BEFORE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH, NEW DELHI

M. A. NO.103/2022
IN
ORIGINAL APPLICATION NO.169 OF 2021

IN THE MATTER OF:

H.C. Arora ...Applicant

Versus

State of Punjab & Ors. ...Respondents

N.D.O.H.: 21.03.2024

INDEX

FILED BY:

Babita Kushwaha

(BABITA KUSHWAHA)
Advocate for the Respondent
206, New Lawyers Chambers,
Supreme Court of India
New Delhi-110001
Mb.:9711028819, 23070053
Email:secretarybharat@gmail.com

Date:14.03.2024

BEFORE THE NATIONAL GREEN TRIBUNAL PRINCIPAL BENCH, NEW DELHI

M.A. No. 103/2022
In
Original Application No. 169/2021

IN THE MATTER OF:

H.C. Arora ...Applicant

Versus

State of Punjab & Ors. ...Respondent

REPLY AFFIDAVIT ON BEHALF OF MR. CHANDER SHEKHAR DHAWAN AND MR. SUNIL AHUJA

NOTARY GOVT. OF INDIA
1795

MOST RESPECTFULLY SHOWETH:

I, Chander Shekhar Dhawan, aged about 69 years, S/o Late Shri Gian Chand Dhawan, R/o.101-A, Sarabha Nagar, Ludhiana, and the Pairokar of Sunil Ahuja, the Respondent in the above M.A., presently at Ludhiana, do hereby most solemnly state and affirm as under:

A. That I have perused a copy of the above-mentioned Miscellaneous Application and have understood the contents thereof and in reply thereto I have to state as under.

B. That I am the Respondent in the above titled case and am fully conversant with the facts of the case and am competent and authorized to file the present Reply Affidavit.

05 MAR 2024

C. That each and every contention made in the M.A as filed by the Applicant is hereby denied most emphatically, jointly and severely, unless specifically admitted to herein below.

D. I am filing the reply to the M.A. in terms of the main issues involved and am not filing a detailed para-wise reply. If deemed necessary, by the Hon'ble Tribunal the answering Respondents reserves the right to file a more detailed Counter Affidavit at a later stage.

PRELIMINARY SUBMISSION:-

1. That in the year 1990, M/s Matharu Steel Pvt. Ltd. wanted to set-up a manufacturing facility for H-Acid (Sodium salt) at Village Toori, Tehsil Bhawanigarh, District Sangrur, Punjab on a parcel of land ad measuring approximately 8 acres.

Gurbir Kaur Sehgal
Ludhiana (Pb.)
Reg. No. 17065
Expiry Dt. 19/9/2024

2. The manufacturing facility was not a zero pollution project. The manufacturing facility, it was declared, would generate waste. The waste generation and handling was to be done as per prescribed guidelines/ parameters applicable to the industry. The industry for manufacturing H-Acid comes under Dye and Dye Intermediate Industries mentioned at Serial No. 8 of the Schedule –I of Environment (Protection) Rules, 1986.

3. Thereafter, various approvals/ permissions were applied for and a No Objection Certificate (NOC) dated 09.07.1990 was obtained by the industry from the Punjab Pollution Control Board before the commencement of the manufacturing activity at the facility. The Punjab Pollution Control Board had granted its No Objection Certificate.

4. M/s. Matharu Steel Pvt. Ltd., also applied for and obtained, as per the applicable laws, the licenses under Water Act, 1974, Air Act, 1991 and under the Hazardous Waste Rules, 1999.

5. It is submitted that on 28.03.2003, the Respondents herein purchased the shareholding of M/s. Matharu Steel Pvt. Ltd. as a going concern from Gurcharan Singh Matharu, and his associates, who had been operating the said unit from 1991 till then. It is also submitted that in the agreement entered into between the Respondents and Mr. Gurcharan Singh Matharu for purchase of M/s. Mathura Steel Pvt. Ltd., it had been categorically stated in Clause 11 thereof that any liability relating to the period upto cutoff date 31.03.2003, whether known or unknown shall be on account of Shri Gurcharan Singh Matharu.

6. It is submitted that entire manufacturing activity of the unit from July 1991 and until 28.03.2003 i.e. for almost 14 years was undertaken by the above-said Directors. The Respondent had no role to play in that year as they were not involved in any manner whatsoever.

7. It is thereafter, submitted that on 05.04.2003, the Respondents were appointed as Additional Directors of the M/s Matharu Steel Pvt. Ltd. Subsequently thereto, the manufacturing unit which was being operated in the name and style of Matharu Chemicals was renamed by the Respondents as Mahalaxmi Orgochem Industries.

1795
Gurbir Kaur Sehgal
Ludhiana (Pb.)
Reg. No. 17065
Expiry Dt. 19/9/2024

8. It is submitted that the Respondents carried out the operations of Mahalaxmi Orgochem strictly in accordance with the applicable law and permissions after obtaining all prior approvals/ permissions/ NOCs. No manufacturing activity was carried out by the Respondents

9. In March 2005, the manufacturing activity was shut down by the Respondents and thereafter on 01.05.2005, the Respondents closed the manufacturing unit and did not carry out any manufacturing activity thereafter.

10. It is further submitted that on 05.05.2025, the Respondents informed the PPCB that the unit had been closed by them permanently.

11. It is submitted that the Respondents carried out manufacturing activities only for a very brief period from April 2003 to March 2005 at the unit, after purchasing the same from its previous owners as mentioned in the above paras.

12. It is submitted that during the entire period when the unit was being operated by the Respondents there was no complaint of any nature whatsoever, alleging of any pollution by the manufacturing activity undertaken by the Respondents at the unit.

13. It is further submitted that after closing the factory the Respondents sold the land to one Shri Tara Singh.

14. It is submitted that one Mr. Ashok Kumar, who was the owner and one of directors of Matharu Steel Pvt. Ltd. and also the then owner of a rice mill at a distance less than 100 meter from the land of the company, raised a dispute with the Respondents and demanded that the land of the manufacturing unit should be sold to him, and no one else. In this regard Mr. Ashok Kumar filed a suit before Additional Civil Judge,

6

Senior Division, Sangrur along with an application under Order 39 rule 1 & 2 CPC which application was dismissed by the Court of Additional Civil Judge on 24.02.2007.

15. That on 26.02.2007, an inspection was carried out by PPCB at site of the manufacturing facility and in the said inspection it was noted that no chemical raw material/ product of industry was lying within premises. The hazardous waste had been stored in storage pit in a safe manner. The industry has provided danger sign near the storage pit but the industry has not provided the barbed fencing. However, the work for providing the barbed fencing was under progress.

16. It is submitted that even till 26.02.2007, there was no complaint of any nature of any pollution by the manufacturing activity undertaken by the Respondents at the unit. However, it is clear from the inspection report by the PPCB dated 26.02.2007, all the hazardous waste was being stored in a safe manner and the industry had been dismantled.

