HEALTH IMPACTS OF INCINERATION and LANDFILLS

DHARMESH SHAH
Center for Technology and Policy, IIT Madras

COMMUNITY

ENVIRONMENTAL

MONITORING

CTaP CENTRE FOR TECHNOLOGY and POLICY
Indian Institute of Technology Madras

gaia

		Oxygen	Temperature	Stack gas volume, Nm^3/te
Open Burning	Incomplete Combustion		<800 ^oC	NA
Incineration	‘complete combustion’	7-14%	900-1600 ^oC	5,000-5,500
Gasification	‘incomplete combustion’			
Pyrolysis	‘thermal degradation’ by indirect heating	0-5%	400-600 ^oC	3,000-4,000

Sources: Porteous, A., 2001. Energy from waste incineration – a state of the art emissions review with an emphasis on public acceptability. Applied Energy 70: 157-167; Weber, R., Sakurai, T., 2001. Formation characteristics of PCDD and PCDF during pyrolysis processes. Chemosphere 45: 1111-1117

	Input	Major Outputs	Dioxin Formation
Incineration	MSW	Stack gas Bottom ash	Yes Primarily in fly ash
Gasification	‘refined MSW’	Gas* (~80%) Coke/tar (~20%)	Yes
Pyrolysis	`single wastes’ (tires, plastic), ‘refined MSW’	Gas/oil** (~60%) Coke/tar** (~40%)	Yes Primarily in gas/oil

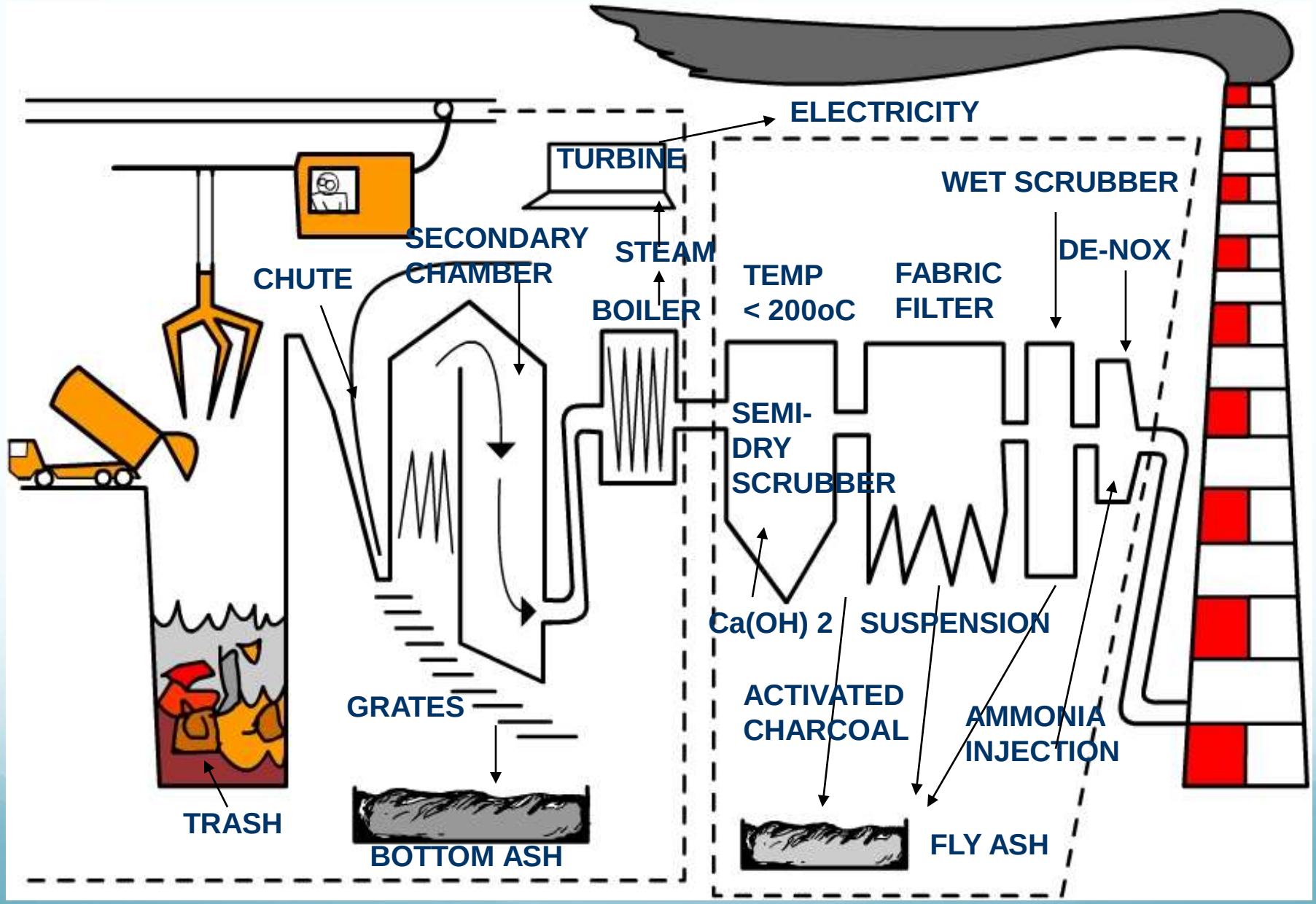
*carbon monoxide, carbon dioxide, hydrogen, methane, water, nitrogen, small amounts of higher hydrocarbons, and tar. Requires additional fuel for combustion

