penalty for violation of the provisions of the Rules so as to enforce Rule 25. However, assessing various types of liabilities and translating the same in terms of monetary value are challenges before the implementing agencies such as State Pollution Control Boards (SPCBs)/ Pollution Control Committees (PCCs). Similar difficulties have also been faced in arriving at financial penalties to be levied for various kind of violations on the occupier, importer, transporter and operator of a facility.

With an objective to address the above, these guidelines have been prepared along with description of liabilities, approach for valuation, methodology for levying financial penalties, role of SPCB/PCC and other stakeholders etc. Consultations were held with industries, experts, academic institutes, SPCBs/PCCs etc. The Ministry of Environment, Forest & Climate Change, Govt. of India, has accorded its approval to these guidelines. I am sure these guidelines shall be very helpful to SPCBs/PCCs and other stake holders in implementing provisions of the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008.

I shall like to put on record my appreciation for work done by my colleagues Shri Bharat K Sharma, Scientist, 'E', Shri B. Vinod Babu, Scientist E & I/c HWMD, and Smt. Deepti Kapil, Scientist 'C'.


 (A. K. Mehta)
 Chairman



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1

BACKGROUND

For safe handling and management of hazardous waste in an environmentally sound manner, Government of India (GOI) has notified the Hazardous Waste (Management & Handling) Rules, 1989, under the Environment (Protection) Act, 1986. However, these Rules were suppressed with re-notification of the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008.

Under the said Rules, hazardous waste has been defined as those wastes which by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances, and shall include wastes as specified in Schedules of the Rules.

The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, lays down provisions for requirement of authorization from the concerned State Pollution Control Board (SPCB)/ Pollution Control Committee (PCC) for generation, processing, treatment, package, storage, transportation, use, collection, destruction, conversion, offering for sale, transfer or the like of the hazardous waste, packaging, labeling, transportation, treatment, recycling, disposal, etc. of hazardous waste. The Rules also stipulate provision of liability of occupier, transporter, operator of a facility and importer for all damages caused to the environment or third party due to improper handling or disposal of the hazardous wastes as well provision to pay financial penalties as levied for any violation of provisions under the Rules.

In order to enforce the aforesaid provision of the Rules, assessment of damages caused to the environment or third party due to improper handling or disposal of the hazardous wastes (such as but not limited to, illegal disposal/ spillage of hazardous waste or fire from improper handling/disposal of hazardous waste) is the foremost requirement besides taking immediate measures for control/containment of impacts upon such incidences. Liability to occupier or importer or transporter or operator of the facility, as the case may be, can be assigned for immediate response, site assessment and remediation and also for compensating the damages caused to third parties. Upon immediate reporting of such incidences, every State Pollution Control Board (SPCB)/ Pollution Control Committee (PCC) is expected to have a well-defined system in place to deal with such emergency along with protocol to be followed. A well-defined system will help in adopting a systematic approach towards reporting/inspection of such incidences of spillages/ disposal/ fire because of improper handling/disposal of hazardous wastes and also in implementing environmental damage liability and financial penalty for violation, if any.

This document outlines various liabilities to be imposed on a responsible party for causing environmental damages arising from improper handling/disposal of hazardous waste. These liabilities are applicable to the occupier, transporter, operator of a facility and importer as the case may be, hereinafter referred to as responsible party. The guidelines also identify the compensation liabilities on a responsible party for causing impacts such as injury, loss of life, effects on flora and fauna, loss of livelihood, reduced yield from crops, property loss, etc. However, evaluation and implementation of the same are not covered in the scope of this document, which may be dealt with by the concerned agency of respective State/UT Government. Role of the responsible party and the concerned SPCB/PCC have been outlined in the event of occurrence of incidences. Further, an attempt has also been made to provide an indicative cost for assessment and

remediation, which may, however, vary case to case. The document also provides guidelines for evaluating and implementing financial penalty for violation of provisions stipulated under the Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008.

This document is in compliance with the order dated 18/2/2014 of the Hon'ble National Green Tribunal, (Western Zone) Bench, Pune, in the matter of Application No. 87/2013(WZ), Ramubhai Kariyabhai Patel & others versus Union of India & others, wherein it has been ordered that "Gujarat Pollution Control Board and Central Pollution Control Board shall immediately undertake efforts for capacity building within their organizations and also, other SPCBs for scientific handling of such accidents, through training and preparation of guidelines and manuals, particularly enforcement of Rule 25 (1) and (2) of HW Rules, 2008. This is utmost essential to develop such capacity in SPCBs and CPCB as they are the scientific and technical organizations having responsibility to handle such environmental hazards and therefore, it is necessary to ensure adoption of suitable scientific tools and techniques to develop suitable response to such accidents".

The National Environment Policy was published by the Ministry of Environment, Forests & Climate Change, GOI, in 2006. This policy is intended to be a guide to action: in regulatory reform, programmes and projects for environmental conservation; and review and enactment of legislation, by agencies of the Central, State, and Local Governments. One of the guiding principles of the National Environment Policy is legal liability. It stipulates that civil liability for environmental damage would deter environmentally harmful actions, and compensate the victims of environmental damage. Conceptually, the principle of legal liability may be viewed as an embodiment in legal doctrine of the "polluter pays" approach, itself deriving from the principle of economic efficiency.

The Section 9 of the Environment (Protection) Act, 1986, stipulates provision about furnishing of information to authorities and agencies and remedial measures where discharge of any environmental pollutant in excess of the prescribed standards occurs or is apprehended to occur due to any accident or other unforeseen act or event. The same is reproduced as below:

9. *Furnishing of information to authorities and agencies in certain cases*

- (1) *Where the discharge of any environmental pollutant in excess of the prescribed standards occurs or is apprehended to occur due to any accident or other unforeseen act or event, the person responsible for such discharge and the person in charge of the place at which such discharge occurs or is apprehended to occur shall be bound to prevent or mitigate the environmental pollution caused as a result of such discharge and shall also forthwith--*
 - (a) *intimate the fact of such occurrence or apprehension of such occurrence; and*
 - (b) *be bound, if called upon, to render all assistance, to such authorities or agencies as may be prescribed.*
- (2) *On receipt of information with respect to the fact or apprehension on any occurrence of the nature referred to in sub-section (1), whether through intimation under that sub-section or otherwise, the authorities or agencies referred to in sub-section (1) shall, as early as practicable, cause such remedial measures to be taken as necessary to prevent or mitigate the environmental pollution.*
- (3) *The expenses, if any, incurred by any authority or agency with respect to the remedial measures referred to in sub-section (2), together with interest (at such reasonable rate as the Government may, by order, fix) from the date when a demand for the expenses is made until it is paid, may be recovered by such authority or agency from the person concerned as arrears of land revenue or of public demand.*

In exercise of powers conferred under Sections 6 and 25 of the Environment (Protection) Act, 1986, GOI has notified Environment (Protection) Rules, 1986. The Rule 12 of the said Rules and amendments made thereof lays down the aforesaid authorities who shall be intimated about the said occurrence or apprehension of such occurrence. The said provision is reproduced as below:

12. *Furnishing of information to authorities and agencies in certain cases*

Where the discharge of environmental pollutant in excess of the prescribed standards occurs or is apprehended to occur due to any accident or other unforeseen act or event, the person in charge of the place at which such discharge occurs or is apprehended to occur shall forth with intimate the fact of such occurrence or apprehension of such occurrence to all the following authorities or agencies, namely:-

- (i) *The officer-in-charge of emergency or disaster relief operation in a district or other region of a state or Union territory specified by whatever designation by the Government of the said State or Union territory, and in whose jurisdiction the industry, process or operation is located.*
- (ii) *Central Board or a State Board as the case may be and its regional officer having local jurisdiction who have been delegated powers under section 20, 21, 23 of the Water (Prevention and Control of Pollution) Act 1974 (6 of 1974)- and section 24 of the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981).*
- (iii) *The statutory authorities or agencies specified in column 3 in relation to places mentioned in column 2 against thereof of the Schedule II.*

The said Schedule II is given at Annexure I.

The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, has been notified by GOI exercising the powers conferred by Sections 6, 8 and 25 of the Environment (Protection) Act, 1986. Besides laying down provisions for handling and management of hazardous waste, it also stipulates provision of accident reporting and liability of occupier, transporter, operator of a facility and importer with regard to damages caused to the environment or third party due to improper handling of hazardous wastes. Provision of paying financial penalty for any violation of the provisions under the Rules has also been stipulated. The same is reproduced as below:

24. *Accident reporting and follow-up.- Where an accident occurs at the facility or on a hazardous waste site or during transportation of the hazardous waste, the occupier or operator of the facility or the transporter, as the case may be, shall report immediately to the State Pollution Control Board about the accident in Form 14.*
25. *Liability of occupier, transporter, operator of a facility and importer.-*
 - (1) *The occupier, importer, transporter and operator of the facility shall be liable for all damages caused to the environment or third party due to improper handling of the hazardous wastes or disposal of the hazardous wastes.*
 - (2) *The occupier and the operator of the facility shall be liable to pay financial penalties as levied for any violation of the provisions under these rules by the State Pollution Control Board with the prior approval of the Central Pollution Control Board.*

Under the National Green Tribunal Act 2010, the National Green Tribunal has been established for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto. The principles of sustainable development, the precautionary principle and the polluter pays principle are applied for passing any order or decision or award by the Tribunal. The National Green

Tribunal Act 2010, lays down provisions for Relief, compensation, restitution and liability vide sections 15 and 17 and the same are reproduced as below:

15.(1) *The Tribunal may, by an order, provide,-*

- a. *relief and compensation to the victims of pollution and other environmental damage arising under the enactments specified in the Schedule I (including accident occurring while handling any hazardous substance);*
 - b. *for restitution of property damaged;*
 - c. *for restitution of the environment for such area or areas, as the Tribunal may think fit.*
- (2) *The relief and compensation and restitution of property and environment referred to in clauses (a), (b) and (c) of sub-section (1) shall be in addition to the relief paid or payable under the Public Liability Insurance Act, 1991.*
- (3) *No application for grant of any compensation or relief or restitution of property or environment under this section shall be entertained by the Tribunal unless it is made within a period of five years from the date on which the cause for such compensation or relief first arose:*
- Provided that the Tribunal may, if it is satisfied that the applicant was prevented by sufficient cause from filing the application within the said period, allow it to be filed within a further period not exceeding sixty days.*
- (4) *The Tribunal may, having regard to the damage to public health, property and environment, divide the compensation or relief payable under separate heads specified in Schedule II so as to provide compensation or relief to the claimants and for restitution of the damaged property or environment, as it may think fit.*
- (5) *Every claimant of the compensation or relief under this Act shall intimate to the Tribunal about the application filed to, or, as the case may be, compensation or relief received from, any other court or authority.*

17(1) *Where death of, or injury to, any person (other than a workman) or damage to any property or environment has resulted from an accident or the adverse impact of an activity or operation or process, under any enactment specified in Schedule I, the person responsible shall be liable to pay such relief or compensation for such death, injury or damage, under all or any of the heads specified in Schedule II, as may be determined by the Tribunal.*

- (2) *If the death, injury or damage caused by an accident or the adverse impact of an activity or operation or process under any enactment specified in Schedule I cannot be attributed to any single activity or operation or process but is the combined or resultant effect of several such activities, operations and processes, the Tribunal may, apportion the liability for relief or compensation amongst those responsible for such activities, operations and processes on an equitable basis.*
- (3) *The Tribunal shall, in case of an accident, apply the principle of no fault.*

The said Schedule II is given at Annexure II.

The National Green Tribunal Act, 2010, has also provisions of penalty for failure to comply with orders of Tribunal. Section 26 of the Act stipulates that whoever, fails to comply with any order or award or decision

of the Tribunal under this Act, he shall be punishable with imprisonment for a term which may extend to three years, or with fine which may extend to ten crore rupees, or with both and in case the failure or contravention continues, with additional fine which may extend to twenty-five thousand rupees for every day during which such failure or contravention continues after conviction for the first such failure or contravention. However, the fine payable by Companies may extend to twenty five crore rupees and one lakh rupees a day in case of continuing default.

Thus, regulatory framework exists in the country that requires a potential polluter to be liable for all damages caused to the environment or third parties due to improper handling of the hazardous wastes or disposal of the hazardous wastes. Further, provisions have also been laid down in respect of financial penalties associated with improper handling or disposal of hazardous wastes.