17. It is submitted that subsequently on 05.03.2007, after the rejection of the stay application filed by the said Mr. Ashok Kumar, a Public Interest Litigation bearing Civil Writ Petition No. 348/2007 was filed before the Hon'ble High Court of

Punjab and Haryana at Chandigarh, at the behest of the said Mr. Ashok Kumar alleging, albeit wrongly and falsely that pollution has been caused by the operation of the said unit.

18. It is submitted that the petitioners in PIL were neither residing nor carrying out an activity near the land where the unit was situated. It is submitted that the PIL was filed only to harass the Respondents to give in to the demands of the said Ashok Kumar..

19. It is further submitted that the PPCB carried out another inspection on 01.06.2007 and reported as under:-

NOTARY
Gurjit Kaur Sehgal
Ludhiana (Pb.)
Reg. No. 17065
Expiry Dt. 19/9/2024
GOVT. OF INDIA

a) *The industry stands dismantled and electric connection stands disconnected.*

b) *The industry has stored the hazardous waste in hazardous waste storage pit. No raw material/ chemical/ product lying seen in open. The hazardous waste was stored in environmentally sound manner.*

c) *The industry has provided 4 no. borewells at a distance of 6 ft. from storage pit around the storage pit as per map plan (signed), enclosed.*

d) *4 no. samples from borewell has been collected and 2 no. back ground samples i.e., one from the rice mill adjoining to the industry at an about 400 mt distance and other from the premises of Bharat Petrolium on Nabha road at an about 400* *mt from the storage pit. Samples collected were sealed, marked and sent to Shri Ram institute for analysis as per purpose explained above.*

e) *No old/ previous borewell exist within the premises of the industry during visit. Representative of industry stated that there was no borewell for sampling present in the industry when they purchased the industry from the previous owner. He also stated that there was one no. borewell to meet the needs of the industry but the same was dismantled during dismantling the industry by present owner.*"

A true copy of Punjab Pollution Control Board's inspection report dated 01.06.2007 is being annexed hereto and marked as **Annexure R/1.**

20. It is submitted that the Department of Agriculture Punjab University, has also given a report stating therein that the water was fit to be used for the purposes of irrigation.

21. It is submitted that till the year 2007, there was no facility for disposal of Hazardous waste in Punjab. The Waste Management Facility in Punjab became operational only on 03.10.2007. Prior to that the waste had to be stored and managed as per the conditions of the grant of authorization provided by the Punjab Pollution Control Board in terms of which the entire waste product had to be stored category wise

on site but away from the plant operational area, which was being done by the Respondents.

22. That in August 2008, after permission and approval from PPCB, Respondents had disposed of 101.83 MT of waste at the disposal facility of the Punjab Government at Dera Bassi Punjab as pursuant to the Hazardous Waste Rules, 1989, as amended from time to time, the waste was to be disposed of only in disposal facilities as authorized for such purposes.

23. It is submitted that in November, 2009, almost four years after the closure and dismantling of the unit and after the waste had been shifted to the disposal facility, an inspection was carried out by Thapar Centre for Industrial Research and Development in the absence of and without the knowledge of the Respondents. All samples collected by TCIRD were in the absence of the Respondents.

24. It is further submitted that in the year 2010, the company was wound up under the Easy Exit Scheme (EES, 2010).

25. It is submitted that thereafter, in the month of January 2011, TCIRD submitted a report, which was based purely on conjectures and surmises. The Thapar Centre for Industrial Research and Development presumed and imagined that the

waste water was being injected in the ground water, even though there was no evidence or material to establish the same. In fact, when the inspection was done, the land was being used only for cultivation. A true copy of Report dated 04.01.2011 issued by Thapar Centre for Industrial Research and Development is being annexed hereto and marked as <u>**Annexure R/2.**</u>

26. It is further submitted that form the table no.3 and 4 of the report issued by Thapar Centre for Industrial Research and Development, it has been clearly demonstrated that all parameters were within the prescribed permissible limits as per the Bureau of Indian Standards for drinking water. It is pertinent to mention that the water was not being used for drinking but only for irrigation purposes and the standards for the two are not the same. Even if the higher standard applicable for drinking water is taken, the parameters were within the permissible limits.

Reg. No. 17065
Expiry Dt. 19/8/2024

27. It is submitted that the report of Thapar Centre for Industrial Research and Development itself shows that the phenolic compounds were below detectable limits when checked by the APHA, 21 Edn. Colorimetric method which is approved by

IS-10500 of drinking water. However, the Thapar report wrongly mentioned that the minimum detection limit as per the said method was 0.02 mg/l. It is pertinent to mention herein that the method was 0.02 mg/l. It is pertinent to mention herein that the detectable limit of APHA method, which is a quantitative method of measurement, is 0.001 mg/l and not 0.02 mg/l as has been wrongly recorded in Thapar's report.

28. It is submitted that the only basis of concluding that ground water had been contaminated was that by using the FTIR Method, presence of phenolic compounds could be detected which is not an approved standard of test as per IS-10500 of drinking water. The said finding in Thapar's report is absolutely irrelevant inasmuch as contamination or pollution has to be ascertained as per the limits prescribed by the Bureau of Indian Standards and on the basis of the standard tests prescribed by BIS. FTIR Method cannot detect quantitative presence of phenolic compounds and can only be used for qualitative analysis. Admittedly, the test prescribed by BIS for phenolic compound in drinking water is 5530 D Photometric Method, which test had been conducted by Thapar and

NOTARY
Gurbir Kaur Sehgal
Ludhiana (Pb.)
Reg. No. 17065
Expiry Dt. 19/9/2024
GOVT. OF INDIA

presence of phenolic compounds was found to be below detectable limits. This is itself demonstrates that the report issued by TCIRD was based on erroneous presumption and assumption and could not have been relied upon.

29. It is submitted that thereafter, the Respondents had filed their objections to the report filed by Thapar Center for Industrial Research and Development before the High Court disputing and denying the correctness of the report.

30. It is submitted that on 03.12.2011, the Respondents also submitted a report from Eco Laboratories and Consultants Pvt. Ltd. which is a NABL accredited laboratory and which showed the phenolic compounds were below detectable limits by applying APHA, 21stEdn, 2005-5530 testing method which has the testing ability to check at least uptil 0.001 mg/l, being the desirable limit in drinking water. A true copy of Report dated 03.12.2011 issued by Eco Laboratories and Consultants Pvt. Ltd. is being annexed hereto and marked as **Annexure R/3.**

31. It is further submitted that the Respondents also filed and relied upon a report by Professor B.K. Guha (Retired), IIT, New Delhi to show that there was no contamination and no

remedial issued by Professor B.K. Guha. A true copy of Report dated September, 2012 issued by Professor B.K. Guha (Retired), IIT, is being annexed hereto and marked as **Annexure R/4.**

32. It is thereafter, submitted that the High Court by way of an order dated 09.10.2012 culled out the issues/questions that were required to be determined in the petition.