**steam, carbon dioxide, carbon oxide, hydrogen, methane, aliphatic hydrocarbons (C2 to C4) and primary tar. Combustible but may require additional fuel.

Sources: Porteous, A., 2001. Energy from waste incineration – a state of the art emissions review with an emphasis on public acceptability. Applied Energy 70: 157-167; Weber, R., Sakurai, T., 2001. Formation characteristics of PCDD and PCDF during pyrolysis processes. Chemosphere 45: 1111-1117

All incinerator outputs have the potential to affect human health and the environment

- Stack gas
- Fly ash
- Bottom ash or slag
- Scrubber water
- Other residues
- Fugitive emissions


ELECTRICITY
TURBINE
WET SCRUBBER
SECONDARY CHAMBER
STEAM
DE-NOX
CHUTE
TEMP < 200oC
FABRIC FILTER
BOILER
SEMI-DRY SCRUBBER
Ca(OH) 2
SUSPENSION
ACTIVATED CHARCOAL
AMMONIA INJECTION
GRATES
TRASH
BOTTOM ASH
FLY ASH

Incinerator impacts

- Releases of metals, dioxins and other pollutants to air, soil, vegetation, and biota in the nearby environment
- Exposure and health impacts on incinerator workers
- Exposure and health impacts of nearby human populations
- Exposure and health impacts on regional and global populations

Most widely known incinerator pollutants of concern

- Dioxins
- Particulate matter (PM)
- Arsenic
- Beryllium
- Cadmium
- Chromium
- Lead
- Mercury
- Acidic gases
- PAHs

Source: National Research Council, 2000. Waste Incineration and Public Health, Washington, DC: National Academy Press

Other toxic pollutants in incinerator gases and residues

METALS: In addition to the six metals previously listed, 19 other metals have been identified in the wastes sent to incinerators or in incinerator stack gas and/or ash.

ORGANIC CHEMICALS: In addition to dioxins, scientists have detected innumerable organic chemicals in incinerator outputs. Among these so-called products of incomplete combustion (PICs) are hundreds of semi-volatile chemicals only 10-14 percent of which have been completely identified. Semi-volatile PICs are likely to be persistent in the environment and lipophilic (fat-loving).

AIR SAMPLE AT PERUNGUDI DUMP YARD

Total of 27 chemicals were found in the sample. These include –

Hydrogen Sulphide	Carbonyl Sulphide	Methyl Mercaptan
Carbon Disulphide	Chloromethane	1,3-Butadiene
Chloroethane	Ethanol	Acetonitrile
Acrolein	Acetone	Trichlorofluoromethane
Methyl Ethyl Ketone	n-Hexane	Benzene
4-Methyl-2-Pentanone	Toluene	Chlorobenzene
Ethylbenzene	m,p-Xylenes	Styrene
o-Xylene	n-Nonane	Cumene
1,3,5-Trimethylbenzene	1,2,4-Trimethylbenzene	d-Limonene

5 out of 27 chemicals exceed the health-based standards set by United States

Environmental Protection Agency Region 6 or other regulatory authorities

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 **34,782** times higher than the safe levels

