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Media Briefing  
**Action Plan**

**Environmental Remediation in and around UCIL, Bhopal**  
Roundtable Meeting, April 25-26, 2013

**SUMMARY OF STUDIES CONDUCTED SO FAR**



## UCIL, 1969–84

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- Mainly produced three pesticides
  - Sevin (carbaryl)
  - Temik (aldicarb)
  - Sevidol (carbaryl and  $\gamma$ -HCH)
- Raw material used and intermediaries include
  - HCH isomers
  - Chlorinated benzene compounds
  - Heavy metals such as mercury and chromium



## UCIL, 1969–84

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- Dumped chemical waste within and outside the plant
  - Three disposal areas, several dumps and pits inside the plant
  - Solar evaporation pond (SEP) area outside the plant comprising three ponds
- **Toxic waste lying ever since, is a continuous source of soil and groundwater contamination**



## Studies Conducted, 1990–2013

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- About 15 studies conducted by
  - CSIR institutes such as NEERI, NGRI, IICT, IITR
  - Central and State agencies such as CPCB, PHED of Madhya Pradesh
  - NGOs such as CSE, Greenpeace International, Fact Finding Mission and People's Science Institute
- Most studies focused on soil and groundwater contamination while few studied waste at SEP and stored toxic waste
- Plant structure and machinery are studied in detail by IICT



# List of Studies

(1/2)

Year	Organisation	Title
2013	IITR	Analysis of Soil and Groundwater Samples in Bhopal
2010	NEERI and NGRI	Assessment and Remediation of Hazardous Waste contaminated Areas in and around M/s Union Carbide India Ltd., Bhopal
2010	IICT	Technical and Tender Document for Detoxification, Decommissioning and Dismantling of Union Carbide Plant
2009	CSE	Contamination of Soil and Water Inside and Outside the Union Carbide India Limited, Bhopal
2009	CPCB	CPCB study (with CSE)
2002	Greenpeace International	Chemical Stockpiles at Union Carbide India Limited in Bhopal: An Investigation
2002	Fact Finding Mission & Shrishti	Surviving Bhopal: Toxic Present, Toxic Future
2001-02	People's Science Institute	Groundwater Contamination near the Union Carbide Plant at Bhopal



# List of Studies

(2/2)

Year	Organisation	Title
1999	Greenpeace International	The Bhopal Legacy
1997	NEERI	Assessment of Contaminated Areas due to Past Waste Disposal Practices by EIL, Bhopal
1996	State Research Laboratory, PHED, MP	Report of Chemicals found in Water for Communities around UCIL premises
1992	NEERI	Process Package for Disposal of SEP Contents at UCIL, Bhopal
1990	Bhopal Group for Information and Action	Union Carbide in Bhopal, India-The lingering legacy
1990	NEERI	Assessment of Pollution Damage due to Solar Evaporation Ponds at UCIL, Bhopal