33. It is submitted that Hon'ble High Court vide order dated 29.01.2013 transferred the Writ Petition to National Green Tribunal and was renumbered as Application No. 35 of 2013.

34. It is submitted that vide order dated 04.07.2013 the Tribunal directed the Central Pollution Control Board to depute an expert or a team of experts to examine the location of site and to give a report.

35. It is further submitted that CPCB filed its report on 03.09.2013, wherein it was stated that there was a need to carry out post monsoon sampling preferably during November to have a representative sample. However, in so far as presence of phenolic compounds is concerned, no comments were made in the said report.

36. The Respondents filed their response to the report filed by CPCB by way of a short affidavit dated 20.11.2013, wherein it was specified and clarified that even as per BIS Standards and specifications for drinking water, none of the samples showed that the water was contaminated or hazardous for drinking. It is also submitted that reliance was placed on a report prepared by the Central Ground Water Board, Ministry of Water Resources, Govt. of India for entire Sangrur District, which showed clearly that the ground water in the entire region was generally having more alkalinity beyond the permissible limit. Thus, the same could not be attributed to the industry.

1795
Gurbir Kaur Sehgal
Ludhiana (Pb.)
Reg. No. 17055
Expiry Dt. 19/9/2024

37. It is submitted that on 08.05.2014, the Tribunal directed the CPCB to conduct the test for identifying the presence of the phenolic compounds in the ground water samples.

38. Subsequently, the Central Pollution Control Board filed its report dated June, 2014 stating therein that-

"samples are found within prescribed limits of BIS Drinking water standards IS 10500:2012 with respect to phenolic compounds, pH, Total Dissolved Solids, Calcium, Sulphate, Cadmium, Copper, Nickel and total Chromium"

It is therefore concluded from the study and analytical results that the impact of erstwhile M/s Mahalakshmi Organochem Industries unit was not found in existing 08 tube wells."

39. It is thereafter, the CPCB also filed an affidavit dated 18.07.2014 in support of its above mentioned report, wherein it admitted that there was no impact of the erstwhile M/s. Mahalaxmi Orgochem Industries Unit on the 8 tubewells from which samples had been collected.

40. It is submitted that on 31.07.2014, on a mis-representation by PPCB , the APHA method, that was applied by CPCB, was not reliable and the FTIR method should be used for detection of sulfonated phenolic compounds, the Tribunal appointed the National Environment Engineering Research Institute (NEERI) for analyzing the samples for ascertaining presence of phenolic compounds by APHA as well as FTIR method.

41. It is thereafter, submitted that the Respondents filed a Review Petition before the Tribunal for recall of order dated 31.07.2014 and on 22.08.2014, the review was dismissed by the Tribunal after giving liberty to the Respondents to agitate all grounds taken in the said review at the time of final arguments. However, at the time submissions made at the time

of final arguments have been totally ignored by the tribunal in the judgement.

42. It is submitted that on 07.01.2015, three scientists from NEERI appeared before the Tribunal and admitted that no quantitative assessment of sulfonated phenolic compounds could be made. It was also submitted by them the FTIR method only shows qualitative presence. The scientists, both of CPCB and NEERI, categorically stated that in view of the reports and the fact that the sulfonated phenolic compounds were below detectable limits, nothing further was required to be done and the water was fit for the purpose for which it was being used i.e. irrigation purpose. However, this was clearly disregarded and ignored by the Tribunal.

43. That Respondents filed their objections/submissions to NEERI's report and clearly brought out the fact that by applying the testing method prescribed by the Bureau of Indian Standards as accepted by NABL, the quantity of phenolic compounds in all water samples was below detectable limits and therefore, only on the basis of the qualitative analysis by FTIR Method, no conclusion could be arrived at that there was any contamination. It was also

brought on record 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 analysis of phenolic compounds in water sample is "IS 3025 (part 43)" and the minimum detectable limit of the said method is 0.001 mg/l.

44. It was also stated that the 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. By applying the FTIR method only the qualitative analysis can be done i.e. presence of various compounds/ elements in the water can be identified but their quantities cannot be determined. For determining the quantities, the method as prescribed in IS 3025 (part 43) is to be applied.

45. It was also brought on record that experts from NEERI had submitted before the Tribunal that the water was fit for the purpose for which it was being used i.e. irrigation purpose and that there was no impact of the industry in the area even as per report of NEERI, which in fact supported the report of CPCB.

46. That thereafter on 27.02.2015, final arguments were concluded and judgment was reserved. It is pertinent to mention herein that the only argument addressed by all the parties during the course of final arguments was as to whether or not presence of phenolic compounds by FTIR Method (which can only be used for qualitative analysis) can be made the basis of any finding qua contamination or pollution especially in light of the fact that the water was fit for drinking as per BIS drinking water standards IS 10500:2012 issued by the Bureau of Indian Standards.

47. Furthermore, no arguments were addressed or made in respect of any remedial measures in view of the statements by the scientists from CPCB and NEERI that no remedial measure was required and the water was fit for the purpose for which it was being used i.e. irrigation.

48. That thereafter on 23.09.2015, almost seven months after reserving the judgment, order dated 23.09.2015 was passed, contrary to the material on record and by totally disregarding and failing to even consider the material and evidence including the submissions on record and by basing its findings on pure presumptions, conjectures and surmises and by

ignoring the scientific methods, practices and standards prescribed by the statutory Acts and the Authorities under the said Acts.

49. In the said order, the Tribunal has framed and answered issues which were neither deliberated upon or were the same ever agitated by any of the parties. The said issues have been framed after the judgment was reserved and have been answered without affording the parties an opportunity of presenting their case qua the said issues.

50. Moreover, not only has the Tribunal erred in holding that the Respondents along with Mr. Gurucharan Singh Matharu, CPCB and M/s Matharu Steel Pvt. Ltd. are responsible for contamination and pollution, even the apportionment of the liability is contrary to the admitted position on record. Admittedly out of the fourteen (14) years of manufacturing activity only two (02) years of manufacturing activity was by the Respondents (from March 2003 to March 2005) whereas the remaining twelve (12) years (from 1991 till February 2003) was by Mr. Gurucharan Singh Matharu and his associates including Shri Ashok Kumar who has impleaded

by an order dated 04.07.2013 but has not been arrayed as a party in the Judgment.

51. It is submitted that the Tribunal has also failed to appreciate that even otherwise, as per the Agreement dated 28.03.2003, which was on record before the Tribunal, the entire liability before 28.03.2003 was to be incurred by Mr. Gurucharan Singh Matharu and his associates.

52. Aggrieved by the impugned Judgment and Order dated 23.9.2015 passed by the National Green Tribunal, Principal Bench, New Delhi in Original Application No. 35/2013 (THC), the Respondents has preferred the appeal under Section 22 of the National Green Tribunal Act, 2010, before the Hon'ble Supreme Court which is still pending.

