

Final Report

**Assessment and Remediation of Hazardous Waste
Contaminated Areas in and around M/s Union
Carbide India Ltd., Bhopal**

Sponsor

**Bhopal Gas Tragedy Relief and Rehabilitation Department
Govt. of Madhya Pradesh, Bhopal**

By



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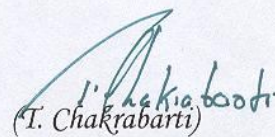
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Foreword

M/s. Union Carbide India Ltd., manufactured carbamate pesticides and the associated intermediate chemicals at their Bhopal unit during 1969 and 1984. The solid, liquid and tarry wastes generated during the manufacture of pesticides and associated chemicals were dumped by UCIL within their premises. The unit was closed down in December 1984 as a result of the accident of leakage of methyl iso-cyanate gas. Since, a considerable time has elapsed and no remedial actions have been taken in the past, the present status of soil and groundwater contamination in and around UCIL premises needed to be assessed so as to delineate suitable strategies for their remediation.

Based on the directives of the Task Force constituted by Hon'ble High Court of Madhya Pradesh, Bhopal Gas Tragedy Relief and Rehabilitation Department (BGTTRRD), Govt. of Madhya Pradesh requested National Environmental Engineering Research Institute (NEERI), Nagpur and National Geophysical Research Institute (NGRI), Hyderabad to undertake a study on assessment of contamination and delineation of suitable strategies for the remediation of contaminated areas in and around the UCIL site. The study was awarded by BGTTRRD in March 2009.

The studies were carried out by NEERI and NGRI which involved reconnaissance survey of the UCIL premises, geophysical and hydrogeological investigation, sampling and analysis of soil and groundwater in and around the UCIL. Based on these studies it was established that soil mostly within UCIL premises and solar evaporation pond area is contaminated and needed appropriate remediation with respect to isomers of hexachlorocyclohexane and mercury on the basis of USEPA standards for groundwater protection. It was also established that the groundwater in general inside the plant area is not contaminated. However, isolated contamination was observed in few wells possibly due to surface runoff from waste dumps or mismanagement of SEP and landfill. Considering the extent of contamination and present site conditions, immediate as well as long term remediation measures are delineated in the report.


(T. Chakrabarti)
Acting Director

June 26, 2010

Executive Summary

- ❖ M/s. Union Carbide India Ltd., manufactured carbamate pesticides and the associated intermediate chemicals at their Bhopal unit during 1969 and 1984. The solid, liquid and tarry wastes generated during the production of these chemicals were dumped by UCIL within their premises, resulting in contamination of soil and groundwater within and outside UCIL premises. The unit was closed down in December 1984 as a result of the accident of leakage of methyl isocyanate gas.
- ❖ Based on the directives of the Task Force constituted by Hon'ble High Court of Madhya Pradesh, the BGTRRD sponsored a joint study in March 2009 to National Environmental Engineering Research Institute (NEERI), Nagpur and National Geophysical Research Institute (NGRI), Hyderabad for assessment of contamination and delineation of suitable strategies for the remediation of contaminated areas in and around the UCIL site.
- ❖ Considering the past studies carried out by NEERI as well as apprehensions/issues raised by various agencies/organizations, field studies were carried out by NEERI and NGRI which involved reconnaissance survey of the UCIL premises, geophysical and hydrogeological investigation, sampling and analysis of soil and groundwater in and around the UCIL.
- ❖ The reconnaissance survey of the site revealed that most of the plant, machineries and buildings within UCIL premises are in dilapidated conditions and appeared to be contaminated. The reconnaissance survey of the UCIL premises also revealed existence of a number of dumps especially in disposal area I and disposal area II. The existence of dumps within UCIL premises indicated that the excavation and recovery of wastes carried out by Madhya Pradesh Pollution Control Board (MPPCB) through M/s Ramkey Ltd. was incomplete.
- ❖ The boundary wall of the UCIL premises was found to be broken at many places which provided an easy access to the people living around the premises.
- ❖ The reconnaissance survey of the SEP area outside the UCIL premises revealed existence of one SEP and an abandoned landfill which were found to be damaged.
- ❖ The field studies for assessment of contamination comprised of detailed hydrogeological investigations (geophysical investigations, borehole drilling, development of monitoring wells etc.), followed by collection and analysis of existing field samples (dumpsite, subsurface soil, and groundwater). The hydrogeological investigations were carried out by NGRI whereas sampling and characterization of soil and groundwater were carried out by NEERI.

