Unfolding Disaster:
A Study of Chemplast Sanmar's Toxic Contamination in Mettur

Community Environmental Monitoring & Corporate Accountability Desk
Programs of the Other Media

November 2007

Acknowledgements:
Gonur West Agriculturist's Development Union
Piyush Sethia, SpeakOut Salem!
Dr. Mark Chernaik, Staff Scientist, ELAW-US
Environmental Law Alliance-US
Ruth Stringer, Independent Scientist
Dr. Rakhal Gaitonde, Community Health Cell, Chennai
V. Mayilsami, Chairman, P.N Patti, PMK
A. Marimuthu, Ward Councillor, P.N. Patti
P.N. Patti Panchayat
T.S.Mani, Periyar Dravida Kazhagam
Association for India's Development, Austin, Texas
Global Greengrants Fund
Global Community Monitor
Marisla Foundation

Written by: Lakshmi Premkumar
Edited by: Nityanand Jayaraman

Sampling Team:
Dharmesh Shah
Shweta Narayan
Lakshmi Premkumar
Jeny Dolly Anthony
Nityanand Jayaraman
Piyush Sethia
Ruth Stringer

Special thanks to Ruth Stringer and Mark Chernaik for their scientific inputs and oversight, and to ELAW-US for their techno-legal advice and assistance with funding.

Photo: Nityanand Jayaraman, Shweta Narayan, Dharmesh Shah

Design & Layout: Think Communication

Cover: Art by Blodsow

Cover Design: Sibi Arasu

Corrigendum (09 July, 2009)

Due to a genuine human error, the guideline value as per State of Washington was incorrectly given for three chemicals - Bis(2-ethylhexyl)phthalate, Hexachlorobenzene and Hexachlorobutadiene. The appropriate corrections have been made and the following is a completely corrected version.

Addendum (12 November, 2007)

Fresh results received on 8 November, 2007, confirm the presence of high levels of dioxins and furans in Mettur's environment. A composite sample of soil and sediment taken from two rainwater drains emptying into a stream that ends up in the River Kaveri was found to contain 6.7 nanogram/kg of total dioxins and furans. [See Annexure 5] This is at least 8 times higher than Canadian interim sediment quality standards of 0.85 ng/kg. Dioxins and furans belong to a category of chemicals known to contain some of the most toxic chemicals known to science.

The very presence of dioxins and furans is cause for concern. The fact that these chemicals were found in water courses that empty into the River Kaveri has serious implications for agriculture, dairy industry and fisheries. Dioxins and furans are persistent in the environment. They accumulate in the fatty tissue of living organisms growing in quantity within the fat over the lifetime of the organism. Levels of these chemicals also increase as one goes up the food chain as predators higher up in the food chain feed on several smaller organisms thereby absorbing their combined body burden of dioxins and furans. Levels in predatory fish and in the milk and meat of goats and cows feeding of contaminated areas can be passed on to humans through the food chain.

On October 16, 2007, Specialty Analytical – the Oregon, US-based laboratory that performed the analyses of samples taken from Mettur – sent a composite sample of sediment/soil taken from two locations, namely Sample CP07004 and CP07006, to Pace Analytical Services, Minneapolis, for dioxin/furan analysis. The above two samples were stored by Specialty as per their routine protocol to allow their clients to opt for additional testing. The composite sample was analyzed for the presence or absence of polychlorodibenzo-p-dioxins (PCDDs) and polychlorodibenzofurans (PCDFs) using a modified version of USEPA Method 8290.

These two samples were considered to be good candidates for dioxin analysis because CP07004 has moderate levels of hexachlorobenzene (HCB) and hexachlorobutadiene (HCBD) -- at 819 and 164 ppb respectively -- and Sample CP07006 has relatively high levels of di-and tri-chlorobenzenes (>5 ppm cumulatively). The presence of higher chlorinated aromatics such as HCB and HCBD, and chlorobenzenes in substantial quantities is an indicator of the likely presence of dioxins. Also, PVC factories are known sources of dioxins.

A detailed study focusing on dioxin contamination in and around Chemplast's PVC factory, and particularly on the river downstream of the factory's effluent outfall in Kaveri is an urgent need.

The original lab report in its entirety can be downloaded from the Reports section of www.sipcotcuddalore.com.

Executive Summary:

In 2007, Mettur-based West Gonur Farmers Welfare Association contacted Chennai-based Community Environmental Monitoring to verify:

1. whether the "treated" waste water discharged legally to the River Kaveri by Chemplast Sanmar Ltd's PVC factory was safe,
2. whether any other illegal channel existed through which toxic effluents were being released into the environment, and
3. whether reports of toxic contamination of well water were true.

The District Administration and the Tamilnadu Pollution Control Board (TNPCB) have routinely responded to people's complaints about pollution by stating that the only discharge of effluents is through the legally approved pipeline, and that this discharge is within safe limits. Tests conducted by the TNPCB and other agencies on well water have only analysed for simple parameters such as dissolved salts and electrical conductivity. Reports of contamination of groundwater by organic chemicals have not been looked into to this date.

In Mettur, Chemplast produces chemicals such as chlorine, caustic soda (through the mercury route), chloromethanes, ethylene dichloride (EDC), vinyl chloride monomer (VCM), Poly Vinyl Chloride (PVC), and chloro fluoro carbons.

In July 2007, Community Environmental Monitoring sent samples of effluents, well water, sediment and soil from in and around Chemplast's chemicals manufacturing complex for scientific analyses at a United States Environmental Protection Agency (USEPA)-approved laboratory in Oregon, U.S.A.

The results revealed that Chemplast's operations have and are contributing to the widespread contamination of Mettur's environment with mercury and a host of toxic chlorinated chemicals, including potentially dioxins. Also, the results of analyses are conclusive that Chemplast's treated wastewater contains unsafe levels of toxic chemicals, and that well and borewell water were indeed contaminated by a host of synthetic poisons. While evidence is conclusive that channels other than the legally approved pipeline have been used to discharge toxic effluents, it is unclear whether the contamination found in these channels and natural drainages was a result of historical or ongoing discharges of effluents.

Undertaken at the request of the West Gonur Farmers Association, the exercise detected 52 chemicals in the nine samples taken in Mettur. Of these, 15 chemicals were found to be above one or more of four safety levels prescribed by various international regulatory agencies.

These chemicals are:

- Mercury
- 1,2,4-trichlorobenzene
- 1,2-Dichlorobenzene
- 1,4-Dichlorobenzene
- Hexachlorobenzene
- Bis(2-chloroethyl)ether
- Chlorobenzene
- 1,1,2-Trichloroethane
- Ethylene Dichloride
- Benzene
- Vinyl Chloride
- Chloroform
- Methylene Chloride
- Tetrachloroethane
- Trichloroethane

Ten of the 15 chemicals are known to cause cancer in humans and/or animals.

The presence of hexachlorobenzene (HCB) in the sediment taken from an open stormwater course between Chemplast's Plant II and Plant III, and the high levels of dichlorobenzenes found in the stormwater drain leaving Plant II is cause for serious concern. These indicate a high likelihood of the presence of dioxins and furans, some of the most toxic chemicals known to science. Also, HCB is a Persistent Organic Pollutant (POP) – a category of chemicals identified for global phase out under the Stockholm Convention owing to their persistent and highly toxic nature. POP chemicals include some of the most poisonous and unmanageable chemicals – such as HCB, dioxins and furans -- known to science.

Even more alarming is the fact that very high levels of poisons, such as chloroform and methylene chloride, tetrachloroethane and vinyl chloride were found in the water from a 500 foot borewell. This confirms the fact that groundwater contamination has seeped to very great depths.

The nature and extent of contamination, seen in light of the other evidence of pollution in Mettur provides sufficient cause to nominate Mettur as a global Toxic Hotspot that qualifies for inclusion in the list of "critically polluted areas" of the Central Pollution Control Board.

All samples were taken on 24 July, 2007 in the presence of an elected local Government official, members of the farmers' association, and a trained scientist with specialisation in chlorine chemistry. The findings are in line with earlier studies conducted on Mettur's environment, and with what can be expected to be found in the environment around plants manufacturing chlorinated organic chemicals, including PVC. The chemicals found are those used in the manufacturing process or those that are released as by-products or end-products during the manufacturing process. However, their presence at such high levels in the environment around the industry and surrounding areas show that precautionary measures in handling and disposing the toxic chemicals are not followed.

Most chlorinated organic compounds are toxic pollutants. Many of them are persistent, do not break down easily, and have a tendency to accumulate in animal tissue. The concentrations of the chemicals get higher as they move up the food chain. The presence of such chemicals in the environment is of particular concern to the economy of Mettur, in which agriculture and fishing continue to play an important role.

Official reports, including those from the Tamilnadu Pollution Control Board, in the possession of the West Gonur Farmers Association confirm widespread contamination of wells in Gonur, Veerakalpudur and P.N. Patti panchayats. However, none of these reports tested for any of the chlorinated organic chemicals that can be expected from facilities such as those run by Chemplast in Mettur.

In 1996, a Greenpeace study[1] reported the presence of chemicals such as mercury in sediments below the chloralkali plant effluent discharge point into the Kaveri at more than 500 times than what is expected in uncontaminated river sediments.

PVC factories are a well-known source of hazardous organochlorines, including dioxins. The Greenpeace study reported the presence of hexachlorobutadiene, among other chemicals, in the effluents and sediment from the PVC plant at the point of discharge into River Kaveri. HCBD is a known animal carcinogen and indicates the presence of dioxins.

On April 5, 2005, Chennai based Community Environmental Monitoring took an air sample from the vicinity of Chemplast Sanmar's PVC effluent discharge point in the River Kaveri. Four of the compounds found in the sample are manufactured in one or other Chemplast units. These include: vinyl chloride, ethylene dichloride (EDC), methylene chloride and chloroform. All four are animal and/or human carcinogens. EDC was more than 32,000 times above a US Environmental Protection Agency (USEPA) safety level. Vinyl chloride was 2100 times above safety level, and hydrogen sulphide was 400 times more than levels above which health effects occur.[2] Benzene, chloroform and methylene chloride were also found above regulatory levels set by the USEPA. India has no prescribed standards for most of these pollutants in ambient air.

In 2005, the Indian Peoples Tribunal (IPT)[3] described "the appalling scenario prevalent in Mettur of indiscriminate disposal and mismanagement of hazardous wastes and the resultant devastation of environment and public health at Mettur." The report also brought to light the apathy and callousness with which the concerned authorities, government and industry officials dealt with pollution related complaints and issues.

Given that the first evidence of the discharge of highly toxic effluents by Chemplast into the River Kaveri emerged in 1997, more than a decade ago, it is unfortunate that the plant continues its discharge unchecked. The widespread presence of mercury in the vicinity of the Stanley Reservoir, a waterbody of critical importance, the continued discharge of persistent organic pollutants into the River Kaveri and the high levels of toxic chemicals such as chloroform and benzene found in groundwater points to potentially irreversible damage to the local environment and community health. This damage may extend beyond Mettur to those relying on Kaveri water for drinking and agriculture, and those consuming agricultural produce and fish from these areas.

---

[1] *"The Stranger-The Chlorine Industry In India", Greenpeace International, 1996. Page 21 & 66*
[2] *"The Indian People's Tribunal report- on Environmental and Human Rights Violations by Chemplast Sanmar and MALCO industries at Mettur, Tamil Nadu", Indian People's Tribunal on Environmental and Human Rights, 2005. Page 16*
[3] *Indian People's Tribunal Report, 2005. Page 1*

Most research has been done on the effects of individual chemicals on the human body. However, in real life, humans are usually exposed to cocktails of chemicals. While the focus of the discussions in this study has been on the chemicals found above standards, the mere presence of highly toxic and persistent chemicals like pentachlorophenol and hexachloroethane is cause for concern.