1795
Gurbir Kaur Sehgal
Reg. No. 17066
Expiry Dt. 19/9/2024

53. It is submitted, that the PPCB has filed a report dated 13.01.2016 before this Tribunal. It is also submitted that in the said report , it is mentioned that:

"a) There is no physical dump of hazardous waste in and around the industrial premises. The land of the industry has been leveled and prepared for irrigation.

d) No colour was visible in the upstream ground water samples i.e. in well-1 and well-2, however light reddish colour was observed in two downstream ground water samples collected from well-3 and well-4."

A true copy of Report dated 13.01.2016 filed by the PPCB is being annexed hereto and marked as **Annexure R/5.**

54. It is submitted that the Applicant herein filed the Original Application No. 169/2021 before this Tribunal and the above Respondents were not been made party in that O.A. No. 169/2021.

55. It is submitted that only vide order dated 05.12.2023, the Hon'ble Tribunal issue notice to the previous owners as well as present owners of the unit.

56. It is submitted that there are other previous owners, but the Applicant herein had not made them party in the present Misceallenous Application.

57. It is submitted that Mr. Ashok Kumar, Mr. Ajay Kumar Mahajan, Mr. Harbhajan Singh Matharu, Mr. Gurmel Singh Matharu, Mr. Darshan Singh Matharu, Mr. Surjit Singh Matharu, were also Directors in different phases of operation of the factory of M/s Matharu Steel Pvt. Ltd. and are the necessary party to the present MA.

1795
Gurbir Kaur Sehgal
Ludhiana (Pb.)
Reg. No. 17063
Expiry Dt. 13/9/2024

58. It is reiterated that the in March 2005, the manufacturing activity was shut down by the above Respondents and

thereafter on 01.05.2005, the Respondents closed the manufacturing unit and did not carry out any manufacturing activity thereafter and the same has been informed by the above Respondents to the Punjab Pollution Control Board.

59. It is submitted that even when the unit was closed by the above Respondents thereafter also the report filed by CPCB on 20.11.2013, wherein it was specified and clarified that even as per BIS Standards and specifications for drinking water, none of the samples showed that the water was contaminated or hazardous for drinking. Thus, the same could not be attributed to the Respondents after so many years. Therefore, no complaint survives against the above Respondents.

NOTARY
1795
Gurbir Kaur Sehgal
Ludhiana (Pb.)
Reg. No. 17065
Expiry Dt. 19/9/2024
GOVT. OF INDIA

That in the above facts and circumstances the above Respondents may be deleted from the arrays of parties.

DEPONENT

VERIFICATION:

I, Chander Shekhar Dhawan, the Deponent mentioned above do hereby most solemnly affirmed and verified that what is

Certified that the affidavit SPA/GPA has
been readover & explained to the
executant who seemed directly to under
the same at the time marking

23

stated in the above Reply Affidavit is true to my knowledge and I believe the same to be true.

Verified at Ludhiana on this the ____day of _____________, 2024.

DEPONENT

NOTARY
1795
Gurbir Kaur Sehgal
Ludhiana (Pb.)
Reg. No. 17065
Expiry Dt. 19/9/2024

ATTESTED AS INDENTIFIED
NOTARY PUBLIC
LUDHIANA (PUNJAB)

05 MAR 2024

Know Deponent Executant
Presonally and He/she Has Signed
Thumb Marked In My Presence

5472 8583 6067

ANNEXURE- R/1

PUNJAB POLLUTION CONTROL BOARD

Visit report

Name of the industry : M/s Mahaluxmi Orgochem Inds.
(M/s. Matharu Chemical (P) Ltd.)
Nabha Road, Bhawanigarh.

Name of representative : Sh. C.S.Dhawan, Director

Date of Visit : 01/06/2007

Purpose : Collection of samples (Ground water) and sent for analysis to M/s. Shri Ram Institute as per proceedings of personal hearing dated 16/04/2007 received vide H.O no. 5108 dated 04/05/2007

Remarks : During visit, report is as under:-

1) The industry stands dismantled and electric connection stands disconnected.
2) The industry has stored the hazardous waste in hazardous waste storage pit. No raw material/ chemical/product lying seen in open. The hazardous waste was stored in environmentally sound manner.
3) The industry has provided 4 no. bore wells at a distance of 6 ft. from storage pit around the storage pit as per map plan (signed), enclosed.

25

4) 4 no. samples from borewell has been collected and 2 no. back ground samples i.e., one from the rice mill adjoining to the industry at an about 400 mt distance and other from the premises of Bharat Petrolium on Nabha Road at an about 400 mt from the storage pit. Samples collected were sealed, marked and sent to Shri Ram institute for analysis as per purpose explained above.

5) No old/ previous borewell exist within the premises of the industry during visit. Representative of industry stated that there was no borewell for sampling present in the industry when they purchased the industry from the previous owner. He also stated that there was one no. borewell to meet the needs of the industry but the same was dismantled , during dismantling the industry by present owner.

Sd/-	sd/-	sd/-
(C.S.Dhawan)	Sh. Charnajit Singh	Lavneet Kumar
Director	A.S.O	A.E.E.

True Copy

26

ANNEXURE - R/3

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

For

Punjab Pollution Control Board, Patiala
Punjab (India)

LOGO
Partners in Industrial Progress

Dr. Akepati S. Reddy
Thapar Center for Industrial Research & Development
(TCIRD)
Thapar University
Patiala (PUNJAB)-147004
INDIA

27

Contents

Tables

Figures

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 me 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.

PHOTOGRAPH

Figure-1: Industrial site location

PHOTOGRAPH

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 ($C_{10}H_5$) with 65% oleum 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 (FeiO3) 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 concentrate solution (circulating cooling water

34

system might have been used), mixing with HC1 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

35

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/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 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 waste water	—	---
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.

37

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 m^3/day of water (26 m^3/day in the manufacturing process, 5 m^3/day in the boiler and 3 m^3/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 waste water).
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

39

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 m^3/day. Generation rates of different wastewaters have been assessed as following:

- Mother liquor (assessed at about 3-4 m^3/batch)
- Foul condensate (assessed at about 5-6 m^3/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
- Coaling 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 in 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

41

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 farther 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.