# Soil Contamination

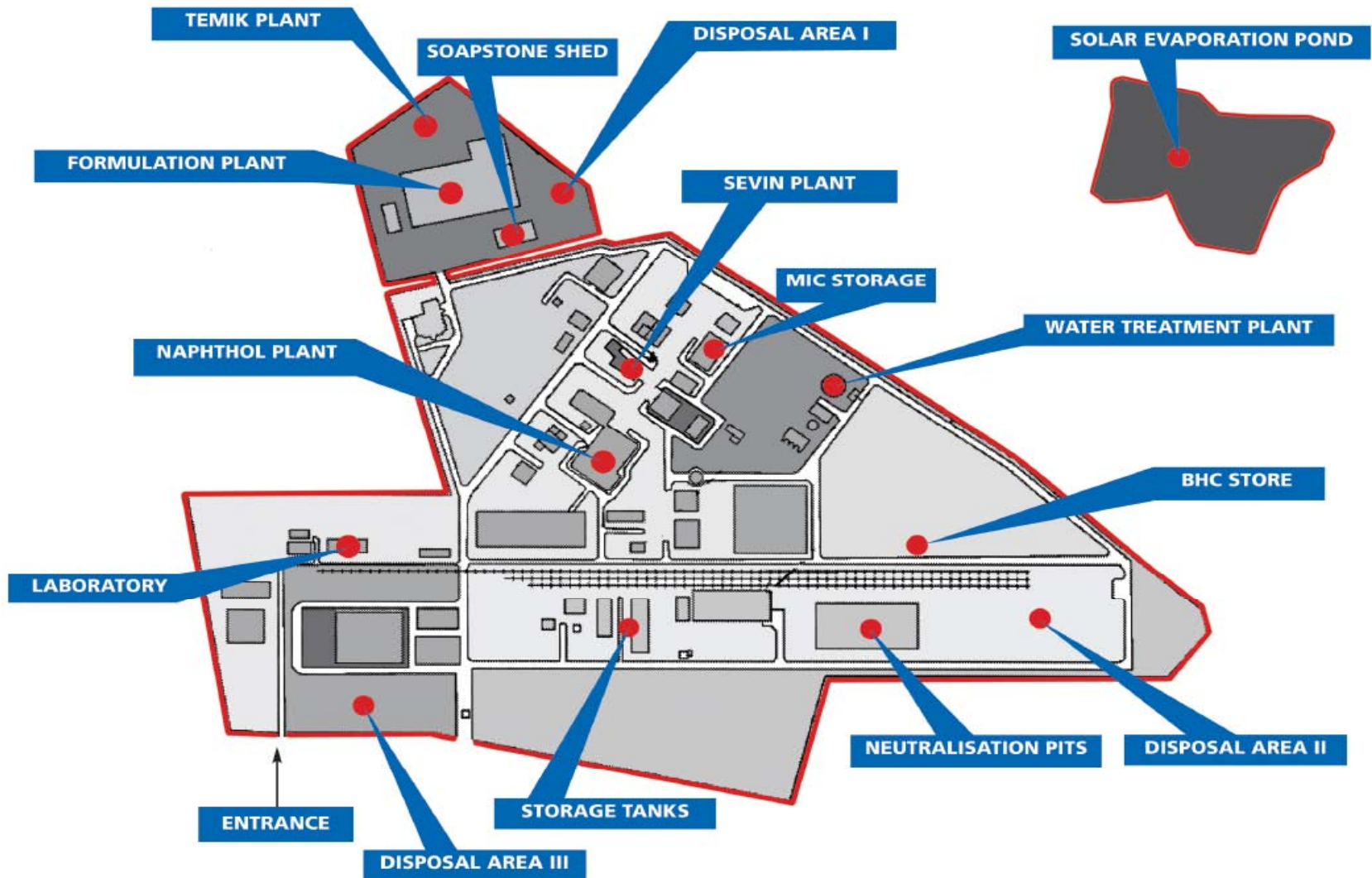
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- Soil inside the UCIL site is found contaminated in all studies
  - Similar places are heavily contaminated
  - Organic chemicals and heavy metals found are similar in most studies
  - Contamination levels varied and maximum concentration of key contaminants is too high
  - Contaminants can be traced back to the production process at UCIL





# Contaminated Areas at UCIL







# Key Contaminants Found

	IITR, 2013	NEERI-NGRI, 2010	CSE, 2009	CPCB, 2009
<b>Organic contaminants</b>				
Carbaryl	√	√	√	√
Aldicarb	√	√	√	√
HCH isomers	√	√	√	√
Chlorinated benzenes	√	√	√	√
<b>Heavy metals</b>				
Mercury	√	√	√	√
Lead	√	√	√	√
Chromium	√	√	√	√



# Maximum Concentration

Key contaminants	Maximum concentration found in soil from specific places* (ppm)
<b>Organic contaminants</b>	
Carbaryl	51,003
Aldicarb	7,876
Dichlorobenzenes	2,049
HCH isomers	99,700
Alpha naphthol	9,914
<b>Heavy metals</b>	
Mercury	1,28,000
Lead	406
Chromium	1,065

\* Specific places include storage, processing and dump areas



# Groundwater Contamination

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- Most studies found groundwater in surrounding areas to be contaminated with organic contaminants
  - Contamination is found more towards the reported direction of the groundwater flow, i.e. north-east
  - Several contaminants could be linked to the production process at the erstwhile UCIL plant
- Heavy metals such as mercury, lead, chromium, manganese, zinc, nickel and copper were found in some studies (IITR, CPCB, certain NGOs)