"The widespread presence of excessive levels of at least 15 chemicals with known harmful effects, and the possible combined effect of long-term exposure to a cocktail of 52 chemicals albeit at low concentrations points to nothing less than a potential public health disaster," according to Dr. Rakhal Gaitonde, a public health expert who reviewed the report. "Unless this dangerous situation is addressed urgently, there is potential for serious, unpredictable and potentially irreversible consequences, as well as long term damage to the environment, livelihoods, food and water security," he concludes.

Based on the evidence generated by the current study, and other studies to this date, it would be prudent to apply the precautionary principle by taking immediate steps to do the following:

1. End discharge of effluents into the River Kaveri
2. Conduct a comprehensive and independent assessment of the spread and depth of contamination, including of groundwater, water courses leading from the factory to the River Kaveri, of environment and fish downstream of Chemplast's effluent discharge point, and of reservoir and reservoir fisheries. The assessments should be conducted with a particular focus on persistent, bioaccumultative poisons such as dioxins and furans, and mercury.
3. Initiate a comprehensive clean-up involving local communities.
4. Assess impact of pollution on the health of people in Mettur. Set up a long-term health monitoring and remediation infrastructure to identify and assist affected persons at the cost of the polluter.
5. Arrange for immediate delivery of clean water for domestic purposes to affected communities and recover costs from the polluter.
6. Initiate legal action and criminal prosecution of the polluter for negligent handling of chemicals and violation of environmental regulations.
7. Set up and enforce standards for organohalogens in various relevant media, including, soil, air, sediment, effluents and water.
8. The Central Pollution Control Board should declare Mettur a "Critically Polluted Area."
9. The Kaveri Government Order prohibiting the expansion or setting up of new polluting industries should be implemented earnestly.
10. Strengthen public health systems to undertake research and treatment of these pollution related problems.

Introduction

Mettur literally means 'town on the hills.' Once an agricultural area, Mettur now hosts a number of chemical industries and a dam. The River Kaveri, the life line of north and central Tamilnadu, enters the south Indian state through Mettur.

According to the 2001 Census of India, Mettur had a population of 3,78,337 with an average literacy rate of 56 percent. Agriculture, fishing and industries are the main contributors to the economy. The 2001 Census registers that half the population i.e., 49 percent, directly depends on agriculture for their income.

The Mettur Dam which forms the Stanley Reservoir was built in 1934, across a gorge where the River Kaveri enters the plains. It is a major source of drinking water. According to Professor Janakarajan, Madras Institute of Development Studies, the Kaveri irrigates 24 lakh acres of land across central and eastern Tamilnadu.

Bloody riots over the sharing of Kaveri's waters between the riparian states of Tamil Nadu and Karnataka are an annual feature. However, this is not the only source of conflict concerning Kaveri's waters. Throughout Kaveri's course in Tamilnadu, farmers are up in arms against polluting industries that use this river as a dump for effluents.

Stretches of the Kaveri are deemed to be among the "most polluted zones of the state," according to a State of Environment of Tamilnadu report released in 2005.[4] At least 1100 industries operate in the Kaveri basin, according to a Tamilnadu Pollution Control Board (TNPCB) survey mentioned in the State of Environment report. The estimated waste water discharge is 16.2 crore litres per day (lpd). Of that, 870 lakh lpd is discharged directly into the Kaveri. Salem district, with 640 lakh lpd, followed by Trichy (57,64,000 lpd) are the largest contributors of effluent to the Kaveri, according to the report.

A Government order[5] dated 8.5.98 stipulates that no permission should be granted to establish water polluting or "Red" category factories within 5 km of notified rivers, including the Kaveri and its tributaries, in Tamil Nadu. This order has had no effect in curtailing expansion of polluting industries or the setting up of new ones near Kaveri. The three largest companies in Mettur, namely Chemplast, Madras Aluminum Company and the Mettur Thermal Power Plant, have all expanded their projects in recent years in violation of the Government Order.

Industries in Mettur

Among the first things that greet the Kaveri as she enters Tamilnadu at Mettur is the toxic effluents from more than half a dozen major industrial operations including five units owned by Chemplast Sanmar, one owned by MALCO, and two thermal power plants owned by MALCO and Tamilnadu Electricity Board.

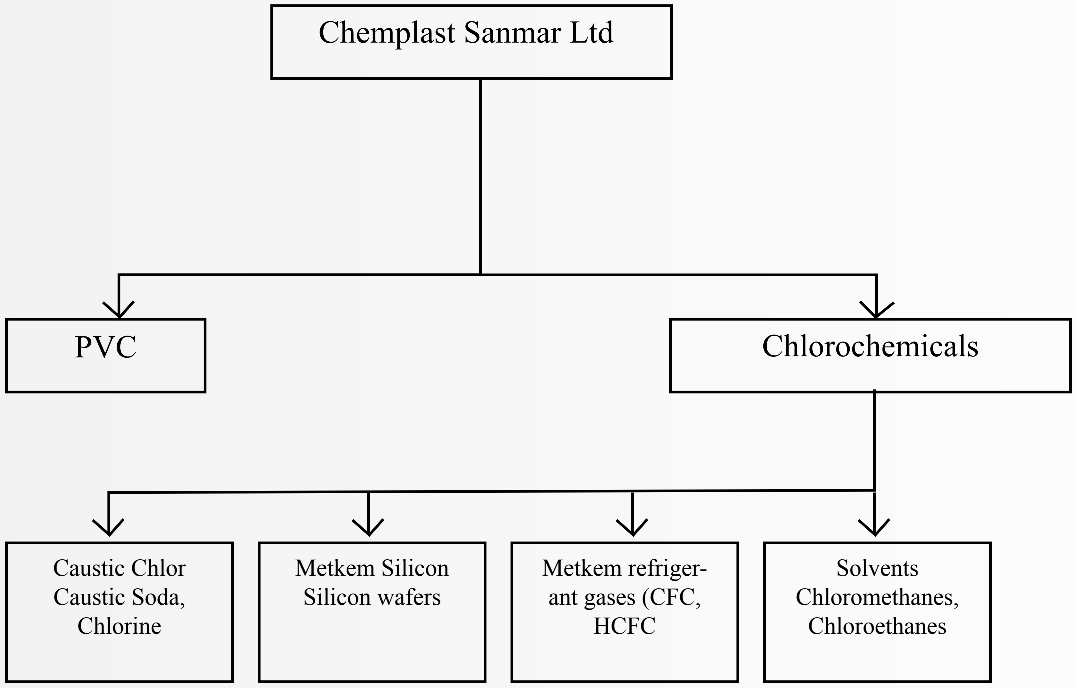
Industrialisation in Mettur began as early as 1936, when Mettur Chemicals and Industries Corporation (MCIC), now Chemplast Sanmar, set up India's first caustic chlorine factory. Over the years, Chemplast Sanmar added a range of facilities including a chloromethanes plant, and a PVC plant including units to produce ethylene dichloride (EDC) and vinyl chloride monomer (VCM). Madras Aluminum Company (MALCO) set up a refinery-cum-smelter near the reservoir in 1965. A number of chemical industries were set up on the banks of the River Kaveri in Mettur as part of Small Industries Development Corporation (SIDCO) industrial estate.

Most of the industries are clustered around three Panchayats (units of local self-government) – P.N. Patti, Veerakalpudur and Gonur. The combined population of these Panchayats is 55,855.

Chemplast's Plant 2 and Plant 3 are the key units dealing with chlorine and chlorinated organic chemicals. Plant 2 manufactures ethylene di chloride, vinyl chloride monomer and poly vinyl chloride. Plant 3 manufactures chlorinated solvents such as carbon tetrachloride, methylene chloride, chloroform and chlorine and caustic soda through the mercury cell route.

[4] *"State of Environment of Tamil Nadu", Dr. S. Balaji, IFS, Department of Environment, Government of Tamil Nadu. Undated. Release date: 2005. http://www.environment.tn.nic.in/soe/soe_report.htm. Downloaded 3 October, 2007.*
[5] *G.O. Ms. No. 127, Department of Environment and Forest, Government of Tamil Nadu, 08.05.1998*

Chemplast Sanmar & its units in Mettur
Diagram no.1



Production Capacity at Chemplast Sanmar Ltd.
Table no.1

Plant	**Product**	**Capacity T/A**
2	EDC	78160
	VCM	68640
	PVC	66000
3	Caustic Soda	43680
	Chlorine	38700
	30% HCL	50880
	Methyl Chloride	1200
	Methylene Chloride	9408
	Chloroform	7056
	Carbon Tetrachloride	7728
	Silicon Tetrachloride	1008
	Trichloroethylene	4950
	Perchloroethylene	77.52
	Dichloroethylene	48
	Tetrachloroethane	6326.76

Source: Tamilnadu Pollution Control Board

Samivelu was exposed during a chlorine gas leak in 2004 from Chemplast Plant 3 when he was 22 days old; his physical development is retarded and he continues to consume large quantities of medicines to date.

Studies conducted in Mettur

Since the early 1960s, local communities have reported incidents of pollution and pollution induced damage to agriculture and the health of livestock as well as humans. In a few instances, they have also been awarded compensation for affected land and wells.[6] Over the last five decades, numerous complaints have been filed. Several agencies have analysed well water and soil quality. A 1995 sampling exercise by the Soil Testing Laboratory, Salem, confirmed the degradation of all 51 irrigation wells sampled in the vicinity of Chemplast.[7]

A 1996 Greenpeace study[8] reported the presence of chemicals such as mercury in sediments below the chloralkali plant effluent discharge point, at more than 500 times the levels that are expected in uncontaminated river sediments. Two other samples taken from two effluent streams discharging to an open channel ultimately leading to the Kaveri contained 1.09 milligram/litre and 149 micrograms/litre of mercury respectively. "The higher value is more than 20 times greater than the [European Community] permitted maximum" and grossly violates Central Pollution Control Board norms, Greenpeace concludes.

PVC factories are a well-known source of hazardous organochlorines, including dioxins. The Greenpeace study reported the presence of hexachlorobutadiene (HCBD), among other chemicals, in the effluents from the PVC plant at the point of discharge in River Kaveri. HCBD is a known animal carcinogen and indicates the presence of dioxins.