42

DIAGRAM

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

PHOTOGRAPH

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 m^3 volume), were apparently used for the storage of the generated gypsum sludge, iron oxide sludge and incineration

43

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

44

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 (SO_4^{2-})
- Nitrate (NO_3^-)
- Carbonate (CO_3^{2-})
- Total Kjeldhahl 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	Ground water 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	BDL	BDL	BDL	BDL	BDL	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)	21st Edn. APHA, AAS Method	0.24	± 0.05%
Carbonate (CO_3^{2-}) [mg/L]	21st Edn. APHA, Titrimetric	2	±0.5%
Sulphate (SO_4^{2-}) (mg/L)	21st Edn. APHA Gravimetric	10	±5%
Choloride (Cl^-) (mg/L)	21st Edn. APHA Ion Selective Electrode	1	±5%
Nitrate (NO_3^-) (mg/L)	21st Edn. APHA Cd Reduction	.05	±1%
COD(mg/L)	21st Edn. APHA Open Reflux Method	10	±5%
TDS (mg/L)	IS: 3205 Part 16, Gravimetric	10	±5%
TKN (mg/L)	IS: 3205 Titrimetric	0.10	±10%
Phenol (mg/L)	21st 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 ground water appeaers to be limited in extent and apparently not spreading. Discontinuity of ground water contamination (since 2004) and continual pumping out of ground

47

water for irrigation at the sampling stations have apparently arrested the spread of the ground water contamination.

The phenolic compounds however could not be measured by the routinely used standard method. The ground water 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 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).

49

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 kind 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 m^2 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.

DIAGRAM

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

DIAGRAM

(Locations-10 and -11 represent waste sludge and boiler ash dumped onsite Location -9 can be treated as control site Locations -6 and -1 are beyond tine 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.-I	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.-1O*	17100	398000	-	778	10.05	6400	10	ND	ND
Loc.-II**	7720	1300	3.77	124	8.18	10400	-	-	-

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

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.

51

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-a-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. Aireal photograph of the site (available from the Google Earth) and physical survey of the industrial

53

site were used as bases in deciding on the soil sampling locations. Altogether 24 locations were chosen (figure-3 and figure-7).

PHOTOGRAPH

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})

54

- 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 sore 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 pizometric 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 tp 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 i;i 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.

PHOTOGRAPH

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

57

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	<IO
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

60

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.

63

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 down ward 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)	Methonal 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-1 9										
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

65

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. HOPE 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 tabie-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 3/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/g)	Sulphate (g/kg)	Nitrate (mg/kg)	Chloride (g/kg)	pH	COD (g/kg)	Metbonal 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	2.80	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	8500	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	123.00	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	JND	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

69

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

70

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 pizometric 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 ~1	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	.7JL5,	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	1 1 (-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 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.

74

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 solid/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 m^3, were apparently disposed off by the industrial unit into the solar evaporation ponds.

75

Solar evaporation ponds of 3600 m^2 area spread in about 4400 m^2 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 m^3. 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).

PHOTOGRAPH

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

Gypsum sludge, iron oxide sludge and incineration ash (and even the

76

organic sludge) were supposedly stored in three sludge storage tanks, each of about 480 m^3 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 m^3 while the storage capacity available was just 480m^3. 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 m^3 while the storage capacity available was just 480 m^3.

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 comer of the industrial plot (please see figure -10), which was not actually designated for the solid/hazardous waste storage.

77

PHOTOGRAPHS

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 m^3 of industrial wastewater at about 140-150 depth.
2. Presence of about 10,000 m^3 of industrial waste concentrated to different levels in the solar evaporation ponds (a potential source of groundwater Contamination)
3. Heavy contamination of about 600 m^2 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.

79

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 m^3 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 TSDP 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 m^3 of waste.

The heavily contaminated soil (with the thick black liquor of the solar evaporation ponds) of about 600 m^2 land area upto 20 feet on the northern side may also be handled as hazardous waste. This waste may amount to 2700 m^3. 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 berns/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.

True Copy

Annexure -R/3

81

ECO LABORATORIES & CONSULTANTS PVT. LTD.

Environment Due-diligence, Monitoring and Analysis Services.

NABL Accreditated T-1775C T-19518 ISO-14001:2004 OHSAS-18001:2007

NABL- T 1775

Test Report

EL-11-12/717 dt. :03/12/11		Lab No.	EL231111NW01-02	Page
Client	M/s Maha Laxmi Orgo Chem. Bhawanigarh			
Type of Sample	Water			
Work Order No. & Date	As per Qtn no. EQMC/T-306 Dated 22.11.11			
Packing, Markings, Seal	Plastic bottle marked '1' & '2'			
Quantity	Each bottle of 2 ltr			

Mode of Receipt of Sample	Sampling by laboratory
Sampling Location	1. Tubewell-1 (Mr. Jang Singh, Vill. Aaloarkah) 2. Tubewell-2 (Mr. Teja Singh, Vill. Aaloarkah)
Date of Sampling	23.11.11
Sampling Protocol	IS:3025-(P-1)-1987-R-1998 Amdt-1
Sampling Team	Lab Representative: Mr. Deepak & Team Customer Representative: Mr. Bhagwan Singh
Date of Receipt of Sample	23.11.11
Date of Reporting	01.12.11
Testing Protocol	IS:10500-1991 R 1993 Ad.2
Remarks & Observations	1. Clear colorless liquid 2. Clear colorless liquid

S.No.	Test Parameters	Units	Results		Requirements		Test Method
			1	2	Desirable limits	In absence of alternate source	
1.	Total hardness (as CaCO3)	mg/l	268	256	Max 300	Max 600	IS:3025(P-21)1983R-2002.Ad
2.	COD	mg/l	12.44	4.148	-	-	APHA 5220B
3.	Iron (as Fe)	mg/l	0.04	0.07	Max 0.3	Max 1.0	IS:3025(P-53) 2003
4.	Chlorides (as Cl)	mg/l	20.12	16.46	Max 250	Max 1000	US:3025(P-32)1988 R-200X
5.	Sulphate (as SO4), Max.	mg/l	16.5	15	200	400 (See col7)	IS:3025(Part 24):1986
6.	Nitrate (as No3), Max.	mg/l	8.4	6.67	45	100	IS:3025(Part 34):1988
7.	Phenolic compounds (as C_6H_3OH), Max.	mg/l	BDL	BDL	0.001	0.002	APHA 21st ED 2005-5530
8.	Solids (Dissolved)	mg/l	320		500	2000	IS:3025(P-16)1984 R-2002
9.	Nitrogen (Total Kjeldhal)	mg/l	9.4		-	-	APHA-21st ED.2005-4500B

84

Opinion: The submitted sample of water confirms to BIS Specification IS:10500-1991 with respect to the above tests MDL – Minimum Detection Limit; BDL= Below Detection Limit

Sd.

Technical Manager

Terms and Conditions

(1) The results relate only to the items tested [2] Giving opinions does not imply endorsement of the tested product by laboratory [3] The test certificate shall not be reproduce except in full or used as advertisement or evidence in court of law without written approval of the laboratory [4] The laboratory has a complaint redress system. Discrepancy if any, in the test report must be brought to the notice within 7 days of issue of report. Customer feedback form and policy Guidelines on Requests and Contracts are available on our website www.ecoparyavaran.in [5] All disputes are subject to jurisdiction of Mohali (Punjab) India.

