

# **SMOKE SCREEN**

**Ambient Air Quality in India**

**Community Environmental Monitoring**  
**June 2006**

**Website: [www.sipcotcuddalore.com](http://www.sipcotcuddalore.com)**

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## Executive Summary

After nearly a century of industrialization, and even as it is poised to nearly double its industrial capacity in the coming years, India is pathetically behind in terms of its infrastructure to safeguard its environment or the health of people from pollution. Air pollution monitoring and regulation is primitive, and the world's fourth largest economy has no standards for some of the most toxic and commonly found air pollutants. According to 1995 estimates in a study commissioned by the Ministry of Environment & Forests, total annual economic losses due to air pollution could exceed Rs. 9000 crores or 1 percent of the GDP<sup>1</sup>.

The public health ramifications of air pollution are immense. Volatile Organic Compounds and sulphur gases are categories of chemicals that include some of the more potent air pollutants that are likely to be found in various settings within an industrial society. Most of these have characteristic odours of nail polish, rotten cabbage, sewer etc. For years, regulators have regarded odours as a mere nuisance rather than as indicators of the presence of highly toxic gases.

Tired of waiting for regulatory authorities to intervene, in 2004, villagers from SIPCOT chemical industrial estate in Cuddalore, Tamilnadu -- a pollution hotspot began sampling and analyzing odour pollution incidents in their villages using a unique and community friendly device called the Bucket. A detachable plastic bag contained within a plastic bucket served as an artificial lung that would trap and seal the polluted air until it can reach a sophisticated laboratory in California. Here it was analysed for 67 VOCs and 20 sulphur compounds. The sampling device, the sampling methodology, the transportation of the sample and its analyses are all approved by the US Environment Protection Agency. Over two years, the SIPCOT Area Community Environmental Monitors took 9 samples and found 25 toxic chemicals, including 8 carcinogens, in the air being breathed by SIPCOT residents. However, the Tamilnadu Pollution Control

Board Chairman said that nothing could be done to remedy the air pollution because there were no standards for toxic gases in ambient air. In other words, people were condemned to breathe poisons because regulators and policy makers had failed to do their jobs. Air pollution monitoring in India currently tests for only five parameters; i.e. Oxides of Sulphur (SO<sub>x</sub>), Oxides of Nitrogen (NO<sub>x</sub>), Suspended Particulate Matter (SPM), Respirable Particulate Matter (RSPM) and Carbon Monoxide (CO).

Between 2004 and 2006, citizens' groups took and analysed 21 air samples from 12 locations around the country using the "Bucket." The effort is notable in that it is the first ever national study of toxic gases covering an entire spectrum of air pollution sources. The National Air Toxics sampling was designed to meet two objectives:

- Develop a list of commonly found toxic gases in ambient air in order to focus standards development and enforcement measures for the same.
- Assess the usefulness of the Bucket as a sampling device for various kinds of air pollution.

Traditionally air samples with the help of the bucket have been taken in industrial settings. In an effort to assess the utility of the bucket in other settings, air samples were also taken from effluent discharge channels, copper smelter, hazardous waste landfills, open garbage incineration site and traffic junction.

- A total of 45 chemicals, including 13 carcinogens (marked by\*), were found. These include: Acetone, Toluene, Chloroform\*, Methylene Chloride\*, Benzene\*, 2-Butanone, Carbon Disulphide, Isopropyl Alcohol, Ethanol, Hydrogen Sulphide, Methyl Mercaptan, Dimethyl Disulphide, n-Hexane, Carbon Tetrachloride\*, Trichloroethene\*, Ethyl Benzene, m,p- Xylenes, Acetonitrile, Acrylonitrile\*, 1,2-Dichloroethane\*, Vinyl Chloride\*, 1,1- Dichloroethane, 1,1,2- Trichloroethane\*, Chlorobenzene, o-Xylene, 1,2,4-Trimethylbenzene,

Alpha-Pinene, d-Limonene, 1,3- Butadiene\*, Acrolein, Methyl tert-Butyl Ether, Styrene, Nonane, Dimethyl Sulphide, Chloromethane\*, n-Butyl Acetate, Hexachlorobutadiene\*, Carbonyl Sulphide, Chloroethane, Trichlorofluoromethane, 4-Methyl-2-Pentanone, Cumene, 1,3,5-Trimethylbenzene, Bromomethane\*, Vinyl Acetate.

- Five chemicals Acetone, Toluene, Carbon Disulphide, Isopropyl Alcohol and Methylene Chloride (a carcinogen) were very commonly found, in 11 or more of the samples. Ten chemicals Ethanol, n-Hexane, Hydrogen Sulphide, Chloroform\*, Methyl Mercaptan, Trichloroethene\*, Benzene\*, m,p- Xylene, 1,2-Dichloroethane\*, 2-Butanone and Acrolein -- were found in 5 to 9 samples.
- The chemicals target virtually every system in the human body -- eyes, central nervous system, skin and respiratory system, the liver, kidneys, blood, the cardiovascular system, reproductive system; heart; the peripheral nervous system, lungs and gastrointestinal tract; the bone marrow and lymphatic nodes.
- At least 28 out of 45 chemicals found violate the US Environmental Protection Agency Region 6 Screening levels for residential air. Some of the chemicals (all known or suspected human/animal carcinogens) are listed below:
  - 1,2-Dichloroethane found in the sample downwind from the Chemplast PVC effluent channel exceeded the screening level by a factor of 32000.
  - Vinyl Chloride found in the sample downwind from Chemplast PVC effluent channel exceeded the screening level by a factor of 2100.
  - 1,3-Butadiene found in the sample downwind of open garbage burning site in Perungudi exceeded the

screening level by factor of 34782, while the same chemical was found at ITO traffic emissions in Delhi exceeded the screening level by a factor of 1174.

- Benzene found in the sample downwind of open garbage burning site in Perungudi exceeded the screening level by a factor of 2360.

All the chemicals listed above are known or suspected human or animal carcinogens.

Some of the worst polluted samples were:

- Sample taken from open garbage incineration site in Perungudi dumping ground of Chennai, Tamil Nadu recorded the highest number of chemicals - 27 chemicals found in any sample.
- Sample taken downwind of the PVC effluent channel from Chempalst PVC plant in Mettur, Tamil Nadu, registered the highest number of carcinogens found in any sample. Of the 17 chemicals found, 6 were known human or animal carcinogens.
- Sample taken downwind of a proposed Secured Landfill Facility within the premises of the Hindustan Insecticides Ltd plant in Eloor recorded the presence of hexachlorobutadiene an indicator for dioxin in the sample. This was the first community sample in the world to register the presence of HCBd, a dioxin indicator. However, only 5 chemicals were found in this sample.

The widespread presence of these chemicals presents a daunting challenge to environmental regulators and communities. The traditional pollution monitoring and control systems cannot deal with toxic gases. For instance, industrial pollution regulation that focuses on stack monitoring and installation of pollution control equipment at point sources of pollution does not take into account

the fact that fugitive emissions, spills and leaks -- not stack emission -- are the most significant sources of VOC and sulphur gases. Seen from the context of addressing VOCs and toxic gases, pollution prevention, toxic use reduction and toxic material substitution can no longer remain a catchword, and must form the basis of environmental policy with regard to pollution.

Moreover, owing to the public health ramifications, the exercise of setting standards, monitoring pollution and health and enforcing regulation should also involve the Ministry of Health, especially because the Ministry of Environment, has in recent years exposed itself as an apologist for polluting industries rather than a protector of the environment.

Many of the chemicals found can have devastating effects on children, women and the elderly. Therefore, policy makers should strive to achieve zero levels of these chemicals in ambient air in residential areas and public thoroughfares. Particular attention must be paid to communities living along the fencelines of hazardous industries, because these communities most often belong to poorer and lower caste sections of the society. Also, the high levels of these chemicals found in ambient air has particularly alarming ramifications for workers inside the factories or children scavenging in garbage dumpsites. Standards setting and enforcement must be health-based rather than based on economic expediency, and must place the lives of workers and communities at a higher premium than the health of the industries and activities that ought to be regulated.

The National Air Toxics exercise is a result of collaboration between various community groups, collectives and NGOs that highlights the possibilities that exist for monitoring air pollution and enforcing regulation. It is efforts such as this -- that assert the ability of communities and citizens' groups to practice and direct science -- that will begin to address the ills that beset India's environmental regulatory system namely, political interference, and lack of scientific temper and integrity.

## Introduction to the Study

Air monitoring in India is unevolved and primitive. Techniques adopted by Central and State Pollution Control Boards are inadequate and do not reflect either the advances in our understanding of air pollution and health, or the developments in monitoring pollutants in ambient air. For most part, routine monitoring is restricted to parameters like Oxides of Sulphur (SO<sub>x</sub>), Oxides of Nitrogen (NO<sub>x</sub>), Suspended Particulate Matter (SPM) and Respirable Particulate Matter (RPM) and in a few instances, of Carbon Monoxide, Ammonia and heavy metals. More recently, limited monitoring for poly aromatic hydrocarbons such as Benzene, Toluene and Xylene are being carried out.

That India's air monitoring regime is primitive is proven by the fact that the country does not have standards for critical and commonly found chemicals of concern in ambient air. Further, the political will or the scientific temperament to aggressively pursue the setting of such standards also seems to be absent; this is manifest from the fact that two years after the Supreme Court Monitoring Committee (SCMC) directed the Central Pollution Control Board (CPCB) to set standards for Volatile Organic Compounds (VOC) and sulphur gases in ambient air, neither the CPCB nor the SCMC have followed up on the matter. The lack of standards is being used by State Pollution Control Boards as an excuse to postpone action or do nothing despite clear evidence that the chemicals in question are life-threatening and are being reported by NGOs at extremely unsafe levels. Faced with regular reports of alarming levels of VOCs in the air in Cuddalore, the Tamil Nadu Pollution Control Board Chairperson Mr. Surjit. K. Choudhary told The Hindu newspaper in 2006 that "as the Central Pollution Control Board has not prescribed any standards for volatile organic compounds, nothing much can be done about that."

The failure of the CPCB to set standards despite considerable expenditure raises questions of accountability, collusion with the industry and lack of political will to protect the environment and

public health. According to the 1999-2000 annual report of the MoEF, the Ministry had provided \$ 6.5 million for "Ambient Air Quality Monitoring" in the World Bank-funded Environment Management Capacity Building Technical Assistance Project; the project was implemented by the CPCB. A key activity under this project was "Benzene and other VOC monitoring in ambient air in metro cities." Apart from this, the ministry had also made a provision of \$1 million in the same project for the "Development of Standards." Main objectives of the project included the study of methodologies adopted world-over and their applicability in India to update indigenous methodology; to develop industry sector specific standards and to review ambient water and air quality criteria<sup>2</sup>. The outcome of this project is not known.

VOCs include many carcinogens that can exert long term even fatal effects at very low concentrations. In September 2004, SIPCOT Area Community Environmental Monitors (SACEM), with the support of the Community Environmental Monitoring program, released a report titled "Gas Trouble" that revealed the presence of 22 toxic VOCs and sulphur compounds in the air breathed by residents of the SIPCOT chemical industrial estate in Cuddalore, Tamilnadu. Trained village environmental monitors from Cuddalore took the samples using a Tedlar bag housed in a plastic bucket (See box titled: "Bucket Brigade") and had it analysed at a US Environmental Protection Agency (USEPA) approved laboratory in California. Even while the State Pollution Control Boards and industry argued that air pollution in SIPCOT was under control, SACEM found at least 8 carcinogens, including chloroform, methylene chloride and carbon tetrachloride in SIPCOT's air.

The Supreme Court Monitoring Committee on Hazardous Wastes, set up by the Supreme Court of India, rightly inferred from "Gas Trouble" that industrial air pollution was a case of hazardous waste dumping in the air. However, after its initial direction to CPCB asking the agency to set up standards for toxic gases, the

4 SCMC too seems to have lost interest in the matter.

SIPCOT is by no means the only pollution hotspot. Numerous other locations with industries, garbage dumps and traffic pollution have conditions very similar to those found in SIPCOT, indicating that unrecorded by the regulatory authorities, thousands of tons of toxic chemicals were being dumped into the air as a result of industrial and other human activities. The setting up and enforcement of standards is essential not only for the well-being of communities in SIPCOT, but for people around the country.

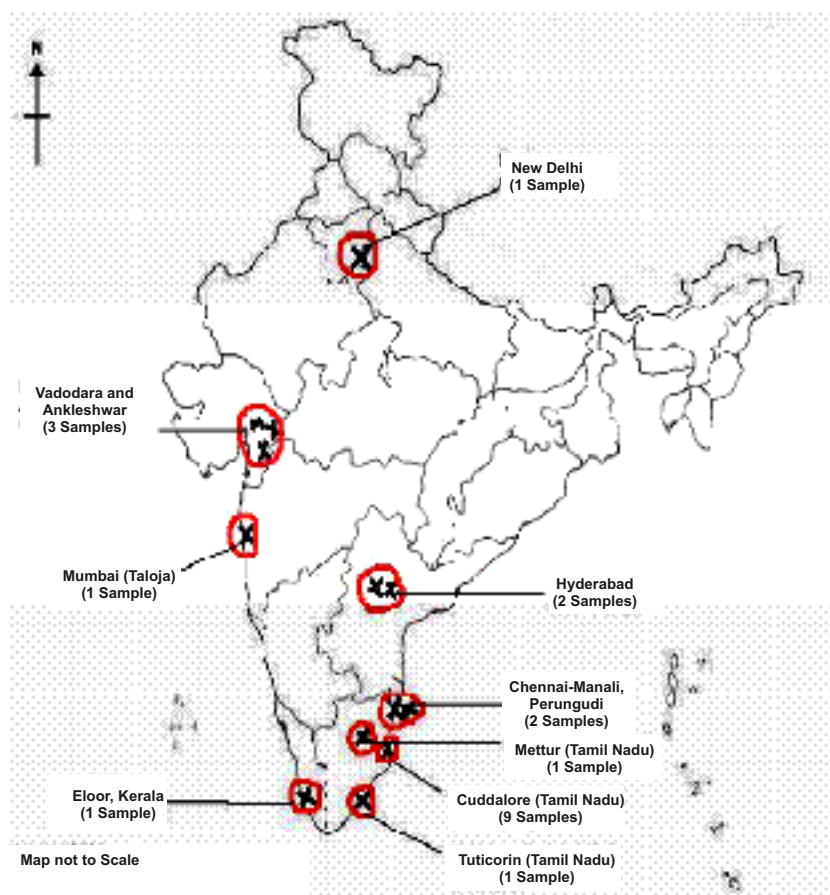
The National Air Toxics study contained in this report was conducted for two reasons:

1. To assess the utility of the Bucket as an air sampling device that can be used by pollution-impacted communities in various situations;
2. To generate a profile of prevalent air pollutants, and direct the Government's efforts in regulating these as a matter of priority.