In April 2005, Chennai-based Community Environmental Monitoring took an air sample from the vicinity of Chemplast Sanmar's effluent discharge point in the river Kaveri. The sample was analysed by the Columbia Analytical Services Laboratory in California. The analysis identified 17 chemicals. At least four of the compounds found are manufactured in one of the Chemplast units. These include: vinyl

PVC Effluent outlet into River Kaveri

[6] *Revenue Divisional Officer, Mettur. Order No. ROC 9468/66 (P3). 10.9.66.*
[7] *Report of Analyses via Letter dt/24.7.95 from Assistant Soil Chemist, Soil Testing Laboratory, Salem, to Village Residents, Thippampatti Kattuvalavu, Gonur.*
[8] *The Stranger-The Chlorine Industry In India", Greenpeace International, 1996. Page 21 & 66.*

Table 2: Chemicals Detected in Air Sample near Chemplast Sanmar's PVC Effluent Outfall, April 2005

Chemicals Detected	Levels Detected	USEPA Region 6 Screening Levels (microgram/cubic meter) unless specified otherwise	Number of times above screening levels
Hydrogen Sulphide	296	1.00	296
Carbon di sulphide	19.5	3 (Texas Long-term screening levels)	6.5
Vinyl Chloride*	470	0.220	2136
Ethanol	180	--	--
Acetone	36	370	
Isopropyl Alcohol	6.8	--	--
Methylene Chloride*	6.7	4.09	1.64
1-1, Dichloroethane	26	520	--
n-Hexane	6.8	210	--
Chloroform*	32	0.0840	381
1,2-Dichloroethane*	2400	0.0740	32,432
Benzene*	6.4	0.250	25.6
1,1,2-Trichloroethane*	8.7	0.120	72.5
Toluene	27	400	--
Chlorobenzene	6.1	63	--
o-Xylene	16	730	--
1,2,4-Trimethylbenzene	5.5	6.2	--

** Animal and/or human carcinogen*

chloride, ethylene dichloride (EDC), methylene chloride and chloroform. All four are animal and/or human carcinogens. EDC was found at levels 32,000 times above the USEPA's Region 6 Screening levels. Vinyl Chloride was more than 2100 times above the same levels. Hydrogen sulphide, a toxic gas capable of damaging the brain, was 296 times higher than screening level.[9] Screening levels are those levels above which health effects may occur. (Refer Table No.2)

In July 2005, at the request of a Mettur-based community group and other voluntary groups from Tamilnadu, the Indian People's Tribunal on Environment and Human rights (IPT) headed by Justice (Retd) Akbar Basha Kadri visited Mettur to assess alleged human rights and environmental violations by Chemplast and Malco. Describing the "appalling scenario prevalent in Mettur of indiscriminate disposal of hazardous wastes and the resultant devastation of environment and public health at Mettur," the report highlighted "the apathy and callousness with which the concerned authorities, government and industry officials dealt with the pollution related complaints and issues."[10]

[9] *Reported in "Smokescreen: Ambient Air Quality in India." March 2007. Page 15-16.*

The panel concluded that the Chemplast's discharges have seriously impacted the ecology, human and animal health, agriculture, livelihoods and socio economic status of Mettur. Justice Kadri recommended the provision of clean water for the communities, the initiation of long-term health monitoring and rehabilitation; clean up of contaminated sites and groundwater and compensation to affected parties.

However, none of these reports have had any effect on regulatory agencies and the district administration. Rather than curb pollution, the company is being allowed to expand. Even in the face of repeated complaints from residents that Chemplast is discharging effluents illegally through streams and canals, the Tamilnadu Pollution Control Board continues to assert, without investigation, that all

Effects of Pollution

Decline in Fishing

- A fish diversity study[11], confirms that though the fish diversity in the reservoir is healthy, the down stream of Kaveri, beneath Chemplast's effluent discharge points is characterised by low or no fish population.
- On 24 November, 2004, and 14 July, 2006, massive fish deaths occurred downstream of Chemplast's effluent discharge point. No punitive action was taken against the company.

Impacts on Agricultural Economy

- Farmers report that contamination of groundwater and soil has led to large-scale decline in agricultural productivity
- The cattle economy has also been devastated. Occurrence of calf-mortality is high while milk yield is low.

Health

- Skin ailments, bloated stomachs, respiratory disorders, cancers, tumours, and dental problems are the most common symptoms that people from the community experience. Irregular menstrual cycles with 10 to 15 days of bleeding, two periods a month and frequent occurrences of miscarriages are reportedly high among women.
- IPT reports that, on average, families spend Rs.900 per month on groceries and Rs.1200 per month on medical treatment.

Gas Leaks

Incidents of gas leaks from the company are said to be frequent consequences of production beyond rated capacity, poor maintenance of equipment, inexperienced workers, low manpower, and negligent and careless handling of chemicals within the factory.

- On 18 July, 2004, following a chlorine gas leak from the company, at least 100 people were exposed to the gas and more than 20 were hospitalized, including a 22 day old child.
- On 27 September, 2007, a similar incident involving a Chlorine gas leak from the company occurred.
- On 02 January, 2007, large quantities of flyash released from Chemplast cost health problems in Gonur, Veerakal Pudur and P N Patti Panchayats.

Source: IPT and local reports

---

[10] *Indian People's Tribunal Report, 2005. Page 1*

[11] *M. Arunachalam and M. Muralidharan. "Histological study on kidney, gill and intestine of two species of fish collected from the confluence of effluent discharge from Chemplast Sanmar group of Companies into the Kaveri River". Sr Paramkalyani Centre for Environmental studies, July 2005*

trade effluents are discharged through a legally-sanctioned pipeline into the surplus course of the Kaveri.[12]

Introduction to the Study

In early 2007, West Gonur Farmers Welfare Association, an organisation in Mettur, contacted Community Environmental Monitoring(CEM) to verify:

- whether the treated waste water discharged legally to the Kaveri by Chemplast was safe,
- whether any other illegal channel existed through which toxic effluents were being released into the environment and
- whether reports of toxic contamination of wells were true.

In June 2007, CEM worked with two experienced scientists -- Ruth Stringer and Mark Chernaik – to develop a protocol for sampling. The former has more than a decade's experience sampling and analysing industries manufacturing chlorinated chemicals, including PVC, and is co-author of an authoritative overview of the chlorine industry called "Chlorine and the Environment."[13] Mark Chernaik is a toxicologist and staff scientist with Environmental Law Alliance Worldwide-US. His techno-legal opinions have been relied upon by various courts around the world, including the Supreme Court of India.

Effluent Sample being collected from "a pit on a road between Chemplast Plant 2 and Plant 3".

The sampling locations were tentatively identified with the help of the scientists, and in collaboration with local residents who mapped the lay of the land, and identified key toxic hotspots such as hazardous waste dumps, streams and drainage courses.

On 24 July, 2007, a total of nine samples, including two water, one effluent and six sediments, were collected. [See Table No.4] The sampling was supervised by Ruth Stringer to ensure compliance with Quality Control and Quality Assurance measures. Details such as sampling location, time of sampling, and other observable conditions such as type of smell, texture of sample at the time of sampling were recorded in a "Sampling Sheet."[14] All samples were collected in the presence of Mr. A. Marimuthu, Councillor of P.N. Patti Town Panchayat Ward 1.

Samples were collected in specially prepared glass bottles supplied by Specialty Analytical, an Oregon, U.S.-based laboratory identified to perform the analyses. The samples were transported to Chennai in a cool box, packed with ice. In Chennai, each sample bottle was repacked in bubble-wrap and replaced in the cool box with ice. On 26th July, 2007, the samples, along with the "chain of custody"[15] forms, were shipped to Specialty Analytical. The samples were analysed for mercury using USEPA's SW7471 method, for Volatile Organic Compounds by USEPA SW8260B method, and for Semi Volatile Organic Compounds using SW8270D.

Findings

The Report of Analyses from Specialty Analytical was sent on 7 August, 2007. The Lab report in its entirety is downloadable from the report section of www.sipcotcuddalore.com

- A total of 52 chemicals were detected in the 9 samples, of which 15 chemicals were found above safe levels. See Annexure 3 for complete list of chemicals detected.

[12] *Inspection Report for Renewal of Consent Orders: Chemplast Sanmar Ltd. Plant III. District Environmental Engineer. Tamilnadu Pollution Control Board. Salem.14.3.06.*
[13] *See Ruth Stringer and Paul Johnston, "Chlorine and the Environment." Kluwer Academic Publishers, 2001.*
[14] *See annexure 1*
[15] *See annexure 2*

Map of Mettur; Sampling Locations marked

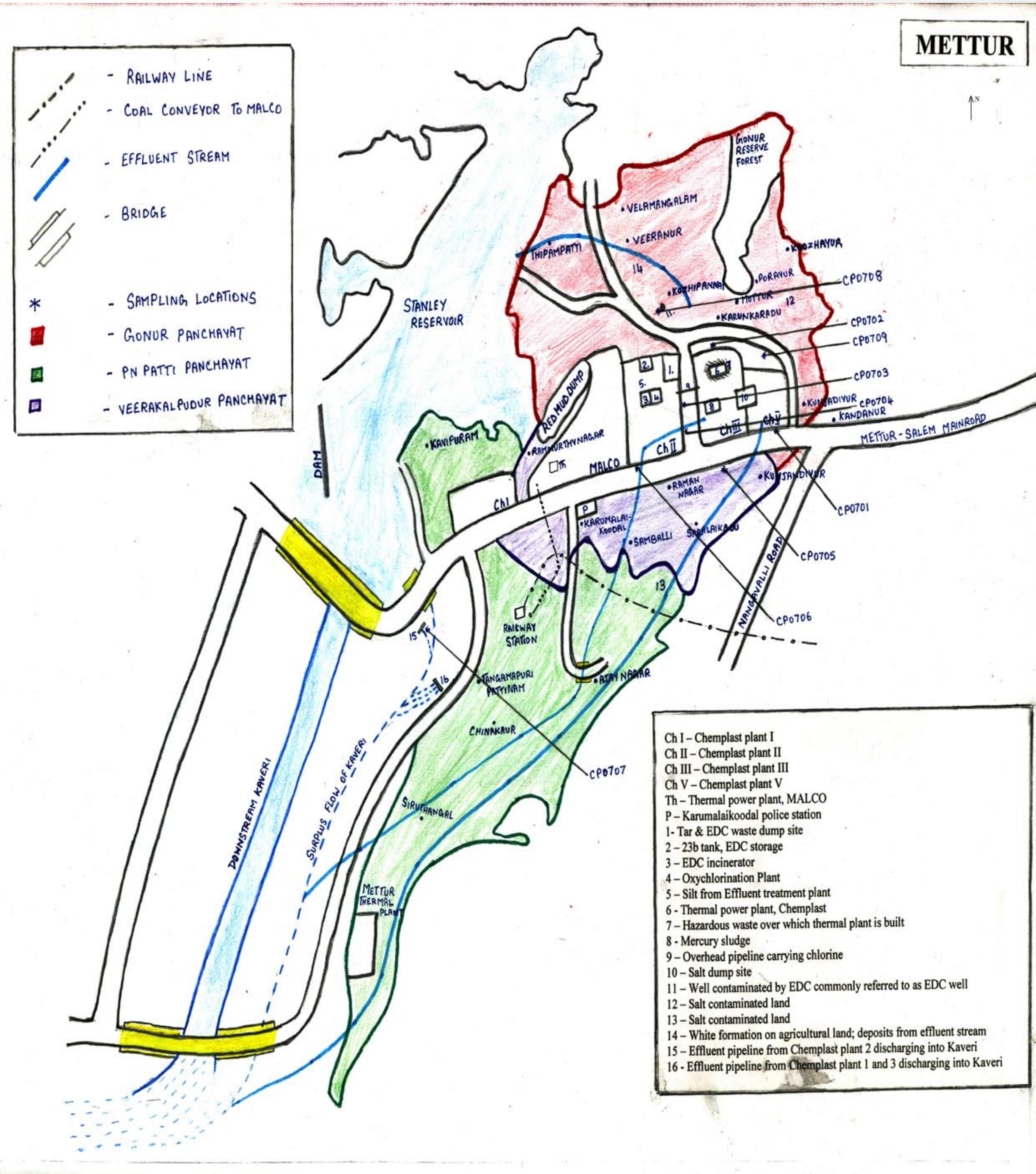


Table no.3: Chemicals Found Above Safe Levels

Mercury	1,2,4-Trichlorobenzene	1,2-Dichlorobenzene
1,4-Dichlorobenzene	Methylene Chloride	Vinyl Chloride
Hexachlorobenzene	Benzene	Chloroform
Bis(2-chloroethyl)ether	Chlorobenzene	1,1,2-Trichloroethane
Ethylene Dichloride	Tetrachloroethane	Trichloroethane

- Out of these 15 chemicals, 12 chemicals target the eyes; 12 chemicals target the skin; 12 target the liver; 3 chemicals target blood; 4 chemicals target the cardio vascular system; 1 chemical targets the lung; 10 chemicals target the central nervous system; 12 chemicals target the respiratory system; 8 chemicals target the kidneys; 1 chemical targets the lymphatic system; 1 chemical targets the bone marrow; 2 chemicals target the reproductive system; 1 chemical targets the gastrointestinal system; 1 chemical targets the brain.
- 10 out of 15 chemicals are known to cause cancer in humans or animals.