3

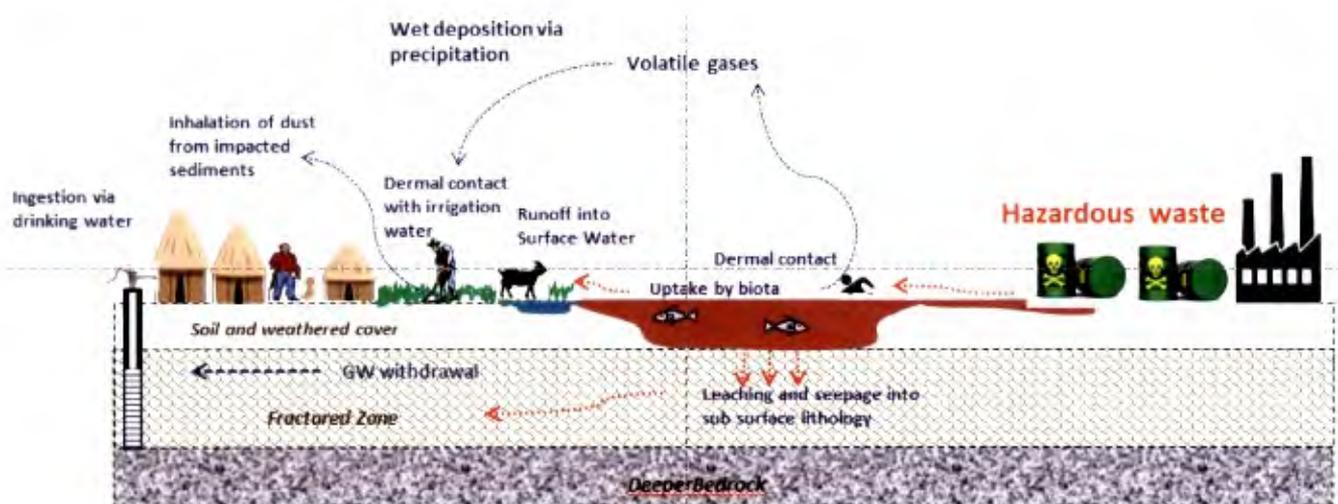
DESCRIPTION OF IMPACTS

Impacts to the environment can be caused through a variety of mechanisms. It is not the intent of this guideline document to capture all possible contamination scenarios that may occur in a multitude of permutations and combinations (e.g. leaking underground storage tanks, unlined drains, waste dumping, spillage of wastes, leaking pipes, etc.) that may impact the natural resources i.e. soil, groundwater and surface water bodies. However, this document mainly focuses on the issues pertaining to environmental impacts arising from dumping of hazardous wastes in open land, inappropriate handling of hazardous wastes at operating facilities, spillage of hazardous wastes during handling or transportation, failures of various engineering systems that would otherwise contain a hazardous waste (e.g. secure landfills, storage sumps/containers, etc.), etc.

Contamination to soil, groundwater and surface water are the main media of contamination covered under this document (impacts on media such as air, sea/ oceans etc., are currently not covered under this document). Contaminated natural resources (soil, groundwater and surface water) have impacts on various receptors, which need to be addressed when dealing with the liabilities that have to be allocated to the polluters.

Impacts also include long term effects on the natural resources themselves, which if affected by contamination, become unusable by the general public. Once contaminated, natural resources require an inordinately long time to replenish and revert back to original status. In most cases, in spite of active remediation efforts, a contaminated resource does not typically revert back to its original (pre-contaminated) state.

The figure below shows an indicative conceptual site model, depicting the different pathways and receptors that run the risk of being exposed to any contaminant in soil, groundwater and surface water due to impact from hazardous waste dumping/leakages.



3.1 Impacts on Soil

Typical examples of how soils are impacted by hazardous wastes include, but are not limited to:

- Clandestine Illegal dumping of hazardous waste on open parcels of land;
- Discharge of liquid hazardous waste onto open parcels of land;
- Breaches of landfill wherein hazardous wastes might either get spilled onto open parcels of adjoining land, and/ or sub grade breaches where hazardous wastes and/ or landfill leachate seeps into the subsoil and potentially into the aquifer;
- Spills/ leaks of hazardous wastes during transportation, leakages from trucks, tanks, pipelines, other fixed or mobile storage containers etc.

Impacted soils can lead to indirect impacts to environment including rendering the land not fit for agricultural purposes, serving as a secondary continuous source of contamination to groundwater, serve as a direct exposure pathway to humans who may come into contact with the contaminated soil media (most significantly children who are most susceptible to health risks).

Soils that are contaminated provide a variety of exposure pathways to various receptors including but not limited to, humans, Livestock, including cattle, poultry, etc. These exposure pathways include, but are not limited to

- Dermal contact with contaminated soils;
- Incidental ingestion of contaminated soils;
- Ingestion of crops that are grown on contaminated soils;
- Inhalation of vapours from the hazardous wastes that are dumped on land

A case example for illustration is where hazardous wastes have been surreptitiously dumped outside plant facilities, and in close vicinity to residential areas. Children will get in touch with this contaminated media, farmers may harvest crops on these parcels of land, all of which cause an immediate exposure of the hazardous (which may be carcinogenic, mutagenic etc.) constituents to human receptors. In India, there are no comprehensive soil quality regulations and standards to ascertain the severity of contamination, however, internationally adopted standards can be applied selectively for setting screening and response levels for contaminated soils in the country.

The table below illustrates the typical source-pathway-receptor linkages that may exist in the event of soil being contamination by hazardous wastes.

Potential Source (primary and secondary)	Potential Exposure Pathways	Receptors		
		Human receptors Including Residents and Workers within the impacted area	Human receptors outside the impacted site, exposed indirectly	Indirect receptors such as cattle, flora, fauna
Soil impacted by Hazardous waste	Incidental ingestion or Dermal contact	✓	X	✓
	Inhalation of dust	✓	X	✓
	Inhalation of volatiles	✓	✓	✓

The impact on soil may further have associated impact on groundwater, surface water, flora, fauna, etc. which has been discussed in subsequent sections below.

3.2 Impacts on Groundwater

Aquifers being the source of vital element of life (drinking water), tend to be the most vulnerable and sensitive natural resources.

Typical examples of how aquifers are impacted with hazardous wastes include, but are not limited to:

- Leaching of contaminants from hazardous wastes dumped onto open parcels of land;
- Leaching of contaminants from hazardous waste storage tanks or leaking underground storage tanks;
- Leaching of contaminants from landfills that are leaking below ground;
- Reverse injection of liquid hazardous waste into deep injection wells;
- Leaching of contaminants from underground leaking pipelines carrying liquid hazardous waste

Typically for aquifers to get contaminated, overlying soils will tend to be contaminated first. Therefore, soil and groundwater contamination often occur simultaneously and are therefore assessed at the same time.

Contaminated aquifers provide a variety of exposure pathways to various receptors, including but not limited to, most importantly Humans, Livestock, including cattle, poultry, flora, fauna etc. These pathways include, but are not limited to

- Dermal contact with contaminated groundwater;
- Ingestion of contaminated groundwater by humans;
- Ingestion of contaminated groundwater by livestock and its potential bio-accumulation in the food chain;
- Ingestion of crops that are irrigated with contaminated groundwater;

Once a groundwater resource (aquifer) is contaminated, the contamination will migrate and spread in the direction of flow of the local/ regional groundwater. If not addressed early enough, and if the source of contamination is allowed to exist, large areas (regional scale) of the aquifer can easily get contaminated, thereby impacting various facets of life in a much larger area.

3.3 Impacts on Surface Water

Surface waters are a common affected natural resource due to illegal disposal or improper handling of hazardous wastes. Surface water, are a highly sensitive receptor in the Indian context (used for bathing purposes, washing purposes, irrigation purposes, in some cases drinking purposes etc.). As mentioned above, surface water bodies in India are used for a multitude of reasons by various human and ecological receptors, and therefore the risk of damage to the environment and human health is very high.

Typical examples of how surface water bodies are impacted with hazardous wastes include, but are not limited to:

- Runoff from hazardous waste dumps entering surface water bodies;
- Discharge of liquid hazardous waste directly into nearby streams or nalla's that ultimately discharge into larger surface water bodies;

Contaminated aquifers provide a variety of exposure pathways to various receptors, including but not limited to, most importantly Humans, Livestock, including cattle, poultry, flora, fauna etc. These pathways include, but are not limited to

- Dermal contact with contaminated surface water;
- Ingestion of contaminated surface water;
- Ingestion of contaminated surface water by livestock and its potential bio-accumulation in the food chain;
- Ingestion of aquatic species that live in contaminated surface waters; etc.

3.4 *Impacts on Human Health*

Hazardous waste spillage may cause direct effects that could potentially have a long term health impact on humans, long term impacts on flora and fauna, etc. Acute effects could include injury due to direct contact with hazardous waste or inhalation of noxious gases emanated from hazardous wastes. Loss of life may occur in rare cases due to improper handling or disposal of highly reactive wastes such as wastes containing reactive cyanide, reactive sulfide, long term exposure to wastes containing carcinogenic constituents, etc.

Indirect impacts on health may occur to human receptors from incidental ingestion of impacted soils (especially by children), consumption of vegetables grown on soil that is contaminated or irrigated with contaminated water, inhalation of vapors that migrate from contaminated soils/ aquifers into basements of buildings, drinking of contaminated groundwater etc

3.5 *Impact on Flora and Fauna (Biodiversity)*

Disposal of hazardous waste on open land may threaten species, populations or endangered ecological communities, or their habitats, known on the site or likely to occur in the locality of the site.

Examples of indirect and direct impacts that are common impacts to biodiversity include clearing/ fragmentation/alteration/destruction of native vegetation and animal habitats, pollution of watercourses and wetlands, sediment, nutrient and pollutant run-off into adjacent vegetation and animal habitats, loss of hollows, nesting and feeding habitats for birds, etc.

Indirect adverse effects on animals may occur from grazing on hazardous waste dumpsites, ingestion of plants grown on contaminated sites, dermal exposure to contaminated ground, drinking of surface water, etc. Contamination in surface water may affect aquatic flora and fauna.

3.6 *Impact on Crops*

Hazardous waste if disposed on crop lands may potentially change the characteristics of the soil being used for agricultural purposes thus resulting in reduction or total loss of yield of the crop and further indirect losses to livelihood. Spills of hazardous substances on land may cause negative impact on plant productivity depending on quantity and type of constituents. For example, Waste oil spills creates anaerobic conditions in the soil, coupled to water logging and acidic metabolites, the result is high accumulation of aluminum and manganese ions, which are toxic to plant growth. Soil contaminated with hazardous waste may affect mineral and organic matter content, and the geochemistry (e.g., the cation exchange capacity, redox properties) and physical properties (e.g., pH, electrical conductivity etc.) in soil.

3.7 *Impact on Property*

Accidental spillage of hazardous wastes may result into damage to the public buildings or private property. Adverse effects may include corrosion of structures/walls due to acid spillage, release of gaseous inside the basements of houses. Fires or explosion in incinerable hazardous waste may cause damage to adjoining properties.

4

ENVIRONMENTAL LIABILITY

Liability losses can be incurred through tort, contractual obligations, or violations of statutes. In addition to these traditional sources of liability, there is a unique legal aspect to environmental liability that makes these risks more difficult to manage. An environmental liability is a legal obligation to make a future expenditure due to the past or ongoing manufacture, use, release or threatened release of a particular substance or other activities that adversely affect the environment or human health. Environmental liability is required to be imposed retroactively with strict liability for clean-up costs as per the provisions under environmental protection Acts and Rules notified thereof.

The environmental liability is applicable for the actual environmental damages or alleged releases of pollutants that makes the responsible party obligated to pay for environmental remediation expenses. Environmental liabilities refer to the cleanup obligations and may also refer to potential for fines, penalties for violations of environmental laws.

Environmental liabilities arise from a variety of sources. A detailed list of environmental liabilities would be very lengthy; however, focusing on the environmental liabilities arising from handling and disposal of hazardous wastes, the following are the broad categories of environmental liabilities;

- Compliance obligations related to environmental regulations and Act/Rules that apply for generation, handling, storage, transportation, disposal etc. of hazardous wastes;
- Remediation obligations (existing and future) related to soil/groundwater/surface water contamination or air pollution that pose an environmental risk or potential risk to human health;
- Obligations to compensate the third parties for personal injury, property damage, and economic loss;
- Obligations to pay punitive damages for paying fines/penalties for gross negligence and criminal penalty for statutory or regulatory non-compliance; and
- Obligations to pay for natural resource damages.

The liabilities are applicable to the occupier, transporter, importer of hazardous waste or operator of a facility, as the case may be, referred as responsible party in this document. The liabilities for damages caused to the environment or third party arising due to improper handling, storage, transportation, disposal etc. of hazardous wastes as per the provisions under Rule 25(1) of Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008 have broadly been classified into the following:

- a) Liability for taking up immediate measures
- b) Liability for assessment of contamination
- c) Liability for remediation of contaminated sites
- d) Liability to pay for natural resource damages and compensation to the third parties for personal injury, property damage, and economic loss (i.e. compensation liability).

The principle of strict liability shall be exercised on the responsible party while implementing environment damage liabilities. Strict liability is the imposition of liability on the responsible party without finding a fault (such as negligence or tortious intent). In cases where two or more persons are liable in respect of same liability, the principle of "joint and several liability" shall be imposed. Under joint and several liability, a claimant may pursue an obligation against any one party as if they were jointly liable and it becomes responsibility of the defendants to sort out their respective proportions of liability and payment.

The obligations to pay punitive damages for paying fines/penalties for gross negligence and criminal penalty for statutory or regulatory non-compliance of the provisions under HWMH&TM) Rules, 2008 have been discussed under chapter "Enforcement of Penalty" of this document.

4.1 Liability for taking up immediate Emergency Response Plan Measures

The most possible scenarios that may occur while handling or disposal of hazardous waste are listed below.

- i. Fire due to inflammable nature of hazardous wastes
- ii. Explosion due to improper handling of hazardous waste
- iii. Incompatible nature of waste, noxious, corrosive, toxic, poisonous, flammable and/ or fire takes place
- iv. Leakages of hazardous gases from hazardous waste due to improper operation and / or installation problems
- v. Spillages due to failure of piping systems (pipes, pumps, flanges, couplings, hoses, and valves) in handling of hazardous wastes
- vi. Leakages or spillages due to external corrosion and structural failure of transporting or storage system (including landfills)
- vii. Spills and overfills due to manual error
- viii. Leaks or spillages during pumping of liquids or gases from truck or rail car to a storage tank or vice versa
- ix. Spillages due to road accidents of trucks or tankers carrying hazardous waste
- x. Illegal dumping insider outside the facilities of industries
- xi. Spills or leakages due to flooding of hazardous waste containment
- xii. Spills or leakages or fire due to hazardous material shifting
- xiii. Spills/ leakages or fire due to other technical problems
- xiv. Improper storage and disposal of hazardous waste

All occupier, transporter, operator or importer of hazardous waste, as the case may be, are liable for taking up immediate emergency response measures in the event of spillage, improper disposal, fire or mishandling of hazardous waste. The main objective of the emergency response measures is to secure immediate human & environmental safety and contain/control further spillage or release of hazardous waste or release of fumes/gases. Each occupier, transporter, operator or importer of hazardous waste, as the case may be, shall, therefore, develop their own Emergency Response Plan (ERP) in this regard for all

potential spillage/release/fire scenarios, which may vary case to case. Requisite basic safety equipment/ Personal Protective Equipment shall be made available at the site/transportation vehicle and concerned persons shall be trained in implementing ERP. Mock drill shall also be performed time to time.