#### **Locations of sampling:**

In all, 21 samples have been considered for the National Air Toxics study, including 9 from SIPCOT Cuddalore, and 12 from various locations around the country. These locations include industrial areas; facilities that are considered to be solutions to pollution such as landfills and common treated effluent forwarding units or channels; traffic junction; and municipal waste dump sites (see map).

## Location of 21 samples taken for the National Air Toxics Study



## Methodology and Analysis

Grab samples of ambient air were taken in Tedlar bags housed in sturdy, easy-to-use buckets (For information see the box on page 9). The sampling device and methodology, and analytical procedures adhere to US EPA norms. Samples were taken by trained personnel using standardised Quality Control and Quality Assurance procedures approved by the US EPA.

The QA/QC procedures ensure that samples are not accidentally contaminated during sampling by emissions from non-target sources such as cigarette smoke or vehicular emissions. This is done by paying attention to wind direction and location of target source in relation to sampling location and other sources of incidental contamination. Details such as wind direction, sampling location with respect to known or potential industrial sources, time and duration of sampling, and other observable conditions such as type of smell and visible pollution at the time of sampling were recorded in a "Chain of Custody" form. All samples were taken downwind of target sources in public thoroughfares and/ or near residential areas.

The Tedlar bag samples were sealed, detached and sent to Columbia Analytical Services an US EPA accredited laboratory in California, USA. The lab analyses the samples for 67 VOCs and 20 sulphur compounds. Bucket samples cannot be analysed for particulate matter, heavy metals or for toxins such as dioxins that attach themselves to particulate matter. Neither can the samples be used to measure acid rain or radiation. Government laboratories in India are currently not equipped to analyse Tedlar bag samples.

The lab uses the USEPA Modified TO15 method using a GCMS (Gas Chromatography and Mass Spectrometry) to screen and quantify VOCs. For reduced sulphur gases like hydrogen sulphide and methyl mercaptan, US EPA Modified Method TO 16 using a gas chromatograph fitted with a Sulphur Chemiluminescence detector is used.

### **Interpretation of Data:**

Analytical data is compared with established benchmarks or standards. In India, ambient air quality standards do not cover toxic gases such as VOCs and sulphur compounds. Even occupational standards are extremely limited despite the fact that many of the VOCs and sulphur compounds are chemicals of occupational concern. Of the 67 VOCs and 20 sulphur compounds tested for, Schedule 2 of the Factories Act, 1948, contains occupational standards for only 18 and 3 chemicals respectively.

Community air monitoring teams in South Africa, USA and the Philippines that use the Bucket routinely compare their analyses with the following screening levels or standards from the US. Residential values are chosen, because all the sampling locations are in residential areas or in public thoroughfares where people, including vulnerable populations such as children, frequent.

Many Screening Levels and standards account for the duration of exposures.

#### **1. Screening or minimum risk level:**

These levels are generally based on studies of health effects of individual pollutants. Concentration levels of these pollutants are set either in relation to a specified level of risk or to the level below which it is thought that the health effects are unlikely. The figures thus represent maximum permissible exposures.

- EPA region 6 Screening Level is calculated for residential exposure. The levels are based on a 1 in a million cancer risk or a 'hazard quotient' of 1 for non-cancer effects.
- Texas Effects screening Levels are set at the level below which health impacts are thought unlikely. Different levels are set for 'short-term' exposure usually one hour and 'long-term' exposure usually one year, but only 24 hours for Benzene and Ethylene dichloride.

- ATSDR (Agency of Toxic Substance and Disease Registry) Minimal Risk Levels also sets levels according to duration of exposure: 'Acute indicates period of up to two weeks, 'intermediate' from two weeks to one year, and 'chronic' as longer than a year.

#### **2. Standards**

Standards are legally enforceable. Two standards were used for comparison in this study:

- Louisiana Ambient Air Quality Standards differentiate between 8 hour exposure and 24 hour exposure.
- North Carolina Ambient Air Standards sets annual standards, 24 hour standards and one hour standards for systemic toxicants and irritants.

#### **Limitations of Study:**

Though the attempt of the study was to develop a profile of toxic chemicals in air, the study encountered the following limitations:

1. Lack of resources for a comprehensive study: The analysis of the air samples are carried out in a laboratory in United States, the costs involved for transportation of the samples and analysis limited the number of samples taken. Though the intention was to cover as many places as possible the financial resources available enabled testing of only 21 samples.
2. Samples analysed out of holding time: All samples reached the laboratory outside the prescribed holding time of 72 hours from time of sampling. Because some of the chemicals are prone to degrading below detection levels if the analyses is conducted after the holding time, the levels and chemicals found represent a conservative estimate of what was originally present in the air sample.



3. Samples damaged in transit: At least three samples were damaged in transit.
4. Lack of appropriate reference values: Throughout the study, grab sample values are compared with reference values, some of them for exposure (usually time-weighted averages) over a duration. This is not desirable, as it would have been better to compare the grab values with the maximum allowable concentration at any given point in time. Such numbers are not available. To the extent possible, grab sample values are compared with with US EPA Region 6 levels, which denote levels below which deleterious effects are unlikely to occur. Readers need to bear in mind that most of these toxic chemicals ought not to be present in residential air in the first place.

The study has to be seen in perspective, as an alarm bell calling for immediate action and simultaneous research to assess the magnitude and specific nature of the problem, and recommend corrective measures. This study is by no means the final word on the topic. Rather, it is the first word, and it is hoped that academic institutions, health professionals and the Government will move in rapidly to study and report on the neglected aspect of toxic gases in ambient air, and related health implications.

## Bucket Brigade

### How does the bucket take an air sample?

The plastic bucket serves as a rugged enclosure for a standard "Tedlar" sampling bag and for the equipment needed to fill the bag with outside air. A small vacuum sucks air out of the bucket. When you open the valve attached to the sampling bag, air rushes in to fill the bag. After taking a sample, a trained person removes the sampling bag and sends it for analysis. A new bag can then be fitted to get the bucket ready for, the next sample.

### What's the use of the buckets?

The buckets can be used to measure everyday pollution levels or to respond to accidental releases at the chemical factory in your area. Buckets take "grab" samples at nose-level and can give you a snapshot of what you are breathing. Buckets have proven to be a valuable tool to keep polluters in line and challenge their baseless claims that emissions are within permissible limits.

The government agencies too are more likely to begin monitoring and publish the

results once they know that communities are taking regular samples and monitoring the state of the environment.

Data generated by the bucket gives information about the levels of several gases, some of them with known toxicological properties. The analytical data thus generated combined with regularly maintained chemical odour incident records provide a fair picture of air quality in an area. It would also alert us to the need, if any, for precautionary action to protect health.

### Are the results credible?

Grab sampling is a well-established environmental monitoring technique in the environmental monitoring industry. The bucket employs the same principles and techniques as the US Environmental Protection Agency and the industries. Indeed, the Bucket was co-developed as a community tool by the US EPA. Bucket samples that were analysed alongside samples taken simultaneously by well-established techniques yielded similar results. Quality assurance and quality control measures provide additional scientific information and increase the credibility of the bucket samples. Currently, Columbia Analytical Services, a US EPA-certified laboratory in California performs the sample analyses. The laboratory is placed among the top 10 laboratories in the U.S.

### Are the buckets difficult to use?

The bucket design is well suited for community use. Sturdy and easy to use, the buckets provide a less expensive way of obtaining comprehensive information relating to toxic gases in the air. This information can help you ask informed questions and express legitimate documented concerns. The buckets represent sound science, and can provide the data-backing required to corroborate community concerns about pollution and related health effects.

### What can the buckets do and not do?

The laboratory can only analyze the bucket sample for gases.

1. Bucket samples cannot be analysed for Particulate Matter (PM).
2. Buckets samples cannot be analysed for toxins that normally attach themselves to particles, such as dioxins.
3. Buckets samples cannot be analysed for acid rain or radiation.

### What pollutants can be tested using bucket samples?

For testing around chemical plants and oil refineries, two common analytical procedures are followed to test for a) VOC's (Volatile Organic compounds) and inorganic gases and b) sulphur compounds.

#### ***Volatile Organics and Inorganics***

With bucket samples, the lab can detect many of these compounds at parts per billion (ppb) levels. Some of the measured VOCs include Benzene, Toluene, 3 types of Xylenes, Methylene Chloride, Tetrachloroethane, Acetone etc.

#### ***Sulphur Compounds***

Sulphur compounds can also be detected at levels below 1 ppb. Some of the sulphur compounds are Hydrogen Sulphide, Carbonyl Sulphide, Carbon Disulphide, 7 types of Mercaptans and 5 types of Thiophenes.

Bucket samples are currently being sent to a USEPA-certified laboratory in the US for analyses, because labs in India don't have one essential component required for the analyses.

**For more details: visit <http://www.gcmonitor.org>**

## Findings

Between March 2004 and December 2005, a total of 21 samples were taken of ambient air in industrial settings, industrial waste disposal sites, a toxic dump yard, open garbage incineration site and a traffic junction.

1. A total of 45 chemicals were detected in 21 samples taken.
  - Out of the 45 chemicals detected, at least 15 chemicals were found to be present in five samples or more. These chemicals are Acetone, Toluene, Chloroform, Methylene Chloride, Carbon Disulphide, Benzene, Isopropyl Alcohol, Ethanol, Hydrogen Sulphide, Methyl Mercaptan, n-Hexane, Trichloroethene, m,p-Xylenes, 1,2-Dichloroethane and Acrolein.
2. Out of the 45 chemicals found, 36 chemicals target the eyes; 35 chemicals target the Central Nervous System; 34 chemicals target the skin and respiratory system; 20 chemicals target the liver; 18 chemicals target the kidneys; 8 chemicals target the blood; 7 chemicals target the Cardio

### CHEMICALS FOUND

#### Volatile Organic Compounds

Acetone  
Toluene  
**Chloroform\***  
**Methylene Chloride\***  
**Benzene\***  
2- Butanone  
Isopropyl Alcohol  
Ethanol  
n-Hexane  
**Carbon Tetrachloride\***  
**Trichloroethene\***  
Ethyl Benzene  
m-p, Xylenes  
Acetonitrile  
**Acrylonitrile\***  
**1-2, Dichloroethane\***  
**Vinyl Chloride\***  
1-1, Dichloroethane  
**1,1,2, Trichloroethane\***  
Chlorobenzene  
o-Xylene  
1,2,4, Trimethylbenzene  
Alpha Pinene  
d-Limonene  
**1-3, Butadiene\***  
Acrolein  
Methyl Tert Butyl Ether  
Styrene  
Nonane  
**Chloromethane\***  
n-Butyl Acetate  
**Hexachlorobutadiene\***  
Chloroethane  
Trichlorofluoromethane  
4-Methyl-2-Pentanone  
Cumene  
1,3,5, Trimethylbenzene  
**Bromomethane\***  
Vinyl Acetate

#### Sulphur Compounds

Carbon Disulphide  
Hydrogen Sulphide  
Methyl Mercaptan  
Dimethyl Disulphide  
Dimethyl Sulphide  
Carbonyl Sulphide  
(\* Known or suspected human or animal carcinogens)

Vascular System; 5 chemicals target the reproductive system; 3 chemicals target the heart; 2 chemicals target the Peripheral Nervous System, lungs and gastrointestinal tract; and 1 chemical targets the bone marrow and lymphatic node.

3. 13 chemicals out of the 45 are known to cause cancer in human or animals. (See Box)
4. Many of the chemicals also cause birth defects, Central Nervous system disorders and respiratory disorders.
5. At least 28 out of 45 chemicals found violate the USEPA Region 6 Screening levels for residential air, some of the chemicals are listed below:
  - 1,2-Dichloroethane found in the sample downwind from the Chemplast PVC effluent channel exceeded the screening level by a factor of 32000.
  - Vinyl Chloride found in the sample downwind from Chemplast PVC effluent channel exceeded the screening level by a factor of 2100.
  - 1,3-Butadiene found in the sample downwind of open garbage burning site in Perungudi exceeded the screening level by factor of 34782, while the same chemical was found downwind of ITO traffic emissions in Delhi exceeded the screening level by a factor of 1174.
  - Benzene found in the sample downwind of open garbage burning site in Perungudi exceeded the screening level by factor of 2360.

All the chemicals listed above are known or suspected human or animal carcinogens.