True Copy

Annexure - R/4

85

COMMENTS ON THE REPORT ON ASSESMENT OF GROUND WATER CONTAMINATION AT THE PLANT SITE OF M/S MAHALAKSHMI ORGANOCHEM INDUSTRIES THAPAR CENTER FOR INDUSTRIAL RESEARCH AND DEVELOPMENT

PROF. BARUN KUMAR GUHA (RETIRED)

CHEMICAL ENGINEERING DEPARTMENT
ENVIRONMENTAL ENGINEERING GROUP
INDIAN INSTITUTE OF TECHNOLOGY, DELHI

SEPTEMBER, 2012

COMMENTS ON THE REPORT ON ASSESSMENT OF GROUND WATER CONTAMINATION AT THE PLANT SITE OF M/S MAHALAKSHMI ORGANOCHEM INDUSTRIES THAPAR CENTER FOR INDUSTRIAL RESEARCH AND DEVELOPMENT

M/s Mahalakshmi Organochem Industries (Previously known as Matharu Chemical Industries), Nabha Road, Bawanigarh has been operating the H-Acid manufacturing plant for about 2 years ending in 2004. The original plant started its manufacturing process in 1991 with a design capacity of 20,300 kg/month of H-acid. The unit has shut down the production process in 2004 and the plants and machineries sold off as scrap. Gradually the unit disposed off all the waste sludge and other materials within the complex.

Subsequently the land was cleared of all the debris and the plot was sold off and used for agricultural purpose. At present several crops like wheat, mustard etc. are being cultivated in the land.

The unit had set up an Effluent Treatment Plant with adequate capacity to handle the total effluent load. In addition to this the solid wastes generated within the plant, were initially stored in a separate shed as per the requirement of pollution board norms. These were later transferred to the secured land fill site once the same was developed within the state of Punjab. The plant had been regularly inspected by the officials from Punjab Pollution Control Board and other authorities. All the recommendations suggested by them had been incorporated at the time.

The Plant Site

The industrial unit was located on the Bhawanigarh-Nabha Road at 4 km distance from Bhawanigarh on the right side. The industrial area is surrounded by agricultural fields all around except for two rice shellar units, a warehouse, one pipe factory, a petrol pump in the nearby areas. The nearest human settlement is in a small village at a distance of about 1000m from the plant.

The Manufacturing Process

The process employed for the manufacturing of H-acid uses Napthalene as the raw material. H-acid is 1-amino, 8-napthol,3,6-disuphonic acid and is manufactured as sodium salt having molecular formula of $C_{10}H_8NO_7S_2Na_2$. It is a grey powder highly soluble in water, alcohol and ether. The manufacturing process involves several steps as outlined below:

1. Sulfonation of naphthalene ($C_{10}H_8$) with 65% oleum and sulphuric acid.
2. Nitration of the resulting mixture with 60% nitric acid.
3. Neutralization of the mixture o acid, sulfonation and nitration products with lime slurry (10% concentration)
4. Filtration of the mass to separate the Gypsum sludge ($CaSO_4$) formed from the intermediate product formed as filtrate including the washing of the filter cake.
5. Reduction of the filtrate by iron powder involving addition of hydrochloric acid, soda ash and acetic acid.
6. Filtration of the mixture to separate the iron sludge, which is disposed off as a by product.
7. The filtrate solution is concentrated in a set of multiple effect evaporator
8. The concentrated product liquid is mixed with hydrochloric acid and common salt to precipitate the H-acid and is recovered by filtration as Koch cake.
9. Mixing the Koch cake with caustic lye/ caustic flakes and then heating the mixture for evaporation and melting /fusing the product in an autoclave heated with thermic fluid.
10. Diluting the fused mass and mixing with sulphuric acid. The mixture is boiled to remove any free sulphur dioxide.

88

11. Cooling the mixture (boiled off mass) and filtering the same to get the sodium salt of H-acid as filter cake.

12. The product H-acid is washed with water and dewatered in a centrifuge. The product is dried and milled to obtain the final product as powdered sodium salt of H-acid.

The manufacturing process outlined above indicates that there are two types of waste generated within the production plant, viz. Solid waste in the form of gypsum sludge & iron sludge and the liquid waste streams in the form of mother liquor after separating the Koch cake and the discarded liquor after precipitating H-acid and finally the wash water stream from the final washing and separating in the centrifuge.

Waste Management:

A. Waste Water Management:

There were mainly two types of waste water generated from the plant. One was the concentrated stream of mother liquor containing high concentration of unconverted raw materials and other organic compounds formed as undesirable side products along with inorganic salts of sulphates etc. This particular stream was incinerated in a specially designed incinerator for the purpose. The incinerator was installed at a later stage and till then all the concentrated stream was handled in a solar evaporator pond fitted with spray system to enhance the rate of evaporation. The total installed capacity to store such waste water within the plant was more than 6000m^3 with a total effective area

89

of 4400m^2. The estimated total waste water generated within the plant was in the range of 23-24m^3/d. This included all other types of waste water, excepting that of the likes of cooling tower blow down and steam condensate etc. These were used for horticulture input within the plant complex. Thus the total area available was more than adequate for taking care of all the waste water generated by solar evaporation. The location of the plant is in a semi arid area where the mean natural solar evaporation rate is about 0.01 m^3/m^2. Thus the evaporation pond area provided was enough to handle nearly 44 m^3/d of solar water evaporation. Further the multiple effect evaporators would have handled some additional volume of concentrated waste water.

B. Solid Wastes

The solid wastes generated within the plant were mostly from process steps and they included, gypsum sludge, iron sludge and incinerator ash. The first two types of sludge 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. The iron sludge has considerable resale value being used for several manufacturing processes like brick kiln and others and is also used as a soil nutrient. Most of it was disposed off by selling to different vendors. Similarly the gypsum sludge has good market value; particularly for the manufacture of cement. It has many other uses like gypsum board making, fertilizers etc. But because of the presence of organic matters in the sludge, the product after drying was

90

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. This sludge along with the unsold part of the iron sludge were initially stored in sludge pits specially made for the same and later on was put in bags and stored in ventilated storage shed designed for the purpose.

Similarly the incinerator ash generated from the incinerator unit was also put in a bag and stored in this specially designed shed.

Sludge Utilization

Iron Sludge: The iron sludge produced within the plant formed the bulk of solid wastes. Major part of this sludge after air drying was supplied to brick kilns who use this material along with the clay to provide the specific colour. Further the organic matters present within the sludge gets incinerated and consequently releasing lots of heat which is very useful for the brick making operation. Particularly the heat release within the brick body improves the quality of the bricks. Thus many of the brick kiln operators were procuring this sludge and mixing them with clay for the making of bricks. In this manner a major fraction of the iron sludge was handled within the plant.

The iron sludge was also used by the farmers for increasing the iron content of the soil. Particularly the land the area has iron deficient soil. Thus the sludge after air drying for a long period was used as a fertilizer supplement to improve the iron content in the soil. The longer period air drying ensured the removal of most of the organic matters by evaporation and oxidation.