As discussed above, the ERP may vary from one case to another. However, an ERP should address procedures for dealing with emergency situations and shall comprise the following, but not limited to:

- Containing and controlling incidents so as to minimise the effects and to limit danger to persons, the environment and property;
- Implementing the measures necessary to protect persons and the environment;
- Description of the actions which should be taken to control the conditions at events and to limit their consequences, including a description of the safety equipment and resources available;
- Arrangements for training staff in the duties they will be expected to perform;
- Arrangements for informing concerned authorities and emergency services; and
- Arrangements for providing assistance with off-site mitigatory action.

Detailed instructions shall be prescribed for evacuation, removal of the waste/contaminated substances to safe place, stabilisation, dilution to safe condition etc., wherever applicable. The ERP should be simple and straightforward, flexible and achieve necessary compliance with legislative requirements. Furthermore separate on-site and off-site ERP should be prepared.

Upon incidence, the responsible party shall immediately report the accident in the prescribed Form 14 along with relevant information to the concerned SPCB/PCC. The said Form 14 is given at Annexure III. Further, (i) the officer-in-charge of emergency or disaster relief operation of the district or other region of the state or Union territory specified by whatever designation by the Government of the said State or Union territory, and in whose jurisdiction the industry, process or operation is located; and (ii) the statutory authorities or agencies specified in column 3 in relation to places mentioned in column 2 against thereof of the Annexure I of this document, as applicable; shall also be intimated the fact of such occurrence or apprehension of such occurrence. Fire department, Police department, Hospitals etc. shall also be informed by the responsible party depending upon type of incidence and the emergency phone numbers of such shall be identified and be made available to the concerned person and emergency response team.

Removal of substance to safe place

The emergency spill control procedure should include the following key sections:

- Spills involving hazardous waste should first be contained to prevent spread of the material to other areas. This may involve the use of temporary diking, sand bags, dry sand, earth or proprietary booms / absorbent pads etc.;
- Wherever possible the waste/contaminated substances should be rendered safe by treating with appropriate chemicals (refer to stabilisation / dilution to safe condition given in succeeding paragraph);
- Waste/contaminated substances in a fine dusty form should not be cleared up by dry brushing. Vacuum cleaners should be used in preference, and for toxic materials one conforming to type H (BS 5415) should be used;
- Treated waste/contaminated substances should be absorbed onto inert carrier material to allow

the material to be cleared up and removed to a safe place for disposal or further treatment as appropriate;

- Waste should not be allowed to accumulate. A regular and frequent waste removal procedure should be adopted.

Stabilisation / dilution to safe condition

Once the hazardous waste has been contained to prevent spread of the material to other areas, the waste/contaminated substances should be treated wherever possible to render it safe. Acidic and alkaline may be treated with appropriate neutralising agents. Due to the differing properties/characteristics of the various categories of hazardous waste, an appropriate treatment strategy with suitable chemicals should be established in each case. For example, highly concentrated spent acid bath will fume when spilled so prior to neutralisation the spill may be diluted with a water spray. However, such dilution shall be carried out preventing spread of diluted waste and emphasising minimal waste generation. Waste specific neutralizing substances/foam should readily be available, as part of the ERP.

Storage and Disposal of spilled waste/ treated waste/contaminated substances/contaminated water

Accumulation of spilled waste/ treated waste/contaminated substances/contaminated water shall not be allowed at the site for long periods. Arrangement shall be made to transport such wastes to secured storage facilities and transferring the same to authorised/permitted treatment and disposal facilities like common hazardous waste treatment, storage and disposal facilities for hazardous wastes or common effluent treatment plant. Inside an industry premise, an incidence may lead to abnormal loading on the effluent treatment plant/common treatment, storage and disposal facilities and in any such situation, the operators of such facilities are reported with suitable information so that appropriate arrangements/preparations can be adopted by them.

Initial Sampling

The responsible party shall carry out sampling of hazardous waste indulged in the incident and spilled/spread waste at various suitable locations for analysis to identify constituents of concern. Samples of soil, surface water, sediment, ground water at appropriate locations, as the case may be, shall also be carried out which shall help in identifying impact. Wherever applicable, air quality monitoring shall also be carried out in upwind, down wind and source area. Responsible party shall submit a report on immediate response taken by them to SPCBs/PCCs within 48 hours of completion of immediate response measures.

Illegal dumping

In case of illegal dumping, the Regional offices of concerned SPCBs/PCC of a State/UT shall be made nodal agencies for inspection of incident sites, reporting to the officer-in-charge of emergency or disaster relief operation, Fire department, Police department, Hospitals etc. depending upon type of incidence. For this purpose, each SPCB shall identify a response team for each Regional Office and impart necessary training on dealing with the situations. Each regional office of SPCB shall maintain a minimum inventory of safety gadgets, spillage containing material & equipment, sampling tools etc or arrangement of an agency for dealing with such situations at any given time.

4.2 Liability for Assessment of Contamination

Note: For de-minimis environmental release situations (specifically, very small and localised spillages of hazardous wastes, cases of improper disposal of very small quantities of hazardous waste or minor fires involving hazardous wastes), wherein the resultant environmental impact or human health risk is deemed to

be very low in the judgement of either the District Magistrate and/ or Regional Officer of State Pollution Control Board, the Responsible Party may be held liable to take up only the immediate emergency response measures and if the same is completed in a satisfactory manner, may be exempted from undertaking detailed assessment or remediation works. It may be noted that the operative principle in all such situations shall be the potential for environmental impact or risk to human health and not simply the quantity of waste involved. As a starting point for further defining the de-minimis release criteria, it may be assumed that wherein the resultant environmental impact or human health risk is deemed to be very low in the judgement of District Magistrate and/ or Regional Officer of State Pollution Control Board, a release (accidental, negligent or otherwise) not exceeding 50 Litres of a liquid hazardous waste or 200 Kilograms of a solid hazardous waste may not necessarily trigger a requirement to undertake detailed assessments or remediation works. However, these criteria should be considered on a site specific basis, taking into consideration the type of contaminant (for example, the toxicity and exposure of waste), depth to groundwater table, sensitive receptors in the vicinity of the spill/ dump etc. It shall be considered that following the emergency response undertaken by the Responsible Party (specifically, very small and localised spillages of hazardous wastes, cases of improper disposal of very small quantities of hazardous waste or minor fires involving hazardous wastes), there shall still be a need to undertake a validation assessment to confirm that the entire contaminated mass has been removed and that natural resources (Soil, surface water and groundwater) are not impacted. In the event that the validation assessment indicates residual contamination in any of the environmental matrices, exceeding the nominated screening criteria (in the absence of an Indian specific criteria, alternative accepted criteria such as the Dutch Standards, Canadian Standards and/ or USEPA standards may be used), then the Responsible Party shall be held liable to undertake further assessment of contamination and remediation (if warranted) of the impacted area.

Example: A truck that is transporting hazardous wastes in bags, accidentally drops a bag on the side of the highway. The authorities may consider case by case, that such small incidents (not exceeding the above mentioned trigger criteria), may only require an emergency response (i. e. pick up the wastes and the underlying soils and transport to the TSDF). However, it shall remain the responsibility of the Responsible Party to document and satisfy the regulatory authorities (SPCB/ PCC's) that the underlying soils and/ or other environmental media are not contaminated.

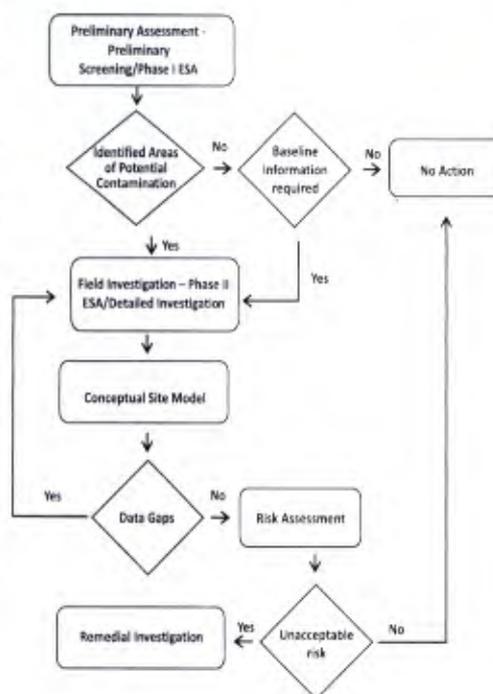
For events involving significant release of hazardous wastes into the environment, the following guidance shall be implemented by the Responsible Party:

- (i) Upon occurrence of an incident, the Responsible Party shall initiate immediate response measures to minimize the environmental impacts as per the guidance laid down in Section 4.1 of this document.
- (ii) The Responsible Party is liable to undertake environmental site assessment to characterise the extent of contamination. Such investigations shall be undertaken by engaging consultant(s) or organization having relevant experience. The said investigations shall also include risk to receptors and based on risk assessment study, various remedial plans shall be outlined.
- (iii) A typical flow chart that may be considered in assessing whether a subject site is contributing to contamination of natural resources and posing a potential risk to the environment and human receptors is provided below.

- (iv) The responsible party shall engage a well-established and experienced professional/organisation to undertake Phase-I and Phase-II environmental site assessment, as given in subsequent paragraphs. As far as possible, the site assessment shall be carried out in line with locally applicable or – preferably – internationally accepted standards, like ASTM methods. The consultant shall have experience in the concerned industrial process or facility operations in which the incidence is reported.

Some of the key parameters that dictate the level of assessment are given below:

- Geology;
- Contaminant or Chemical of Concern;
- Carcinogenic or non-carcinogenic;
- Single contaminant (e.g., Chromium VI) or multiple contaminants (e.g., Chromium VI, Lead and Mercury), single class of contaminants (metals) or multiple class of contaminants (Metals, Benzene, Toluene and Polynuclear Aromatic Hydrocarbons);
- Impacted matrix (only soil, only groundwater, soil & groundwater, sediments, surface water, and combinations thereof);
- Current and future land use (industrial, commercial, agricultural, residential and combinations thereof);
- Offsite migration of contamination or localised to onsite impacts;
- Impacted receptors (drinking water receptors, agricultural fields, marine waters etc., and combinations thereof);
- Impacted media volumes;
- Duration of contamination;
- Free phase liquids in the case of volatile organic compounds and total petroleum hydrocarbons;



It is evident from the list above and the various potential combinations which make each site unique, initial investigation and assessment is of utmost importance and serve as a foundation for all further actions, penalties, remedial actions to be undertaken, liabilities to be assessed etc.

Phase I Environmental Site Assessment (ESA I)

The responsible party shall submit a Phase I Soil and Groundwater assessment report to the concerned SPCB/PCC within four (04) weeks from date of occurrence of the incidence. This Phase-I assessment report shall provide a description of the incident, land-use, geological and hydrogeological characterization and identify the potential for soil and/or groundwater contamination. This assessment includes limited sampling

and analysis of soil, groundwater and/or surface water samples to identify constituents of concern. Phase-I assessment shall include review of the following aspects;

- Relevant Permits and licenses issued to or held by the Responsible Party
- Site layout plans on suitable maps
- Details type of land use at which the incident occurred including historical use of the land
- Site vicinity/neighbours which may have active or suffer passive impact
- Site situation geographic (including climate conditions, surface waters, geology, hydrology, groundwater flow etc.)
- Cadastral information and ownership documents
- Details of surface water drainage, sewerage and nearby water bodies. Present and former underground structures, including sewers, drains, interceptors and storm water pipes.
- Impacts on air quality and discharge of effluent from incident site
- Presence of nearby wetlands
- Incident report (fires, spills, etc. due to hazardous waste handling)
- Historical maps, plans, photographs
- Records pertaining to generation, storage, transportation or handling of hazardous wastes
- Waste Management practices currently and in the past
- Details of site management, technical staff, employment history of persons involved in handling or management of hazardous wastes
- Neighbours and owners of adjacent properties, if relevant
- The location of the site in relation to sensitive receptors which could drive remedial liabilities shall be identified. Examples include potable water supplies, surface water bodies, sensitive ecosystems (i.e. wetlands), and residential housing location

All analysis of constituent parameters shall be analysed by laboratories accredited under EPA/NABL for those parameters.

In case, the ESA I report reveals non-exceedance of the nominated screening criteria (in the absence of an Indian specific criteria, alternative accepted criteria such as the Dutch Standards, Canadian Standards and/or USEPA standards may be used), then Phase II Environmental Site Assessment may not be required and neither risk assessment or remediation is warranted. However, decision on the same shall be taken by the respective SPCB/PCC of their own or constituting an expert committee thereof, wherein samples taken by the SPCB/PCC during the spill, leakages etc. shall also be taken into consideration.