Discussion

Though recognized as highly toxic, India has not evolved standards for many of the chemicals found. Therefore, the results of analyses were compared against seven sets of international health-based standards by Dr. Mark Chernaik of ELAW-US. Standards 1 to 4 were applied to Samples CP07001 to CP07006. Standard 5 was applied to Sample CP07007. Standards 6 and 7 were applied to Samples CP07008 to CP07009.

1. U.S. EPA sediment quality criteria (assuming that sediment contains a standard value of 1 % total organic compounds). [16]
2. Environment Canada's (Canadian environmental regulatory agency) sediment quality criteria (assuming that sediment contains a standard value of 1 % total organic compounds). [17]
3. State of Washington sediment quality criteria (assuming that sediment contains a standard value of 1 % total organic compounds).[18]
4. State of Wisconsin sediment quality standards. [19]
5. U.S. EPA water quality criteria for waters from which fish is consumed. [20]
6. U.S. EPA drinking water quality criteria. [21]
7. World Health Organisation (WHO) drinking water quality criteria. [22]

Water sample being collected from borewell belonging to G. Nallathambi

[16] *http://www.epa.gov/waterscience/cs/report/2004/nsqs2ed-complete.pdf (assume sediment contains 1% total organic carbon)*
[17] *http://www.elaw.org/assets/pdf/sediment%5Fsummary%5Ftable.pdf (assume sediment contains 1% total organic carbon)*
[18] *http://www.ecy.wa.gov/programs/tcp/smu/sed_chem.htm (assume sediment contains 1% total organic carbon)*
[19] *http://www.dnr.state.wi.us/org/aw/rr/technical/cbsqg_interim_final.pdf*
[20] *http://www.elaw.org/assets/pdf/USEPAcriteria.pdf (Human health for consumption of organism only)*
[21] *http://www.elaw.org/assets/pdf/USEPAcriteria.pdf (Human health for consumption of water + organism)*
[22] *http://www.who.int/entity/water_sanitation_health/dwq/gdwq0506_ann4.pdf*

All samples of sediments contained mercury, pointing to the widespread contamination of the environment with this toxic heavy metal. Additionally, in applying these criteria, the results show that EACH sample contains unsafe levels of contamination in the following aspects:

Table4.1: Sediment sample from "A dry storm water drain from Chemplast Plant 5"
Sample ID CP07001 A&B
Findings: 10 chemicals found; 1 chemical above health-based standard

Name	Value	Standard	No of times above standard	Carcinogen
Mercury mg/kg	0.989	Environment Canada	5.8	No

Table 4.2: Sediment sample from "a dried up pond said to receive run-off from the salt godown behind Plant 3"
Sample ID CP07002 A&B
Findings: 3 chemicals found; 1 chemical above health-based standard

Name	Value	Standard	No of times above standard	Carcinogen
Mercury mg/kg	1.54	Environment Canada	9	No

Table 4.3: Sediment sample from "a pit on a road between Plant 2 and Plant 3, said to be located adjacent and downgradient of a location where tarry wastes had been dumped."
Sample ID CP07003 A&B
Findings: 20 chemicals found; 3 chemicals above standards

Name	Value ug/kg	Standard	No of times above standard	Carcinogen
1,2,4-Trichlorobenzene	157	State of Wisconsin	20	No
1,2-Dichlorobenzene	490	State of Wisconsin	21	No
1,4-Dichlorobenzene	652	State of Wisconsin	21	Yes

Table 4.4: Sediment sample from "Storm drain between Plant 2 and plant 3"
Sample ID CP07004 A&B
Findings: 12 chemicals found; 2 chemicals above standards

Name	Value	Standard	No of times above standard	Carcinogen
Mercury mg/kg	34.90	Environment Canada	190	No
Hexachlorobenzene ug/kg	819	State of Washington	2.15	Yes

Table 4.5: Sediment Sample from "Partially constructed sump in Bhupathy's residence"
Sample ID CP07005 A&B
Findings: 1 chemical found; 1 chemical above standard

Name	Value	Standard	No of times above standard	Carcinogen
Mercury mg/kg	1.12	Environment Canada	6.6	No

Table 4.6: Sediment Sample from "Stormwater drain leaving plant 2 (PVC Plant)"
Sample ID CP07006 A&B
Findings: 29 chemicals found; 5 chemicals above standards

Name	Value	Standard	No of times above standard	Carcinogen
Mercury mg/kg	0.332	Environment Canada	1.9	No
1,2,4-Trichlorobenzene ug/kg	1290	State of Wisconsin	161	No
1,2-Dichlorobenzene ug/kg	1390	States of Wisconsin	60	No
1,4-Dichlorobenzene ug/kg	2080	States of Wisconsin	67	Yes
Chlorobenzene ug/kg	949	USEPA	1.15	No

Table 4.7: Effluent Sample from "Piped effluent outfall from PVC Plant discharged into the surplus course of River Kaveri"
Sample ID CP07007 A&B
Findings: 28 chemicals found; 6 chemicals above standards

Name	Value ug/L	Standard	No of times above standard	Carcinogen
1,2-dichloroethane	1260	World Health Organisation	82	Yes
Bis(2-chlorethyl)ether	136	USEPA safety standard for consumption of fish caught near pool	257	Yes
1,1,2-Trichlorethane	50.50	USEPA safety standard for consumption of fish caught near pool	3.15	Yes
1,2-Dichlorobenzene	2460	USEPA safety standard for consumption of fish caught near pool	65	No
Benzene	14.6	World Health Organisation	1.5	Yes
Vinyl chloride	164	World Health Organisation	546	Yes

Table 4.8: Water Sample from "350-ft borewell on agricultural land belonging to S. Chinnu, Thippampatti Kattuvalavu, Mettur."
Sample ID CP07008 A&B
Findings: 7 chemicals found; 1 chemical above standard

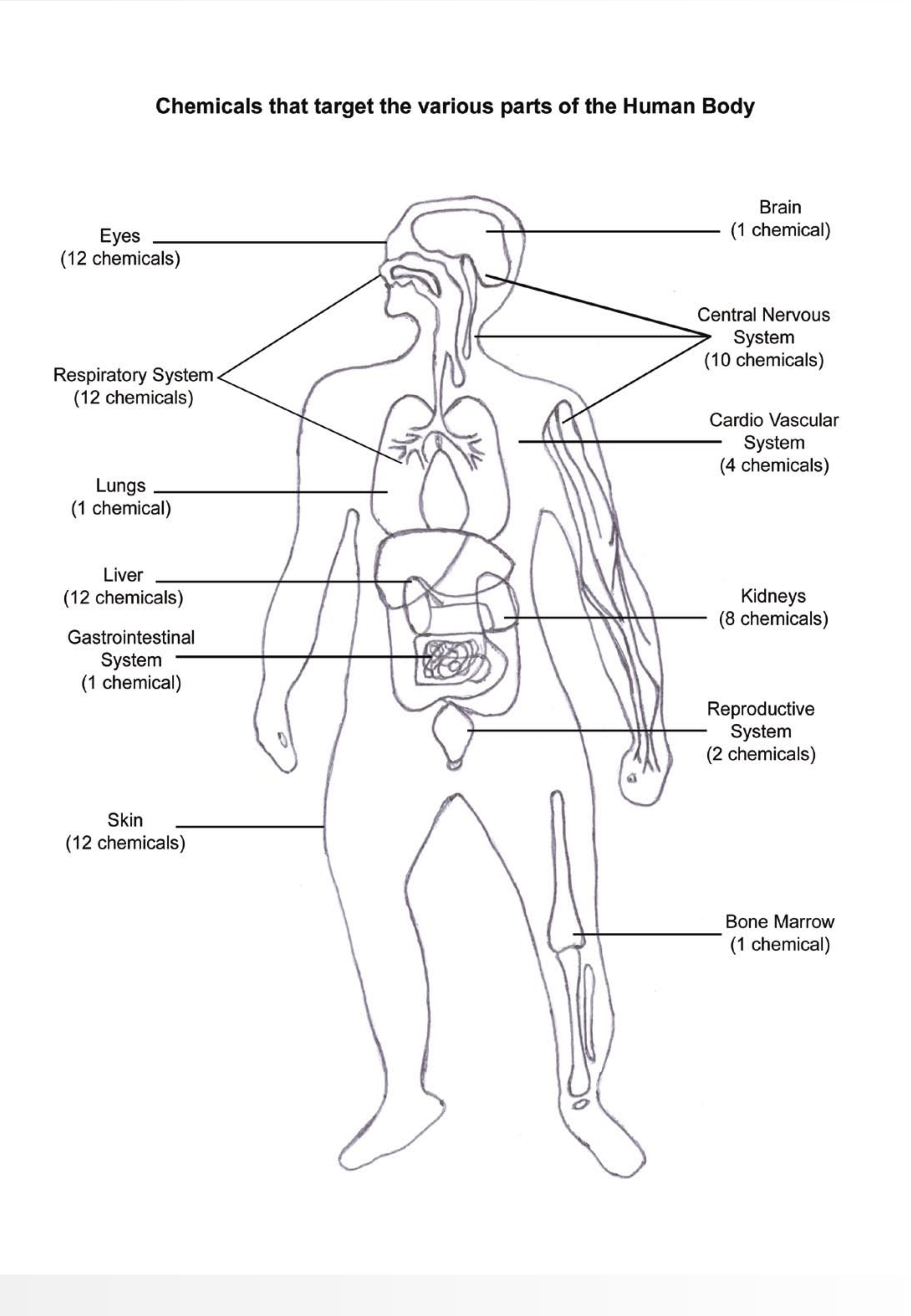
Name	Value ug/L	Standard	No of times above standard	Carcinogen
Benzene	7.76	USEPA for drinking water	3.5	Yes

Table 4.9: Water sample from "500 feet Borewell emptying into water tank belonging to G. Nallathambi"
Sample ID CP07009 A&B
Findings: 10 chemicals found; 6 chemicals above standard

Name	Value ug/L	Standard	No of times above standard	Carcinogen
1,1,2-Trichloroethane	33.60	USEPA for drinking water	57	Yes
Chloroform	10,100	USEPA for drinking water	1771	No
Methylene chloride	1,140	USEPA for drinking water	248	Yes
Tetrachloroethane	55.60	USEPA for drinking water	327	Yes
Trichloroethane	22.20	USEPA for drinking water	38	No
Vinyl chloride	2.57	USEPA for drinking water	8	Yes

Mercury dump site inside Chemplast Plant 3

Diagram No.2


Chemicals that target the various parts of the Human Body
Eyes (12 chemicals)
Brain (1 chemical)
Respiratory System (12 chemicals)
Central Nervous System (10 chemicals)
Cardio Vascular System (4 chemicals)
Lungs (1 chemical)
Liver (12 chemicals)
Kidneys (8 chemicals)
Gastrointestinal System (1 chemical)
Reproductive System (2 chemicals)
Skin (12 chemicals)
Bone Marrow (1 chemical)

Conclusion

Evidence at hand indicates the extensive nature of damage already caused. The continued discharge of toxic effluents into the River Kaveri poses a risk to the drinking water installations, to fish consumers to agricultural produce consumers downstream. The indiscriminately disposed toxic waste presents an ongoing source of groundwater pollution.

The fact that the environment is contaminated by a range of complex and highly toxic and persistent chemicals, including mercury, organochlorines like hexachlorobutadiene, hexachlorobenzene, and potential dioxins and furans qualifies categorization of Mettur as a Toxic Hotspot. While this has huge environmental consequences, there also is likely to be major detrimental effects on human health. These conclusions are based on accepted knowledge about
these chemicals.