# Contaminated Areas Around UCIL





# Key Organic Contaminants

	IITR, 2013	NEERI-NGRI, 2010	CSE, 2009	CPCB, 2009
Carbaryl	x	x	√	x
HCH isomers	√	x	√	√
Chlorinated benzenes	√	x	√	√

- In general, NEERI-NGRI report of 2010, did not reported groundwater contamination stating low permeability of the black and yellow silty soil ( $10^{-9}$  cm/sec). The limited contamination found in downstream areas was attributed to surface runoff



## Maximum Concentration Found

<b>Key organic contaminants</b>	<b>Maximum concentration found in water (ppb)</b>
Carbaryl	28
Dichlorobenzenes	2,875
HCH isomers	40



# Toxic Waste at the UCIL site and SEP

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- Huge amount of waste is known to be dumped by the UCIL during 1969–84
- Limited testing is done on this waste dumped at the UCIL site and SEP area (secured landfill in particular)
  - Results of testing in the SEP area are largely contrary. A detailed study is needed



# Waste dumped during 1969–1984

Chemicals: key contaminants	Quantity (MT)
Aldicarb	2
Alpha naphthol	50
Carbaryl	50
Carbon tetrachloride	500
Mercury	1
Naphthalene	50
Ortho dichlorobenzene	500

Source: T. R. Chauhan, Former Plant Operator, UCIL





# Plant, machinery and structure at UCIL

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- IICT's technical and tender document proposed:
  - Dismantling after in-situ detoxification
  - Dismantling to begin with pipelines followed by the equipments and finally the structure
  - Decommissioning after detoxification which should be done by cutting components into pieces to make them unfit for reuse



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# Annexure



# Organic Contamination in Soil (ppm) (1/3)

	IITR, 2013	NEERI-NGRI, 2010	CSE, 2009	CPCB, 2009	Greenpeace, 2002	Fact finding mission, 2001-02	Greenpeace, 1999	NEERI, 1997
<b>Temik plant</b>	0.366 (Car) 0.809 (HCH) 0.324 (DCB)	24.3 (Car) 923 (Ald) 36.36 (HCH) 0.000097 (DCB) 42.7 (Nap)	29.17 (HCH) 4.94 (TCB)	0.03 (Ald) 21.17 (HCH)	Not tested	Not tested	Not tested	
<b>Formulation plant</b>	0.295 (Car) 2572.67 (HCH) 3.774 (Nap)	1.3 (Car) 3.734 (Ald) 1.152 (HCH) 1.9(Nap)	7.5 (Car) 190.7 (Ald) 3119.4 (HCH) 2048.5 (DCB) 507.0 (TCB)	5.25 (Car) 6193 (HCH)	0.001122 (Car) 99700 (HCH)	Not tested	Detected (HCH)	
<b>Soapstone shed</b>	0.201 (Car) 1.431 (HCH) 0.209 (DCB) 2.186 (Nap)	24.6 (Car) 0.76 (HCH) 14.94 (Nap)	Not tested	Not tested	0.001839 (Car) 38.5 (HCH)	Not tested	Not tested	
<b>Sevin plant</b>	0.172 (Car) 0.39 (HCH) 0.15 (Nap)	0.126 (Car) 0.77 (HCH) 0.000017 (DCB) 0.54 (Nap)	412.83 (HCH) 26.93 (DCB) 23.72 (TCB)	13.468 (HCH)	0.000083 (Car) 5010 (HCH)	1.6878 (HCH) 0.1292 (DCB) 0.1927 (TCB)	Detected (HCH)	
<b>MIC storage</b>	0.286 (Car) 0.018 (HCH) 3.549 (Nap)	18.3 (Car) 3.778 (Ald) 0.118 (DCB) 0.267 (Nap)	Not tested	Not tested	Not tested	Not tested		

Not tested (mentioned wherever specified or is inferred). NEERI 1997 report primarily segregates the entire area into three disposal areas and rest of the area