Benzene was found **2,360** times higher than the safe levels

Chloromethane was found **209** times higher than the safe levels

HEALTH IMPACTS

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.**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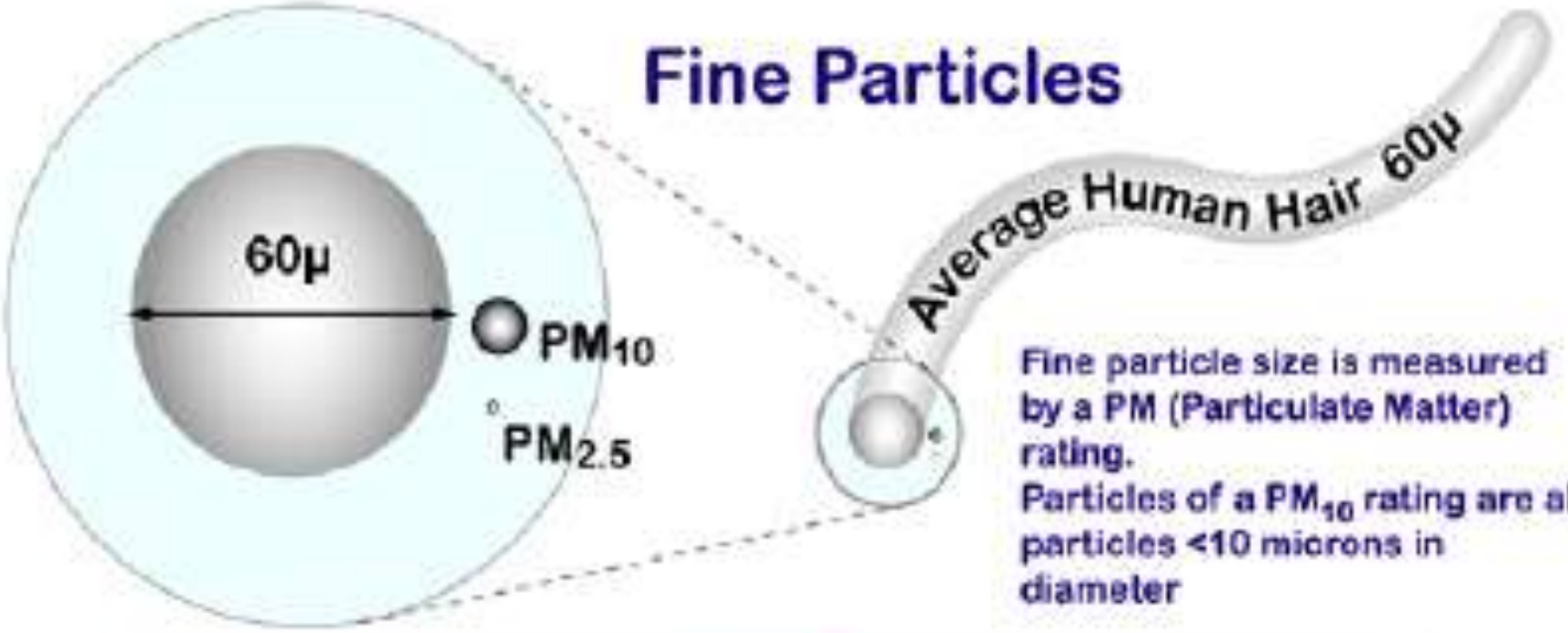
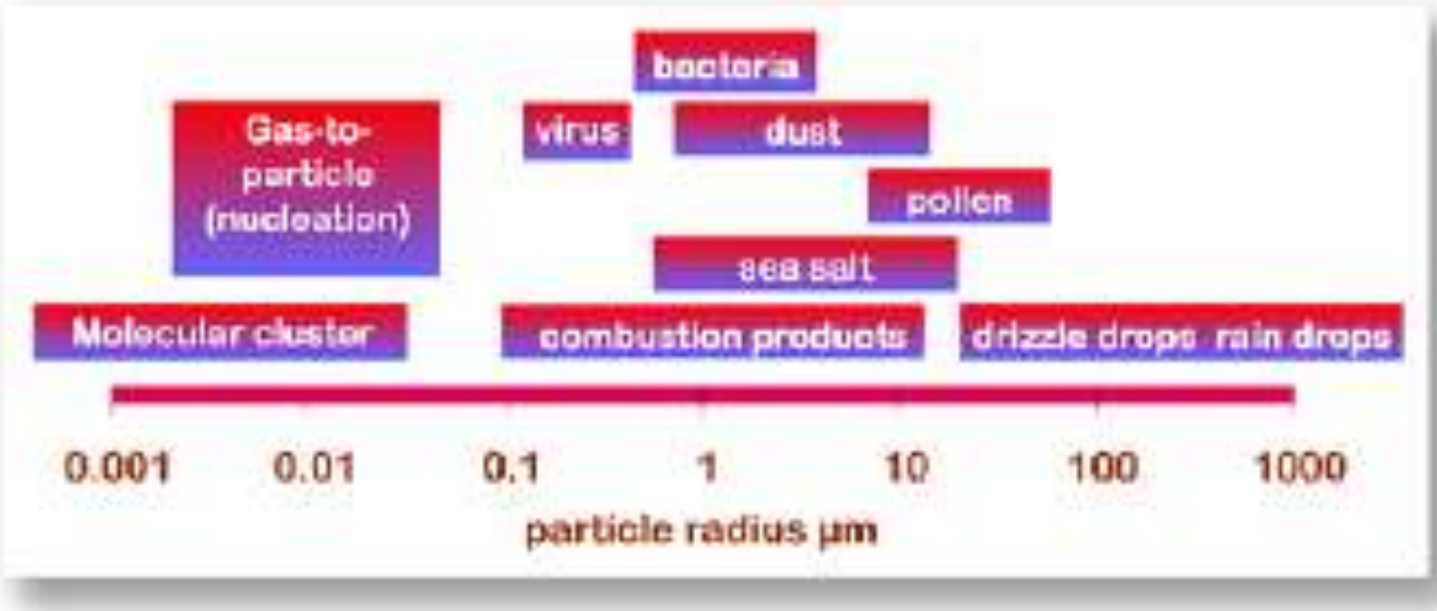
ChesterLabNet Report # 13-147, dated March 26th, 2013, shows that levels of very fine particulate matter (having a diameter of less than 2.5 microns, or **PM2.5**) were **601 micrograms per cubic meter (µg/m3)** in an air sample collected on March 4th, 2013, from the terrace of a resident of Haji Colony at a distance of 50 meters from the TOWMC incinerator. The same report shows that levels of **PM2.5** were **277.1 µg/m3** in an air sample collected on March 5th, 2013, from the terrace of a resident of Sukhdev Vihar, at a distance of 110 meters from the TOWMC incinerator