The three most polluted samples out of the 21 taken were:

- A. **Sample taken downwind of an open garbage burning site in Perungudi waste dumping ground of Chennai:**

- Highest number of chemicals was detected in this sample a total of 27 chemicals were found.
- This sample also had the highest number of chemicals above the levels prescribed by the USEPA Region 6 Screening levels - 15 out of the 27 chemical found were above the USEPA level.
- 3 out of 27 chemicals (1,3-Butadiene, Benzene, Chloromethane) are known to cause cancer in humans and/or animal
  - a) 1,3-Butadiene was found 34782 times higher than the safe levels
  - b) Benzene was found 2360 times higher than the safe levels
  - c) Chloromethane was found 209 times higher than the safe levels

**B. Sample taken downwind of a proposed Secured Landfill Facility within the premises of the Hindustan Insecticides Ltd. Plant in Eloor:**

Though only 5 chemicals were found in this sample, this sample becomes significant because for the first time in the history of a Bucket sampling, Hexachlorobutadiene (HCBD) -- a dioxin indicator -- was found.

**Hexachlorobutadiene (HCBD):**

Hexachlorobutadiene is a colourless liquid with turpentine like odour. It is a widespread environmental contaminant.

It can exist in the atmosphere as a vapour or absorbed to airborne particulate matter and it has been found in

waste water from chlorine industries, in leachate from landfills and hazardous waste sites, in the air, soils, surface

water and sediments. It has also been detected in the fly ash from the incineration of HCBD-containing hazardous

wastes. It is toxic to aquatic organisms. It also bioaccumulates in the food chain, especially in the fish.

If ingested HCBD concentrates in the kidney, its 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 kidneys and liver. It is classified as a potential occupational carcinogen and causes kidney tumours in animals.

HCBD is an indicator of the presence of even more toxic chemicals such as dioxins and furans.

Source: "Chlorine and the Environment." Ruth Stringer and Paul Johnston, Kluwer Academic Publishers, 2001.

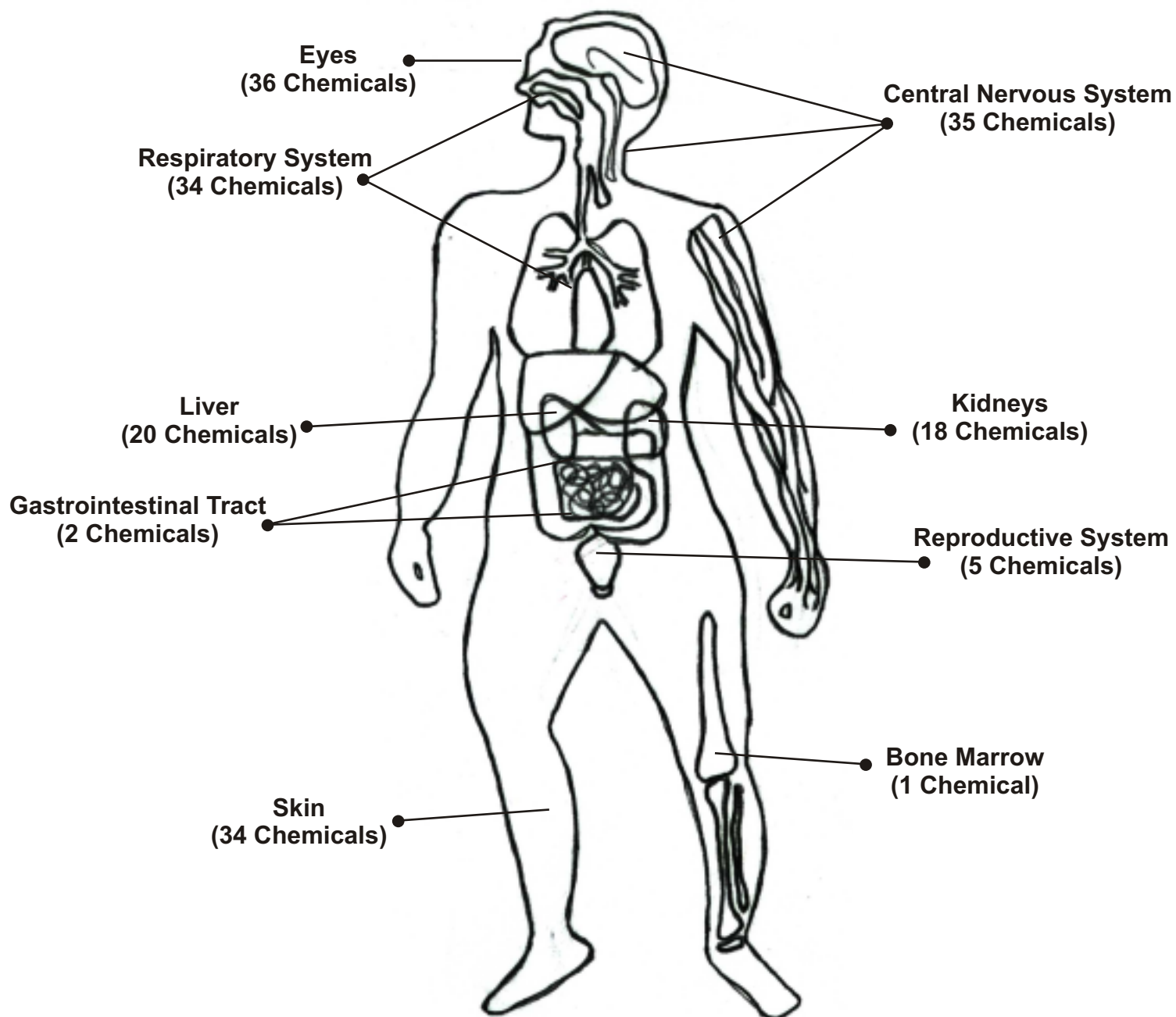
**C. Sample taken downwind of the PVC effluent channel from Chemplast PVC plant in Mettur, Tamil Nadu:**

- Highest number of carcinogens were found in this sample. Out of the 17 chemicals detected, 6 are known human or animal carcinogens.

The following were the carcinogens found:

<i>Name of Chemical</i>	<i>Type of Cancer</i>	<i>Exceeds the USEPA Region 6 Screening levels by a factor of</i>
1,2-Dichloroethane	In Animals: Cancer of fore-stomach, mammary gland and circulatory system; potential occupational carcinogen	32000
Vinyl Chloride	Liver cancer in human	2100
Chloroform	In Animals: Cancer of liver and kidneys; potential occupational carcinogen	380
1,1,2-Trichloroethene	In Animals: Cancer of liver	72
Benzene	Leukemia or cancer of bone marrow in humans	25
Methylene Chloride	In Animals: Cancer of lungs, liver, salivary and mammary glands	1.6

## Chemicals that target the various parts of the Human Body



**Details of the location of the sample:**

Sample Id	Date of sampling	Location of the sample	Key findings
Sample 1 Cuddalore, Tamilnadu	04 March 2004	SIPCOT Road No.5, Opposite Loyal Super Fabrics.	- 7 Chemicals detected - 2 Carcinogens - 4 Chemicals above the USEPA Region 6 Screening levels
Sample 2 Cuddalore, Tamilnadu	05 March 2004	Downwind of Shasun Chemicals.	- 11 Chemicals detected - 3 Carcinogens - 5 Chemicals above the USEPA Region 6 Screening levels
Sample 3 Cuddalore, Tamilnadu	03 June 2004	Downwind of Shasun Chemicals.	- 9 Chemicals detected - 3 Carcinogens - 5 Chemicals above the USEPA Region 6 Screening levels
Sample 4 Cuddalore, Tamilnadu	21 June 2004	Downwind of Tagros Chemicals.	- 14 Chemicals detected - 6 Carcinogens - 5 Chemicals above the USEPA Region 6 Screening levels
Sample 5 Cuddalore, Tamilnadu	21 June 2004	Downwind of Asian Paints.	- 6 Chemicals detected - 1 Carcinogen - 3 Chemicals above the USEPA Region 6 Screening levels
Sample 6 Cuddalore, Tamilnadu	30 October 2004	Downwind of Tantech Agro Chemicals.	- 8 Chemicals detected - 2 Carcinogens - 4 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 7 Cuddalore, Tamilnadu	25 February 2005	Downwind of Bayer Arkema Complex.	- 5 Chemicals detected - 2 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 8 Cuddalore, Tamilnadu	28 March 2005	Downwind of Tantech Agro Chemicals.	- 8 Chemicals detected - 2 Carcinogens - 5 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 9 Cuddalore, Tamilnadu	28 March 2005	Downwind of SPIC.	- 3 Chemicals detected - 2 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 10 Mettur, Tamilnadu	05 April 2005	Downwind of PVC effluent channel of Chemplast Sanmar plant.	- 17 Chemicals detected - 6 Carcinogens - 8 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 11 ECPL, Gujarat	01 June 2005	Downwind of ECPL project in Vadodara Gujarat	- 9 Chemicals detected - 3 Carcinogens - 4 Chemicals above the USEPA Region 6 Screening levels or any other screening levels

<b>Sample Id</b>	<b>Date of sampling</b>	<b>Location of the sample</b>	<b>Key findings</b>
Sample 12 Ranoli Bridge, Gujarat	02 June 2005	Downwind of Gujarat Alkalies and Chemicals Ltd. Gujarat	- 7 Chemicals detected - 2 Carcinogens - 3 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 13 Ankleshwar, Gujarat	02 June 2005	Between Sara Chemicals and RPG Lifesciences, downwind of most of the industries in the area	- 16 Chemicals detected - 4 Carcinogens - 8 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 14 TSDF Taloja, Maharashtra	10 June 2005	Downwind of the TSDF	- 7 Chemicals detected - 1 Carcinogens - 2 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 15 Manali Petrochemical Complex, Tamilnadu	25 July 2005	Downwind of Futura Polymers	- 12 Chemicals detected - 1 Carcinogens - 5 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 16 ITO Traffic Junction in New Delhi	30 July 2005	ITO Traffic Junction opposite the Police Commissioner's office	- 18 Chemicals detected - 3 Carcinogens - 8 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 17 Pashamylaram Industrial Area Hyderabad, Andhra Pradesh	8 August 2005	Downwind of Hyderabad Chemicals	- 15 Chemicals detected - 3 Carcinogens - 8 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 18 Eloor Industrial Estate. Near Kochi, Kerala	20 August 2005	Downwind of the site of proposed Secured Landfill Facility inside the HIL premises	- 5 Chemicals detected - 3 Carcinogens - 4 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 19 TSDF Kazhipally industrial area near Hyderabad, Andhra Pradesh	15 September 2005	Downwind of TSDF in Kazhipally industrial area near Hyderabad	- 9 Chemicals detected - 3 Carcinogens - 4 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 20 Open garbage incineration site, Perungudi, Tamilnadu	28 September 2005	Downwind of an open garbage incineration site	- 27 Chemicals detected - 3 Carcinogens - 15 Chemicals above the USEPA Region 6 Screening levels or any other screening levels
Sample 21 Sterlite Industries, Tuticorin, Tamilnadu	31 December 2005	Downwind of Sterlite Industries in Tuticorin	- 3 Chemicals detected - 1 Chemicals above the USEPA Region 6 Screening levels or any other screening levels

## Background of the locations and sample results

### I. SIPCOT Industrial Complex, Cuddalore:

**Sampling date:** 2004-2005

**Sampling Location:** Various locations downwind of various industries in SIPCOT, Cuddalore. (See box above)

The SIPCOT Industrial complex of Cuddalore, Tamil Nadu hosts a number of chemical, pharmaceutical, pesticide, dyes, dyestuffs and related industries. Currently, 19 units are operational. Located on the banks of River Uppanar, the industrial estate is notorious for pollution. For the last twenty years, SIPCOT residents have complained to the Tamilnadu Pollution Control Board (TNPCB) and Government authorities about the pollution-related health and environmental effects. Air pollution is so intense that villagers can identify industries by the unique chemical odours emanating from them. Rather than assess and remedy the problem, the TNPCB has dismissed villagers' concerns and actively shielded the industry from regulation.

Between March 2004 to August 2004 and October 2004 to March 2005, trained monitors of SIPCOT Area Community Environmental Monitoring (SACEM), a SIPCOT-based community organisation, took air samples with the help of a "Bucket". The samples were taken downwind of various industries on 9 different occasions when the chemical odours from these units were intense and unbearable. The results of the samples were released in forms of reports, "Gas Trouble: Air Quality in SIPCOT Cuddalore", in September 2004 and "Gas Trouble II: Air Quality Status and Assessment of TNPCB's Compliance to the Supreme Court Monitoring Committee's Order" in May 2005.

#### Results of the samples:

1. A total of 25 chemicals were detected in the 9 samples taken from SIPCOT Complex. These chemicals were

Acetone, Toluene, n-Hexane, Chloroform, Methylene Chloride, Acetonitrile, Trichloroethene, 1,2-Dichloroethane, Hydrogen Sulphide, Methyl Mercaptan, Dimethyl Disulphide, Ethanol, Isopropyl Alcohol, Carbon Tetrachloride, n-Butyl Acetate, Carbondisulphide, Vinyl Chloride, Bromomethane, Benzene, Acrolein, Vinyl Acetate, 2-Butanone (MEK), 4-Methyl-2-Pentanone, m,p-Xylenes, Dimethyl Sulphide.

2. Eight of the 25 chemicals are known to cause cancer in animals and/or humans. These include Chloroform, Methylene Chloride, Trichloroethene, 1,2-Dichloroethane, Carbon Tetrachloride, Vinyl Chloride, Bromomethane and Benzene.
3. At least 15 out of 25 chemicals violate the US EPA Region 6 Screening Levels for residential air.
  - 1,2-Dichloroethane, taken downwind of Tagros Chemicals a pesticide factory -- exceeded the screening levels by a factor of 22,973.
  - Chloroform was above Region 6 Screening Levels by a factor of 5119 in the sample taken downwind of Shasun Chemicals.
  - Methylene Chloride and Hydrogen Sulphide were found in the sample taken downwind of CUSECS No. 5 at levels 905 and 874 times respectively above the Effects Screening Levels.
  - Trichloroethene and Acrolein in the samples taken downwind of Asian Paints exceeded EPA Region 6 levels by factors of 127 and 320 respectively.