Phase II Environmental Site Assessment (ESA II)

The purpose of a Phase II environmental site assessment is to build on ESA I findings by collecting soil, groundwater, surface water and sediment samples and chemical analysis data from Areas of Concern (AOCs) identified in the ESA I in order to determine if impacts are present that could pose a risk to human

health and the environment. The ESA II will also identify costs for obtaining ultimate goal to determine liabilities associated with remediation.

The exact number of intrusive soil and groundwater sampling points will be related to the size of the site, the findings from the ESA I and the overall potential for environmental risk. As a minimum, a ESA II shall include the following objectives, or scope of work items:

- Assessment of potential releases of hazardous waste and impact from such releases. Requisite sampling and analysis of soil, surface water, ground water etc., as applicable, shall be carried out in this regard.
- Media specific (soil, groundwater, surface water and sediment) analytical data shall be collected and analysed in an overall framework of identifying risks and potential pathways and receptors – i.e., direct contact and inhalation pathways for soil and groundwater, ingestion of groundwater, degradation of sensitive ecologies and acute risks (for example potential for spontaneous ignition or explosive decomposition) of hazardous constituents. Soil and groundwater sampling locations should be chosen not only to detect contaminated source areas but also to account for risk pathways toward identified receptors.
- Groundwater flow directions shall be derived and documented for the site, if impacts are known or suspected for groundwater. Both upstream (i.e. background) and downstream (i.e. leaving the site) groundwater quality shall be documented.
- Analysis of soil and groundwater samples shall utilize generally acceptable laboratory techniques (an appropriately certified lab) and include the suite of constituents (which consists of a comprehensive analysis of several groups or classes of constituents such as, but not limited to Metals, volatile organic compounds, semi-volatile organic compounds, petroleum hydrocarbons) for analysis that have been utilized on site particularly if these constituents could pose as a risk driver for damage to the environment and/ or human health.
- Analytical techniques should have method detection limits that are at least, lower than concentrations that could pose a risk (i.e. lower than screening values, intervention values etc.).
- All intrusive work should also include a Health and Safety Plan to ensure that safe practices are followed by personnel in the field, and a plan for dealing with emergencies is documented before any field work is initiated.
- Soil samples should be collected from the surface and from the vadose zone (i.e. above the water table). Screening techniques might be used to focus a subset of samples for laboratory analysis, thereby minimizing a large number of samples for broad analytical suites (i.e. PID screening, headspace analysis, use of NAPL indicator dyes, visual and olfactory observations, etc.).
- Groundwater samples should be collected from different depths to account for potential impacts in different aquifers and/or stratigraphic horizons. Well construction (whether temporary or permanent) should be consistent with the chosen standards and biased vertically to account for the presence of non-aqueous phase liquids if they are suspected (i.e. floating Light NAPLs or sinking Dense NAPLs).

The responsible party shall submit site assessment plan for ESA II along with the estimated cost for review/ approval by SPCB/PCC. The responsible party shall proceed for ESA II as per the approval from the concerned

SPCB/PCC followed by risk assessment and, as required, remediation plan.

Risk Assessment

Risk based approach for arriving at site-specific target or clean-up levels for an intended land use (which shall be decided by SPCBs/PCCs) shall be adopted. Assessment of human health risk is necessary to support the decision on arriving at site specific target levels for remediation.

Risk Assessment provides an evaluation of the potential threat to human health and the environment. It provides the basis for determining whether or not remedial action is necessary and the justification for performing remedial actions.

A tiered approach to Risk Assessment should be undertaken:

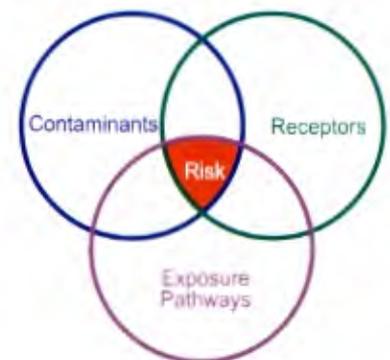
- a) **Generic Quantitative Risk Assessment (Tier 1 Risk Assessment)** – Risk assessment is carried out after ESA II using generic assessment criteria based on local, regional or national screening criteria, international criterion such as Dutch intervention values or US EPA Regional Screening Level.
- b) **Site-specific Quantitative Risk Assessment (Tier 2 Risk Assessment)** – A site specific assessment criteria shall be developed.

The major components of Risk Assessment are summarized below:

Contaminants – The first step in the Risk Assessment is to identify the type and constituent of concerns (COCs) present at the site as the level of risk posed by COCs is a function of type of contaminants, their impact on human health and environment, toxicity and their concentration at a site.

Receptors – The sensitive receptors to which the contamination at the site can reach are identified through receptor survey. Examples of receptors considered in the risk assessment include people (local residents, industrial employee, agricultural worker etc.), animals (cattle), properties (school, hospital etc.), water bodies (groundwater, surface water, etc.).

Exposure Pathways – The various pathways through which the contamination at the site can reach the identified sensitive receptors are determined through developing the Conceptual Site Model.



Components of Risk assessment

The responsible party shall submit their assessment report including ESA I and II reports, along with risk assessment report and, wherever applicable, remediation plan specifying remedial alternatives and selected remedial technologies, proposed Site Specific Targets Levels (SSTL) indicating remedial costs in executing remedial plan for approval of SPCBs/PCCs.

It is imperative that any assessment/ investigations undertaken by the responsible party should have a formal report with third party analytical reports. Any reports should also be reviewed and finally approved by SPCB/PCC or a third party auditor appointed by SPCB/PCC having expertise on the same.

4.3 Liability for Remediation of Contaminated Sites

Having completed the environmental site assessment (ESA I and II) and risk assessment, as above, the Responsible Party is also liable to undertake remediation activity, as applicable. With regard to selection

and implementation of remediation activity, the Responsible Party shall submit to SPCBs/PCCs a detailed report based on ESA I and ESA II along with risk assessment report, remediation plan specifying most applicable remedial technology to bring the site-specific contamination levels down to no risk or an accepted risk level (based on environment/ human health scenario) and estimated costs for remediation. Upon review of the same, the concerned SPCB/PCC shall fix and impose remediation objective and Site Specific Target Levels of requisite constituents of concerns along with intermediate target levels of each of the constituent vis-à-vis time schedule so as to monitor the progress of remediation in between also. Evaluation and fixation of the same may be carried out by the concerned SPCB/PCC of their own or by constituting Expert Committee thereof. An indicative approach for arriving at an appropriate remediation option is given in the flow sheet in this section.

Once the said remediation plan with site specific target levels is approved by the SPCBs/PCCS, responsible party shall undertake site remediation accordingly.

The key parameters that ultimately dictate the level and costs of remediation activities are same as identified for ESA i.e. ecology, CoCs, number of contaminants, Impact matrix, Current and intended future land use (industrial, commercial, agricultural, residential and combinations thereof), migration of contamination, Impacted receptors, Impacted media volumes, Free phase liquids etc.

4.4 Compensation Liability

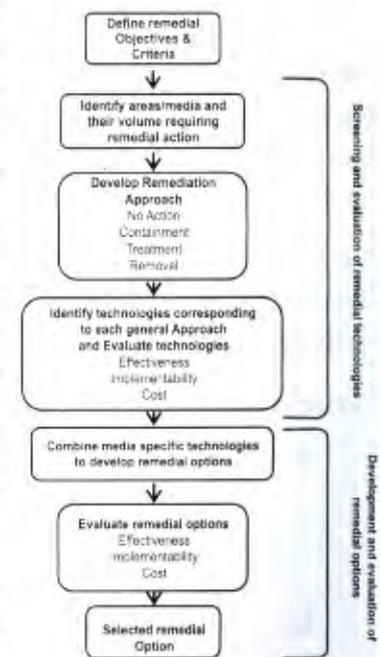
In the cases where handling or disposal of hazardous waste has resulted into contamination that impacted appropriate loss to livelihood, health related effects and impacts or damages to third party etc.; the responsible party is liable to compensate for such losses by paying costs as decided by the District Magistrate or the concerned agency of the State/UT Govt., as the case may be. Compensations shall be applicable in case of loss of property, loss of crop, reduce yield of product, loss of life, hospitalization costs, loss of flora and fauna etc., resulting out of such handling or disposal of hazardous wastes.

The following compensations are envisaged, but not limited to;

- a) Loss of property
- b) Loss of crop
- c) Reduce yield of product
- d) Loss of life
- e) Treatment cost towards human health impacts
- f) Loss of flora and fauna (including cattle and livestock)

Contaminated natural resources (soil, groundwater, surface water and sediments) may have impacts on various receptors, which need to be addressed when dealing with the costs and liabilities that have to be allocated to the responsible party. These may include compensation for Loss of property, loss of crop, reduce yield of product, loss of life and hospitalization treatment cost; cost liability for compensating for damages caused to flora and fauna, etc.

It is not in the scope of this document to prescribe a detailed methodology for assessing aforesaid



compensation liability. However, an indicative list of possible impacts and recovery measures which may help in assessing compensation liability is given in the following table:

Table-1 : Parameters for assessing indirect Compensation Liability

Indirect Impact	Environment	Economy	Society	Potential indirect impact (detail)	Possible recovery measure
Drinking water			×	Deterioration of the drinking water quality (groundwater, surface water) next to the site or in a distance from the site	Provide replacement drinking water supply, i.e. supplying through piping, tankers or provide treatment stations and develop monitoring systems. Potential liability cost depends on the extent of the impact and magnitude of the recovery measures
Ecology	×			Destruction/perturbation of fauna/flora species and habitats	Develop monitoring, protection and conservation systems
Agriculture		×	×	Loss of crops due to contamination or irrigation with contaminated water	Provide monetary compensation for the loss of crops, provide replacement irrigation systems, provide replacement lands
Infrastructures/property	×	×	×	Disturbance or damage of public or private infrastructures (schools, roads, sewage, etc.), interruption of public services	Provide replacement infrastructures, repair damaged infrastructures, build new structures
Resettlement/Relocation			×	Deterioration of the well-being of populations and living conditions due to adverse effects of the contamination	Definitive or temporary resettlement/relocation
Health			×	Disease, allergies, emotional and psychological effect	Provide monetary compensation, health structures and health monitoring program
Injury			×	Burns, toxic inhalation, physical impact by blast waves	Move the victim from the immediate area of fire, explosion, or spill (if this can be done without further injury to the victim or you). Locate nearest emergency eyewash or safety shower. Remove any contaminated clothing from the victim and flush all areas of the body contacted by chemical constituents with water. Provide first aid as appropriate and seek medical attention.
Loss of life			×	Death due to chemical spill or occurrence of fire	Provide monetary compensation, employment to the any one member of the family

Assessment of compensation liability and cost thereof for compensating the loss of livelihood, injury, treatment/hospitalization costs, loss of life, damage to property, damage to crop and reduced yield of crops may be imposed by the District Magistrate or the concerned agency of the State/UT Govt., as the case may be.

5

APPROACH FOR VALUATION OF LIABILITIES (IMMEDIATE RESPONSE, SITE ASSESSMENT & REMEDIATION)

- a) Upon receipt of information and site inspection, SPCBs/PCCs taking cognizance of a suspected impact to the environment and/or potential risk to human health, an immediate response liability of not less than INR 10,00,000/- may be levied upon the responsible party for the incident. This would capture only the cost of immediate response and Phase-I environmental assessment. Allocating a liability of INR 10,00,000/- may not mean that the responsible party has to pay this amount, but that he is liable to pay for this. This approach would be to encourage the responsible party to investigate on his own (through a third party auditor and appropriately validated by the regulator), the impacts to the environment/ human health that have occurred on his account. In case the immediate response is initiated by SPCBs / PCCs, the responsible party has a liability to pay two times the immediate response liability i.e. INR 20,00,000/- and interest as decided by the SPCB/PCC.
- b) SPCBs/PCCs shall also impose legal and financial liability for undertaking ESA II, risk assessment and remediation work.
- c) As described in Section 4.2, the scope of assessment varies largely depending on the constituent; extent of contamination, location, nature of physical setting, etc. and, therefore, it is not possible to derive a simplistic formula for allocating a financial liability for assessment on the responsible party. It is, therefore, recommended that initially, SPCBs/PCCs may include a minimum assessment liability of INR 20,00,000/- (in addition to the immediate response liability) which may be increased up to a maximum of INR 4,50,00,000/- depending on the type and extent of contamination. The indicative cost for assessment and remediation works as given in Table 2 may be referred. Further, in addition to assessment liability, SPCB/PCC may impose the remediation liability based on remediation technology and indicative costs thereof given in Table-2. The responsible party shall submit a bank-guarantee equivalent to the sum of liabilities for the assessment and remediation or for the amount as specified by SPCB/PCC. This however does not include compensatory liabilities that may still be present.
- d) Upon finalization of remediation objective and SSTL, the responsible party may approach SPCBs/ PCCs for deduction of site assessment liabilities from the total liabilities imposed upon him in the form of bank guarantee.
- e) In the event that the responsible party does not undertake any of the above actions, in spite of the SPCBs/PCCs directions, then SPCB shall undertake the immediate response, assessments and remediation work to the desired clean-up levels (in the larger interest of safeguarding the environment, public health and other relevant mandates under Central/State government regulations) and fix the liability for the same by imposing two to three times the costs incurred along with interest, as decided by the SPCB/PCC. This will serve as a deterrent for operators to follow the status quo of their contamination issue, and encourage them to act by themselves. Further, in case the responsible party does not respond, SPCBs/PCCs shall file FIR under Code of Criminal Procedure (CrPC) or approach National Green Tribunal or appropriate courts, as deemed fit, for initiating proceedings and recovery of the said amount from the responsible party along with the interest.