# Organic Contamination in Soil (ppm) (2/3)

	IITR, 2013	NEERI-NGRI, 2010	CSE, 2009	CPCB, 2009	Greenpeace, 2002	Fact finding mission, 2001-02	Greenpeace, 1999	NEERI, 1997
<b>BHC store</b>	1.004 (Car) 36.783 (HCH) 0.918 (DCB) 3.195 (Nap)	2.48 (Car) 6.17 (HCH) 1.55 (Nap)	Not tested	Not tested	0.000962 (Car) 22100 (HCH)	Not tested	Not tested	
<b>Water treatment plant</b>	0.588 (Car) 4.733 (HCH) 2.499 (DCB) 5.612 (Nap)	0.174 (Car) 1.037 (HCH) 0.000013 (DCB) 0.511 (Nap)	Not tested	Not tested	Not tested	Not tested	Not tested	
<b>Neutralisation pits</b>	0.504 (Car) 0.01 (HCH) 0.203 (DCB) 1.588 (Nap)	10729 (Car) 3.884 (Ald) 13.34 (HCH) 0.165 (DCB) 1460 (Nap)	Not tested	Not tested	Not tested	Not tested	Detected (HCH) Detected (DCB)	53 (Car) 5105 (Ald) 23 (Nap)
<b>Storage tanks</b>		2.43 (HCH)			Not tested	Not tested		
<b>Laboratory</b>	0.127 (Car) 9.368 (HCH)	10.77 (Car) 0.31 (HCH) 0.11 (DCB) 32.9 (Nap)	Not tested	Not tested	Not tested	Not tested	Not tested	
<b>SEP</b>		6.88 (Car) 8.15 (Ald) 2.55 (HCH) 3.51 (Nap)	19.83 (HCH) 2.68 (DCB)	0.137 (Car) 1.479 (HCH)	87.5 (DCB) 59 (Nap)	0.0358 (HCH) 0.1215 (DCB)		

Not tested (mentioned wherever specified or is inferred). NEERI 1997 report primarily segregates the entire area into three disposal areas and rest of the area



# Organic Contamination in Soil (ppm) (3/3)

	IITR, 2013	NEERI-NGRI, 2010	CSE, 2009	CPCB, 2009	Greenpeace, 2002	Fact finding mission, 2001-02	Greenpeace, 1999	NEERI, 1997
Disposal Area I								51003 (Car) 116 (Ald) 210 (HCH) 9914(Nap)
Disposal Area II			56.17 (Ald) 1162.19 (HCH) 2.35 (DCB)	333.5 (Car) 269.12 (HCH) 6.34 (DCB)				4162 (Car) 7876 (Ald) 82 (HCH) 1024 (Nap)
Disposal Area III	Not tested	Not tested	Not tested	Not tested	Not tested	Not tested	Not tested	462 (Car) 58 (Nap)

Not tested (mentioned wherever specified or is inferred). NEERI 1997 report primarily segregates the entire area into three disposal areas and rest of the area



# Heavy Metals Found in Soil (ppm) (1/2)

	IITR, 2013	NEERI-NGRI, 2010	CSE, 2009	CPCB, 2009	Greenpeace, 2002	Fact finding mission, 2001-02	Greenpeace, 1999	NEERI, 1997
<b>Temik plant</b>	0.084 (Hg) 29.614 (Cr) 88.583 (Pb)	2.22 (Cr) 4.3 (Pb)	74.14 (Hg) 297.7 (Cr) 111.78 (Pb)	48.48 (Hg) 343 (Cr) 92 (Pb)	Not tested	Not tested	Not tested	
<b>Formulation plant</b>	3.568 (Hg) 145.08 (Cr) 26.031 (Pb)	1.29 (Hg) 2.32 (Cr) 4.29 (Pb)	108.4 (Cr)	2.87 (Hg) 183 (Cr) 42 (Pb)	Not tested	Not tested	2.6 (Hg) 85.7 (Cr) 19.4 (Pb)	
<b>Soapstone shed</b>	1.547 (Hg) 26.186 (Cr) 24.047 (Pb)	2.1 (Hg) 2.97 (Cr)	Not tested	Not tested	Not tested	Not tested	Not tested	
<b>Sevin plant</b>	0.088 (Hg) 24.977 (Cr) 30.545 (Pb)	1.83 (Cr) 6.64 (Pb)	8188.33 (Hg) 192.13 (Cr) 84.05 (Pb)	7995.83 (Hg) 451 (Cr) 95 (Pb)	Not tested	0.152 (Cr)	128000 (Hg) 480.7 (Cr) 174.6 (Pb)	
<b>MIC storage</b>	31.751 (Pb)	0.1 (Hg) 3.04 (Cr) 0.98 (Pb)	Not tested	Not tested	Not tested	Not tested	Not tested	
<b>BHC store</b>	3.541 (Hg) 30.012 (Cr) 25.458 (Pb)	4.17 (Hg) 3.02 (Cr) 5.99 (Pb)	Not tested	Not tested	Not tested	Not tested	Not tested	
<b>Water treatment plant</b>	0.242 (Hg) 37.197 (Cr) 25.263 (Pb)	2.41 (Cr) 4.62 (Pb)	Not tested	Not tested	Not tested	Not tested	Not tested	