AQI Category	Index Values	Previous Breakpoints (1999 AQI) ($\mu g/m^3$, 24-hour average)	Revised Breakpoints ($\mu g/m^3$, 24-hour average)
Good	0 - 50	0.0 - 15.0	0.0 – 12.0
Moderate	51 - 100	>15.0 - 40	12.1 – 35.4
Unhealthy for Sensitive Groups	101 – 150	>40 – 65	35.5 – 55.4
Unhealthy	151 – 200	> 65 – 150	55.5 – 150.4
Very Unhealthy	201 – 300	> 150 – 250	150.5 – 250.4
Hazardous	301 – 400	> 250 – 350	250.5 – 350.4
	401 – 500	> 350 – 500	350.5 – 500

Fine Particles



Fine particle size is measured by a PM (Particulate Matter) rating.
Particles of a PM_{10} rating are all particles <10 microns in diameter



Ash management

3 tons of waste = 1 ton ash

- In Germany & Switzerland fly ash put into nylon bags and placed in salt mines
- In Japan some incinerators vitrify the ash
- In Denmark…
- They send all the ash to Norway
- In the US they allow the fly ash to be mixed with the bottom ash before testing - it usually passes this inadequate test and is then sent to regular landfills where it is sometimes used as landfill cover!

Chemical contaminants in workers' urine and blood at elevated concentrations -- dioxins, PCBs, hexachlorobenzene, chlorophenols, benzene, toluene, xylene, arsenic, lead, mercury, and nickel. Sources: Kumagai et al. (2002); Kumagai et al. (2001); Kitamura et al.(2000); Schecter et al. (1999); Kurttio et al. (1998); Van den Hazel and Frankort (1996); Wrbitzky et al. (1995); Papke et al. (1993); Malkin et al. (1992); Angerer et al. (1992); Schecter et al. (1991).

Dioxin levels in blood increased by 10-25 percent during the two years following the startup of a new incinerator. Gonzalez et al. (2000)

Mercury levels in the hair of people living near a waste incinerator increased by 44-56% over 10 years and with greater proximity to the facility. Kurttio et al. (1998)

Elevated rates of congenital anomalies were reported in four studies, while one study found eye malformations were not increased. Cordier et al. (2004); Dummer and Parker (2003); Ten Tusscher et al. (2000); Aelvoet et al. (1998); Gatrell and Lovett (1989)

A study of adolescent children who lived near two incinerators found as follows (Staessen et al., 2001. Lancet 357:1660-1669):

✓Elevated blood levels of PCBs, dioxins and metabolites of volatile organic compounds (VOCs) were in the children's blood.

✓Delayed sexual maturation was noted among these children;

✓Reduced testicular volume was found among the boys.

✓Delayed breast development in girls was positively correlated with serum concentrations of dioxins.

✓Delayed genital development in boys was correlated with serum concentrations of PCBs.