- f) In the event that the responsible party is not traceable, then the SPCBs/PCCs may undertake the immediate response, assessments and remediation on their own or by engaging third party. In case funds are not available, they may approach respective State / UT Government for the same. Further, in such circumstances, FIR may be filed by SPCBs/PCCs under the Code of Criminal Procedure (CrPC) for necessary investigation and for identifying the responsible party and initiate recovery of liability equivalent to three times the cost incurred.
- g) The occupier, transporter, importer or operator of a facility, may insure for an appropriate amount (depending on types of hazardous waste, quantum, possible impacts etc.) with insurance company to meet various environmental damage liabilities including compensation liability in the event of environmental damages due to handling and disposal of disposal of hazardous waste.

5.1 Indicative Cost of liabilities for Site Assessment and Remediation

It is to be noted that in the absence of any detailed database of sites having been assessed and remediated and the associated costs, a simplistic approach is adopted for assessing the cost of liabilities. Therefore the cost range will vary widely from case to case.

Liability for remediation cannot be calculated or judged without undertaking preliminary assessments and investigations. However, in order to aid the SPCBs/PCCs in setting a baseline yardstick with which they can hold the operator financially accountable, based on current Indian scenarios, a reasonable and worst case likely costs (or liability) estimations are possible. It is expected that the initial assessments and liability allocations, may be large, varying and at times inaccurate. Once a database of such liabilities is created, with more data, the ability to allocate these costs/ liabilities more precisely will increase. As a guidance tool and for indicative purposes, in order to assist the SPCB/ PCC's, a very broad order of magnitude cost matrix for allocating direct liability under some common Indian Hazardous Waste release scenarios has been presented in Table 2. It is emphasized that these costs are indicative in nature, will vary on a case to case basis, between different States, for different type of wastes, site physical setting, etc.

Table 2: Indicative cost for Site Assessment and Remediation

Scenario (onsite and offsite)	Site Assessment/ Risk Assessment		Remediation	
	Cost of liability (INR)	Notes	Cost of liability (INR)	Notes
Landfill breach and release of hazardous waste into environment	20,00,000 to 15,000,000	Costs can vary depending on volume of breach, whether the breach is above ground surface or below ground surface, whether the groundwater resources have been contaminated etc. Costs can vary in relation to the quantity of waste released, type of wastes, etc.	1,0000,000 to 250,000,000 and higher	Low range is applicable for basic excavation of above ground wastes and high range is applicable for situations where breach has occurred below ground contaminating groundwater resources. These complex situations of below ground breach can further be complicated and costly depending on the type of contaminant leaching into the groundwater, the sensitive receptors using that groundwater resource etc.

Scenario (onsite and offsite)	Site Assessment/ Risk Assessment		Remediation	
	Cost of liability (INR)	Notes	Cost of liability (INR)	Notes
Spillage of liquid hazardous waste due to transportation incident, including pipeline failures, spillage from drums, tanks etc also included	20,00,000 to 22,500,000	Costs can vary depending on what type of environmental receptors are located in the immediate spill vicinity (lake, river, stream, shallow potable groundwater aquifer, flora/ fauna, human receptors, etc.)	10000,000 to 200,000,000 and higher	Low costs may be applicable to sites where the groundwater table is very deep and the overlying strata is confining (example thick clay layer, competent rock with no weathering or fractures etc.). High costs may be applicable where the liquid hazardous waste immediately finds it to sensitive receptors including groundwater resources, surface water bodies used by humans, flora and fauna, etc.
Dumping of hazardous waste on open grounds without secondary containment	20,00,000 to 35,000,000	Costs will vary from a small dump (not exceeding 400 kg) to a large dump covering more than 100 m ² spatial extent (not considering the vertical depth). Costs will be higher for sites where groundwater table is shallow, where contaminants are carcinogenic, etc.	10000,000 to 250,000,000 and above.	
Costs less than 10,000,000 may be applicable to small volumes of less than 1 ton and immediate lifting and transportation to TSDF and not residual waste further contaminating the subsurface	Low costs may be applicable to sites where the groundwater table is very deep and the overlying strata is confining (example thick clay layer, competent rock with no weathering or fractures, etc.). High costs may be applicable where the liquid hazardous waste immediately finds it to sensitive receptors including groundwater resources, surface water bodies used by humans, flora and fauna, etc.			

Scenario (onsite and offsite)	Site Assessment/ Risk Assessment		Remediation	
	Cost of liability (INR)	Notes	Cost of liability (INR)	Notes
Improper handling and storage of hazardous waste	10,00,000 to 10,000,000	Low costs are applicable for small spatial impacts (less than 10,000 m ²), whereas higher costs are for larger spatial impacts (greater than 10,000 m ²). Costs will also vary depending upon the local site settings, geology, hydrogeology, etc.	5,000,000 to 75,000,000 and higher	Low costs may be applicable to sites where the groundwater table is very deep and the overlying strata is confining (example thick clay layer, competent rock with no weathering or fractures, etc). High costs may be applicable where the liquid hazardous waste immediately finds it to sensitive receptors including groundwater resources, surface water bodies used by humans, flora and fauna, etc. Costs are also dependent on the type of contaminant etc.
Fire incident leading to spillage of hazardous waste/ contaminated runoff water	20,00,000 to 10,000,000		10000,000 to 75,000,000 and higher	Low costs may be applicable to sites where the water runoff is low and contact with hazardous wastes has been minimal. Higher costs would be applicable to situations where large volume of contaminated runoff has migrated offsite, spills of hazardous wastes have occurred due to the fire, etc. The costs will also get magnified based on the local site settings, depth to groundwater etc.

Note: The factors that should be accounted for in estimating remediation liabilities based on the remediation technologies are given at Annexure-V. This Annexure may be referred by SPCBs/PCCs to estimate remediation liability.

6

ENFORCEMENT OF PENALTY

The Rule 25(2) of the Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008 stipulates that *"The occupier and the operator of the facility shall be liable to pay financial penalties as levied for any violation of the provisions under these rules by the State Pollution Control Board with the prior approval of the Central pollution Control Board."*

Section 15 of the Environment (Protection) Act, 1986, lays down provision for penalty for contravention of the provisions of the Act and the Rules, orders and directions issued thereunder. The same is reproduced as below:

15. PENALTY FOR CONTRAVENTION OF THE PROVISIONS OF THE ACT AND THE RULES, ORDERS AND DIRECTIONS

- (1) *Whoever fails to comply with or contravenes any of the provisions of this Act, or the rules made or orders or directions issued thereunder, shall, in respect of each such failure or contravention, be punishable with imprisonment for a term which may extend to five years with fine which may extend to one lakh rupees, or with both, and in case the failure or contravention continues, with additional fine which may extend to five thousand rupees for every day during which such failure or contravention continues after the conviction for the first such failure or contravention.*
- (2) *If the failure or contravention referred to in sub-section (1) continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term which may extend to seven years.*

In view of above, financial penalty to be levied by the concerned SPCB/PCC for any violation may be limited to maximum of one lakh rupees per provision violated so as to ensure that levying of financial penalty remain within the brief of the Environment (Protection) Act, 1986, since the said Rules have been notified under the Environment (Protection) Act, 1986. However, non-compliance may attract violation of one or several provisions of the said Rules and thus the total financial penalty amount may be arrived by adding up number of provisions violated. Further, additional fine up to Rupees five thousand rupees for every day may also be imposed in case of failure continues by the responsible party beyond period by which remedial/corrective measures would have been implemented as suggested by the SPCB/PCC.

SPCBs/PCCs shall, therefore, send proposals of imposing financial penalty to be levied on defaulting party, as above, to CPCB for their approval. Such proposals shall include background and details of each and every violation of various provisions laid down under the Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008, and financial penalty for each of such violations including the additional fine for continuing failures, wherever applicable. CPCB, upon examining the violations, may approve the same.

SPCB/PCC shall also ensure that case is filed in the court for invoking criminal case as stipulated under section 15 of the Environment (Protection) Act, 1986, especially in cases of gross violations of the provisions of the said Act/Rules.

7

ROLES OF STATE POLLUTION CONTROL BOARD / POLLUTION CONTROL COMMITTEE

- (i) Every SPCB/PCC shall constitute an in-house team which may be named as "Hazardous Waste Incident Response Team" comprising officials having expertise in the field of hazardous waste management, soil, hydrogeology, water pollution, air pollution, and sampling/analysis. The objective of the aforesaid team shall be to collect all relevant data/samples/information which shall help in estimating/implementing environmental damage liability and financial penalty. In case adequate analysis facility is not available with SPCB/PCC, an arrangement may be made with EPA/NABL accredited laboratory for this purpose to handle such situation at any given time. The team shall develop its own protocol for immediate response assigning role of each of the officials/laboratory personnel etc. like team leader, sampling equipment mobilization (such as hand held X-Ray Fluorescence (XRF) tool for metals, hand held Photo-Ionization Detector (PID) for VOCs, soil sampling tools, oil-water interface probe, water level meter, etc.), field reconnaissance, data/information collection, etc. The cost incurred in this regard shall be recovered from the responsible party.
- (ii) In cases of receiving information about any illegal disposal of hazardous waste, that has occurred but not been reported by the responsible party, the concerned SPCBs/PCCs shall act immediately on receipt of such information as per the protocol identified in Section 4.1 of these guidelines.
- (iii) The following data/samples/information (including but not limited to) may be collected by the said Hazardous Waste Incident Response Team:
- Basic information of incident as per format given in Annexure IV;
 - Background and possible causes of incident;
 - Estimated quantification of each of the affected media such as land, surface water, ground water, air quality, human population, flora, fauna, third party properties, etc. in terms of area (m²), volume (m³), numbers, percentage etc., as applicable and possible. In case air quality is affected, the same may be reported based on physical observation in terms of area and population under direct impact, physical observation on air quality etc.;
 - Collection of hazardous waste samples (minimum 03 samples at different location) indulged in the incident for characterisation and analysis of parameters of concern (w.r.t. impacts/contamination to land/surface water/ ground water etc.) based on preliminary investigation;
 - Minimum 03 samples each of soil, surface water, sediment, ground water, ambient air etc., as the case may be, at different locations of affected areas as per the judgement of the Hazardous Waste Incident Response Team. However, more number of samples may be required depending on nature of incidence/site conditions;
 - Sampling of atleast one sample in unaffected area/up-gradient, as the case may be, of soil, surface water, sediment, ground water, ambient air etc. for comparison of contamination/impacts and estimating liability;

- (g) Total number of provisions of the HWM Rules, 2008 and conditions of authorisation granted by the concerned SPCB/PCC that violated in the said incident with elaboration of each of such violations. The same shall help in estimating/ implementing the financial penalty, and;
- (h) Note on emergency measures taken by responsible party to alleviate the effect of incident.

More samples/data/information may require to be taken depending upon nature of incidence and site conditions.

- (iv) The Hazardous Waste Incident Response Team shall also co-ordinate with the officer-in-charge of emergency or disaster relief operation of the district or other region of a state or Union territory specified by whatever designation by the Government of the said State or Union territory, and in whose jurisdiction the industry, process or operation is located. It shall also co-ordinate with the statutory authorities or agencies, as the case may be, specified in column 3 in relation to places mentioned in column 2 against thereof of the Annexure I of this guidelines.
- (v) Based on the report of the Hazardous Waste Incident Response Team and accident reporting (submitted by the responsible party), the SPCB/PCC shall ensure that the immediate response measures are taken by the responsible party to contain further environmental damage. In case the said measures are not being taken by the responsible party adequately, SPCB/PCC shall undertake such measures on its own or engaging a third party and two times the amount incurred in this regard along with interest shall be recovered from the responsible party as immediate response liability (as part of direct liability).
- (vi) The SPCB/PCC shall obtain bank guarantee, equivalent to estimated assessment (including risk assessment) and remediation cost liabilities or for the amount as decided by SPCB/PCC, from the responsible party as early as possible but not later than three weeks from day of the incidence. The cost in this regard may be estimated separately (i.e. for assessment and remediation work) by the SPCB/PCC on case to case basis. However, an indicative cost in this regard is given in Section 5.1 which may be helpful.
- (vii) SPCB/PCC shall ensure that ESA I report is received from the responsible party within four weeks of the incidence and shall impose ESA II activity, wherever required, also taking into account of data/information/sampling results provided by the Hazardous Waste Incident Response Team. Upon receipt of sampling (ESA II) and assessment plan by the responsible party along with the estimated cost, the SPCB/PCC shall examine the same. SPCB/PCC may approve the same by modifying or adding to the scope of the said sampling and assessment plan, if required.

The approval of the aforesaid plan, including risk assessment, shall be accorded by the SPCB/PCC to the responsible party and the work of assessment thereof shall be monitored by the SPCB/PCC.

Upon receipt of the assessment report, which shall also comprise of risk assessment, proposed remediation objective and remediation plans along with the cost and time schedule, SPCB/PCC shall examine the same and set remediation objective/standard. If required, SPCB/PCC may ask the responsible party to submit any alternate remediation plan along with cost which has not been given in the said assessment report. The approved remediation objective/standard shall be executed by the responsible party which shall be monitored by SPCB/PCC as per the time schedules and phase wise concentration targets thereof as declared in the assessment report so as to meet the said remediation objective/standard. During such monitoring, few sampling and analysis thereof shall also be carried out by the SPCB/PCC for validation.

Upon satisfactory completion of sampling and assessment work and acceptance of the same along with

finalization of remediation objective and remediation plan and cost thereof, the SPCB/PCC may return the part of bank guarantee retaining the said remediation cost. In case submitted bank guarantee value is lesser than estimated remediation cost or the amount specified by SPCB/PCC, the responsible party shall submit additional bank guarantee within a stipulated time.