Four out of the above six chemicals, with the exception of Hydrogen Sulphide and Acrolein, are known or suspected human or animal carcinogens.

For more details on the levels of chemicals detected please refer to the reports:

**"Gas Trouble - Air Quality in SIPCOT Cuddalore". September 2004:**  
[http://www.sipcotcuddalore.com/downloads/cuddalore\\_air\\_quality\\_report.pdf](http://www.sipcotcuddalore.com/downloads/cuddalore_air_quality_report.pdf)

**"Gas Trouble II - Air Quality Status and Assessment of TNPCB's Compliance to Supreme Court Monitoring Committee Order". May 2005:** [http://www.sipcotcuddalore.com/downloads/gas\\_trouble\\_2.pdf](http://www.sipcotcuddalore.com/downloads/gas_trouble_2.pdf)

## II. Manali Petrochemical Complex, Chennai, Tamil Nadu:

**Sampling Date/Time:** 25 July 2005, at around 7:30 pm

**Sampling Location:** Opposite the Futura Polymers gate near the graveyard.

**Other description:** Wind direction was towards south west, though the wind was very shifty.

**Sample taken in the presence of:** Youth and residents of Manali Petrochemical Complex

Manali petrochemical complex, located in North Madras is the largest petrochemical complex in the state with about 25 large industries operating in the area. The leading industries in the area are Chennai Petrochemical Corporation Ltd, Futura Polymers, Madras Refineries Ltd, Madras Fertilisers Ltd, SPIC, Manali Petro Products, Kothari Chemicals and CETEX. Most of the industries deal with petroleum products and other volatile chemicals that need extra precaution while storing and handling.

There have been numerous complaints of environmental pollution from the residents of Manali; flaring is a common way of discharging hazardous chemicals into the atmosphere, and stack flares are noticeable at any time of the day in one or more

industries. Residents also complain of regular emissions and gas leaks from the units in the area. Air pollution-related health problems are prevalent -- respiratory ailments and burning sensation in the eyes and throat.

### Results of the sample:

1. 12 chemicals were found.

S No.	Chemicals detected	Levels detected (ug/m3)	Screening levels (ug/m3)
1.	Hydrogen Sulphide	19.1	1.00 (US EPA Region 6 Screening Level)
2.	Carbon Disulphide	46.1	3 (Texas Long-Term Screening Levels)
3.	Ethanol	180	--
4.	Acetone	3400	370 (US EPA Region 6 Screening Level)
5.	Isopropyl Alcohol	5.2	--
6.	2-Butanone (Methyl Ethyl Ketone)	8.1	1000 (US EPA Region 6 Screening Level)
7.	n-Hexane	6.7	210 (US EPA Region 6 Screening Level)
8.	Benzene*	6.2	0.250 (US EPA Region 6 Screening Level)
9.	Toluene	520	400 (US EPA Region 6 Screening Level)
10.	Ethylbenzene	25	1100 (US EPA Region 6 Screening Level)
11.	m,p- Xylenes	17	--
12.	o-Xylene	6.4	730 (US EPA Region 6 Screening Level)

\* Known or suspected human or animal carcinogen

2. 5 chemicals found out of 12 exceeded the USEPA Region 6 or other health-based screening levels. These chemicals were Hydrogen Sulphide, Carbon Disulphide, Acetone, Benzene and Toluene



3. 1 chemical is known to cause cancer in human or animal;
  - Benzene, a chemical known to cause leukaemia (blood cancer), is 24.8 times above the USEPA Region 6 Screening Level.
4. All 12 chemicals found target the eyes, 11 chemicals target the skin, Central Nervous System and the respiratory system, 4 chemicals target the liver and kidneys, 3 chemicals target the blood, 2 chemicals target the Peripheral Nervous System, reproductive system and the gastrointestinal system, and 1 chemical affects the Cardio Vascular System.

### III. PVC effluent channel of Chemplast Sanmar plant, Mettur, Tamil Nadu:

**Sampling Date/Time:** 05 April 2005, 3:10 pm

**Sampling Location:** Downwind of the PVC effluent discharge



Air Sample being taken from the PVC effluent outfall point

point in old Kaveri riverbed near Thangamapuripatnam village.

**Other description:** Shifty wind, a faint odour of plastics and a strong odour of organic chemicals were reported along with symptoms of dizziness and nausea as a result of exposure to the odour.

**Sample taken in the presence of:** West Konnur Farmer's Association

Mettur is located in Salem district of Tamil Nadu. This is where the River Kaveri enters Tamil Nadu. At one time, agriculture was the main driver of Mettur's economy. Groundwater was abundant and allowed farmers to raise more than one crop in a year. However, pollution from two mega units, Chemplast Sanmar and Madras Aluminium Company Ltd., has made life unlivable and devastated groundwater and agriculture. Chemplast, which manufactures Chloromethanes and PVC is identified as a significant air polluter, and is accused of numerous incidents of dangerous chlorine leaks.

Most of the residents do not know the toxicity and impact of the products or chemicals used in the industrial units. There is no information among the residents about the health effects of the chemicals or what action should be taken in the event of a disaster.

Industrial accidents including gas leaks and emissions from the units are frequent in the area. There was a major chlorine gas leak from the Chemplast plant on July 18, 2004 that affected at least 100 people; 25 people and a 20-day old baby had to be hospitalised as a result of the exposure. However, all authorities, including the Police, the district authorities, the Factories Inspectorate and the Tamilnadu Pollution Control Board, have openly protected the industry and have even threatened villagers who bring allegations against the company, villagers say.

Chemplast is notorious for illegal dumping of hazardous waste on land, air and water. The company discharges effluents from at

least two plants in to the old riverbed of Kaveri, at a point 1 km from the current course of the river. The discharge point is located near Thangamapuripatnam village. According to the company, it only discharges treated effluents into the river<sup>3</sup>. However, the effluent discharge point is thick with the smell of organic chemicals, and a faint odour of plastics.

An air sample, rather than water sample was taken because many of the chemicals discharged by Chemplast's PVC and chloromethane unit tend to volatilise from water and the intention was to capture the volatile and odourous compounds released from the effluents. Those present close to the discharge point reported symptoms of dizziness and nausea.

#### Results of the sample:

17 chemicals were detected.

#### Levels of Chemicals detected in PVC effluent discharge

S No.	Chemicals detected	Levels detected (ug/m3)	USEPA Region 6 Screening levels (ug/m3), unless specified otherwise
1.	Hydrogen Sulphide	296	1.00
2.	Carbon Disulphide	19.5	3 (Texas Long-Term Screening Levels)
3.	Vinyl Chloride*	470	0.220
4.	Ethanol	180	--
5.	Acetone	36	370
6.	Isopropyl Alcohol	6.8	--
7.	Methylene Chloride*	6.7	4.09
8.	1-1, Dichloroethane	26	520
9.	n- Hexane	6.8	210
10.	Chloroform*	32	0.0840
11.	1,2 Dichloroethane*	2400	0.0740
12.	Benzene*	6.4	0.250

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S No.	Chemicals detected	Levels detected (ug/m3)	USEPA Region 6 Screening levels (ug/m3), unless specified otherwise
13.	1,1,2 Trichloroethane*	8.7	0.120
14.	Toluene	27	400
15.	Chlorobenzene	6.1	63
16.	o-Xylene	16	730
17.	1,2,4 Trimethylbenzene	5.5	6.2

\*Known or suspected human or animal carcinogen

- 8 chemicals out of 17 exceeded the USEPA Health-based Screening levels or any other health based screening levels. These chemicals were Hydrogen Sulphide, Carbon Disulphide, Vinyl Chloride, Methylene Chloride, Chloroform, 1,2- Dichloroethane, Benzene, 1,1,2-Trichloroethane.
- 6 out of 17 chemicals found, is known to cause cancer in human or animal,
  - 1,2- Dichloroethane, a potential occupational carcinogen and a known animal carcinogen was 32000 times above the safe levels prescribed by USEPA Region 6.
  - Vinyl Chloride, a known human carcinogen was 2100 times above the USEPA Region 6 Screening levels.
- 4 out of the 17 chemicals found -- vinyl chloride, ethylene dichloride, methylene chloride and chloroform -- are used by the company as raw materials. All four are confirmed animal and/or human carcinogens.

#### IV. Sterlite Industries, Tuticorin, Tamil Nadu:

**Sampling Date/Time:** 31 December 2005, 5 pm

**Sampling Location:** The sample was taken on the western road between Sterlite and Killburn Chemicals, downwind of the chimney of the Sterlite plant.

**Other description:** The conditions for sampling were difficult. The wind was strong and shifty. There was a faint odour of burnt material emanating from the unit and the chimneys were spewing out dark black smoke. There was a lot of soot in the air because of the smoke.

**Sample taken in the presence of:** Lion's Club of Tuticorin

Sterlite Industries India Ltd, a subsidiary of UK based Vedanta Group, operates a copper smelter in the coastal town of Tuticorin. The unit has been a hotbed of controversies right from the time it was set up in the area. The unit was earlier supposed to be built in Ratnagiri district of Maharashtra; the company's license was revoked after local farmers and fishermen put up a stiff resistance against the company on account of its pollution potential. The unit



Sterlite Copper smelter at Tuticorin, Tamilnadu

relocated to Tuticorin, in Tamilnadu, where the Government and the Tamilnadu Pollution Control Board have actively assisted the company by regularizing illegalities and condoning others. The workers in neighboring units have frequently complained of noxious emissions and gas leaks from the Sterlite unit.

#### Results of the samples:

3 chemicals were found in the sample.

Levels of Chemicals detected in Sterlite sample:

S No.	Chemicals detected	Levels detected (ug/m3)	Screening levels (ug/m3)
1.	Carbon Disulphide	10	3 (Texas Long-Term Screening Levels)
2.	Isopropyl Alcohol	23	--
3.	Toluene	5.8	400 (US EPA Region 6 Screening Level)

- 1 out of 3 chemical exceeded the USEPA Health based Screening levels or any other health based screening levels.
  - Carbon Disulphide exceeded the Texas Long Term Screening Levels by a factor of 3.3.
- Out of the 3 chemicals found all chemicals target the eyes and skin, 2 chemicals target the Central Nervous System, respiratory system, liver and kidneys and 1 chemical targets the Peripheral Nervous System, reproductive system and the Cardio Vascular System.

## V. Open Garbage Incineration Site, Perungudi Dumping Ground, Chennai:

**Sampling Date/Time:** 28 September 2005, around 7:00 am

**Sampling Location:** The sample was taken on the Thuraipakkam Road, about 50 meters South and across the road from the entrance to the Onyx dumping ground. The sample was not of air from the dumping ground, but of pollution from a smouldering pile of garbage dumped along the road.

**Other description:** The wind direction at the time of the sampling was from South West to North East; white smoke from the waste dump (sample site) was recorded and severe eye and throat irritation and breathlessness was reported as a result of exposure to the smoke. The smell was identical to the smell of burning mixed garbage. The garbage contained organic matter and various kinds of packaging, including plastics of different kinds, and was similar to any of the millions of garbage mounds that dot the Indian urban landscape.



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A scene of burning garbage at the Perungudi dumpsite

**Sample taken in the presence of:** Save Pallikaranai Marshlands Forum

Open burning of garbage is a common sight in India. Garbage dumps, including ones used by Municipal authorities or their contractors, are notorious for the air pollution they cause. Often, children are found working in these dumps amidst smouldering piles of garbage. Perungudi, in South Chennai, is one of the major municipal waste dumping grounds for the city. Onyx Environmental Services, subsidiary of French water giant Vivendi, dumps a third of the city's garbage in the Pallikaranai marshlands which Perungudi borders. The wetland, the largest natural rainwater harvesting system in the city, spreads over several hundred hectares. Residents living in the vicinity and wildlife enthusiasts have condemned the waste dumping and burning carried out in Perungudi. Both, the main dumping ground, and the roads leading to the dumpsite are littered with smouldering piles of municipal waste.

The sample was taken to get a sense of the kinds of pollutants likely to be emitted from any combustion of garbage, including incineration and combustion-based waste-to-energy plants, and to understand the kinds of chemicals behind the complaints of local residents.