Not tested (mentioned wherever specified or is inferred). NEERI 1997 report primarily segregates the entire area into three disposal areas and rest of the area



# Heavy Metals Found in Soil (ppm) (2/2)

	IITR, 2013	NEERI-NGRI, 2010	CSE, 2009	CPCB, 2009	Greenpeace, 2002	Fact finding mission, 2001-02	Greenpeace, 1999	NEERI, 1997
Neutralisation pits	0.098 (Hg) 29.106 (Cr) 24.46 (Pb)	3.07 (Hg) 3.97 (Cr) 7.58 (Pb)	Not tested	Not tested	Not tested	Not tested	8.1 (Hg) 520.8 (Cr) 406.3 (Pb)	101 (Cr) 11 (Pb)
Laboratory	0.089 (Hg) 34.745 (Cr) 40.547 (Pb)	1.98 (Cr) 2.41 (Pb)	Not tested	Not tested	Not tested	Not tested	Not tested	
Naphthol plant	0.255 (Hg) 38.811 (Cr) 30.926 (Pb)	0.41 (Hg) 3.8 (Cr) 2.03 (Pb)	Not tested	Not tested	Not tested	1.898 (Hg)	Not tested	
Cycle shed			Not tested	Not tested	Not tested	0.0206 (Cr)	Not tested	
SEP	0.114 (Hg) 40.809 (Cr) 95.73 (Pb)	0.30 (Hg) 5.21 (Cr) 3.53 (Pb)	18 (Hg) 1064.57 (Cr) 22.34 (Pb)	28.13 (Hg) 1110 (Cr)	0.1 (Hg) 96 (Cr) 12 (Pb)	0.5269 (Cr) 0.2767 (Pb)	1.1 (Hg) 73 (Cr) 17 (Pb)	
Disposal Area I	Not tested	Not tested	Not tested	Not tested	Not tested	Not tested	Not tested	61 (Cr) 11 (Pb)
Disposal Area II			1064.61 (Hg) 86.18 (Cr) 46.39 (Pb)	557.53 (Hg) 112 (Cr) 22 (Pb)	Not tested			58 (Cr) 10 (Pb)
Disposal Area III					Not tested			36 (Cr) 7 (Pb)

Not tested (mentioned wherever specified or is inferred). NEERI 1997 report primarily segregates the entire area into three disposal areas and rest of the area





# Organics in Groundwater (ppb)

(1/2)

	IITR, 2013	CSE, 2009	CPCB, 2009	Fact finding mission, 2001-02	Greenpeace, 1999
J. P. Nagar	Not tested	3.1 (HCH) 0.0008 (DCB) 11.3 (Car)	0.11 (HCH)	1.8 (HCH) 9.4 (DCB)	50 (DCB)
Nawab Colony	0.688 (HCH) 2.027 (DCB)	0.4 (HCH) 0.3 (DCB)	0.72 (HCH)	1.3 (HCH) 1.2 (DCB)	2875 (DCB)
Shiv Shakti Nagar	0.251 (HCH) 9.917 (DCB)	Not tested	Not tested	Not tested	
Blue moon Colony	0.991 (HCH) 3.621 (DCB)	0.6 (HCH) 0.7 (DCB) 0.2 (Car)	Not tested	Not tested	
Atal Ayub Nagar		1.1 (HCH) 0.5 (DCB) 0.8 (Car)	0.12 (HCH) 651.91 (DCB)	2.7 (HCH) 0.8 (DCB)	
Anu Nagar	4.249 (DCB)	0.5 (HCH) 0.4 (DCB)	Not tested	40.2 (HCH) 10.4 (DCB)	Not tested
Kainchi Chhola	6.375 (DCB)	Not tested	0.56 (HCH)	3.2 (HCH) 14.7 (DCB)	Not tested
Arif Nagar	0.029 (HCH)	Not tested	Not tested	Not tested	Not tested