- (viii) Upon satisfactory completion and validation of the remediation objective and standards (SSTL), SPCB/PCC may return the remaining bank guarantee submitted by the responsible party.
- (ix) For examining the assessment report, setting remediation objectives/standards, remediation plan and closure reports, SPCB/PCC may carry out the same of their own or constituting an expert committee thereof. Further, to monitor work of assessment and remediation, SPCB may engage a consultant having experience in the field of contaminated site remediation. The cost incurred in this regard shall be paid to SPCB/PCC by the responsible party.
- (x) In case the responsible party fails to undertake timely assessment and remediation work, SPCB/PCC shall carry out the same of its own or by engaging a consultant/contractor. In such case, SPCB/PCC shall impose liability equivalent to two times the cost incurred on the same to the responsible party. The said liability amount shall be recovered with interest as applicable. Further, in case the responsible party does not respond, SPCBs/PCCs shall file FIR under Code of Criminal Procedure (CrPC) or approach National Green Tribunal or appropriate courts, as deemed fit, for initiating proceedings and recovery of the said amount from the responsible party.
- (xi) In the event that the responsible party is not traceable, then the SPCBs/PCCs may undertake the immediate response, assessments and remediation on their own or by engaging third party. In case funds are not available, they may approach respective State / UT Government for the same. Further, in such circumstances, FIR may be filed by SPCBs/PCCs under the Code of Criminal Procedure (CrPC) for necessary investigation and for identifying the responsible party and initiate recovery of liability equivalent to three times the cost incurred.
- (xii) For imposing rate of interest on liability amount to be recovered from the date when the same is raised, SPCB/PCC shall ensure that such rate of interest is fixed by the Government through order in compliance with the provisions stipulated under section 9 of the Environment (Protection) Act, 1986.
- (xiii) SPCB/PCC shall impose following conditions in the existing and new authorisation issued to the occupier, transporter, importer or operator of a facility under the Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008:
 - (a) Evolve and implement Emergency Response Plan (ERP) for hazardous wastes for which this authorisation is being granted considering all site specific possible scenarios such as spillages, leakages, fire etc. and their possible impacts. Mock drill in this regard shall be carried out at regular interval of time; and
 - (b) Provisions outlined in these guidelines shall be followed by the unit/person, whom authorisation is hereby granted.

A declaration on non-judicial stamp paper shall be obtained from authorised person/unit that they will follow all provisions including the scope of submitting bank guarantee stipulated in this guidelines in the

event of spillage, leakage or fire while handling hazardous waste by them. All new authorisations shall be granted only after obtaining the said declaration on non-judicial stamp paper.

For ease in implementing environmental damage liability on responsible party, all SPCBs/PCCs may pursue with respective Government for delegation of power to the SPCB/PCC for recovering amount, as mentioned in this document, as land revenue from the responsible party in case immediate response/ site assessment/ risk assessment/ remediation work, as applicable, is carried out by the SPCB/PCC.

Annexure I

The Environment (Protection) Rules, 1986

[SCHEDULE V]

(See rule 12)

S.No	Place at which the discharge of any environmental Pollutant in excess of prescribed standards occurs or is apprehended to occur	Authorities or agencies to be intimated	Appointed under
	2	3	4
1	Factories as defined under the factories Act, 1948		
	(a) owned by Central Government and engaged in carrying out the purposes of the Atomic Energy Act; 1962;	I. the atomic energy regulatory Board (AERB)	The Atomic Energy Act, 1962
		II. The Ministry of Environment and forests.	
	(b) Factories other than those mentioned in paragraph (a)	I. The chief Inspector of Factories.	
2.	Mine as defined under the Mines and Minerals (Regulation and Development) Act, 1957	II. The Inspector of Factories having local jurisdiction.	The Factories Act, 1948.
		III. The Ministry of Environment and Forests.	-do-
3.	Port as defined under the Indian Ports Act, 1908	I. Conservator of Ports	The Indian Ports Act, 1908
		II. The Ministry of Environment & Forests	-
4.	Plantations as defined under the Plantations Labour Act, 1951	I. The Chief Inspector of Plantations.	The Plantations Labour Act, 1951
		II. The Inspector of Plantation having local jurisdiction.	-
		III. the Ministry of Environment & Forests.	-

5.	Motor Vehicles as defined under the Motor Vehicles Act, 1939	I. State Transport Authority	The Motor Vehicles Act, 1939
		II. Regional Transport Authority having regional jurisdiction.	
		III. The Ministry of Environment & Forests	
6.	Ship as defined under the Merchant Shipping Act, 1958	I. Director General of Shipping	The Merchant Shipping Act, 1958
		II. Surveyor having jurisdiction.	-do-
		III. The Ministry of Environment & Forests.	

1 Schedule II relating to rule 12 re-numbered as Schedule V vide G.S.R. 422 (E) dated 19.05.1993, published in the Gazette No. 174 dated 19.05.1993.

Annexure II

Schedule II [See Sections 15(4) and 17(1)] Heads under Which Compensation or Relief for Damage May Be Claimed

- a. Death;
- b. Permanent, temporary, total or partial disability or other injury or sickness;
- c. Loss of wages due to total or partial disability or permanent or temporary disability;
- d. Medical expenses incurred for treatment of injuries or sickness;
- e. Damages to private property;
- f. Expenses incurred by the Government or any local authority in providing relief, aid and rehabilitation to the affected persons;
- g. Expenses incurred by the Government for any administrative or legal action or to cope with any harm or damage, including compensation for environmental degradation and restoration of the quality of environment;
- h. Loss to the Government or local authority arising out of, or connected with, the activity causing any damage;
- i. Claims on account of any harm, damage or destruction to the fauna including milch and draught animals and aquatic fauna;
- j. Claims on account of any harm, damage or destruction to flora including aquatic flora, crops, vegetables, trees and orchards;
- k. Claims including cost of restoration on account of any harm or damage to environment including pollution of soil, air, water, land and eco-systems;
- l. Loss and destruction of any property other than private property;
- m. Loss of business or employment or both;
- n. Any other claim arising out of, or connected with, any activity of handling of hazardous substance.

Annexure III

Form 14

(See rule 24)

FORMAT OF ACCIDENT REPORT

[To be submitted by the occupier or operator of a facility and the transporter to the SPCB/PCC]

1. The date and time of the accident. :
2. Sequence of events leading to accident. :
3. The hazardous waste involvement in accident. :
4. The date for assessing the effects of the accident on health or the environment.
5. The emergency measures taken. :
6. The steps taken to alleviate the effects of accidents. :
7. The steps taken to prevent the recurrence of such an accident. :

Place: **Signature:**

Date: **Designation**

Annexure IV

ENVIRONMENT POLLUTION INCIDENT REPORT

INCIDENT REPORTED BY (NAME): CONTACT No.:	ORGANISATION/ AGENCY:
INCIDENT LOCATION:	
RESPONSIBLE PARTY'S NAME:	PHONE & ADDRESS:
HAZARDOUS WASTE INVOLVED	
FORM: SOLID <input type="checkbox"/> TARRY <input type="checkbox"/> SLURRY <input type="checkbox"/> LIQUID <input type="checkbox"/> OTHERS(Please Specify) <input type="text"/>	
QUANTITY OF HAZARDOUS WASTE INDULGED:	
CHARACTERISTICS OF HAZARDOUS WASTE INDULGED:	
EXPLOSIVE <input type="checkbox"/> CORROSIVE <input type="checkbox"/> TOXIC <input type="checkbox"/> FLAMMABLE <input type="checkbox"/>	
OTHER(Please Specify) <input type="text"/>	
SOURCE OF HAZARDOUS WASTE INDULGED:	
NAME OF HAZARDOUS WASTE INDULGED (INCLUDING COMMON & TRADE NAME):	
CATEGORY AS PER THE SCHEDULE OF THE HWM RULES, 2008:	
DATE/TIME INCIDENT OCCURRED:	
TYPE OF INCIDENT: FIRE <input type="checkbox"/> ACCIDENT <input type="checkbox"/> SPILLAGES <input type="checkbox"/> BREACH OF CONTAINMENT <input type="checkbox"/>	
OTHER(Please Specify) <input type="text"/>	
DURATION OF TIME:	

MEDIA POSSIBLY AFFECTED: AIR GROUND WATER SOIL SURFACE WATER

SUSPECTED LOSS OF AQUATIC LIFE: Yes No

TOP SOIL CHARACTERISTIC IN THE AREA BASED ON PHYSICAL APPEARANCE (silty, clayey, sandy, etc.) :

AQUIFER CHARACTERISTICS: LOCAL POPULATION IN THE VICINITY:

SITUATION DESCRIPTION: Below points may be answered, if possible, in addition to any other information that might be available)

GEOLOGY TYPE: (Sand, Clay, Silt, Weathered rock, fracture rock, competent rock)

DEPTH TO GROUNDWATER: (M BELOW GROUND SURFACE)

GROUNDWATER USAGE IN VICINITY: (Drinking, agricultural, bathing, washing, industrial use)

GROUNDWATER VULNERABILITY : (Likelihood of contaminants reaching the groundwater)

GROUNDWATER SENSITIVITY: (potential significance of any impact)

OTHER WATER RESOURCES VULNERABILITY & SENSITIVITY:

RECEPTORS IN VICINITY: (Residential, industrial, agricultural, marine life, wetlands, etc)

CONDITION

LEAKAGE LEAKING FIRE ACCIDENT SPILLAGES OVERFILL ILLEGAL DUMP

ANY OTHER, PLEASE SPECIFY:

EVACUATION CONDUCTED: Yes No IF YES, AT WHAT DISTANCE:

HUMAN INJURIES: Yes No IF YES, HOW MANY AND WHAT TYPE:

HUMAN CASUALTY: Yes No IF YES, HOW MANY:

EXTENT OF SPILLAGE/FIRE/ACCIDENT:

POSSIBLE SCENARIOS

FIRE DUE TO INFLAMMABLE NATURE OF HAZARDOUS WASTE EXPLOSION DUE TO IMPROPER HANDLING

FIRE/EXPLOSION DUE TO INCOMPATIBLE NATURE OF HAZARDOUS WASTE LEAKAGES/SPILLAGES DUE TO CORROSION

SPILLAGES DUE TO FAILURE OF PIPING SYSTEMS LEAKAGES/SPILLAGES DURING TRANSFER OF HAZARDOUS WASTES

SPILLS/OVERFILLS DUE TO MANUAL ERROR SPILLS/FIRE DUE TO ACCIDENTS ILLEGAL DUMPING
 SPILLS/LEAKAGES DUE TO FLOODING OF HAZARDOUS WASTE CONTAINMENTS IMPROPER STORAGE/DISPOSAL
 SPILLS/LEAKAGES/FIRE DUE TO TECHNICAL ERROR LEAKAGE OF HAZARDOUS WASTE LANDFILL PRESENT ON-SITE

ANY OTHER, PLEASE SPECIFY:

ANY KNOWN OR ANTICIPATED RISK:

COMMENTS/REMARKS:

DATE:	TIME:	INITIALS:	HAZARDOUS CLASS:

NAME & DESIGNATION OF THE OFFICIAL REPORTING THE INCIDENT:

TELEPHONE #:

SIGNATURE:

Annexure V

Factors to be accounted for estimating liability for remediation of soil, groundwater, surface water and sediment contaminate sites based on the remediation technologies

Note: Considering large number of parameters that ultimately dictate the liability and costs for clean-up to the recommended levels, it is currently not possible to generate a complete table with exact costs. Each case/ site is unique in itself as each site has very different key critical parameters, each of which has a different weightage in terms of gravity or impact.