### Results of the samples:

1. Total of 27 chemicals were found in the sample.

### Levels of Chemicals detected in Perungudi sample:

S No.	Chemicals detected	Levels detected (ug/m <sup>3</sup> )	Screening levels (ug/m <sup>3</sup> )
1.	Hydrogen Sulphide	58.2	1.0 (USEPA Region 6 Screening levels)
2.	Carbonyl Sulphide	34.8	8.0 (Texas Short Term screening levels)
3.	Methyl Mercaptan	59.5	2.10 (USEPA Region 6 Screening levels)

S No.	Chemicals detected	Levels detected (ug/m3)	Screening levels (ug/m3)
4.	Carbon Disulphide	28	3 (Texas Long Term screening levels)
5.	Chloromethane*	230	1.1 (USEPA Region 6 Screening levels)
6.	1,3-Butadiene*	240	0.0069 (USEPA Region 6 Screening levels)
7.	Chloroethane	14	2.3 (USEPA Region 6 Screening levels)
8.	Ethanol	530	--
9.	Acetonitrile	48	34 (Texas Long Term screening levels)
10.	Acrolein	110	0.021 (USEPA Region 6 Screening levels)
11.	Acetone	480	370 (USEPA Region 6 Screening levels)
12.	Trichlorofluoromethane	20	--
13.	Methyl Ethyl Ketone	120	1000 (USEPA Region 6 Screening levels)
14.	n-Hexane	140	210 (USEPA Region 6 Screening levels)
15.	Benzene *	590	0.25 (USEPA Region 6 health based screening levels)
16.	4-Methyl-2-Pentanone	8.1	83 (USEPA Region 6 Screening levels)
17.	Toluene	300	188 (Texas Long Term screening levels)
18.	Chlorobenzene	12	63 (USEPA Region 6 Screening levels)
19.	Ethylbenzene	81	1100 (USEPA Region 6 Screening levels)
20.	m,p-Xylenes	46	--
21.	Styrene	65	11 (Texas Long Term screening levels)
22.	o-Xylene	28	730 (USEPA Region 6 Screening levels)

S No.	Chemicals detected	Levels detected (ug/m3)	Screening levels (ug/m3)
23.	n-Nonane	70	--
24.	Cumene	10	400 (USEPA Region 6 Screening levels)
25.	1,3,5-Trimethylbenzene	10	6.2 (USEPA Region 6 Screening levels)
26.	1,2,4-Trimethylbenzene	7.6	6.2 (USEPA Region 6 Screening levels)
27.	d-Limonene	53	--

\* Known or suspected animal or human carcinogen

- 15 out of 27 chemicals exceed the health-based standards set by United States Environmental Protection Agency Region 6 or other regulatory authorities. These chemicals include Hydrogen Sulphide, Carbonyl Sulphide, Methyl Mercaptan, Carbon Disulphide, Chloromethane, 1,3-Butadiene, Chloroethane, Acetonitrile, Acrolein, Acetone, Benzene, Toluene, Styrene, 1,3,5- Trimethylbenzene and 1,2,4- Trimethylbenzene.
- 3 out of 27 chemicals (1,3-Butadiene, Benzene, Chloromethane) are known to cause cancer in humans and/or animal
  - 1,3-Butadiene was found 34782 times higher than the safe levels
  - Benzene was found 2360 times higher than the safe levels.
  - Chloromethane was found 209 times higher than the safe levels
- Out of the 27 chemicals found - 24 chemicals target the Central Nervous System, 23 chemicals target the respiratory system, 22 chemicals target the eyes, 21 chemicals target the skin, 10 chemicals target the liver, 8 chemicals target the kidneys, 7 chemicals target the blood,

5 chemicals target the Cardio Vascular System and the reproductive system and 2 chemicals target the gastrointestinal system and the Peripheral Nervous System.

### **Interpretation and implications:**

It is expected that the chemicals found in this sample may be typical of open household garbage burning or incinerator emissions. It takes on increased importance given the widespread nature of the practice, and the growth of incinerators, in India and other industrializing countries.

Most of the chemicals found target the Central Nervous System and the Respiratory System. This is significant given the large residential population in the area. Even more distressingly, all the smouldering mounds of garbage are worked upon by armies of ragpickers many of them, children less than 14 years of age. Young children, whose immune and reproductive systems are not fully developed, can be permanently affected by chronic exposure to these chemicals.

Chemicals found in such samples depend upon the materials that are burnt. It would not be sufficient to merely ban open burning because of the difficulty in enforcing such bans in poor countries with large populations. Instead, it is recommended that the regulation be moved upstream to change our materials use policy to encourage the use of material, particularly for packaging, that poses little or no risk at its end-of-life.

## **VI. Effluent Channel Project Ltd. Ekalbara, Vadodara, Gujarat:**

**Sampling Date/Time:** 01 June 2005, around midnight

**Sampling Location:** ECPL channel in Ekalbara, about 50 mts to

the west of Shiva Pharmachem Pvt Ltd.

**Other description:** There was no wind at the time of sampling. The odour from the channel was pungent and caused severe eye, nose and throat irritation, and headache.

**Sample taken in the presence of:** Paryavaran Suraksha Samiti and Farmers Action Group

The Effluent Channel Project Ltd. (ECPL) of Gujarat was commenced in 1983 as a remedy to the industrial pollution in the area. Industrialisation in Vadodara started in the early 1960s when industries such as Gujarat Refinery, Gujarat State Fertilizer and Chemicals Ltd, Indian Petro Chemicals Ltd, Petrofils, GSFC Polymers, Oil and Natural Gas Corporation, Heavy Water Plant, Gujarat Dyestuff Industry, Indian Dyestuff Industry and ABS Plastic were set up. Air and water pollution are intense in the industrial estate. To address the water pollution problem, the government consulted engineers and environmental institutes and came up with a scheme that collected effluents from 150 industries in the estate and forwarded it through one common channel to the Gulf of Khambat. The project was executed by Effluent Channel Project Ltd (ECPL)<sup>4</sup>.

The combined effluent is conveyed through a 56 km-long concrete-lined channel, which passes through agricultural lands in 24 villages in Vadodara and Bharuch districts. The channel is covered in part with cement slabs. The ECP meets the Gulf in Sarod village of Bharuch District. The effluent is reportedly treated before discharge into the channel, but local farmers report overpowering smells emanating from the effluent channel.

Results of the sample:

1. Total of 9 chemicals detected.

S No.	Chemicals detected	Levels detected (ug/m3)	Screening levels (ug/m3)
1.	Acetone	32	370 (USEPA Region 6 Screening Levels)
2.	Toluene	31	400 (USEPA Region 6 Screening Levels)
3.	Chloroform*	34	0.0840 (USEPA Region 6 Screening Levels)
4.	Methylene Chloride*	18	4.09 (USEPA Region 6 Screening Levels)
5.	Benzene*	11	0.250 (USEPA Region 6 Screening Levels)
6.	2- Butanone	5.7	1000 (USEPA Region 6 Screening Levels)
7.	Carbon Disulphide	18.8	3 (Texas Long-Term Screening Levels)
8.	Isopropyl Alcohol	44	--
9.	Ethanol	37	--

\* Known or suspected animal or human carcinogen

#### Levels of Chemicals detected in ECPL sample:

2. 4 chemicals Chloroform, Methylene Chloride, Benzene and Carbon Disulphide, exceeded the USEPA Region 6 Screening levels.
3. 3 out of 9 chemicals are known to cause cancer in humans or animals; all the cancer causing chemicals are above screening levels
  - Chloroform was 404 times above the USEPA Region 6 Screening Level
  - Methylene Chloride was 4.4 times above the USEPA Region 6 Screening Level.
  - Benzene was 44 times above the USEPA Region 6 Screening Level.

3. Out of the 9 chemicals found, all of them target the eyes, 8 chemicals target the skin, 7 target respiratory and central nervous system, 4 target the liver, 3 chemicals target kidneys, 2 target the blood, reproductive system and the Cardio Vascular System and 1 targets the bone marrow and Peripheral Nervous System.

It is quite evident from the chemicals found in the sample that untreated effluents are being discharged by the industries in the region. The ECP passes through agricultural lands in 24 villages and poses a serious threat to the crops, lives and livelihood of thousands of farmers in the area. The farmers have raised the issue of contamination and failure of crops because of effluents from ECP. In 1999 the Indian People's Tribunal headed by Justice (Retd.) Hosbet Suresh of the Bombay High Court conducted a detailed investigation of the pollution in the Golden Corridor of Gujarat and the pollution related to ECP was also discussed. The Tribunal was of the view that the design and concept of ECP was flawed. It also recommended underground pipelines for carrying treated effluents and further investigations into the heavy metal contamination of food products cultivated along the ECP channel. It also was of the view that liability and responsibility for the pollution should be fixed on polluters and that farmers should be compensated.

#### VII. Ranoli Bridge, Vadodara, Gujarat

**Sampling Date/Time:** 02 June 2005, 10:00 pm

**Sampling Location:** Downwind of Gujarat Alkalies and Chemicals Ltd (GACL) outside its gate on the Ranoli Bridge road.

**Other description:** Shifty wind; wind direction was generally from north west to south east. The air smelt of mangoes and coconut milk and there were whiffs of a pungent unidentifiable odour as well. Eyes, nose and throat irritation and breathing trouble were

reported by the sampling personnel.

Sample taken in the presence of: Paryavaran Suraksha Samiti and Farmers Action Group

The Gujarat Industrial Development Corporation (GIDC) industrial complex of Ranoli, Vadodara hosts mega units like Gujarat Alkalies and Chemicals Ltd, Indian Petro Chemical Ltd, Gujarat Petro Synthesis Ltd etc. This industrial complex primarily hosts units that deal with petrochemicals and plastics.

Residents of the area have repeatedly complained about the noxious chemical odours and air pollution from the units. An air sample was taken to confirm the claims of the residents about chemical pollution.

#### Results of the sample:

1. 7 chemicals were detected.

#### Levels of Chemicals detected in GACL sample:

S No.	Chemicals detected	Levels detected (ug/m3)	Screening levels (ug/m3)
1.	Carbon Disulphide	16.8	3 (Texas Long-Term Screening Levels)
2.	Acetonitrile	5.7	62 (USEPA Region 6 Screening Levels)
3.	Isopropyl Alcohol	7.09	--
4.	Acrylonitrile*	5.2	0.0280 (USEPA Region 6 Screening Levels)
5.	2- Butanone (MEK)	5.09	1000 (USEPA Region 6 Screening Levels)
6.	1,2 Dichloroethane*	12	0.740 (USEPA Region 6 Screening Levels)
7.	Toluene	14	400 (USEPA Region 6 Screening Levels)

\* Known or suspected animal or human carcinogen

2. 3 chemicals found out of 7 exceeded the USEPA Region 6 or any other health-based screening levels
  - 1,2-Dichloroethane was 162 times above the USEPA Region 6 Screening levels.
  - Acrylonitrile was 185 times above the USEPA Region 6 Screening levels.
  - Carbon Disulphide was 14 times above the Texas Long Term Screening Levels.
2. 2 out of 7 chemicals are known to cause cancer in humans or animals; both chemicals - Acrylonitrile and 1, 2 - Dichloroethane were also above the screening levels.
3. Out of the 7 chemicals found 6 chemicals target the eyes and the Central Nervous System, 5 chemicals target the kidneys and the skin, 4 chemicals target the liver, Cardio Vascular System, and the respiratory system, and 1 chemical target the Peripheral Nervous System and the reproductive system.

### VIII. Ankleshwar Industrial Complex, Gujarat:

**Sampling Date/Time:** 02 June 2005, evening

**Sampling Location:** The sample was taken downwind of units in the complex and the sampling point was the service road between Sara Chemicals and RPG Life Sciences.

**Other description:** Strong wind from south west to north east. There was an irritating odour of chemicals in the air and the immediate symptoms included headache and vomiting sensation.

**Sample taken in the presence of:** Paryavaran Suraksha Samiti and Farmers Action Group



Established in 1974, Ankleshwar is one of the biggest industrial complexes of Gujarat. The Gujarat Industrial Development Corporation complex is located on the Mumbai Ahmedabad highway over 1600 hectares of land. It hosts about 1500 small, medium and large industries. Ankleshwar industrial complex is also ranked as one of the most polluted industrial sites not only in Gujarat but in India. Indiscriminate dumping of hazardous waste on land, water and air has poisoned the environment of Ankleshwar. Villagers around the industries report complete ground water contamination and the color of the water ranges from yellow to orange to dark red<sup>5</sup>.

The area has a variety of chemical odours. People report that industries release noxious gases late in the night and early in the morning. The residents especially children reportedly suffer from difficulty in breathing and respiratory disorders.

#### Results of the sample:

- 16 chemicals detected.

#### Levels of Chemicals detected in Ankleshwar sample:

S No.	Chemicals detected	Levels detected (ug/m3)	Screening levels (ug/m3)
1.	Hydrogen Sulphide	21.5	1.0 (USEPA Region 6 Screening Levels)
2.	Methyl Mercaptan	35.6	2.1 (USEPA Region 6 Screening Levels)
3.	Carbon Disulphide	42	3 (Texas Long-Term Screening Levels)
4.	Dimethyl Disulphide	18.8	--
5.	Ethanol	280	--
6.	Acetone	77	370 (USEPA Region 6 Screening Levels)
7.	Isopropyl Alcohol	29	--
8.	Methylene Chloride*	7.8	4.09 (USEPA Region 6 Screening Levels)

S No.	Chemicals detected	Levels detected (ug/m3)	Screening levels (ug/m3)
9.	2- Butanone (MEK)	6.7	1000 (USEPA Region 6 Screening Levels)
10.	n-Hexane	9.69	210 (USEPA Region 6 Screening Levels)
11.	Benzene*	52.0	0.250 (USEPA Region 6 Screening Levels)
12.	Carbon Tetrachloride*	8.5	0.130 (USEPA Region 6 Screening Levels)
13.	Trichloroethene*	19	1.10 (USEPA Region 6 Screening Levels)
14.	Toluene	130	188 (Texas Long Term Screening Levels)
15.	Ethyl Benzene	10	1100 (USEPA Region 6 Screening Levels)
16.	m, p- Xylenes	5.7	--

\* Known or suspected animal or human carcinogen

- 8 chemicals Hydrogen Sulphide, Methyl Mercaptan, Carbon Disulphide, Methylene Chloride, Benzene, Carbon Tetrachloride, Trichloroethene and Toluene, exceed the USEPA Region 6 or any other health based screening levels.
  - Benzene is 208 times above the USEPA Region 6 Screening Level.
  - Carbon Tetrachloride is 65 times above the USEPA Region 6 Screening Level
  - Trichloroethene is 17.2 times above the USEPA Region 6 Screening Level
  - Methylene Chloride is 1.9 times above the USEPA Region 6 Screening Level.
- 4 out of 16 chemicals (Benzene, Carbon Tetrachloride, Trichloroethene and Methylene Chloride) are known to

cause cancer in humans or animals; all carcinogens are above the screening levels.