- ❖ The geophysical investigations carried out by NGRI indicated possibility of contamination at three sites (Site I, Site III and Site V) out of nine sites. The depth of contamination at these sites is limited to about 2 m, except at one dump (Site III) that could be deeper (4-8m). These dumps were isolated from each other.
- ❖ The lithology of the area as determined through drilling of borewells by NGRI revealed existence of black and yellow silty clay up to a depth of 22 to 25 m below ground level. The groundwater in the area exists under confined below a depth of about 25 m from the ground surface. The general groundwater flow direction is towards east.
- ❖ Sampling and analysis of subsurface soil (collected during drilling of borewells) indicated contamination of soil up to a depth of about 2 m. Major contaminants detected at the site include: BHC, aldicarb, carbaryl, α -naphthol and mercury. The sampling and analysis of soil from possible dump areas (other than drilling areas) also indicated contamination of soil in terms of above mentioned contaminants. The soil in and around SEPs area located outside UCIL premises was also found to be contaminated.
- ❖ The total volume of soil (within and outside UCIL premises) amounts to 6,50,000 m³ which is equivalent to about 11,00,000 MT.
- ❖ Monitoring of groundwater from the borewells constructed by NGRI within UCIL premises and the existing wells around UCIL premises indicated that groundwater in general is not contaminated due to seepage of contaminants from the UCIL dumps. However, isolated contamination in terms of pesticides and/or dichlorobenzene was observed in 5 well in the immediate vicinity of UCIL premises in the north-east and east direction. The source of contamination of these wells was, attributed to surface runoff from the dumps. The quantum of contaminated groundwater could not be estimated due to isolated nature of contamination.
- ❖ Considering the extent of contamination and various site conditions, immediate and well as long term remedial measures were recommended.
- ❖ Under immediate measures following recommendations were made:
 - Proper fencing and security to UCIL premises and SEP area for preventing unauthorized access and use of these areas by public.
 - Immediate sealing of five contaminated wells so as to prevent use of water from these wells for any purpose by the residents.
 - Excavation and recovery of dumps materials. The incinerable wastes should be disposed off in TSDF at Pithampur. The non-incinerable wastes to be disposed off in an on-site secured landfill facility to be constructed at UCIL.
 - Decontamination and decommissioning of plant, machineries and buildings prior to remediation of contaminated soil and groundwater.

- ❖ Under long-term measures, remediation of contaminated soil and groundwater was recommended. For remediation of contaminated soil, an on-site secured landfill facility was recommended. For contaminated groundwater, pump-and-treat system was recommended.

- ❖ The cost of soil remediation through secured landfill is estimated to be in the range of Rs 78 crore to 117 crore (average Rs. 100 crore). The capital cost for pump and treat unit shall be in the range of 25 to 30 lakhs. The operating and maintenance cost of such unit is in the range of Rs. 10 to 15 lakhs per annum including cost of activated carbon and its disposal.

- ❖ It is recommended that, BGTRRD should engage competent professional contractors for detailed engineering, and execution of various remedial measures recommended by NEERI.

Contents

Sr. No.	Title	Page No.
1.0	Background of the study	1
1.1	Preamble	1
1.2	Background data/information for the study	2
1.2.1	Past studies carried out by NEERI & NGRI	2
1.2.2	GTZ project proposal	6
1.2.3	Greenpeace report	7
1.2.4	Sambhavana Trust Clinic's input	7
1.2.5	Srishti's report	7
1.2.6	MPPCB report	8
1.2.7	Study by Dr. V. Birke and Dr. H. Burmeier	9
1.2.8	Site cleaning activity carried out by MPPCB	9
1.3	Objective and scope of work for the present study	10
1.4	Approach and methodology adopted for the present study	11
2.0	Site reconnaissance	13
2.1	Preamble	13
2.2	Past waste disposal activities	15
2.3	Inspection of UCIL permission and surrounding area	16
3.0	Field investigation for assessment of contamination	21
3.1	Preamble	21
3.2	Geophysical investigations	21
3.3	Hydrogeological investigations	27
3.4	Monitoring soil and groundwater	35
3.5	Overall observation on extent of contamination	66