Sr No	Remediation Technologies	Applicability	Assumptions	Comments
In- Situ Biological Treatments for Soil and Sediment Contaminated Sites				
1.	<p>Bioventing</p> <p>Oxygen is delivered to contaminated unsaturated soils by forced air movement (either extraction or injection of air) to increase oxygen concentrations and stimulate biodegradation.</p>	<p>Bioventing techniques have been successfully used to remediate soils contaminated by petroleum hydrocarbons, nonchlorinated solvents, some pesticides, wood preservatives, and other organic chemicals.</p>	<p>Key Cost Drivers</p> <p>1) Surface area is the primary cost driver</p> <p>Impacts the number of injection/extraction wells that are installed. The number of wells installed (and cost) increases with surface area.</p> <p>2) Soil containing sand and gravel produced significantly lower costs by reducing the number of injection/extraction wells that needed to be installed.</p> <p>3) Other factors include contaminant type and concentration, soil permeability, well spacing and number, pumping rate, and off-gas treatment. This technology does not require expensive equipment and relatively few personnel are involved in the operation and maintenance of a bioventing system. Periodic maintenance monitoring is conducted.</p>	<p>1. Low degree of Operation & Maintenance (O&M) intensity</p> <p>2. Low degree of capital investment</p> <p>3. High reliability & low maintenance</p> <p>4. Low degree of general costs</p>

Sr No	Remediation Technologies	Applicability	Assumptions	Comments
2.	<p>Bioremediation</p> <p>The activity of naturally occurring microbes is stimulated by circulating water-based solutions through contaminated soils to enhance in situ biological degradation of organic contaminants or immobilization of inorganic contaminants. Nutrients, oxygen, or other amendments may be used to enhance bioremediation and contaminant desorption from subsurface materials.</p>	<p>Bioremediation techniques have been successfully used to remediate soils, sludges, and ground water contaminated with petroleum hydrocarbons, solvents, pesticides, wood preservatives, and other organic chemicals</p>	<p>Factors that affect cost include the soil type and chemistry, type and quantity of amendments used, and type and extent of contamination</p>	<ol style="list-style-type: none"> 1. High degree of Operation & Maintenance (O&M) intensity 2. Average degree of capital investment 3. Average reliability & low maintenance 4. Low degree of general costs
3.	<p>Phytoremediation</p> <p>Phytoremediation is a process that uses plants to remove, transfer, stabilize, and destroy contaminants in soil and sediment. Contaminants may be either organic or inorganic.</p>	<p>Phytoremediation may be applicable for the remediation of metals, pesticides, solvents, explosives, crude oil, PAHs, and landfill leachates</p>	<p>Key Cost Drivers</p> <ol style="list-style-type: none"> 1) Scale of effort 2) Density of sampling <p>Area of contamination is the primary cost driver</p> <p>Primary cost driver of sampling cost; may be directed by regulatory requirements.</p>	<ol style="list-style-type: none"> 1. Low degree of Operation & Maintenance (O&M) intensity 2. Low degree of capital investment 3. Low reliability & low maintenance 4. Low degree of general costs
n- Situ Physical/Chemical Treatments for Soil and Sediment Contaminated Sites				
4.	<p>Chemical Oxidation</p> <p>Oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.</p>		<p>Data can be gathered from Chemical Oxidation for Groundwater</p>	<ol style="list-style-type: none"> 1. High degree of Operation & Maintenance (O&M) intensity 2. Average degree of capital investment 3. Average reliability & low maintenance 4. Average degree of general costs

Sr No	Remediation Technologies	Applicability	Assumptions	Comments
5.	<p>Soil Vapor Extraction</p> <p>Vacuum is applied through extraction wells to create a pressure/concentration gradient that induces gas-phase volatiles to be removed from soil through extraction wells. This technology also is known as in situ soil venting, in situ volatilization, enhanced volatilization, or soil vacuum extraction.</p>	<p>The target contaminant groups for in situ SVE are VOCs and some fuels. The technology is typically applicable only to volatile compounds with a Henry's law constant greater than 0.01 or a vapor pressure greater than 0.5 mm Hg (0.02 inches Hg). Other factors, such as the moisture content, organic content, and air permeability of the soil, will also affect in situ SVE's effectiveness.</p>	<p>Key Cost Drivers</p> <p>1) Economy of Scale</p> <p>Quantity of material treated has a large impact</p> <p>2) Soil Type</p> <p>Based on the number of wells required</p> <p>3) Can be radically different if no airflow treatment is required</p> <p>4) The cost of in situ SVE is site-specific, depending on the size of the site, the nature and amount of contamination, and the hydrogeological setting (EPA, July 1989). These factors affect the number of wells, the blower capacity and vacuum level required, and the length of time required to remediate the site. A requirement for off-gas treatment adds significantly to the cost. Water is also frequently extracted during the process and usually requires treatment prior to disposal, further adding to the cost.</p>	<p>1. High degree of Operation & Maintenance (O&M) intensity</p> <p>2. Average degree of capital investment</p> <p>3. High reliability & low maintenance</p> <p>4. Low degree of general costs</p>
6.	<p>Solidification/Stabilization</p> <p>Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).</p>	<p>The target contaminant group for in situ Solidification/Stabilization is generally inorganics (including radionuclides).</p>	<p>Costs for Solidification/Stabilization processes vary widely according to materials or reagents used, their availability, project size, and chemical nature of contaminants (e.g., types and concentration levels for shallow applications). The major factor driving the selection process beyond basic waste compatibility is the availability of suitable reagents</p>	<p>1. Average degree of Operation & Maintenance (O&M) intensity</p> <p>2. High degree of capital investment</p> <p>3. High reliability & low maintenance</p> <p>4. Low degree of general costs</p>
In- Situ Thermal Treatment for Soil and Sediment Contaminated Sites				

Sr No	Remediation Technologies	Applicability	Assumptions	Comments
7.	<p>Thermal Treatment</p> <p>Steam/hot air injection or electrical resistance/ electromagnetic/fiber optic/radio frequency heating is used to increase the volatilization rate of semi-volatiles and facilitate extraction.</p>	<p>High moisture content is a limitation of standard SVE that thermally enhanced SVE may help overcome. Heating, especially radio frequency heating and electrical resistance heating can improve air flow in high moisture soils by evaporating water. The system is designed to treat SVOCs but will consequently treat VOCs. Thermally enhanced SVE technologies also are effective in treating some pesticides and fuels, depending on the temperatures achieved by the system.</p>	<p>Key Cost Drivers</p> <p>1) Soil Type</p> <p>The primary cost driver is soil type, which once again determines soil permeability. For thermal treatment, soils of lower permeability (silts/silty-clays) are less expensive to remediate as they require less gas flow.</p> <p>2) Depth to Top/Thickness of Contaminated Area</p> <p>The secondary cost drivers are depth to the top and thickness of the contaminated zone. A deeper and thicker region of contaminated soils has higher remedial costs</p>	<ol style="list-style-type: none"> 1. High degree of Operation & Maintenance (O&M) intensity 2. High degree of capital investment 3. High reliability & low maintenance 4. Average degree of general costs
Ex-Situ Biological Treatment for Soil and Sediment Contaminated Sites (assuming excavation)				
8.	<p>Biopiles</p> <p>Excavated soils are mixed with soil amendments and placed in aboveground enclosures. It is an aerated static pile composting process in which compost is formed into piles and aerated with blowers or vacuum pumps</p>	<p>Biopile treatment has been applied to treatment of nonhalogenated VOCs and fuel hydrocarbons. Halogenated VOCs, SVOCs, and pesticides also can be treated, but the process effectiveness will vary and may be applicable only to some compounds within these contaminant groups.</p>	<p>Costs are dependent on the contaminant, procedure to be used, need for additional pre- and post-treatment, and need for air emission control equipment. Biopiles are relatively simple and require few personnel for operation and maintenance.</p>	<ol style="list-style-type: none"> 1. Low degree of Operation & Maintenance (O&M) intensity 2. Low degree of capital investment 3. High reliability & low maintenance 4. Low degree of general costs
Ex-Situ Physical/Chemical Treatments for Soil and Sediment Contaminated Sites (assuming excavation)				
9.	<p>Chemical Reduction/Oxidation</p> <p>Reduction/oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.</p>			

Sr No	Remediation Technologies	Applicability	Assumptions	Comments
10.	<p>Soil Washing</p> <p>Contaminants sorbed onto fine soil particles are separated from bulk soil in an aqueous-based system on the basis of particle size. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and heavy metals.</p>	<p>The target contaminant groups for soil washing are SVOCs, fuels, and heavy metals. The technology can be used on selected VOCs and pesticides. The technology offers the ability for recovery of metals and can clean a wide range of organic and inorganic contaminants from coarse-grained soils.</p>	<p>Key Cost Drivers</p> <p>1) Economy of Scale</p> <p>Quantity of material treated has a large impact</p> <p>2) Processor speed</p> <p>Also depends on the amount of waste being processed</p>	<p>1. High degree of Operation & Maintenance (O&M) intensity</p> <p>2. High degree of capital investment</p> <p>3. High reliability & low maintenance</p> <p>4. Average degree of general costs</p>
11.	<p>Solidification/ Stabilization</p> <p>Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).</p>	<p>The target contaminant group for ex situ S/S is inorganics, including radionuclides. Most S/S technologies have limited effectiveness against organics and pesticides, except vitrification which destroys most organic contaminants</p>	<p>Key Cost Drivers</p> <p>1) Type of Waste</p> <p>Moisture content in the sludge drives up costs compared to solid</p> <p>Contaminant concentration and type determine the amount of reagents added to the waste to attain the required treatment standards</p> <p>2) Size of the mobile s/s system</p> <p>Choosing the correct size mobile s/s system to adequately handle the throughput of waste volume</p>	<p>1. Average degree of Operation & Maintenance (O&M) intensity</p> <p>2. High degree of capital investment</p> <p>3. High reliability & low maintenance</p> <p>4. Low degree of general costs</p>
Ex- Situ Thermal Treatments for Soil and Sediment Contaminated Sites (assuming excavation)				
12.	<p>Incineration</p> <p>High temperatures, 870-1,200 °C, are used to combust (in the presence of oxygen) organic constituents in hazardous wastes</p>	<p>Incineration is used to remediate soils contaminated with explosives and hazardous wastes, particularly chlorinated hydrocarbons, PCBs, and dioxins.</p>	<p>Key Cost Drivers</p> <p>1) Type of waste</p> <p>Debris < Soil < Sludge < Sediment</p> <p>2) Quantity</p> <p>There is only a INR 18000 - INR 24000 gap in cost for quantities ranging from 5,000 - 100,000.</p>	<p>1. High degree of Operation & Maintenance (O&M) intensity</p> <p>2. High degree of capital investment</p> <p>3. Average reliability & low maintenance</p> <p>4. High degree of general costs</p>

Sr No	Remediation Technologies	Applicability	Assumptions	Comments
13	<p>Thermal Desorption</p> <p>Wastes are heated to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to the gas treatment system.</p>	<p>Thermal desorption systems have varying degrees of effectiveness against the full spectrum of organic contaminants.</p> <p>The target contaminant groups for Low Temperature Thermal Desorption (LTTD) systems are nonhalogenated VOCs and fuels. The technology can be used to treat SVOCs at reduced effectiveness.</p> <p>The target contaminants for High Temperature Thermal Desorption (HTTD) are SVOCs, PAHs, PCBs, and pesticides; however, VOCs and fuels also may be treated, but treatment may be less cost-effective.</p>	<p>Key Cost Drivers</p> <p>1) Economy of Scale</p> <p>Quantity of material treated has a large impact</p> <p>2)Moisture content</p> <p>Increases required heat input (increasing fuel costs)</p>	<p>1. High degree of Operation & Maintenance (O&M) intensity</p> <p>2. High degree of capital investment</p> <p>3. Average reliability & low maintenance</p> <p>4. Average degree of general costs</p>
Containment for Soil and Sediment Contaminated Sites				
14.	<p>Landfill Cap</p> <p>Landfill caps are used for contaminant source control.</p>	<p>Landfill Caps may be temporary or final. Temporary caps can be installed before final closure to minimize generation of leachate until a better remedy is selected. They are usually used to minimize infiltration when the underlying waste mass is undergoing settling. A more stable base will thus be provided for the final cover, reducing the cost of the post-closure maintenance. Landfill caps also may be applied to waste masses that are so large that other treatment is impractical.</p>	<p>Landfill caps are generally the least expensive way to manage the human health and ecological risks effectively</p>	<p>1. Average degree of Operation & Maintenance (O&M) intensity</p> <p>2. High degree of capital investment</p> <p>3. High reliability & low maintenance</p> <p>4. Low degree of general costs</p>
Other Treatment for Soil and Sediment Contaminated Sites				
15.	<p>Excavation, Retrieval, and Off-Site Disposal</p> <p>Contaminated material is removed and transported to permitted off-site treatment and disposal facilities. Pretreatment may be required.</p>	<p>Excavation and off-site disposal is applicable to the complete range of contaminant groups with no particular target group. Excavation and off-site by relocating the waste to a different (and presumably safer) site</p>	<p>These estimates include excavation/removal, transportation, and disposal at a RCRA permitted facility. Additional cost of treatment at disposal facility may also be required. Excavation and off-site disposal is a relatively simple</p>	<p>1. Low degree of Operation & Maintenance (O&M) intensity</p> <p>2. Low degree of capital investment</p> <p>3. High reliability & low maintenance</p>

Sr No	Remediation Technologies	Applicability	Assumptions	Comments
			process, with proven procedures. It is a labor-intensive practice with little potential for further automation. Additional costs may include soil characterization and treatment to meet land ban requirements.	
In-Situ Biological Treatments for Groundwater and Surface Water Contaminated Sites				
16.	<p>Bioremediation</p> <p>The rate of bioremediation of organic contaminants by microbes is enhanced by increasing the concentration of electron acceptors and nutrients in ground water, surface water, and leachate. Oxygen is the main electron acceptor for aerobic bioremediation. Nitrate serves as an alternative electron acceptor under anoxic conditions.</p>	<p>Target contaminants for enhanced biodegradation processes are nonhalogenated VOCs, nonhalogenated SVOCs, and fuels. Pesticides also should have limited treatability. Nitrate enhancement has primarily been used to remediate ground water contaminated by BTEX.</p>	<p>Variables affecting the cost are the nature and depth of the contaminants, use of bioaugmentation and/or hydrogen peroxide or nitrate addition, and ground water pumping rates.</p>	<ol style="list-style-type: none"> 1. High degree of Operation & Maintenance (O&M) intensity 2. Average degree of capital investment 3. Average reliability & low maintenance 4. Low degree of general costs
17.	<p>Monitored Natural Attenuation</p> <p>Natural subsurface processes—such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials—are allowed to reduce contaminant concentrations to acceptable levels.</p>	<p>Target contaminants for natural attenuation are VOCs and SVOCs and fuel hydrocarbons. Fuel and halogenated VOCs are commonly evaluated for natural attenuation. Pesticides also can be allowed to naturally attenuate, but the process may be less effective and may be applicable to only some compounds within the group.</p>	<p>There are costs for modeling and monitoring. Modeling determines whether natural attenuation is a feasible remedial alternative. The most significant costs associated with natural attenuation are most often due to monitoring requirements, which include two major parts - site characterization and performance monitoring. Site characterization determines the extent of contamination and contaminant degradation rates. Performance monitoring tracks down contaminants migration and degradation and cleanup status</p>	<ol style="list-style-type: none"> 1. High degree of Operation & Maintenance (O&M) intensity 2. Average degree of capital investment 3. Average reliability & low maintenance 4. Low degree of general costs