4. Out of the 16 chemicals found 15 chemicals target the eyes, 14 chemicals target the skin and Central Nervous System, 12 target respiratory system, 6 target the liver, 5 chemicals target kidneys, 4 chemicals target the blood, 3 chemicals target reproductive system and the Cardio Vascular System, 2 chemicals target the Peripheral Nervous System, and 1 targets the bone marrow and stomach.

In Gujarat, after the air sampling results were released, the Chairperson acknowledged that no monitoring system was in place and promised that GPCB will “come out with a proper study” about gases by December 31, 2005<sup>6</sup>. No such study has been made public.

### **IX. Pashamylaram Industrial Complex, Hyderabad:**

**Sampling Date/Time:** 08 August 2005, 2:55 pm

**Sampling Location:** Outside the gate of Hyderabad Chemicals

**Other description:** The wind was gentle but shifty and the wind direction could not be ascertained. The chemical odour during the sampling was pungent and sweetish with occasional whiffs of onion and garlic-like odour. The odour caused severe headache and vomiting sensation among the sampling personnel.

**Sample taken in the presence of:** Hyderabad-based Citizens Against Pollution and Patancheru Anti-Pollution Committee

Pashamylaram Mega Industrial Park was set up in mid 1980s and has been described as an industrial estate with 'well developed prime industrial land and good social and civic infrastructure' for



Pashamylaram Industrial Complex near Hyderabad.

units<sup>7</sup>. The industrial estate is spread over 1500 acres of land and is located about 30 km north west of Hyderabad in Medak district. Some of the major players of this area are BPL, Aurobindo Pharma (which has 3 units in the area), Phillip Morris, Kirby Building Systems, Neuland Labs Hyderabad and Hyderabad Chemicals.

Three visits were made to the chemical estate but the conditions were not favorable for sampling in the first two. Finally a sample was taken on the third visit to the area. During the visits, the crippled state of environment in the area could be noticed. The entire industrial estate is perpetually covered with smoke and the visibility is low. Hazardous wastes were found dumped on either sides of the road.

#### **Results of the sample:**

15 chemicals were detected.

### Levels of Chemicals detected in Pashamylaram sample:

S No.	Chemicals detected	Levels detected (ug/m3)	Screening levels (ug/m3)
1.	Methyl Mercaptan	251	2.1 (EPA Region 6 Screening Level)
2.	Dimethyl Sulphide	203	0.3 (Texas Long-Term Screening Levels)
3.	Carbon Disulphide	13	3 (Texas Long-Term Screening Levels)
4.	Dimethyl Disulphide	87.4	--
5.	Chloromethane*	17	1.1 (EPA Region 6 Screening Level)
6.	Ethanol	83	--
7.	Acetonitrile	54	34 (Texas Long-Term Screening Levels)
8.	Acetone	63	370 (EPA Region 6 Screening Level)
9.	Isopropyl Alcohol	31	--
10.	Methylene Chloride*	450	4.09 (EPA Region 6 Screening Level)
11.	1,2 Dichloroethane*	63	0.0740 (USEPA Region 6 Screening Levels)
12.	Toluene	490	400 (EPA Region 6 Screening Levels)
13.	n-Butyl Acetate	6.5	--
14.	Ethylbenzene	12	1100 (EPA Region 6 Screening Level)
15.	m,p- Xylenes	6	--

\* Known or suspected animal or human carcinogen

- 8 chemicals out of 15 exceeded the USEPA Region 6 or any other health based screening levels. These chemicals were - Methyl Mercaptan, Dimethyl Sulphide, Carbon Disulphide, Chloromethane, Acetonitrile, Methylene Chloride, 1,2-Dichloroethane, Toluene
- 3 out of 15 chemicals are known to cause cancer in human or animal; all three were above known screening levels

- 1,2- Dichloroethane is 851 times above the USEPA Region 6 Screening Level.
  - Methylene Chloride is 110 times above the USEPA Region 6 Screening Level
  - Chloromethane is 15.45 times above the USEPA Region 6 Screening Level.
- Out of the 15 chemicals found 13 chemicals target the Central Nervous System, 12 chemicals target the eyes and skin, 10 chemicals target the respiratory system, 6 chemicals target the liver and kidneys, 4 chemicals target the cardiovascular system and blood, 3 chemicals target the reproductive system, and 1 chemical targets the Peripheral Nervous System and gastrointestinal tract.

### X. TSDF of Hyderabad Waste Management Ltd, Kazhipally Industrial Area, Hyderabad:

**Sampling Date/Time:** 15 September 2005, 2:30 pm

**Sampling Location:** The sample was taken about 25 meters away from the landfill fence on the western side of the facility.

**Other description:** There was a pungent odour with occasional litchi fruit like odour. The wind was strong and was blowing from east to west at the time of sampling.

**Sample taken in the presence of:** Hyderabad-based Citizen Against Pollution

The TSDF managed by Hyderabad Waste Management Ltd, a subsidiary of Ramky Group started its operations in September 2001. The TSDF is located in the Kazhipally Industrial Area of Dundigal district of Andhra Pradesh. The landfill that spreads over 80 acres of land in the northern side of the industrial area is



"Rotten eggs and sour smell from the landfill makes us sick", says Budevi Kanni of Tanda Village

cordoned off with electric fencing. Contravening CPCB siting guidelines for hazardous waste facilities, the facility is located adjacent a residential area, with the main Tanda village at a distance of 400 m from the facility. Fenceline communities complain of perpetual oppressive odours including sweet, pungent and sewer-like odours, from the facility. The women in the nearby village complain of nausea, vomiting and excessive loss of hair as a result of exposure to the toxic gases. Due to groundwater contamination because of the landfill, villagers have to walk more than a kilometer to fetch drinking water; the groundwater in their area is yellow in color and foul-smelling.

Interestingly, Ramky is considered a state-of-the-art hazardous waste management company by bureaucrats and environmental regulators, and promoted by the Government and even the Supreme Court Monitoring Committee.

#### Results of the sample:

1. Total of 9 chemicals found.

#### Levels of Chemicals detected in TSDF Kazhipally sample:

S No.	Chemicals detected	Levels detected (ug/m3)	Screening levels (ug/m3) (USEPA Region 6 Screening Levels unless specified otherwise)
1.	Carbon Disulphide	16.3	3 (Texas Long-Term Screening Levels)
2.	Ethanol	49	--
3.	Acetone	46	370
4.	Isopropyl Alcohol	14	--
5.	Methylene Chloride*	61	4.09
6.	n-Hexane	11	210
7.	Chloroform*	21	0.0840
8.	1,2- Dichloroethane*	11	0.0740
9.	Toluene	35	400

\* Known or suspected animal or human carcinogen

2. 4 chemicals out of 9 exceed the USEPA Health based Screening levels or any other health based screening levels
  - Carbon Disulphide was 5.4 times higher than the Texas Long-term Screening Level
  - Chloroform, a carcinogen, was 250 times higher than the US EPA Region 6 screening levels.
  - 1,2-Dichloroethane, a carcinogen, was 148 times higher than the US EPA Region 6 screening levels.
  - Methylene Chloride, another carcinogen, was 14.9 times higher than the US EPA Region 6 screening levels.
3. 3 out of 9 chemicals found are known to cause cancer in human or animal, these include Methylene Chloride, Chloroform and 1,2-Dichloroethane.

- All 9 chemicals target the eyes and the skin, 7 chemicals target the Central Nervous System, 5 chemicals target the respiratory system, 4 chemicals target the kidneys, liver and the Cardio Vascular System, and 2 chemicals target the Peripheral Nervous System and the reproductive system.

### XI. Hindustan Insecticides Ltd, Eloor, Kerala:

**Sampling Date/Time:** 20 August 2005, around 11:15 am

**Sampling Location:** From site of the proposed Secure Landfill Facility (SLF), about 50 metres north of incinerator, and 100 metres north of endosulphan plant.

**Other description:** The wind was from west to east and at the time of sampling, the samplers reported a pesticide odour and strong burning sensation and irritation of throat.

**Sample taken in the presence of:** Members of Periyar Malineekarana Virudha Samiti and Local Area Environment Committee.

Eloor industrial area was declared a Global Toxic Hotspot by Greenpeace in 1999. The Hindustan Insecticides Ltd., (HIL) in the Eloor industrial area has always been notorious for spills, leakages and disasters. The HIL factory is a public sector undertaking that manufactures pesticides and is the sole producer of DDT in the country. In 1990 there was fire because of a large scale Toluene spill in the creek adjacent to the factory premises. On June 6, 2004, there was a major fire in the endosulphan plant of the factory that had affected more than 400 people in the area.

The company has indiscriminately buried and dumped toxic wastes within the factory premises. Owing to public pressure and directions by the Supreme Court Monitoring Committee, the

company began civil works, including excavation, inside its premises to prepare the land for a Secure Landfill Facility. The chosen site was over an existing dumpsite for hazardous wastes and off-spec chemicals, including Hexa Chloro Cyclo Pentadiene and endosulfan. Intense odours were observed when the site was being excavated and this prompted community members to take an air sample to find out the chemicals present in the sample. The sample was taken by trained community environmental monitors from Eloor. The sampling personnel also included members of the Local Area Environmental Committee set up by the Supreme Court Monitoring Committee.



HIL Factory after a fire accident in June 2004

#### Results of the sample:

- 5 chemicals were found.

#### Levels of Chemicals detected in HIL Eloor sample:

S No.	Chemicals detected	Levels detected (ug/m3)	Screening levels (ug/m3)
1.	Carbon Disulphide	21	3 (Texas Long-Term Screening Levels)
2.	Chloroform*	7	0.084 (USEPA Region 6 Screening Levels)
3.	Carbon Tetrachloride*	11	0.130 (USEPA Region 6 Screening Levels)
4.	Toluene	7	400 (USEPA Region 6 Screening Levels)
5.	Hexachlorobutadiene*	57	0.087 (USEPA Region 6 Screening Levels)

\*Known or suspected animal or human carcinogen

2. All chemicals, except Toluene, were found to exceed United States Environmental Protection Agency's health based screening levels, or other relevant safety limits.
3. 3 chemicals chloroform, carbon tetrachloride and hexachlorobutadiene are known to cause cancer in humans and/or animals. All these chemicals were above safe levels.
  - Hexachlorobutadiene, an indicator of the presence of dioxin, was 655 times above the USEPA Region 6 Screening Level.
  - Chloroform is 83 times above the USEPA Region 6 Screening Level.
  - Carbon Tetrachloride is 84.5 times above the USEPA Region 6 Screening Level.
4. Out of the 5 chemicals found all chemicals affect the eyes, skin and kidneys; 4 chemicals affect the Central Nervous System and liver, 3 chemicals affect the respiratory system, 2 chemicals affect the Cardio Vascular System, and 1 chemical affects the reproductive system and the Peripheral Nervous System.

#### **Interpretation of results and implications:**

The results demonstrate that the SLF is proposed to be located on an existing illegal hazardous waste dump. The presence of chemicals like chloroform and carbon tetrachloride are of significant concern. Both tend to volatilise when in contact with air. But in soil and sub-soil, these chemicals tend to migrate down and reach the groundwater. The presence of these chemicals in the air sample indicates a good probability of finding high levels at greater depths in the soil matrix.

Hexachlorobutadiene is toxic to aquatic organisms. It

bioaccumulates in the food chain, especially in fish. If ingested, HCBBD concentrates in the kidney, its main target organ. Of most concern is the fact that HCBBD indicates the presence of dioxins.

## **XII. Delhi Traffic Junction**

**Sampling Date/Time:** 30 July 2005, 1:50 pm

**Sampling Location:** At the ITO junction opposite the Police Commissioner's Office.

**Other description:** Mild breeze, and heavy traffic. A strong odour of petrol and diesel.

In the mid 1990s, New Delhi was one of the world's 10 most polluted cities, with vehicles accounting for 70 per cent of polluting emissions<sup>8</sup>. Pollution levels of Suspended Particulate Matter (SPM) exceeded the maximum acceptable standard set by the World Health Organisation by an average of five times<sup>9</sup>. But in 1998 after the Supreme Court stepped in and initiated the introduction of Compressed Natural Gas as fuel for automobiles, there has been a sharp and palpable decline in the pollution levels in the city. In 2003, Delhi won the US Department of Energy's first 'Clean Cities International Partner of the Year' award for "bold efforts to curb air pollution and support alternative fuel initiatives." Compared to 1997, for instance, carbon monoxide levels are down 32 per cent; sulphur dioxide levels are down 39 per cent<sup>10</sup>.

While the change is remarkable, it has also lulled regulators into complacency. The air has never been monitored for toxic gases, and has therefore never been regulated for the same.

#### **Results of the sample:**

1. 18 chemicals were found.