Much of the damage done to Mettur's environment may well be irreversible. The Tamilnadu Pollution Control Board and the District Administration have failed miserably in administering their duties. Both agencies seem to be subservient to the diktats of big polluters, and are reluctant to implement the law. More curiously, neither agency has sought to meet the residents and understand their problems. The fact that the Police and the District Administration continue to dismiss local concerns about pollution as a law and order issue, and continue to view complainants as extremists and trouble-makers bodes ill for the future of the environment in Mettur and downstream of Kaveri. The evidence about the contamination in Mettur is conclusive. All that remains to be assessed is the extent of the damage already done. The situation in Mettur is unlikely to change until the TNPCB, the Police and the District Administration begin viewing local people with more respect and free themselves from the clutches of polluting industries.

It is not merely the presence of excessive levels of 15 toxic chemicals in the environment that should cause concern. The fact that 52 chemicals, many of which have known harmful effects, and may act synergistically to create an even more poisonous cocktail is reason enough to declare Mettur as a toxic hotspot. It is a known fact that the toxicity of some chemicals multiplies several fold when they act in conjunction with other chemical agents.

"The widespread presence of excessive levels of at least 15 chemicals with known harmful effects, and the possible combined effect of long-term exposure to a cocktail of 63 chemicals albeit at low concentrations points to nothing less than a potential public health disaster," according to Dr. Rakhal Gaitonde, a public health expert who reviewed the report. "Unless this dangerous situation is addressed urgently, there is potential for serious, unpredictable and potentially irreversible consequences, as well as long term damage to the environment, livelihoods, food and water security," he concludes.

Recommendations

Based on the evidence generated by the current study, and other studies to date, it would be prudent to apply the precautionary principle in taking immediate steps to do the following:

1. End discharge of effluents into the River Kaveri
2. Conduct a comprehensive and independent assessment of the spread and depth of contamination, including of groundwater, water courses leading from the factory to the River Kaveri, of environment and fish downstream of Chemplast's effluent discharge point, and of reservoir and reservoir fisheries. The assessments should be conducted with a particular focus on persistent, bioaccumultative poisons such as dioxins and furans, and mercury.
3. Initiate a comprehensive clean-up involving local communities.
4. Assess the impact of pollution on the health of people in Mettur. Set up a long-term health monitoring and remediation infrastructure to identify and assist affected persons at the cost of the polluter.
5. Arrange for immediate delivery of clean water for domestic purposes to affected communities and recover costs from the polluter.
6. Initiate legal action and criminal prosecution of polluter for negligent handling of chemicals and violation of environmental regulations.
7. Set up and enforce standards for organo-halogens in various relevant media, including, soil, air, sediment, effluents and water.
8. The Central Pollution Control Board should declare Mettur a "Critically Polluted Area."
9. The Kaveri Government Order prohibiting the expansion or setting up of new polluting industries should be implemented earnestly.
10. Strengthen public health systems to undertake research and treatment of these pollution-related health problems.

ANNEXURE 1

Toxicity Profiles of Key Chemicals [23]

The 17 chemicals found above permissible limits are listed below with their toxicological profiles.

Mercury:

Mercury is a naturally occurring silver-white, heavy, odourless liquid metal. Mercury and its compounds are widely distributed in the environment as a result of both natural and synthetic processes. It is used in the manufacture of thermometers and batteries, and fluorescent lamps. However the largest consumer of mercury is the chlor-alkali industry, which manufactures caustic soda and chlorine. Workers engaged in the chloralkali production are exposed to high levels of elemental mercury.

Elemental mercury combines with other elements, such as chlorine, sulphur, or oxygen, to form inorganic mercury compounds or "salts." Inorganic mercury enters the air, water or soil from natural deposits, disposal of wastes, from manufacturing plants and volcanic activity. Mercury also combines with carbon to form organic mercury compounds. Organic mercury is more dangerous than inorganic forms, but many inorganic mercury compounds can be converted to the organic type in the environment.

Mercury is toxic to aquatic animals and is persistent in the environment. Contaminated fish consumption is the most common route of exposure to methyl mercury, the most toxic form of mercury, in humans, as it binds tightly to the proteins in fish tissue and also accumulates as it passes through the food chain [see diagram no.3]. In humans, it is absorbed readily into the blood and distributed to all tissues including the brain. It also readily passes through the placenta to the foetus and foetal brain.

Acute exposure to toxic amounts of elemental mercury can cause symptoms like vision and hearing disturbance, dizziness, nausea, vomiting, and respiratory problems. Long term exposure to the various forms of mercury is known to cause emotional disturbance, tremors, and other neurological problems, dental problems, skin disorders and kidney injury. Mercury is a potent neurotoxin and affects the central nervous system causing irreversible damages.

Children exposed to mercury show symptoms of mental retardation, sensory disturbances and neuro-behavioral changes.

The fishing town of Minamata in Japan suffered a severe methyl mercury poisoning incident during the 1950s and 1960s. Mercury was discharged in the Minamata Bay from a factory owned by Chisso Corporation. Over years, the mercury accumulated in fish was consumed by the local community. More than 20,000 people were reportedly affected by mercury contamination.

A mother bathes her child; one of the many born with severe birth defects known to be caused by exposure to methyl mercury

1,2,4-Trichlorobenzene:

1,2,4-Trichlorobenzene (1,2,4-TCB) is a synthetic chemical that is an aromatic, colourless liquid. It is used to make herbicides and other organic chemicals.

1,2,4-Trichlorobenzene evaporates slowly when exposed to air. It mixes poorly in water. Once in air, it breaks down to other chemicals. Unless it evaporates, TCB is likely to stay in soil and water. Plants and animals can store small amounts of TCB.

TCB enters the body when people breathe air or consume contaminated food or water. It can also be absorbed through skin contact. Once in the body small amounts of TCB can remain, stored in fat tissue.

Short term effects of 1,2,4-TCB include changes in liver, kidneys and adrenal glands. It also targets the eyes, skin and respiratory system in humans.

[23] *For this section the following sources have been extensively relied on.*
Agency for Toxic Substances and Disease Registry. www.atsdr.cdc.gov/facts
U.S Environmental Protection Agency. www.epa.gov
Pocket Guide to Chemical hazards. US Department of health and Human Services. February 2004

1,2-Dichlorobenzene:

Dichlorobenzenes do not occur naturally. 1,2-Dichlorobenzene is a colorless to pale yellow liquid used to make herbicides. The substance decomposes on burning producing toxic and corrosive gases including hydrogen chloride. When released into the environment, dichlorobenzenes bind to soil and sediment. Dichlorobenzenes in soil usually are not easily broken down by soil organisms. Evidence suggests that plants and fish absorb dichlorobenzenes. The substance is toxic to aquatic organisms.

Because of their relatively high lipid solubility and relatively low water solubility, dichlorobenzenes are likely to be absorbed by most routes of exposure by membrane diffusion.

Inhaling the vapor or dusts of 1,2-DCB and 1,4-DCB at very high concentrations can cause irritation of the eyes and nose, burning and tearing of the eyes, coughing, difficult breathing, and an upset stomach. The substance may also affect the central nervous system. Human toxicity data for 1,2-dichlorobenzene is sparse but chromosomal aberrations, anemia and leukemia have been reported. It is also found to be toxic to higher plants. Long term exposure targets the liver and kidneys. It has also been described to defat (remove fat) the skin after long term and repeated exposure.

1,4-Dichlorobenzene (carcinogen):

1,4-Dichlorobenzene occurs as colorless or white solid with a distinctive aromatic odour, similar to mothballs. It is practically insoluble in water. When it is heated, toxic gases and vapors such as hydrochloric acid and carbon monoxide are released.

For the past 20 years 1,4-dichlorobenzene has been used primarily as a deodorant in products such as room deodorizers, urinal and toilet bowl blocks, and as an insecticide fumigant for moth control. 1,4-Dichlorobenzene has been detected in meats and eggs following exposure of the animals and in fish from contaminated waters.

1,4-Dichlorobenzene may be absorbed both through the inhalation of vapours, through the skin and through consumption of contaminated food. Once absorbed 1,4-dichlorobenzene is stored in fatty tissue.

Dizziness and headaches can occur due to very high levels of 1,4-DCB. Other symptoms include damage to the kidneys and lungs. It is known to cause eating disorders (anorexia), jaundice and liver disorder (cirrhosis). The International Agency for Research on Cancer (IARC) determined that 1,4-Dichlorobenzene is possibly carcinogenic to humans.

The presence of high levels of dichlorobenzenes is used as an indicator for the likely presence of dioxins.

Bis(2-Ethylhexyl)phthalate (carcinogen):

Bis(2-ethylhexyl)phthlate (DEHP) is a manufactured chemical that is commonly added to plastics to make them flexible. It is a colorless liquid with almost no odor. DEHP can enter the environment through releases from factories that make or use DEHP.

Over long periods of time, it can move out of plastic materials into the environment. When DEHP is released to soil, it usually attaches strongly to the soil and does not move very far from where it was released. When DEHP is released to water, it dissolves very slowly into underground water or surface waters that contact it. DEHP is everywhere in the environment because of its use in plastics. One can be exposed to DEHP through air, water, or skin contact with plastics that have DEHP in them.

Acute exposure to large oral doses of DEHP can cause gastrointestinal distress in humans. It affects the reproductive system and liver. The International Agency for Research on Cancer has classified Bis (2-ethylhexyl) phthalate as Group 2B: Possible human carcinogen (IARC, 1987).

Hexachlorobenzene (carcinogen):

Hexachlorobenzene is a white crystalline solid that is not very soluble in water. It does not occur naturally in the environment. It is formed as a by-product while making other chemicals, in the waste streams of chloralkali, and when burning municipal waste.

HCB is a persistent chemical and is widely distributed throughout the environment because it may be carried in the air on dust particles and is resistant to degradation. Hexachlorobenzene can enter your body when you eat food contaminated with it, when you breathe particles of it in the air, or when it gets on your skin. A large portion of hexachlorobenzene in the fat of a mother can be transferred to her baby in breast milk. During pregnancy, this substance can transfer to the unborn child through the mother's blood.

HCB is toxic to aquatic life, plants, animals and humans. It is classified as a possible human carcinogen and tumour promoter by the International Agency for Research on Cancer (IARC). HCB is toxic at very low concentrations and doses with chronic exposures. HCB damages the developing foetus, liver, immune system, thyroid, kidneys and central nervous system. The liver and nervous system are the most sensitive to its effects. Porphyria a liver disorder characterised by red-colored urine, skin sores, change in skin color, arthritis, and problems of the liver, nervous system, and stomach is a common symptom of HCB.

More than 600 people in Turkey experienced severe skin disorders (porphyria) after consuming HCB-treated grain between 1955 and 1959. Children born to women exposed to this chemical had skin lesions and 95% of them died before their first birthday.[24]

Hexachlorobutadiene (HCBD) (carcinogen):

HCBD is a colourless liquid with a turpentine like odour. It is produced either commercially or as a by-product of manufacturing other chlorinated hydrocarbons including Tetrachloroethene, Trichloroethene, VCM/PVC, and Carbon Tetra Chloride. HCBD is a widespread environmental contaminant. HCBD is an indicator of the presence of even more toxic chemicals such as dioxins and furans

Hexachlorobutadiene is released to the environment in air, water, and soil, mainly as a result of its disposal following industrial use. It can exist in the atmosphere as a vapour or absorbed to airborne particulate matter. It has been found in the wastewater from the chlorine industry, in leachate from landfills and hazardous waste sites and in air, soil, surface water and sediments. It is toxic to aquatic organisms. It also bioaccumulates in the food chain, especially in the fish. One may be exposed to hexachlorobutadiene by breathing contaminated air, eating contaminated food, drinking contaminated water, or by direct skin contact with this chemical.

If ingested HCBD concentrates in the kidney, the main target organ. HCBD interferes with the fundamental process of cell respiration and can, as a result or along with other compounds in the body, react with DNA, resulting in cell death or the development of tumours. It is also known to cause damage to the liver. HCBD is classified as a potential occupational carcinogen by the USEPA and it also causes kidney tumours in animals.