Gypsum Sludge: Gypsum sludge is produced while neutralizing the acid after the sulphonation of naphthalene with oleum and sulphuric acid. The resulting $CaSO_4$ is an important raw material for the manufacture of cement. The sludge when mixed with the usual raw material mix of lime stone, coke/coal and gypsum rock supplement the ID requirement of the latter. In this case also the organic matters do not cause any problem for the manufacturing operation as they get incinerated releasing heat which is useful for the cement kiln operation. Only limitation on the use of the sludge material was the fineness of the sludge particles. This prevented use of the sludge in excess quantity beyond a limit, which otherwise would cause increased loss of dust in the flue gas. However, most of the cement kiln operators were quite happy to use the material so long it is available at very marginal or no cost basis. M/s Mahalakshmi Organochem. Industries (Matharu Chemical Industries as was known earlier) was very happy to supply the material at free of cost to the nearby cement kiln operators, even supporting the transportation cost of the same to dispose of the solid waste from their premises.

Incinerator Ash: The incinerator ash was of relatively small quantity and contained very little toxic matter, particularly materials which can leach out easily. The ash produced from the incinerator was packed in HDPE bags. The bags were then stored in shed designated for the purpose.

The solid wastes were stored in the premises in properly designed sludge pits which were lined with impermeable HOPE sheet to prevent any leachate to go into soil and thereby having the potential for damage of land and surrounding water bodies in the area due to the storage of

92

these sludge.

Solar Evaporation Ponds

As already mentioned earlier the manufacturing unit had large dedicated area of shallow evaporation pond to take care of the effluent generated within the complex. All these ponds were lined and any possibility of large scale percolation in the soil was quite minimal. 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 rain fall or irrigation for the crop cultivation has resulted in its percolation to the soil. However, the quantity of such material will be quite low. Further as is evident from the recent ground water analysis by M/s Eco Laboratories and Consultants and the earlier analysis by M/s Thapar Centre for Industrial Research & Developments these materials have been washed off the soil and has been diluted. Thus all the contaminant levels in the ground water samples are below the detection limit.

This is a common phenomena with such land pollution that the natural redemption process takes precedent over any artificial process designed to take care of such problem. The soil in the area is quite porous and allows washing of the soil by rain water and the degree of contamination if there was any decreases over the years. Several studies have been done on such natural redemption of soil by rain water and shows that in most cases the after about 7 /8 cycles the contamination level becomes quite negligible [Ref. Dr. Anwar Ali Khan, "Ground Water Contamination from Dumping of Solid Wastes on Land", Ph. D thesis, IIT Delhi (2007)]. Thus it can be considered that the residual contamination left behind by the chemical manufacturer after the operation was stopped in 2005, is quite negligible. Particularly since the land has been used for growing different crops which needed regular irrigation of the land which would have accelerated the washing process. Further the crops do not show any symptom of being affected by the effect of any residual chemical contamination in terms of plant growth or productivity of the soil (as measured in terms of the yield of the crop wheat or mustard per acre of land in the area).

It is also of particular interest that there was no complaints from the farmers in the area for any problems with respect to agriculture activity or with irrigation water.

Analysis of Potential Environmental Impact on the Ground

The manufacturing of H-acid was stopped by the plant management in 2005 due to financial problems of the managing company. The land was cleared of all the structures and materials within a short period after the same.

The plot was sold off in 2006. This was being used as an agricultural land to grow crops like wheat, mustard etc. However, later on in 2011 under instruction from Punjab Pollution Control Board, Thapar-Center for Industrial Research & Development, Patiala had carried out a detailed study of the Assessment of the Length, Breadth and Depth of Ground water Contamination by the by the same unit.

The investigating team after several visits to the site came out with many conclusions based on the data obtained by them and made some drastic remedial actions recommendations. Most of them are based on observations which are not corroborated by the facts or are based on presumed estimation based on historical data rather than monitoring the site condition at the present time.

There are several issues raised in the report which are not based on the facts or are based on calculations which are quite different from the realities as highlighted in following section:

1. There are several inconsistencies in the results. Thus in Table 10 of the TCIRD report (attached) the soil core sample from sampling location 22 show that at a depth of 3 ft the sodium content 387.3 g/kg where as sulphate and chloride content are 433 and 4.4 g/kg. If it is assumed that all the sodium is in the form of sodium sulphate and sodium chloride, then the amount of sulphate and chloride would require sodium content of only 210 g/kg. it is not clear in what form the residual sodium is present in the soil. Similar is the case for soil sample collected at a depth of 10ft at the same location as well as for samples collected from location 19 also.

2. There is no data on the background salinity of the soil from nearby

so called non contaminated area

3. It is not very clear whether the COD values are for water extractable part only or also includes that of the methanol extract.

4. One of the conclusion for the top soil layers being less contaminated is that the areas have been filled with iron rich soil (soil mixed with iron sludge) does not agree with the results of soil analysis. The results indicate that in most cases the iron concentration increases with the depth.

5. One of the major contradiction is in the quality of water. The recent sampling by M/s Eco Laboratories & Consultants Pvt. Ltd. A govt. Approved NBL accredited laboratory indicate the water from the bore wells in the vicinity of the pant area devoid of any contaminants other than traces of organic compound (as indicated by COD values). Particularly they are colourless clear samples of water. The level of the total dissolved solids are also quite low indicating the absence of any contamination due to the movement of dissolved solids from the site. It may be mentioned that the contaminants are primarily iron (Fe) and Sulphate compounds. Both the components are within the permissible limits of IS standards 10500 of drinking water (attached).

6. 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 showing are within the limits which are normal for many of the soils. (Analysis of a reference sample from the area which is perceived to be non-contaminated

96

was not , carried but and is not available for comparison.

7. The methanol extract of the soil samples may contain many components other than the Compound - A or B. The qualitative presence of these chemicals does not make the system any problematic. Particularly it appears that they are insoluble in water. In that case the movement of the chemical constituents along the soil depth is not clear. In fact at no stage any organic solvent was used within the complex and hence the movement from the adsorbed matrix in the soil is very unlikely. But the results in the tables show the similar trend

8. The water samples were also tested for the methanol extract value. 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. The ratio of Methanol Extract to COD value varies from a low of 1.7 to as high as 3.7.

9. There is no data on the TDS (total dissolved solids) or hardness of water at different depth to corroborate the estimated total salt concentration in water which varies from one depth to other quite arbitrarily without any proper ionic balance. Thus the highest level of Calcium is shown at a different depth from where the Sulphate, Nitrate or Chloride is at highest level. This is not possible at all since Calcium if not from background level will have to be combined with one or more of the three anion components

mentioned above. In case it is in the background water, then its prevalence would have shown in the form of hardness or other parameters also.