### Levels of Chemicals detected in ITO Delhi sample:

S No.	Chemicals detected	Levels detected (ug/m3)	Screening levels (ug/m3)
1.	Carbon Disulphide	34.9	3 (Texas Long-Term Screening Levels)
2.	1,3- Butadiene*	8.1	0.00690 (US EPA Region 6 Screening Level)
3.	Ethanol	50	--
4.	Acrolein	13	0.021 (USEPA Region 6 Screening Level)
5.	Acetone	77	370 (USEPA Region 6 Screening Level)
6.	Isopropyl Alcohol	19	--
7.	Methylene Chloride*	12	4.09 (USEPA Region 6 Screening Level)
8.	Methyl tert-Butyl Ether	98	45 (Texas Short-Term Screening Levels)
9.	2-Butanone	8.6	1000 (USEPA Region 6 Screening Level)
10.	n-Hexane	31	210 (USEPA Region 6 Screening Level)
11.	Benzene*	26	0.250 (USEPA Region 6 Screening Level)
12.	Toluene	170	400 (USEPA Region 6 Screening Levels)
13.	Ethylbenzene	29	1100 (USEPA Region 6 Screening Level)
14.	m,p- Xylenes	80	--
15.	Styrene	5	1100 (USEPA Region 6 Screening Level)
16.	o-Xylene	29	730 (USEPA Region 6 Screening Level)
17.	Nonane	6.09	--
18.	1,2,4- Trimethylbenzene	16	6.2 (USEPA Region 6 Screening Level)

\*Known or suspected animal or human carcinogen

- 8 out of 18 chemicals exceed the USEPA Region 6 or any other health based screening levels. These chemicals include Carbon Disulphide, 1,3-Butadiene, Acrolein, Methylene Chloride, Methyl tert-butyl Ether, Benzene, Toluene, 1,2,4- Trimethylbenzene.
- 3 out of 18 chemicals are known to cause cancer in human or animal; all cancer causing chemicals are above the screening levels
  - 1,3-Butadiene is 1174 times above the USEPA Region 6 Screening Level.
  - Benzene is 104 times above the USEPA Region 6 Screening Level.
  - Methylene Chloride is 2.5 times above the USEPA Region 6 Screening Level
- Out of the chemicals found, 17 target the eyes, 16 target the skin, 15 target the Central Nervous System and the respiratory system, 5 target the liver, 4 target the blood and reproductive system, 3 target the Cardio Vascular System and kidneys, and 2 target the Peripheral Nervous System and the gastrointestinal system.

### XIII. Mumbai Waste Management Ltd, Taloja, Mumbai, Maharashtra:

**Sampling Date/Time:** 10 June 2005, 11:10 am

**Sampling Location:** Northern side about 50 meters away from the landfill and incinerator.

**Other description:** The wind was from North to South, gentle and shifty. There was a faint litchi fruit like odour from the landfill and health symptoms of headache and dizziness was reported.

**Sample taken in the presence of:** Members of Mumbai based India Center for Human Rights and Law

The Treatment Storage Disposal Facility (TSDF) for hazardous waste was set up in Taloja, Mumbai in 2002. The TSDF is operated by Mumbai Waste Management Ltd, a subsidiary of Hyderabad-based Ramky Group. Ramky Group specializes in hazardous



Hazwaste incinerator spewing out toxics at TSDF in Taloja

waste management and is one of the emerging waste management companies in the country. Ramky has bagged the maximum number of contracts for setting up hazardous waste facilities in India, and is currently operating two facilities, one at Taloja near Mumbai in Maharashtra and the other one at Kazhipally Industrial area near Hyderabad in Andhra Pradesh. The company's attempts to set up hazardous waste facilities in Tamilnadu have run into stiff opposition, and have faltered despite open collusion between the Government and the company to do away with due process.

The TSDF in Taloja is located in the extreme western side of the industrial area. Spread over 39 acres of land, this TSDF has a hazardous waste landfill, a hazardous waste incinerator and a medical waste incinerator. The hazardous waste incinerator of the landfill was operational during the visit but the smoke was coming out of the chimney in spurts; the colour of the smoke ranged from light gray to dark black. There was a faint sweet litchi fruit-like odour from the facility. Residents of the area informed that a pungent odour emitted from the facility usually in the evenings and also mentioned that oily effluents were occasionally discharged.

### Results of the sample:

1. Total of 7 chemicals detected.

### Levels of Chemicals detected in TSDF Taloja sample:

S No.	Chemicals detected	Levels detected (ug/m3)	Screening levels (ug/m3)
1.	Carbon Disulphide	25.6	3 (Texas Long-Term Screening Levels)
2.	Acetone	29	370 (USEPA Region 6 Screening Levels)
3.	Isopropyl Alcohol	6.5	-- (USEPA Region 6 Screening Levels)
4.	Methylene Chloride*	21	4.09 (USEPA Region 6 Screening Levels)
5.	Toluene	33	400 (USEPA Region 6 Screening Levels)
6.	Alpha-Pinene	12	-- (USEPA Region 6 Screening Levels)
7.	d-Limonene	31	-- (USEPA Region 6 Screening Levels)

\*Known or suspected animal or human carcinogen

2. 2 chemicals found out of 7 exceed the USEPA Health based Screening levels or any other health based screening levels
  - Carbon Disulphide was 8.5 times higher than the Texas Long-term Screening Level
  - Methylene Chloride, a carcinogen, was 5 times higher than the USEPA Region 6 screening levels.
3. One chemical, Methylene Chloride, is a carcinogen.
4. All chemicals target the eyes and the skin, 5 chemicals target the Central Nervous System and the respiratory system, 4 chemicals target the kidneys, 3 chemicals target the liver, 2 targets the Cardio Vascular System and 1 chemical target the Peripheral Nervous System and the reproductive system.



## Conclusion

The absence of standards for toxic gases in ambient air, an effective monitoring and correction regime and enforcement of the law is a serious shortcoming that requires the urgent attention of regulatory authorities, the public and policy makers. The way forward for India is not uncharted. Several countries already have standards for many of the chemicals of concern. It is in deploying the implementation and enforcement regime that India needs to pay particular attention to communities.

Regulatory authorities do not have the resources to detect environmental violations. Also, because of political interference, many officials in such agencies are unable to fulfill their responsibilities. This is where community participation becomes crucial. In Eloor, Kerala, and Cuddalore, Tamilnadu, residents from pollution-impacted communities keep a hawk-like vigil over

their local industries. Pollution incidents, occupational injuries and deaths, and accidents that would otherwise go unreported and unaddressed by regulators, now cannot be ignored because vigilant residents report such incidents and demand actions.

As a first step, the Government must fast-track the process to notify health-based and legally enforceable standards for toxic gases in ambient air. Second, the Government must take communities into confidence, and enlist their assistance in monitoring the environment. In the case of industrial pollution, communities can also be part of monitoring industries' compliance with consent conditions.

The following table lays out standards adopted by various regulatory systems for the 45 chemicals found in ambient air in India. These numbers may serve as a starting point for notifying national standards and as de-facto standards until such time that Indian reference levels are notified.

### International Standards on Chemicals detected:

S No.	Name of the Chemical	EPA Region 6 Levels (ug/m3)	Texas Effects Screening Levels Short Term (ug/m3)	Texas Effects Screening Levels Long Term (ug/m3)	North Carolina Annual Standards (ug/m3)	North Carolina 24 - Hr Standards (ug/m3)	North Carolina 1 - hr Standards (irritants) (ug/m3)	California EPA Rfc* ug/m3 (health numbers) #
1.	Hydrogen Sulphide	1.00	1.00	--	--	--	330	--
2.	Methyl Mercaptan	2.10	2.00	0.200	--	--	50	--
3.	Dimethyl Sulphide	---	3.00	0.300	--	--		--
4.	Ethanol	---	18800	1880	--	--	--	--
5.	Methylene Chloride	4.09	260	26.0	24.0	--	--	3000
6.	Trichloroethene	1.10	1350	135	59	--	--	600
7.	Toluene	400	1880	188	--	4700	4700	400
8.	Dimethyl Disulphide	--	--	--	--	--	--	--
9.	Acetone	370	5900	590	--	--	--	--
10.	Isopropyl Alcohol	---	7850	785	--	--	--	--
11.	n-Hexane	210	1760	176	--	1100	--	--

S No.	Name of the Chemical	EPA Region 6 Levels (ug/m3)	Texas Effects Screening Levels Short Term (ug/m3)	Texas Effects Screening Levels Long Term (ug/m3)	North Carolina Annual Standards (ug/m3)	North Carolina 24 - Hr Standards (ug/m3)	North Carolina 1 - hr Standards (irritants) (ug/m3)	California EPA Rfc* ug/m3 (health numbers) #
12.	Chloroform	0.0840	98.0	9.80	4.30	--	--	300
13.	Carbon Tetrachloride	0.130	126	13.0	6.70	--	--	40
14.	Benzene	0.250	12.0	3.00	0.120	--	--	60
15.	2-Butanone (Methyl Ethyl Ketone)		1000	3900	390		3700	1000
16.	Carbon Disulphide	730	30.0	3.00	--	186	--	--
17.	Ethylbenzene	1100	2000	200	--	--	--	1000
18.	m,p Xylenes	---	2070	208	--	--	--	--
19.	Acetonitrile	62.0	340	34.0	--	--	--	60
20.	Acrylonitrile	0.0280	43.0	4.30	0.15	--	--	2
21.	1,2-Dichloroethane	0.0740	16.0	4.00	3.80	--	--	400
22.	Vinyl Chloride	0.220	130	13.0	0.380			10
23.	1,1 Dichloroethane	520	4000	400				500
24.	1,1,2-Trichloroethane	0.120	550	55				400
25.	Chlorobenzene	63	460	46.0				20
26.	o-Xylene	730	---	---				--
27.	1,2,4-Trimethylbenzene	6.20	1250	125				--
28.	Alpha-Pinene	--	--	--	--	--	--	--
29.	d-Limonene	--	--	--	--	--	--	--
30.	1,3-Butadiene	0.00690	110	11.0	0.170			8
31.	Acrolein	0.0210	2.30	0.230				0.02
32.	Methyl tert-Butyl Ether	3100	450	45.0				3000
33.	Styrene	1100	110	11.0			10600	1000
34.	Nonane	--	--	--	--	--	--	--
35.	Chloromethane	1.10	1030	103				--
36.	N-Butyl Acetate	--	1850	185				--
37.	Hexachlorobutadiene	0.0870	2.10	0.210				90
38.	Carbonyl Sulphide	--	8.0	0.8				--
39.	Chloroethane	2.3	500	50				10000
40.	Triclorofluoromethane	--	--	--	--			--

S No.	Name of the Chemical	EPA Region 6 Levels (ug/m3)	Texas Effects Screening Levels Short Term (ug/m3)	Texas Effects Screening Levels Long Term (ug/m3)	North Carolina Annual Standards (ug/m3)	North Carolina 24 - Hr Standards (ug/m3)	North Carolina 1 - hr Standards (irritants) (ug/m3)	California EPA Rfc* ug/m3 (health numbers) #
41.	4-Methyl-2-Pentanone	83.0	2050	205		2560	2560	--
42.	Cumene	--	--	--	--	--	--	--
43.	1,3,5-Trimethylbenzene	6.2	1250	125				--
44.	Bromomethane	5.20	117	12.0				--
45.	Vinyl Acetate	210	150	15.0				200

# [Source: USEPA Technology Transfer Network, Air Toxic Website, <http://www.epa.gov/ttn/atw/hlthef/>]

\*RfC (inhalation reference concentration): An estimate of the daily inhalation dose, expressed in terms of an ambient concentration, that can be taken daily over a lifetime without appreciable risk.

**Notes:**

EPA Region 6 Screening Levels

EPA region 6 Screening Level is calculated for residential exposure. The levels are based on a 1 in a million cancer risk or a 'hazard quotient' of 1 for non-cancer effects. These screening levels are not legally enforceable.

Texas Effects Screening Levels

Texas Effects screening Levels are set at the level below which health impacts are thought unlikely. Different levels are set for 'short-term' exposure usually one hour and 'long-term' exposure usually one year, but only 24 hours for Benzene and Ethylene dichloride. They are not legally enforceable.

North Carolina Ambient Air Standards

These levels are legally enforceable standards in North Carolina, developed through North Carolina's regulatory process. They are based on health effects information about the chemicals.

## Annexure 1

### National Ambient Air Quality Standards<sup>11</sup>

Pollutants	Time-weighted average	Concentration in ambient air			Method of measurement
		Industrial Areas	Residential, Rural & other Areas	Sensitive Areas	
SulphurDioxide (SO <sub>2</sub> )	Annual Average*	80 µg/m <sup>3</sup>	60 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>	- Improved West and Geake Method - Ultraviolet Fluorescence
	24 hours**	120 µg/m <sup>3</sup>	80 µg/m <sup>3</sup>	30 µg/m <sup>3</sup>	
Oxides of Nitrogen as (NO <sub>x</sub> )	Annual Average*	80 µg/m <sup>3</sup>	60 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>	- Jacob & Hochheiser Modified (Na-Arsenite) Method
	24 hours**	120 µg/m <sup>3</sup>	80 µg/m <sup>3</sup>	30 µg/m <sup>3</sup>	- Gas Phase Chemiluminescence
Suspended Particulate Matter (SPM)	Annual Average*	360 µg/m <sup>3</sup>	140 µg/m <sup>3</sup>	70 µg/m <sup>3</sup>	- High Volume Sampling, (Average flow rate not less than 1.1 m <sup>3</sup> /minute). 100 µg/m <sup>3</sup>
	24 hours**	500 µg/m <sup>3</sup>	200 µg/m <sup>3</sup>	100 µg/m <sup>3</sup>	
RespirableParticulate Matter (RPM) (size less than 10 microns)	Annual Average*	120 µg/m <sup>3</sup>	60 µg/m <sup>3</sup>	50 µg/m <sup>3</sup>	- Respirable particulate matter sampler
	24 hours**	150 µg/m <sup>3</sup>	100 µg/m <sup>3</sup>	75 µg/m <sup>3</sup>	
Lead (Pb)	Annual Average*	1.0 µg/m <sup>3</sup>	0.75 µg/m <sup>3</sup>	0.50 µg/m <sup>3</sup>	- ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	1.5 µg/m <sup>3</sup>	1.00 µg/m <sup>3</sup>	0.75 µg/m <sup>3</sup>	
Ammonial	Annual Average*	0.1 mg/ m <sup>3</sup>	0.1 mg/ m <sup>3</sup>	0.1 mg/m <sup>3</sup> .	
	24 hours**	0.4 mg/ m <sup>3</sup>	0.4 mg/m <sup>3</sup>	0.4 mg/m <sup>3</sup>	
CarbonMonoxide (CO)	8 hours**	5.0 mg/m <sup>3</sup>	2.0 mg/m <sup>3</sup>	1.0 mg/ m <sup>3</sup>	- Non Dispersive Infra Red (NDIR) Spectroscopy
	1 hour	10.0 mg/m <sup>3</sup>	4.0 mg/m <sup>3</sup>	2.0 mg/m <sup>3</sup>	

\* Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.  
\*\* 24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.