Bis (2-chloroethyl)ether (carcinogen):

Bis(2-chloroethyl)ether is a colourless, non-flammable liquid with a strong unpleasant odor. It does not occur naturally. Bis(2-chloroethyl) is made in factories, and most of it is used to make pesticides. Some of it is used as a solvent, cleaner, component of paint and varnish, or as a chemical intermediate to make other chemicals.

Breathing low concentrations of bis(2-chloroethyl) ether will cause coughing, and irritation to nose, eyes, skin, throat and lungs. In some cases, damage to the lungs can be severe enough to cause death. The USEPA has classified this chemical as a Group B2, probable human carcinogen.

Chlorobenzene:

Chlorobenzene is a colourless, flammable liquid with an aromatic, almond-like odor. It does not occur naturally in the environment. The greatest use of chlorobenzene is in the manufacture of other organic chemicals, dyestuffs and insecticides. It is also a solvent for adhesives, drugs, rubber, paints and dry-cleaning.

Chlorobenzene enters your body through air, ingestion of food or water, or through contact with the skin. In animals, exposure to high concentrations of chlorobenzene affects the brain, liver, and kidneys. Workers exposed to high levels of chlorobenzene complained of headaches, numbness, sleepiness, nausea, and vomiting. Chlorobenzene has the potential to cause liver, kidney and central nervous system damage from long term exposure. Effects on the central nervous system from breathing chlorobenzene include loss of consciousness, tremors, restlessness, and death.

1,1,2-Trichloroethane (carcinogen):

1,1,2-Trichloroethane is a colorless, sweet-smelling liquid. 1,1,2-Trichloroethane is not known to occur as a natural product, It is used to make vinylidene chloride which is in turn used to make synthetic fibers and plastic wraps such as the saran wrap. 1,1,2-Trichloroethane is sometimes present as an impurity in other chemicals, and it may be formed when another chemical breaks down in the environment under conditions where there is no air.

---

[24] *Ruth Stringer and Paul Johnston, "Chlorine and the Environment." Kluwer Academic Publishers, 2001.*

Most 1,1,2-trichloroethane released into the environment will go into the air and it breaks down slowly in air. 1,1,2-Trichloroethane may enter the groundwater by filtering through the soil and also appears to stay in water for a long time; it takes years for it to break down.

Breathing outdoor air that contains it from industrial releases or air near hazardous waste site, drinking contaminated water are the common routes of exposure to 1,1,2-trichloroethane.

Physical contact with 1,1,2-trichloroethane can result in stinging and burning of the skin. Acute animal studies have reported effects on the liver, kidney, and central nervous system (CNS) from inhalation and oral exposure to 1,1,2-trichloroethane, while chronic animal studies have reported effects on the liver and immune system from oral exposure. USEPA has classified 1,1,2-trichloroethane as a Group C possible human carcinogen.

Ethylene Dichloride (carcinogen):

Ethylene Dichloride (EDC) is a manufactured chemical that is not found naturally in the environment. It is primarily used in the manufacture of Vinyl Chloride Monomer – the building block for PVC. It is both an intermediate in the manufacture of PVC and a pollutant released from PVC facilities in large quantities. It is a pleasant-smelling, colourless, volatile liquid, which does not persist long in the environment but is both hazardous and toxic. It decomposes on heating and on burning, producing toxic and corrosive fumes including hydrogen chloride and phosgene. An explosive accident involving EDC can result in Bhopal-like disasters because of the tendency of explosion by-products like hydrogen chloride and phosgene to form clouds and spread far and wide.

Once released in the environment, EDC volatilises into the air. It is not absorbed into the soil but it leaches through the soil to the groundwater where it remains for a longer time, thus contaminating the water.

Because of its volatility the prime route of exposure is through inhalation. However, it can also cause harm through skin or eye contact. It causes irritation of the eyes, the skin and the respiratory tract. Inhalation of the vapour may cause lung oedema – a condition where the lung fills up with fluid. EDC also impairs the functioning of the central nervous system, kidneys and liver. Other symptoms of exposure include - abdominal pain, cough, dizziness, drowsiness, headache, nausea, sore throat etc.

It is distributed to all tissues of the body and can pass both the blood/brain barrier and the placenta. EDC is classified by the International Agency for Research on Cancer (IARC) in Group 2B (possibly carcinogenic to humans) and can be toxic at concentrations too low to be detected by smell. In animals it causes cancer of stomach, mammary gland and blood.

Benzene (carcinogen):

Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities. Some industries use benzene to make other chemicals which are used to make plastics, resins, and nylon and synthetic fibers. It is also used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Industrial processes are the main source of benzene in the environment. It breaks down more slowly in water and soil, and can pass through the soil into underground water. Natural sources of benzene, which include gas emissions from volcanoes and forest fires, also contribute to the presence of benzene in the environment. Benzene is also present in crude oil and gasoline and cigarette smoke.

Breathing very high levels of benzene can result in death, while high levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, and death.

The major effect of benzene from long-term exposure is on the blood. Benzene causes harmful effects on the bone marrow and can cause a decrease in red blood cells leading to anemia. It can also cause excessive bleeding and can affect the immune system, increasing the chance for infection. Some women who breathed high levels of benzene for many months had irregular menstrual periods and a decrease in the size of their ovaries. Benzene is a known human carcinogen (Group 1 as assessed by IARC) and has been associated with leukemia.

Vinyl Chloride (carcinogen):

Vinyl Chloride, a synthetic chemical is both an intermediate in the manufacture of PVC and a pollutant released from PVC facilities in large quantities. VCM is a colourless sweet smelling gas under normal conditions. Most of the vinyl chloride that enters the environment comes from vinyl chloride manufacturing or processing plants, which release it into the air or into waste water. Breathing vinyl chloride that has been released from plastics industries, hazardous waste sites, and landfills, breathing vinyl chloride in air or during contact with your skin or eyes in the workplace and drinking water from contaminated wells are the common routes of exposure in humans.

Inhalation of vinyl chloride can cause dizziness, headaches, drowsiness or unconsciousness, memory loss, sleep disturbances, and nervousness. Inhaling large amounts of Vinyl Chloride may even cause death. Vinyl Chloride is known to cause lung related problems. It also affects the immune systems, liver, spleen, thyroid functions, and reproductive system in both men and women. Vinyl Chloride also causes changes in the blood flow to the hands. It is a known human carcinogen (Group 1 as assessed by IARC). Studies demonstrate that it causes malignant tumour of the liver in the occupationally exposed; other studies have also shown elevated levels of cancer of brain and nervous system, lung and respiratory tract and the lymphatic system.

Chloroform (carcinogen):

Chloroform is a heavy, colourless, non-flammable liquid with a sweetish burning taste and a pleasant, sweet, ethereal odour. It is a naturally-occurring chemical, but most of the chloroform in the environment is man-made. It was used as an anaesthetic in the past, but the US Food and Drug Administration banned its use in 1976 after it was found that chloroform is a potential carcinogen. Most of the chloroform released in air breaks down eventually, but it is a slow process. The breakdown products in air include phosgene and hydrogen chloride, which are both toxic. It is poorly absorbed in the soil and can travel through soil to ground water where it may persist for years. It dissolves easily in water where it may break down to form other chemicals. It is extremely toxic to aquatic animals.

One is most likely to be exposed to chloroform by drinking water and breathing indoor or outdoor air containing it.

Exposure to chloroform may cause irritation of eyes, skin, dizziness, mental dullness, nausea, confusion, headache, weakness, exhaustion, and enlarged liver. Chloroform is also a potential occupational carcinogen and causes cancer of liver, kidney and intestine in animals. It has also shown to cause reproductive damage in lab animals. USEPA has classified chloroform as a Group 2B, probable human carcinogen.

Methylene Chloride (carcinogen):

Methylene Chloride is a colourless liquid with chloroform like odour which does not occur naturally in the environment. Methylene chloride is mainly released to the environment in air. It does not easily dissolve in water, but small amounts may be found in drinking water. Methylene chloride is mainly released to the environment in air, and to a lesser extent in water and soil, due to industrial and consumer uses. Methylene chloride is poorly absorbed in the soil but can travel through soil to ground water where it may persist for years.

Methylene chloride may enter your body when you breathe in contaminated air. It may also enter your body if you drink water from contaminated wells, or it may enter if your skin comes in contact with it.

Exposure to Methylene Chloride may cause irritation eyes, skin, weakness, exhaustion, drowsiness, dizziness, numbness, a tingling sensation in the limbs, and nausea. Methylene chloride is a potential occupational carcinogen and causes cancer in the lungs and liver of animals. Exposure to high levels of methylene chloride may cause unconsciousness and even death.

Tetrachloroethane (carcinogen):

1,1,2,2-Tetrachloroethane is a manufactured, colourless, dense liquid that does not burn easily. It is volatile and has a sweet odor. Tetrachloroethane is one of the most toxic chlorinated hydrocarbons.

Most 1,1,2,2-tetrachloroethane released into the environment eventually moves into the air or groundwater. If released on the land, it does not tend to attach to soil particles. 1,1,2,2-Tetrachloroethane can enter the body when a person breathes air containing the chemical or when the chemical comes into contact with a person's skin. Acute exposure to concentrated fumes can rapidly cause fatigue, vomiting, dizziness, and possibly unconsciousness. Breathing, drinking, or having 1,1,2,2-tetrachloroethane come into contact with your skin may cause liver damage, stomachaches, or dizziness if you are exposed long enough to high amounts. The USEPA has classified 1,1,2,2-tetrachloroethane as a Group C possible human carcinogen.

Trichloroethane:

1,1,1-Trichloroethane is a synthetic Chemical. Manufacture of this chemical for domestic use in the United States was banned as of January 1, 2002 because it affects the ozone layer. Most of the 1,1,1-trichloroethane released into the environment enters the air, where it lasts for about 6 years. 1,1,1-Trichloroethane has many industrial and household uses, including use as a solvent to dissolve other substances, such as glues and paints; to remove oil or grease from manufactured metal parts; and as an in gredient of household products such as spot cleaners, glues, and aerosol sprays.

Once in the air, it can travel to the ozone layer where sunlight can break it down into chemicals that may reduce the ozone layer. Contaminated water from landfills and hazardous waste sites can contaminate surrounding soil and nearby surface water or groundwater.

Breathing 1,1,1-trichloroethane in contaminated outdoor and indoor air is the most common route of exposure in humans. Because 1,1,1 trichloroethane is used so frequently in home and office products, one is likely to be exposed to higher levels indoors than outdoors or near hazardous waste sites.

Effects reported in humans due to acute (short-term) inhalation exposure to trichloroethane include hypotension, mild hepatic effects, and central nervous system (CNS) depression. Symptoms of acute inhalation exposure include dizziness, nausea, vomiting, diarrhea, loss of consciousness, and decreased blood pressure in humans. Studies in animals show that breathing air that contains very high levels of 1,1,1- trichloroethane damages the breathing passages and causes mild effects in the liver, in addition to affecting the nervous system.

Dioxins and furans:

These are formed as an unintentional by-product of industrial processes involving chlorine, and are especially linked to the production of Poly Vinyl Chloride, which is also known as the Poison Plastic.

High doses of dioxin cause a severe skin disease called chloracne. Dioxin exposure has also been linked to cancer, suppressed immune system, severe reproductive problems, developmental problems, hormonal problems, inability to maintain pregnancy, decreased fertility, reduced sperm counts, endometriosis, diabetes, learning disabilities, lung problems, skin disorders, lowered testosterone levels and much more.

Persistent Organic Pollutants

Dioxins/furans and Hexachlorobenzene are classified as Persistent Organic Pollutants (POPs), and are slotted for global phase-out under the international Stockholm Convention on POPs. All POPs exhibit certain key characteristics, and are considered extremely dangerous. The characteristics include:

Persistence: Once released into the environment, they bind strongly to the soil and remain there for long periods of time without being broken down.