Sr No	Remediation Technologies	Applicability	Assumptions	Comments
18.	<p>Phytoremediation</p> <p>Phytoremediation is a set of processes that uses plants to remove, transfer, stabilize and destroy organic/inorganic contamination in ground water, surface water, and leachate.</p>	Phytoremediation can be used to clean up organic contaminants from surface water, ground water, leachate, and municipal and industrial wastewater.	<p>Key Cost Drivers</p> <p>1) Scale of effort</p> <p>Area of contamination is the primary cost driver</p> <p>2) Tree size (maturity) is the secondary cost driver.</p>	<p>1. Low degree of Operation & Maintenance (O&M) intensity</p> <p>2. Low degree of capital investment</p> <p>3. Low reliability & low maintenance</p> <p>4. Low degree of general costs</p>
In-Situ Physical/Chemical Treatments for Groundwater and Surface Water Contaminated Sites				
19.	<p>Air Sparging</p> <p>Air is injected into saturated matrices to remove contaminants through volatilization</p>	The target contaminant groups for air sparging are VOCs and fuels.	<p>Key Cost Drivers</p> <p>1) Surface area (contaminant orientation)</p> <p>Surface area of contamination is the primary cost driver, and directly affects the quantity of air sparge points.</p> <p>2) Depth to Contamination</p> <p>Depth is the secondary cost driver. Cost increases with depth since it impacts the drilling costs.</p>	<p>1. Low degree of Operation & Maintenance (O&M) intensity</p> <p>2. Low degree of capital investment</p> <p>3. High reliability & low maintenance</p> <p>4. Low degree of general costs</p>
20.	<p>Bioslurping</p> <p>Bioslurping combines the two remedial approaches of bioventing and vacuum-enhanced free-product recovery. Bioventing stimulates the aerobic bioremediation of hydrocarbon-contaminated soils. Vacuum-enhanced free-product recovery extracts LNAPLs from the capillary fringe and the water table.</p>	Bioslurping can be successfully used to remediate soils contaminated by petroleum hydrocarbons. It is a cost-effective in situ remedial technology that simultaneously accomplishes LNAPL removal and soil remediation in the vadose zone. Bioslurping is also applicable at sites with a deep ground water table (>30ft.).		<p>1. Low degree of Operation & Maintenance (O&M) intensity</p> <p>2. Low degree of capital investment</p> <p>3. Average reliability & low maintenance</p> <p>4. Low degree of general costs</p>
21.	<p>Chemical Oxidation</p> <p>Oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.</p>		<p>Key Cost Drivers</p> <p>1) Economy of Scale</p> <p>Quantity of material treated has a large impact</p> <p>2) Moisture content in waste</p> <p>Slight increase in costs between soil and sludge</p> <p>3) Contaminant concentrations</p> <p>High influent and low effluent concentrations will drive up costs</p>	<p>1. High degree of Operation & Maintenance (O&M) intensity</p> <p>2. Average degree of capital investment</p> <p>3. Average reliability & low maintenance</p> <p>4. Average degree of general costs</p>

Sr No	Remediation Technologies	Applicability	Assumptions	Comments
22.	<p>Dual Phase Extraction</p> <p>A high vacuum system is applied to simultaneously remove various combinations of contaminated ground water, separate-phase petroleum product, and hydrocarbon vapor from the subsurface.</p>	<p>The target contaminant groups for dual phase extraction are VOCs and fuels (e.g., LNAPLs). Dual phase vacuum extraction is more effective than SVE for heterogeneous clays and fine sands.</p>	<p>Key Cost Drivers</p> <p>1) Soil Type</p> <p>Soil type determines permeability, which is the primary cost driver. Dual phase extraction works best for permeable sand-silt mixtures. Impermeable (clayey) or excessively permeable (gravel/sand) soils are more recalcitrant.</p> <p>2) Depth to Base of Contamination</p> <p>Depth to the base of contamination is the secondary driver, as an increased thickness and depth of contaminated groundwater increases cost.</p>	<p>1. High degree of Operation & Maintenance (O&M) intensity</p> <p>2. High degree of capital investment</p> <p>3. Average reliability & low maintenance</p> <p>4. Average degree of general costs</p>
23.	<p>In-Well Air Stripping</p> <p>Air is injected into a double screened well, lifting the water in the well and forcing it out the upper screen. Simultaneously, additional water is drawn in the lower screen. Once in the well, some of the VOCs in the contaminated ground water are transferred from the dissolved phase to the vapor phase by air bubbles. The contaminated air rises in the well to the water surface where vapors are drawn off and treated by a soil vapor extraction system.</p>	<p>The target contaminant groups for vacuum vapor extraction are halogenated VOCs, SVOCs, and fuels.</p>	<p>Data Not Available</p>	<p>1. Average degree of Operation & Maintenance (O&M) intensity</p> <p>2. High degree of capital investment</p> <p>3. Average reliability & low maintenance</p> <p>4. Average degree of general costs</p>
24.	<p>Passive/Reactive Treatment Walls</p> <p>These barriers allow the passage of water while causing the degradation or removal of contaminants.</p>	<p>Target contaminant groups for passive treatment walls are VOCs, SVOCs, and inorganics. The technology can be used, but may be less effective, in treating some fuel hydrocarbons.</p>	<p>Key Cost Drivers</p> <p>1) Economy of Scale</p> <p>2) Quantity of material treated has a large impact</p> <p>3) Width of the plume to be treated</p> <ul style="list-style-type: none"> • Choice of supplemental amendments • Additional monitoring required by regulators 	<p>1. Average degree of Operation & Maintenance (O&M) intensity</p> <p>2. High degree of capital investment</p> <p>3. Low reliability & low maintenance</p> <p>4. Average degree of general costs</p>

Sr No	Remediation Technologies	Applicability	Assumptions	Comments
In- Situ Thermal Treatment for Groundwater and Surface Water Contaminated Sites				
25.	<p>Thermal Treatment</p> <p>Steam is forced into an aquifer through injection wells to vaporize volatile and semivolatile contaminants. Vaporized components rise to the unsaturated zone where they are removed by vacuum extraction and then treated.</p>	<p>The target contaminant groups for hot water or steam flushing/stripping are SVOCs and fuels. VOCs also can be treated by this technology, but there are more cost-effective processes for sites contaminated with VOCs.</p>	<p>The most significant factor affecting cost is the time of treatment or treatment rate. With the mobile system, treatment rate is influenced primarily by the soil type, waste type, and on-line efficiency. Cost estimates for this technology are strongly dependent on the treatment rate and range.</p>	<ol style="list-style-type: none"> 1. High degree of Operation & Maintenance (O&M) intensity 2. High degree of capital investment 3. Average reliability & low maintenance 4. Average degree of dependent on the general costs
Ex- Situ Biological Treatment for Groundwater and Surface Water Contaminated Sites				
26.	<p>Constructed Wetlands</p> <p>The constructed wetlands-based treatment technology uses natural geochemical and biological processes inherent in an artificial wetland ecosystem to accumulate and remove metals, explosives, and other contaminants from influent waters.</p>	<p>Constructed wetlands have most commonly been used in wastewater treatment for controlling organic matter; nutrients, such as nitrogen and phosphorus; and suspended sediments.</p>	<p>Data Not Available</p>	<ol style="list-style-type: none"> 1. Average degree of Operation & Maintenance (O&M) intensity 2. High degree of capital investment 3. NA 4. Average degree of general costs
Ex- Situ Physical/Chemical Treatment for Groundwater and Surface Water Contaminated Sites				
27.	<p>Adsorption/Absorption</p> <p>In liquid adsorption, solutes concentrate at the surface of a sorbent, thereby reducing their concentration in the bulk liquid phase.</p>	<p>The target contaminants groups for adsorption/absorption processes are most organic contaminants and selected inorganic contaminants from liquid and gas streams.</p>		<ol style="list-style-type: none"> 1. High degree of Operation & Maintenance (O&M) intensity 2. Average degree of capital investment 3. Average reliability & low maintenance 4. High degree of general costs
28.	<p>Advanced Oxidation Processes</p> <p>Advanced Oxidation Processes including ultraviolet (UV) radiation, ozone, and/or hydrogen peroxide are used to destroy organic contaminants as water flows into a treatment tank. If ozone is used as the oxidizer, an ozone destruction unit is used to treat collected off gases from the treatment tank and downstream units where ozone gas may collect, or escape.</p>	<p>Practically any organic contaminant that is reactive with the hydroxyl radical can potentially be treated.</p>	<p>Factors that influence the cost to implementing UV/oxidation include:</p> <ul style="list-style-type: none"> - Types and concentration of contaminants (as they affect oxidizer selection, oxidizer dosage, UV light intensity, and treatment time). - Degree of contaminant destruction required. - Desired water flow rates. - Requirements for pretreatment and/or post-treatment. 	<ol style="list-style-type: none"> 1. High degree of Operation & Maintenance (O&M) intensity 2. High degree of capital investment 3. Average reliability & low maintenance 4. Average degree of general costs

Sr No	Remediation Technologies	Applicability	Assumptions	Comments
29.	Air Stripping Volatile organics are partitioned from extracted ground water by increasing the surface area of the contaminated water exposed to air. Aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration.	Air stripping is used to separate VOCs from water. It is ineffective for inorganic contaminants. Henry's law constant is used to determine whether air stripping will be effective. Generally, organic compounds with constants greater than 0.01 atmospheres · m ³ /mol are considered amenable to stripping.	Key Cost Drivers • Influent flow rate • Relative contaminant volatility • Off-gas treatment (when necessary)	1. High degree of Operation & Maintenance (O&M) intensity 2. Average degree of capital investment 3. High reliability & low maintenance 4. Low degree of general costs
30.	Granulated Activated Carbon (GAC)/Liquid Phase Carbon Adsorption Ground water is pumped through a series of canisters or columns containing activated carbon to which dissolved organic contaminants adsorb. Periodic replacement or regeneration of saturated carbon is required.	The target contaminant groups for carbon adsorption are hydrocarbons, SVOCs and explosives.	Costs associated with GAC are dependent on wastestream flow rates, type of contaminant, concentration of contaminant, mass loading, required effluent concentration, and site and timing requirements.	1. High degree of Operation & Maintenance (O&M) intensity 2. Average degree of capital investment 3. High reliability & low maintenance 4. Average degree of general costs
31.	Groundwater Pumping/ Pump and Treat Ground water pumping is a component of many pump-and-treat processes, which are some of the most commonly used ground water remediation technologies at contaminated sites.		Cost varies from site to site for ground water pump and treat technology.	1. High degree of Operation & Maintenance (O&M) intensity 2. High degree of capital investment 3. High reliability & low maintenance 4. High degree of general costs
32.	Ion Exchange Ion exchange removes ions from the aqueous phase by exchange with counter ions on the exchange medium.	Ion exchange can remove dissolved metals and radionuclides from aqueous solutions. Other compounds that have been treated include nitrate, ammonia nitrogen, and silicate.	Key cost factors include: -Pretreatment requirements. -Discharge requirements and resin utilization. -Regenerant used and efficiency.	1. High degree of Operation & Maintenance (O&M) intensity 2. High degree of capital investment 3. High reliability & low maintenance 4. Average degree of general costs
33.	Precipitation/ Coagulation/Flocculation This process transforms dissolved contaminants into an insoluble solid, facilitating the contaminant's subsequent removal from the liquid phase by sedimentation or filtration.	Precipitation is used mainly to convert dissolved ionic species into solid-phase particulates that can be removed from the aqueous phase by coagulation and filtration. Remedial application of this technology usually involve removal of dissolved toxic	Key Cost Drivers • No sensitivity analysis possible as only variable is influent flow rate.	1. Average degree of Operation & Maintenance (O&M) intensity 2. High degree of capital investment 3. High reliability & low maintenance 4. Average degree of general costs

Sr No	Remediation Technologies	Applicability	Assumptions	Comments
	The process usually uses pH adjustment, addition of a chemical precipitant, and flocculation.	metals and radionuclides. Depending on the process design, sludges may be amenable to metal recovery		
34.	Separation Separation techniques concentrate contaminated waste water through physical and chemical means.	The ex situ separation process is used mainly as a pretreatment or post-treatment process to remove contaminants from waste water.		<ol style="list-style-type: none"> 1. Average degree of Operation & Maintenance (O&M) intensity 2. High degree of capital investment 3. High reliability & low maintenance 4. High degree of general costs
Containment for Groundwater and Surface Water Contaminated Sites				
35.	Physical Barriers These subsurface barriers consist of vertically excavated trenches filled with slurry. The slurry, usually a mixture of bentonite and water, hydraulically shores the trench to prevent collapse and retards ground water flow.	Slurry walls contain the ground water itself, thus treating no particular target group of contaminants. They are used to contain contaminated ground water, divert contaminated ground water from drinking water intake, divert uncontaminated ground water flow, and/or provide a barrier for the ground water treatment system.	<p>Factors that have the most significant impact on the final cost of soil-bentonite slurry wall installation include:</p> <ul style="list-style-type: none"> -Type, activity, and distribution of contaminants. -Depth, length, and width of wall. -Geological and hydrological characteristics. -Distance from source of materials and equipment. -Requirements for wall protection and maintenance. -Type of slurry and backfill used. -Other site-specific requirements as identified in the initial site assessment (e.g., presence of contaminants or debris). -Planning, permitting, regulatory interaction, and site restoration. 	<ol style="list-style-type: none"> 1. Average degree of Operation & Maintenance (O&M) intensity 2. High degree of capital investment 3. High reliability & low maintenance 4. Low degree of general costs