4.0	Strategy for remediation of contaminated soil and groundwater	69
4.1	Preamble	69
4.2	Immediate measures	69
4.3	Long-term measures	70
4.3.1	Risk based remediation levels	71
4.3.2	Remediation of contaminated soil	72
4.3.3	Remediation of contaminated groundwater	74
5.0	Conclusion and Recommendations	75
	Annexure I – NGRI report on geophysical investigation	
	Annexure II – NGRI report on hydrogeological investigation	

List of Tables

Table No.	Title	Page No.
1	Production of seven and MIC at UCIL, Bhopal	4
2	Chemicals reported to be dumped by UCIL from 1969-1984	8
3	Quantity of waste recovered and stored by HPPCB	9
4	Well inventory studies by NGRI	28
5	Sampling & analysis protocols follows by the study	35
6	Details of borehole locating	36
7	Soil samples collected from different depths	36
8	Location of soil sample collected within UCIL premises	38
9	Details of upstream & downstream soil sample collected and around UCIL premises	39
10	Details of ground water samples collected around UCIL premises	42
11	Presence of Aldicarb in the surface and subsurface soil samples around the UCIL premises	44
12	Presence of Carbaryl in the surface and subsurface soil samples around the UCIL premises	44
13	Presence of α -naphthol in the surface and subsurface soil samples around the UCIL premises	45
14	Presence of α -HCH in the surface and subsurface soil samples around the UCIL premises	45
15	Presence of β -HCH in the surface and subsurface soil samples around the UCIL premises	45
16	Presence of γ -HCH in the surface and subsurface soil samples around the UCIL premises	46

Contd...

Table No.	Title	Page No.
17	Physico-chemical characteristics of soil samples collected from upstream and downstream of the UCIL plant	47
18	Metals concentration in the soils samples collected from upstream and downstream of the UCIL plant	47
19	Presence of Aldicarb in soil samples from UCIL premises	48
20	Presence of Carbaryl in soil samples from UCIL premises	48
21	Presence of α -naphthol in soil samples from UCIL premises	49
22	Presence of α -HCH in soil samples from UCIL premises	50
23	Presence of β -HCH in soil samples from UCIL premises	50
24	Presence of γ -HCH in soil samples from UCIL premises	51
25	Presence of δ -HCH in soil samples from UCIL premises	51
26	Presence of Dichlorobenzene in soil samples from UCIL premises	52
27	Metals concentration in the soils samples collected from the UCIL premises	53
28	Physico-chemical characteristics of soil samples collected from the UCIL plant premises	55
29	Contaminants profile of soil samples collected from the Temik and formulation plant area	57

Contd...

Table No.	Title	Page No.
30	Contaminants profile of soil samples collected from MIC storage and water treatment plant area	58
31	Contaminants profile of soil samples collected from disposal area II on the eastern side of the plant area	58
32	Contaminants profile of soil samples collected near storage tanks	59
33	Contaminants profile of soil samples collected from naphthol plant	59
34	Presence of contaminants in the groundwater samples collected within UCIL plant	62
35	Presence of contaminants in the groundwater samples collected around the UCIL plant	63
36	Physico-chemical characteristics of groundwater samples collected around the UCIL plant	64
37	Metals concentration in the groundwater samples collected around the UCIL plant	65
38	Screening standards for assessing the contamination levels (Compounds relevant to the studies)	72

List of Figures

Figure No.	Title	Page No.
1	Location of Union Carbide India Limited	13
2	Plant layout of UCIL, Bhopal	14
3	Electrical Resistivity Profiling (ERP)	22
4	Locations of HERT survey	23
5	Locations of suspected dumps at UCIL premises	25
6	Location of sites selected for drilling within UCIL premises	30
7	Litholog and drill-time log at bore well A	32
8	Litholog and drill-time log at bore well B	32
9	Litholog and drill-time log at bore well C	33
10	Litholog and drill-time log at bore well D	33
11	Litholog and drill-time log at bore well E	34
12	Fence diagram showing geological strata at UCIL premises	34
13	Locations of soil samples collected within UCIL premises	37
14	Locations of upstream and downstream soil sample collected from outside UCIL premises	39
15	Locations of groundwater samples collected around UCIL premises	41

List of Plates

Plate No.	Title	Page No.
1	General view of UCIL plant	15
2	Plant and machinery in dilapidated conditions	17
3	Existence of dumps within UCIL premises	18
4	Wastewater released by the hutments/industries at UCIL	19
5	Improper management of SEP and abandoned landfill	20
6	Drilling of borewells within UCIL premises	30
7	Tamperd/broken borewells within UCIL premises	40