Not tested (mentioned wherever specified or is inferred)





# Organics in Groundwater (ppb)

(2/2)

	IITR, 2013	CSE, 2009	CPCB, 2009	Fact finding mission, 2001-02	Greenpeace, 1999
Prem Nagar	0.576 (HCH) 5.651 (DCB)	1.7 (HCH) 0.5 (DCB)	Not tested	Not tested	Not tested
Navjeevan Colony	0.388 (HCH) 8.271 (DCB)	Not tested	Not tested	Not tested	Not tested
Garib Nagar		1.4 (HCH) 0.9 (DCB)	0.4752 (HCH)	Not tested	Not tested
Sundar Nagar	Not tested	0.8 (HCH) 0.4 (DCB)	0.0804 (HCH)	Not tested	Not tested
New Arif Nagar		1.2 (HCH) 0.5 (DCB) 27.6 (Car) 0.5 (Ald)	Not tested	3 (HCH)	Not tested
Shakti Nagar	5.04 (DCB)	Not tested	Not tested	36.7 (HCH)	Not tested
Preet Nagar	6.411 (DCB)	Not tested	Not tested	Not tested	Not tested
Shiv Nagar	8.751 (DCB)	3.5 (DCB)	Not tested	Not tested	Not tested
Indira Nagar		Not tested	0.1038 (HCH)	Not tested	Not tested

Not tested (mentioned wherever specified or is inferred).



# Heavy Metals in Groundwater (ppb) (1/2)

	CSE, 2009	CPCB, 2009	Fact finding mission, 2001-02	Peoples Science Institute, 2001
J. P. Nagar		1590 (Zn) 100 (Mn)	14.9 (Cr) 744.7(Ni) 49.7 (Pb)	Not tested
Nawab Colony	90 (Cd) 1220 (Pb)	50 (Cu) 1810 (Zn) 350 (Mn)	9.5 (Cr) 1800 (Ni) 11.7 (Pb)	42 (Hg)
Atal Ayub Nagar		30 (Cu) 40 (Zn)	11.7 (Cr) 1875 (Ni)	
Anu Nagar	Not tested	Not tested	293.9 (Hg) 10.7 (Cr) 903.6 (Ni) 1.3 (Pb)	70 (Hg)
Kainchi Chhola	Not tested	400 (Zn) 20 (Mn)	21 (Cr) 941.7 (Ni) 54.8 (Pb)	Not tested
Garib Nagar	Not tested	550 (Zn) 40 (Mn)	Not tested	24 (Hg)
Sundar Nagar	Not tested	480 (Zn) 20 (Mn)	Not tested	Not tested

Not tested (mentioned wherever specified or is inferred).



## Heavy Metals in Groundwater (ppb) (2/2)

	CSE, 2009	CPCB, 2009	Fact finding mission, 2001-02	Peoples Science Institute, 2001
<b>New Arif Nagar</b>	Not tested	Not tested	119.7 (Hg) 5.7 (Cr) 1080 (Ni) 39.8 (Pb)	40 (Hg)
<b>Shakti Nagar</b>	Not tested	Not tested	31.7 (Hg) 12.6 (Cr) 715.5 (Ni) 11.3 (Pb)	Not tested
<b>Shiv Nagar</b>	24 (Hg)	Not tested	Not tested	Not tested
<b>Indira Nagar</b>	Not tested	130 (Zn) 2770 (Mn)	Not tested	Not tested
<b>Panchwati</b>	Not tested	730 (Zn) 20 (Mn)	Not tested	Not tested
<b>Chhola Naka</b>	Not tested	280 (Zn) 20 (Mn)	Not tested	Not tested
<b>SEP</b>		Not tested	34.3 (Hg) 11.6 (Cr) 186.1 (Ni) 32.1 (Pb)	Not tested

Not tested (mentioned wherever specified or is inferred).