- 1 Chapter 1, State of Environment Report, India 1999, Ministry of Environment and Forests; <http://www.envfor.nic.in/soer/1999/chap1.html>
- 2 Ministry of Environment and Forests (MoEF) Annual Report 1999-00; <http://www.envfor.nic.in/report/9900/chap09.html>
- 3 "The Indian People's Tribunal Report on Environmental and Human Rights Violation by Chemplast Sanmar and MALCO Industries at Mettur, Tamil Nadu". IPT on Environment and Human Rights, July 2005.
- 4 "Who Bears the Cost: Industrialisation and Toxic Pollution in 'Golden Corridor' of Gujarat." Indian People's Tribunal on Environment and Human Rights, February 1999.
- 5 "Who Bears the Cost: Industrialisation and Toxic Pollution in 'Golden Corridor' of Gujarat." Indian People's Tribunal on Environment and Human Rights, February 1999.
- 6 "All pollutants not being measured by PCBs", Times of India, Vadodara, 2 August 2005.
- 7 Mega Industrial Park, Pashamylaram, Hyderabad; Infrastructure and Industrial Parks; ReachoutHyderabad.com; <http://www.reachouthyderabad.com/business/gparks/index.htm>
- 8 "Feature: Indian capital breathes easy after pollution checks", Sugita Kalyal; Planet Ark, September 13, 2002.
- 9 "Pollution: world has one last card to play", Michael Schuman; Far Eastern Economic Review, 19 Sept, 1991
- 10 "Why Mumbai Is Choking", Darryl D'Monte; Infochange News & Features, July 2004 <http://www.infochangeindia.org/analysis25.jsp>
- 11 National Air Monitoring Standards, Central Pollution Control Board; <http://www.cpcb.nic.in/as.htm>

## Annexure 2

### Profile of the Chemicals found in the Bucket samples:

Source: National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards, U. S. Department of Health and Human Services, February 2004.

S No.	Name of the Chemical	Odour	Symptoms	Target Organs	Carcinogen
1.	Hydrogen Sulphide	Rotten eggs	Irritation of eyes, respiratory system; coma, convulsion, conjunctivitis, eye pain, tears to eyes, dizziness, headache, weakness and exhaustion, insomnia, gastrointestinal disturbance	Eyes, respiratory system, Central Nervous System	No
2.	Methyl Mercaptan	disagreeable odour like garlic or rotten cabbage	Irritation eyes, skin, respiratory system; convulsion	Eyes, skin, respiratory system, Central Nervous System, blood	No
3.	Dimethyl Sulphide	NA	Irritation eyes, skin, respiratory system	Eyes, skin, respiratory system, Central Nervous System, blood	No
4.	Ethanol	Characteristic suffocating odour	Irritation eyes, skin, nose; headache, drowsiness, weakness, exhaustion, cough; liver damage; anaemia; reproductive effects	Eyes, skin, respiratory system, central nervous system, liver, blood, reproductive system	No
5.	Methylene Chloride	Faint sweet odour	Irritation eyes, skin; weakness, exhaustion, drowsiness, dizziness; numbness, tingle limbs; nausea; [potential occupational carcinogen]	Eyes, respiratory system Cancer Site: [in animals: lung, liver, salivary & mammary gland tumours]	Yes
6.	Trichloroethene	Chloroform like odour	Irritation of eyes and skin; headache, visual disturbances, weakness and exhaustion, dizziness, tremor, drowsiness, nausea, vomiting, dermatitis liver injury	Eyes, skin, respiratory system, heart, liver, kidneys Cancer Site: [in animals: liver and kidney cancer]	Yes
7.	Toluene	Sweet pungent benzene like odour	Irritation of eyes, nose, weakness and exhaustion, confusion, euphoria, dizziness, headache, dilated pupils and tears to eyes, anxiety, muscle fatigue, insomnia, dermatitis, liver injury, kidney damage	Eyes, skin, respiratory system, Central nervous system, liver and kidney	No
8.	Dimethyl Disulphide	NA	Irritation eyes, skin, respiratory system	Eyes, skin, respiratory system, Central Nervous System, blood	No
9.	Acetone	Fragrant mint like odour	Irritation eyes, nose, throat; headache, dizziness, central nervous system depression; dermatitis	Eyes, skin, respiratory system, central nervous system	No
10.	Isopropyl Alcohol	Odour of rubbing	Irritation eyes, nose, throat; drowsiness, dizziness, headache; dry cracking skin alcohol	Eyes, skin, respiratory system	No
11.	n-Hexane	Gasoline like odour	Irritation of eyes, nose, nausea, headache, peripheral neuropathy, numbness, extremities,	Eyes, skin, respiratory system, Central Nervous	No

S No.	Name of the Chemical	Odour	Symptoms	Target Organs	Carcinogen
			muscle weakness, dermatitis, dizziness, chemical pneumonia	System	
12.	Chloroform	Pleasant Odour	Irritation of eyes, skin; dizziness, mental dullness, nausea, confusion; headache, weakness, exhaustion; enlarged liver [potential carcinogen]	Liver, kidneys, heart, eyes, skin, Central nervous system Cancer Site: [in animals: liver and kidney cancer]	Yes
13.	Carbon Tetrachloride	Characteristic ether like odour	Irritation of eyes, skin, CNS depression, nausea, vomiting, liver, kidney injury, drowsiness, dizziness	Eyes, respiratory system, lungs, liver, kidney, skin Cancer Site: [in animals: liver cancer]	Yes
14.	Benzene	An aromatic odour	Irritation eyes, skin, nose, dizziness; headache, nausea, exhaustion; bone marrow depression; [potential occupational carcinogen]	Eyes, skin, respiratory system, blood, central nervous system bone marrow Cancer Site [leukaemia]	Yes
15.	2-Butanone (Methyl Ethyl Ketone)	A moderately sharp, fragrant, mint- or acetone-like odour	Irritation eyes, skin, nose; headache; dizziness; vomiting; dermatitis	Eyes, skin, respiratory system, central nervous system	No
16.	Carbon Disulphide	A sweet ether-like odour	Dizziness, headache, poor sleep, weakness, exhaustion, anxiety, weight loss; gastritis; kidney, liver injury; eye, skin burns; dermatitis; reproductive effects	central nervous system, peripheral nervous system, cardiovascular system, eyes, kidneys, liver, skin, reproductive system	No
17.	Ethylbenzene	An aromatic odour.	Irritation eyes, skin, mucous membrane; headache; coma	Eyes, skin, respiratory system, central nervous system	No
18.	m,p Xylenes	An aromatic odour.	Irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; nausea, vomiting, abdominal pain; dermatitis	Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneys	No
19.	Acetonitrile	An aromatic odour	Irritation nose, throat; nausea, vomiting; chest pain; weakness, exhaustion, convulsions; in animals: liver, kidney damage	Respiratory system, cardiovascular system, central nervous system, liver, kidneys	No
20.	Acrylonitrile	An unpleasant odour	Irritation eyes, skin; headache; sneezing; nausea, vomiting; weakness, exhaustion, dizziness; skin [potential occupational carcinogen]	Eyes, skin, cardiovascular system, liver, kidneys, central nervous system Cancer Site [brain tumours, lung & bowel cancer]	Yes

S No.	Name of the Chemical	Odour	Symptoms	Target Organs	Carcinogen
21.	1,2-Dichloroethane	Chloroform-like odour	Irritation eyes, central nervous system depression; nausea, vomiting; dermatitis; liver, kidney, cardiovascular system damage; [potential occupational carcinogen]	Eyes, skin, kidneys, liver, central nervous system, cardiovascular system Cancer Site [in animals: forestomach, mammary gland & circulatory system cancer]	Yes
22.	Vinyl Chloride	Pleasant odour at high concentrations	Weakness, exhaustion; abdominal pain, gastrointestinal bleeding; enlarged liver [potential occupational carcinogen]	Liver, Central Nervous System, blood, respiratory system, lymphatic system	Yes
23.	1,1 Dichloroethane	Chloroform-like odour	Irritation skin; central nervous system depression; liver, kidney, lung damage	Skin, liver, kidneys, lungs, Central Nervous System	No
24.	1,1,2-Trichloroethane	Sweet, chloroform-like odour	Irritation eyes, nose; central nervous system depression; liver, kidney damage [potential occupational carcinogen]	Eyes, respiratory system, Central Nervous System, liver, kidneys Cancer Site [in animals: liver cancer]	Yes
25.	Chlorobenzene	Almond like odour	Irritation eyes, skin, nose; drowsiness, incoordination; central nervous system depression; in animals: liver, lung, kidney injury	Eyes, skin, respiratory system, central nervous system, liver	No
26.	o-Xylene	Aromatic odour	Irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, anorexia, nausea, vomiting, abdominal pain; dermatitis	Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneys	No
27.	1,2,4-Trimethylbenzene		Irritation eyes, skin, nose, throat, respiratory system; bronchitis; headache, drowsiness, fatigue, dizziness, nausea, incoordination; vomiting, confusion; chemical pneumonitis	Eyes, skin, respiratory system, central nervous system, blood	No
28.	Alpha-Pinene	A characteristic odour	Irritation eyes, skin, nose, throat; headache, dizziness, convulsions; blood in the urine, kidney damage; abdominal pain, nausea	Eyes, skin, respiratory system, central nervous system, kidneys	No
29.	d-Limonene	Characteristic citrus odour.	Irritation of eyes, nose, lungs, lightness of head, difficulty in breathing, skin irritation, liver injury, kidney damage	Eyes, skin, respiratory system, liver and kidney	No
30.	1,3-Butadiene	Mild aromatic and gasoline like odour	Irritation eyes, nose, throat; drowsiness, dizziness; reproductive damages; [potential occupational carcinogen]	Eyes, respiratory system, central nervous system, reproductive system Cancer Site [blood cancer]	Yes
31.	Acrolin	a piercing, disagreeable odour	Irritation eyes, skin, mucous membrane; chronic respiratory disease	Eyes, skin, respiratory system, heart	No
32.	Methyl tert-Butyl Ether	NA	NA	NA	NA

S No.	Name of the Chemical	Odour	Symptoms	Target Organs	Carcinogen
33.	Styrene	A sweet, floral odour	Irritation eyes, nose, respiratory system; headache, weakness, exhaustion, dizziness, confusion, drowsiness, unsteady gait; possible liver injury; reproductive effects	Eyes, skin, respiratory system, central nervous system, liver, reproductive system	No
34.	Nonane	A gasoline-like odour	Irritation eyes, skin, nose, throat; headache, drowsiness, dizziness, confusion, nausea, tremor	Eyes, skin, respiratory system, central nervous system	No
35.	Chloromethane	A faint, sweet odour	Dizziness, nausea, vomiting; visual disturbance, stagger, slurred speech, convulsions, coma; liver, kidney damage reproductive, [potential occupational carcinogen]	central nervous system, liver, kidneys, reproductive system Cancer Site [in animals: lung, kidney & forestomach tumours]	Yes
36.	N-Butyl Acetate	A fruity odour	Irritation eyes, skin, upper respiratory system; headache, drowsiness	Eyes, skin, respiratory system, central nervous system	No
37.	Hexachlorobutadiene	A mild, turpentine-like odour	In animals: irritation eyes, skin, respiratory system; kidney damage; [potential occupational carcinogen]	Eyes, skin, respiratory system, kidneys Cancer Site [in animals: kidney tumours]	Yes
38.	Carbonyl Sulphide	NA	NA	NA	NA
39.	Chloroethane	A pungent, ether-like odour	Incoordination, abdominal cramps; cardiac arrest; liver, kidney damage	Liver, kidneys, respiratory system, cardiovascular system, central nervous system	No
40.	Trichlorofluoromethane	Odourless liquid	Incoordination, tremor; dermatitis; cardiac arrest	Skin, respiratory system, cardiovascular system	No
41.	4-Methyl-2-Pentanone	A mild odour	Irritation eyes, skin; headache, drowsiness; dermatitis	Eyes, skin, central nervous system	No
42.	Cumene	A Sharp, penetrating, aromatic odour	Irritation eyes, skin, mucous membrane; dermatitis; headache, coma	Eyes, skin, respiratory system, central nervous system	No
43.	1,3,5-Trimethyl benzene	A distinctive, aromatic odour	Irritation eyes, skin, nose, throat, respiratory system; bronchitis; headache, drowsiness, fatigue, dizziness, nausea, incoordination; vomiting, confusion; chemical pneumonitis	Eyes, skin, respiratory system, central nervous system, blood	No
44.	Bromomethane	A chloroform like odour at high temperatures	Irritation eyes, skin, respiratory system; Central Nervous System depression; liver, kidney disease, cardiac arrest, [Potential occupational carcinogen]	Eyes, skin, respiratory system, liver, kidneys, Cardiovascular System, Central Nervous System	Yes
45.	Vinyl Acetate	A pleasant fruity odour	Irritation eyes, skin, nose, throat; hoarseness, cough; loss of smell; eye burns, skin blisters	Eyes, skin, respiratory system	No