Conclusions

In view of the above mentioned discussions it may be following matters may be concluded :

1. The recommendations regarding the redemption of water is quite misleading. Particularly the ground water aquifer is a dynamic system where the water is always moving in a particular direction. In that case the contamination levels keep on getting diluted with fresh water movement from the surrounding areas. Further the front for the water also keeps on moving from one location to other. The pollutant levels keep on getting diluted and ultimately becomes untraceable. This is indicated from the recent sampling which does not show the similar degree of contaminated water in the wells. Further there has not been any observation on this issue in recent time by the residents or farmers in the area, providing further evidence that the proposal for redemption of the ground water is unwarranted.

2. The redemption is usually carried out for the soil. However, in this case the analysis of soil shows that they have been washed by rain and irrigation water. Further washing of the soil must have taken place during the last two years after the period when the original sampling was done M/s TCIRD. It appears therefore that there is no need for redemption of the solids at the site.

3. The process of redemption method suggested is quite vague and does not have dear end point fixation in terms of characteristics of water and the process to be adopted. Particularly how the methanol extract fraction will be removed from the system and what will be the fate of this treated water. Further extracting so much water within a short period of time is not only impractical but also has long term impact on the geology of water table movement. The rain fall in the area is not that high to replenish the water table and there will be significant lowering of the water table in the nearby areas. This would have tremendous adverse effect on the agricultural activity in the area. Most of the farmers are dependent on the ground water and any lowering of water table will affect irrigation of farm lands and cause hardship of the farmers.

4. There is no evidence of any adverse effect of the soil or the underground water on the health of the human A being in the area or the agricultural output from the land in the area. This is evident from the crops being grown on the same plot which shows healthy growth of plant. There is no report on the uptake of the contaminants by the crop outputs viz., wheat and mustard.

5. There is no record of any unusual health problem in the area which can be attributed to the quality of water or on the crops produced in the area.

6. A concerted effort should be made to evaluate this phenomena in terms of the effect of the so called contaminants on the crops and

human health by taking up a long term exercise to monitor the same. In the absence of any such data it will not be advisable to carry out any redemption plan for the soil or water in the area which may have more detrimental impact on the environment than providing any benefit.

SD/-
DR. BARUN KUMAR GUHA
PROFESSOR (RETIRED)
CHEMICAL ENGINEERING DEPARTMENT
INDIAN INSTITUTE OF TECHNOLOGY, DELHI

True copy

ANNEXURE - R/5

Sub:- Proceedings of the joint inspection of the site of M/s Mahaluxmi Orgochem Industry, Nabha Road, Bhawanigarh, District Sangrur on 04/12/2015.

The following team members have visited the site of M/s Mahaluxmi Orgochem Industry, Nabha Road, Bhawanigarh, District Sangrur on 04/12/2015:-

1. Er. B. Vinod Babu, Additional Director, Central Pollution Control Board, Delhi.
2. Er. A.K. Kalsi, Senior Environmental Engineer, Punjab Pollution Control Board, Zonal Office-II, Patiala.
3. Dr. Anoop Verma, Assistant Professor, School of Energy and Environment, Thapar University, Patiala.
4. Er D.K. Singla, Environmental Engineer, Punjab Pollution Control Board, Zonal Office-II, Patiala.
5. Er G.S. Gill, Environmental Engineer, Punjab Pollution Control Board, Regional Office, Sangrur.
6. Er. Navtesh Singla, Assistant Environmental Engineer, Punjab Pollution Control Board, Regional Office, Sangrur.

1. The above said team visited the site and its surrounding areas and observed the following:-
    - i. There is no physical dump of hazardous waste in and around the industrial premises. The land of the industry has been levelled and prepared for irrigation.
    - ii. A coloured patch of soil was found in North east portion of the site.
    - iii. One ground water sample was collected from well No-2 located at East to site (as shown in map shown in Annexure-1) and two samples of ground water taken from well-3 and well-4 across the road towards West of the site
    - iv. No colour was visible in the upstream ground water samples i.e. in well-1 and well-2, however light reddish colour was observed in two dowhstream ground water samples collected form well-3 and well-4,
2. Punjab Pollution Control Board has communicated in written to the respondent no. 6 i.e. Sh. Chander Sekhar Dhawan, Respondent no.7 i.e. Sh. Sunil Ahuja & Respondent no. 9 i.e. Sh. Gurcharan Singh Matharu with request to attend the inspection to be carried out by the above team vide Board's letter no. 5932-35 dated 01/12/2015
3. The Message regarding visit inspection has also been conveyed to respondent no. 6 & 9 through email, telephone & SMS. As no contact no./email address of respondent no. 7 was available therefore, only letter has been issued to convey the date of inspection on its address available to the Board.
4. During visit, only respondent no. 9 i.e. Sh. Gurcharan Singh Matharu was present. However, E-mail has been received from respondent no. 6 i.e. Sh. Chander Sekhar Dhawan regarding his non availability on said date. Respondent no. 7 has neither attended the visit nor given any submission regarding his non availability.

101

5. Observations and recommendations of the team:-

   i. Immediate intervention measures for remediation such as lifting and transfer of waste to TSDF is not possible since no dump of hazardous waste could be seen at site. The contaminated land in the premises has apparently been leveled and no discrete boundaries of waste could be identified.

   ii. It is required to carry out a detailed site investigation to identify and delineate boundaries of contaminated soil and waste (that is lying beneath the surface). Detailed investigations are also required to identify the constituents of concern, to quantify the waste, to understand the hydro geological conditions, to outline the plume of groundwater contamination etc. Such study can be carried out by engaging a qualified consultant.

   iii. It was decided that Central Pollution Control Board would prepare a scope of work for conducting detailed site investigations within 15 days.

   iv. After finalizing the scope of work, Punjab Pollution Control Board may invite limited tenders from qualified parties for conducting detail investigations and provide feasible options for remediation along with a Detail Project Report (DPR). The remediation of contaminated site can be carried out based on the remediation objectives and scope finalized in the DPR.

   v. The process of tendering or hiring consultant to carry out above study can be started only after receipt of an initial advance of 50.0 lacs (Fifty Lacs only) in favor of Punjab Pollution Control Board from respondent no. 6, 7 and 9 in proportions as decided by Hon'ble NGT.

   vi. The actual remediation works can be carried out only after completion of detailed investigations and preparation of DPR, which may take about 5- 6 months. Such remediation works can be executed by engaging competent contractors having relevant experience.

Er. B. Vinod Babu
Additional Director,
CPCB, Delhi

Er. A.K. Kalsi, SEE
PPCB, Zonal Office-II,
Patiala

Dr. Anoop Verma
Assistant Professor,
Thapar University,
Patiala

Er. G.S. Gill, EE,
PPCB, Regional Office,
Sangrur

Er. Navtesh Singla, AEE,
PPCB, Regional Office,
Sangrur

.....

Annexure-1

Map showing Location of contaminated site at M/s Mahaluxmi Orgochem Industry, Nabha Road, Bhawanigarh, District Sangrur