Fat-loving: All POPs have an affinity to fatty substances. That is why they are found in largest quantities in the fatty tissue of living organisms.

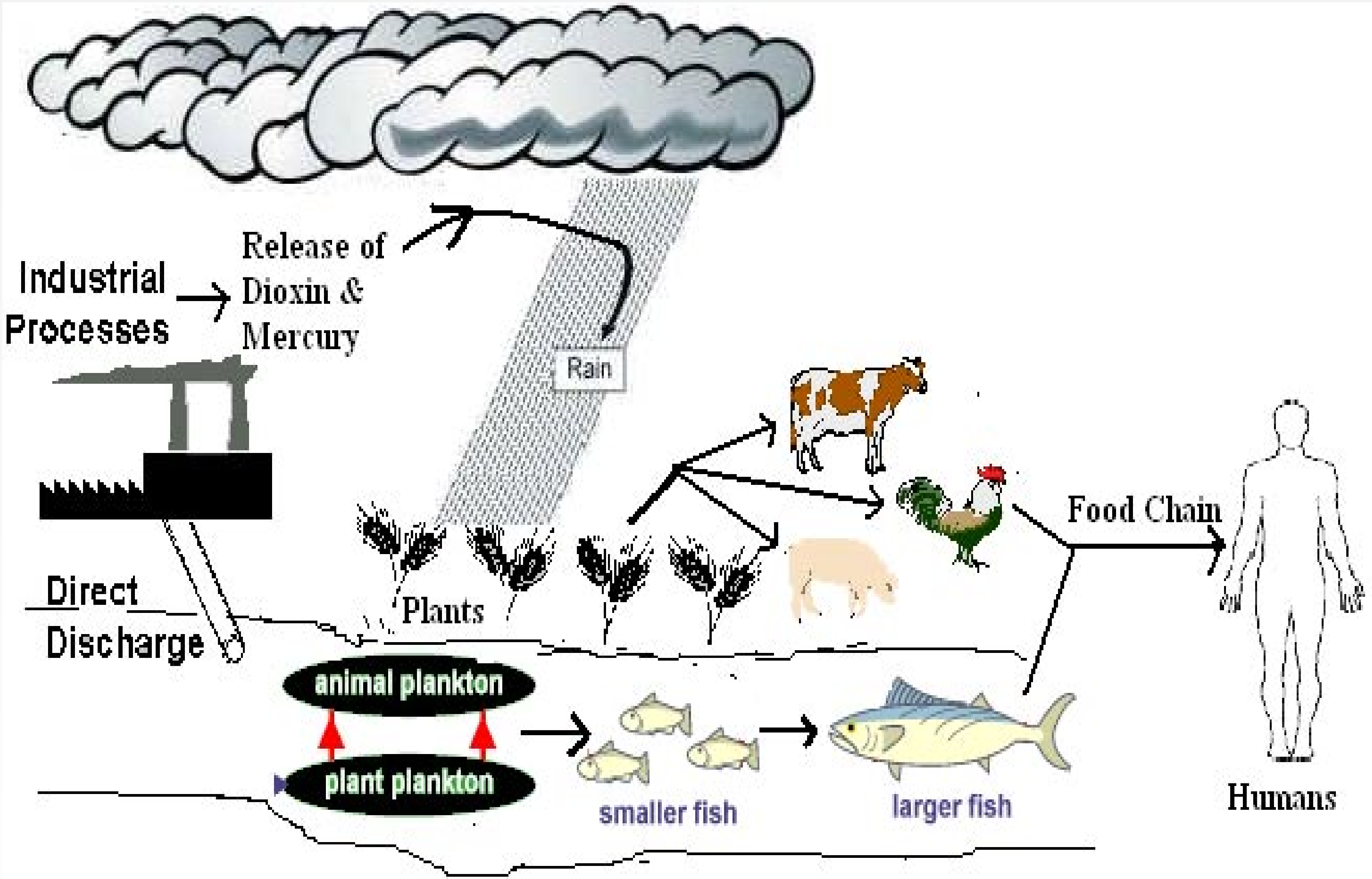
Bioaccumulation: Because they are fat-soluble and resist natural breakdown processes, POPs tend to build up (bioaccumulate) in the fatty tissues of animals and humans.

Biomagnification: For many POPs, the levels increase as one animal eats another lower on the food chain. The highest levels are found in predators at the top of food chains such as humans, birds of prey and predatory fish.

Transgenerational Poisons: POPs are transferred from mother to offspring through the placenta, or via breast milk. Exposure at these early stages of life is especially dangerous because this is the time when the body's systems and organs are developing. Chemicals such as dioxins can significantly alter the course of a foetus or child's development.

Toxicity: Even at very low concentrations, sometimes not measurable, POPs have the potential to harm human and animal health. Many of these effects are irreversible. Pre-birth effects of these chemicals include malformations, neurological effects and changes to the immune system giving rise to cancer or infections.

Mercury and Dioxin Cycle; in the environment
Diagram No.3



Annexure 2

Sample Sheet

Sample ID:

Type of Sample: water/ sediment/ effluent/ other (please descreibe)

Location:

Address of sample location –
(include city, State, and Country)
Name and type on industry –
(for industrial samples)
Description of location –
Coordinates –

Description of sample:

Odour –
Colour –
Suspended Solids –
Visible oil or grease –
Temperature (can be approximate) –
Other –

Any other comments about location or the nature of the sample:

Description of the tests to be conducted on the sample:

VOCs –
SVOCs –
PCDD/Fs –
Hg –
MeHg –
Other –

Date:

Time:

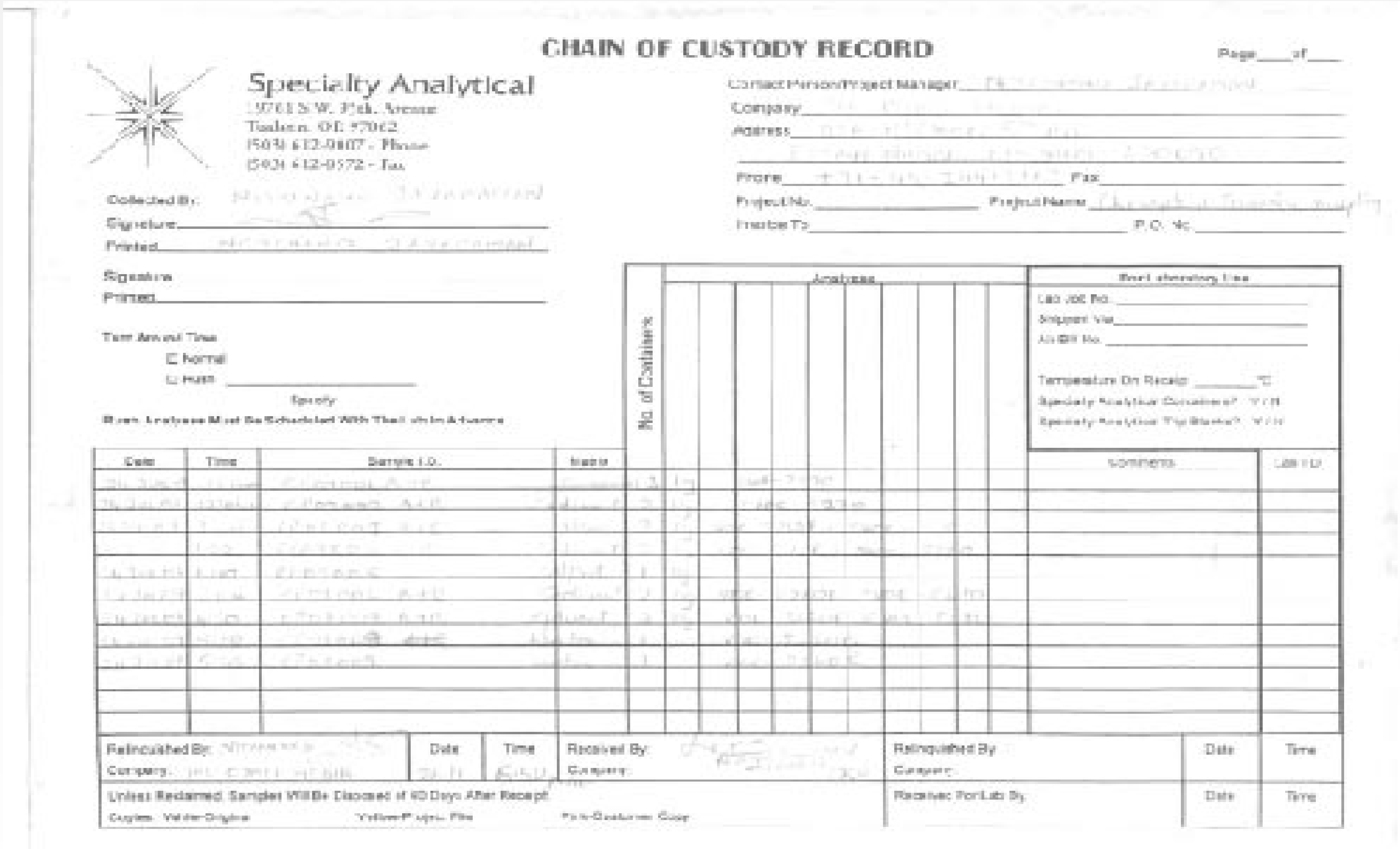
Name of the sampler:

Signature of the sampler:

Sampled in the presence of:

Annexure 3

Chain of Custody



CHAIN OF CUSTODY RECORD

Page ____ of ____

Specialty Analytical
15761 S.W. 72nd Avenue
Tualatin, OR 97062
(503) 612-9807 - Phone
(503) 612-9572 - Fax

Contact Person/Project Manager ______
Company ______
Address ______
Phone ______ Fax ______
Project No. ______ Project Name ______
Invoice To ______ P.O. No. ______

Collected By: ______
Signature ______
Printed ______

Signature ______
Printed ______

Turn Around Time
☐ Normal
☐ Rush ______ Specify

Rush Analyses Must Be Scheduled With The Lab In Advance

For Laboratory Use
Lab Job No. ______
Shipped Via ______
Air Bill No. ______
Temperature On Receipt ______ °C
Specialty Analytical Containers? Y / N
Specialty Analytical Trip Blanks? Y / N

Date	Time	Sample I.D.	Matrix	No. of Containers	Analyses									Comments	Lab I.D.

Relinquished By:	Date	Time	Received By:	Relinquished By:	Date	Time
Company:			Company:	Company:		
Unless Reclaimed, Samples Will Be Disposed of 60 Days After Receipt				Received For Lab By:	Date	Time

Copies: White-Original Yellow-Project File Pink-Customer Copy

Annexure 4
List of all Chemicals detected in the 9 samples

S.No	Chemical		CP07001	CP07002	CP07003	CP07004	CP07005	CP07006	CP07007	CP07008	CP07009
1	Mercury*		0.989 mg/kg	1.54 mg/kg	0.121 mg/kg	34.9 mg/kg	0.332 mg/kg	1.12 mg/kg			
2	Benz(a)anthracene		59.0 ug/kg								
3	Benzo(a)pyrene		59.7 ug/kg								
4	Benzo(b)fluoranthene		114 ug/kg			60 ug/kg		48.3 ug/kg			
5	Bis(2-ethylhexl)phthalate*		496 ug/kg			1220 ug/kg		5020 ug/kg			
6	Chrysene		51.7 ug/kg								
7	Dimethyl Phthalate		144 ug/kg			46 ug/kg					
8	Fluoranthene		116 ug/kg			60.3 ug/kg		52 ug/kg			
9	Phenanthrene		53.7 ug/kg					40.3 ug/kg			
10	Pyrene		99.3 ug/kg			42.3 ug/kg		44.3 ug/kg			
11	3-&4-Methyphenol			676 ug/kg		576 ug/kg					
12	Phenol			70.7 ug/kg							
13	1,2,4-Trichlorobenzene*	S **			157 ug/kg			1290 ug/kg	1.37 ug/L		
		V			122 ug/kg			90.8 ug/kg			
14	1,2-Dichlorobenzene*	S			149 ug/kg			1390 ug/kg	6.91 ug/L		
		V			490 ug/kg			474 ug/kg	11.7 ug/L	4.91 ug/L	
15	Trichloroethane								3.31 ug/L		
16	Bis(2-Chloroethyl)ether*				625 ug/kg			712 ug/kg	136 ug/L		

17	1,2,3-Trichlorobenzene				32.8 ug/kg						
18	1,2-Dichloroethane*				57.6 ug/kg			150 ug/kg	2460 ug/L		
19	1,2-Dichloropropane				59.5 ug/kg			10.1 ug/kg	13.8 ug/L		
20	1,3-Dichlorobenzene	S						208 ug/kg			
		V			20.3 ug/kg			37 ug/kg			
21	1,3-Dichloropropane				16.9 ug/kg			17.3 ug/kg	2.19 ug/L		
22	1,4-Dichlorobenzene*	S			199 ug/kg			2080 ug/kg	8.45 ug/kg		
		V			652 ug/kg			665 ug/kg	14.8 ug/L	5.93 ug/L	
23	2-Butanone				131 ug/kg						
24	2-Chlorotoulene				19.8 ug/kg			37.4 ug/kg	1.62 ug/L	1.07 ug/L	
25	4-Chlorotoulene				10.1 ug/kg			17.4 ug/kg			
26	Benzene*				17.5 ug/kg			55.5 ug/kg	14.6 ug/L	7.76 ug/L	
27	Chlorobenzene*				521 ug/kg			949 ug/kg	48.6 ug/L	34.8 ug/L	
28	Naphthalene	S						241 ug/kg	1.85 ug/L		
		V			23.4 ug/kg			19.6 ug/kg			
29	Vinyl Chloride*				23.1 ug/kg			14.2 ug/kg	164 ug/L		2.57 ug/L
30	Di-N-Butyl Phthalate					44.7 ug/kg		34.7 ug/kg			
31	Hexachlorobenzene*					819 ug/kg					
32	Hexachlorobutadiene*					164 ug/kg					
33	Hexachloroethane					480 ug/kg					
34	Pentachlorophenol					123 ug/kg					

35	Toulene						26.9 ug/kg	1.35 ug/L	1.56 ug/L	98.3 %REC
36	2-Methylnaphthalene						50 ug/kg			
37	1,1-Dichloroethane						53 ug/kg	44.3 ug/L	4.39 ug/L	1.51 ug/L
38	1,1,2-Trichloroethane*							50.5 ug/L		33.6 ug/L
39	1,2,3-Trichloropropane							2.74 ug/L		
40	Bromochloromethane							2.90 ug/L		
41	Bromodichloromethane							2.43 ug/L		1.93 ug/L
42	Bromoform							30.6 ug/L		
43	Chloroform*							252 ug/L		10100 ug/L
44	Chloromethane							2.734ug/L		
45	cis-1,2-Dichloroethene							15.7 ug/L		4.08 ug/L
46	Dibromochloromethane							12.2 ug/L		
47	Dibromomethane							10.2 ug/L		
48	Trans-1,2-Dichloroethane							8.37 ug/L		
49	1,1-Dichloroethene									1.39 ug/L
50	Methylene Chloride*									1140 ug/L
51	Tetrachloroethene*									55.6 ug/L
52	Trichloroethene*									22.2 ug/L

*Chemicals found at levels above the permissible limit
** S-Semivolatile, V-Volatile

Annexure 5

Pace Analytical Services, Inc.
1700 Elm Street - Suite 200
Minneapolis, MN 55414

Tel: 612-607-1700
Fax: 612- 607-6444

Method 8290 Sample Analysis Results

Client - Specialty Analytical

Client's Sample ID	0710092-01		
Lab Sample ID	1061251001		
Filename	U71107B_10		
Injected By	SMT		
Total Amount Extracted	12.5 g	Matrix	Soil
% Moisture	20.0	Dilution	NA
Dry Weight Extracted	10.0 g	Collected	07/24/2007
ICAL Date	09/27/2007	Received	10/18/2007
CCal Filename(s)	U71107B_02 & U71107B_18	Extracted	10/29/2007
Method Blank ID	BLANK-14615	Analyzed	11/07/2007 16:56

Native Isomers	Conc ng/Kg	EMPC ng/Kg	RL ng/Kg		Internal Standards	ng's Added	Percent Recovery
2,3,7,8-TCDF	4.90	-----	0.26	A	2,3,7,8-TCDF-13C	2.00	77
Total TCDF	40.00	-----	0.26		2,3,7,8-TCDD-13C	2.00	77
					1,2,3,7,8-PeCDF-13C	2.00	71
2,3,7,8-TCDD	0.33	-----	0.22	JA	2,3,4,7,8-PeCDF-13C	2.00	72
Total TCDD	2.90	-----	0.22		1,2,3,7,8-PeCDD-13C	2.00	76
					1,2,3,4,7,8-HxCDF-13C	2.00	115
1,2,3,7,8-PeCDF	6.20	-----	1.00		1,2,3,6,7,8-HxCDF-13C	2.00	93
2,3,4,7,8-PeCDF	5.40	-----	1.00		2,3,4,6,7,8-HxCDF-13C	2.00	94
Total PeCDF	35.00	-----	1.00		1,2,3,7,8,9-HxCDF-13C	2.00	89
					1,2,3,4,7,8-HxCDD-13C	2.00	104
1,2,3,7,8-PeCDD	ND	-----	1.00		1,2,3,6,7,8-HxCDD-13C	2.00	78
Total PeCDD	ND	-----	1.00		1,2,3,4,6,7,8-HpCDF-13C	2.00	75
					1,2,3,4,7,8,9-HpCDF-13C	2.00	72
1,2,3,4,7,8-HxCDF	-----	21.0	1.00	E	1,2,3,4,6,7,8-HpCDD-13C	2.00	75
1,2,3,6,7,8-HxCDF	6.30	-----	1.00		OCDD-13C	4.00	69
2,3,4,6,7,8-HxCDF	3.50	-----	1.00	J			
1,2,3,7,8,9-HxCDF	3.30	-----	1.00	J	1,2,3,4-TCDD-13C	2.00	NA
Total HxCDF	39.00	-----	1.00		1,2,3,7,8,9-HxCDD-13C	2.00	NA
1,2,3,4,7,8-HxCDD	ND	-----	1.90	A	2,3,7,8-TCDD-37Cl4	0.20	80
1,2,3,6,7,8-HxCDD	-----	2.2	2.00	IA			
1,2,3,7,8,9-HxCDD	ND	-----	1.10	A			
Total HxCDD	ND	-----	1.70				
1,2,3,4,6,7,8-HpCDF	60.00	-----	1.00		Total 2,3,7,8-TCDD		
1,2,3,4,7,8,9-HpCDF	11.00	-----	1.00		Equivalence: 6.7 ng/Kg		
Total HpCDF	130.00	-----	1.00		(Using ITE Factors)		
1,2,3,4,6,7,8-HpCDD	-----	44.0	1.40	IA			
Total HpCDD	ND	-----	1.40				
OCDF	460.00	-----	2.00				
OCDD	380.00	-----	2.00				

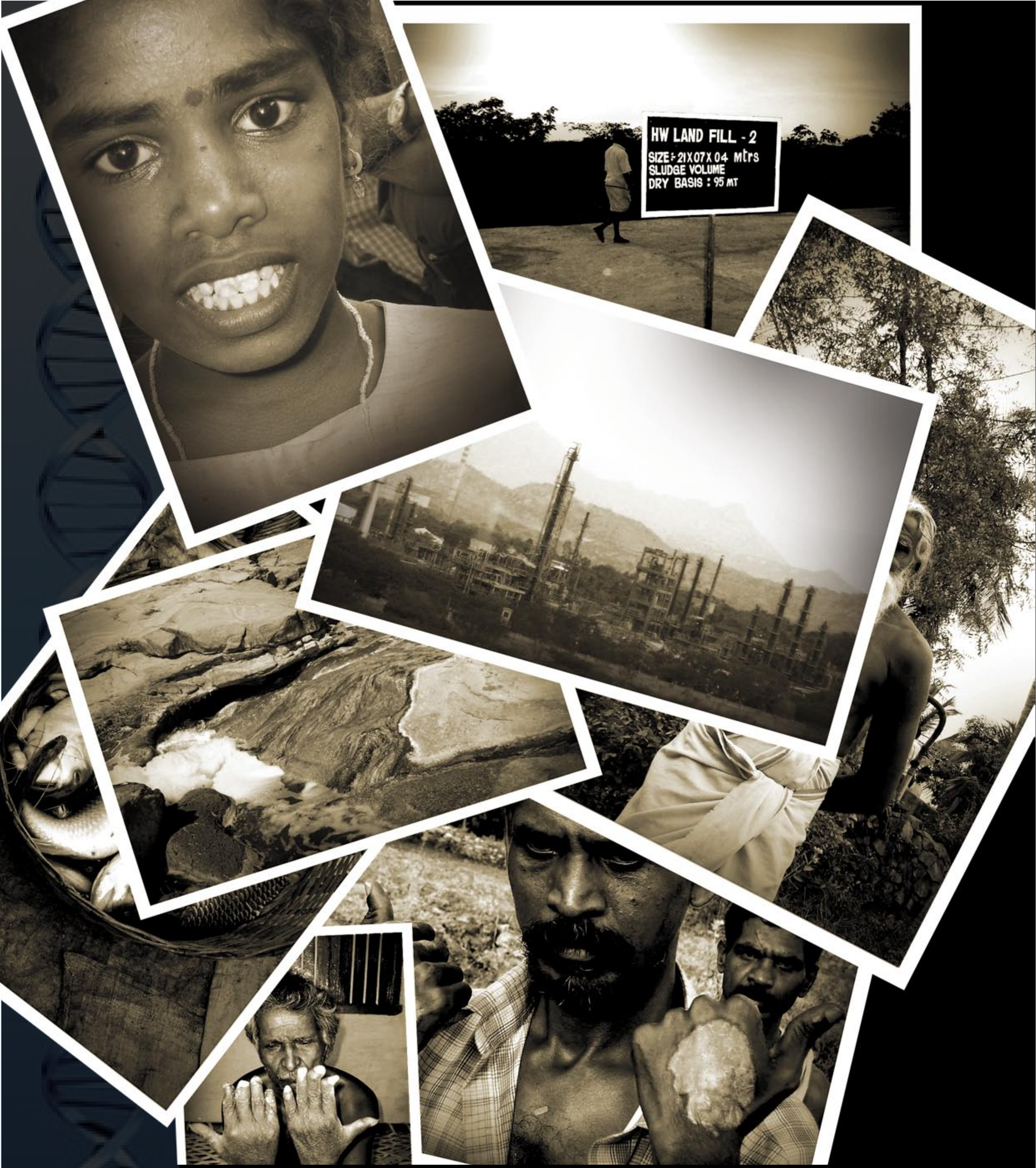
Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
A = Reporting Limit based on signal to noise
E = PCDE Interference
I = Interference present

REPORT OF LABORATORY ANALYSIS

Report No.....1061251



Community Environmental Monitoring
Ist Floor, 42 A, 5th Avenue,
Besant Nagar, Chennai - 600 090
Ph: 044-24463763

UNFOLDING DISASTER

A study on Chemplast Sanmar's Toxic Contamination in Mettur

Community Environmental Monitoring

November 2007