LANDFILLS

TABLE 3. Average Landfill Gas Composition (ppmv)[a]

compound	concn (ppmv)	compound	concn (ppmv)
methane	55.63%	*o*-ethyltoluene	3.43
carbon dioxide	37.14%	*p*-diethylbenzene	2.67
oxygen	0.99%	*m*-ethyltoluene	2.49
total NMOC	438.09	*t*-2-pentene	2.37
ethane	222.61	*o*-xylene	2.17
total unidentified VOCs	134.55	*o*-dichlorobenzene	2.17
limonene	35.38	*n*-propylbenzene	2.09
toluene	14.57	styrene	2.02
n-decane and *p*-dichlorobenzene	13.97	1-undecene	2.02
p-isopropyltoluene	13.14	*p*-ethyltoluene	2.01
propane	13.03	1,2,3-trimethylbenzene	1.90
isobutane	8.24	benzyl chloride and *m*-dichlorobenzene	1.88
a-pinene	7.85	1,3,5-trimethylbenzene	1.76
3-methylpentane	7.75	*n*-butylbenzene	1.50
acetone	6.09	*m*-diethylbenzene	1.46
p-xylene + *m*-xylene	5.97	dichlorodifluoromethane	1.27
n-undecane	5.50	chlorobenzene	1.15
1,2,4-trimethylbenzene and *t*-butylbenzene	5.06	dichlorotoluene	1.15
ethylbenzene	4.71	*n*-octane	0.99
1,3-butadiene	3.98	*n*-pentane	0.97
n-butane	3.80	benzene	0.93
isopentane	3.76	*n*-hexane	0.92
n-nonane	3.57	isobutene + 1-butene	0.92

[a] Values are given for all compounds detected above an average concentration of 0.90 ppm or greater in the landfill gas collection system headers.

Eklund, B., Anderson, E., Walker, B., Burrows, D., 1998. Characterization of landfill gas composition at the Fresh Kills Municipal Solid-Waste Landfill. Environ. Sci. Technol. 32: 2233-2237

- The trace **volatile organic compounds** (VOCs) in landfill gas were examined at **seven** U.K. waste disposal **facilities**. Over **140 compounds** were identified, of which more than **90 were common** to all seven sites. The groups of compounds and concentrations observed were alkanes, 302-1543 mg m-3; aromatic compounds, 94-1906 mg m-3; cycloalkanes, 80-487 mg m-3; terpenes, 35-652 mg m-3; alcohols and ketones, 2-2069 mg m-3; and halogenated compounds, 327-1239 mg m-3.

- Three sites were found to have total **chlorine concentrations**, derived from the organochlorine compounds in the gas, of above 250 mg m-3. Chlorine contents of this level were considered to be potentially damaging to landfill gas fueled engines used for electricity generation. **Chloroethene** (>0.1-87 mg m-3) was identified as the most abundant toxic component. Chloroethene levels in the landfill gases from two of the sites studied were found in excess of the U.K. maximum exposure limit by a factor of 5 and 3. Total VOCs emissions from four of the seven sites studied were estimated to be of the order of 104 kg/yr.

Allen, M., Braithwaite, A., Hills, C., 1997. Trace organic compounds in landfill gas at seven U.K. waste disposal sites. Environ. Sci. Technol. 31: 1054-1061.

PCDD/Fs have been measured in … landfill gas and leachate ..

Emission factors are 0.32-0.36 ng I-TEQ/m3 of fugitive gas, and 0.1-1 ng I-TEQ/m3 of flue gas.

Eduljee, G. PCDD/PCDF releases from various waste management strategies. Http://www.wrf.org.uk/previous/WB46-dioxin.html

Hg vapor was released to the atmosphere at readily detectable rates from all sources measured. Emission rates ranged from ~1 to 20 ng m-2 hr-1 over aged surface covers (generally comparable to background soils), from ~6 to 2400 ng/hr from LFG vents and flares, and from ~5 to 60 mg/hr at the WF. In general the fluxes increased from older to newer landfills, from fresh to aged cover, and from passive to active venting systems.

Limited data suggest that **methyl and other organo-mercury** compounds may also be emitted from these sites

We estimate that atmospheric Hg releases from municipal landfill operations in the state of Florida are on the order **of 10 kg/yr**

Lindberg, S., Price, J., 1999. Airborne emissions of mercury from municipal landfill operations: A short-term measurement study in Florida. J. Air & Waste Manage. Assoc. 49: 520-532.

1. Source Separation

2. Door to Door Collection

3. Composting

4. Recycling

5. Reuse, Repair & Community Centers

6. “Pay As You Throw” (Residuals)

7. Residual Reduction Initiatives

8. Residual Separation & Research Center

9. Better Industrial Design

Temporary Landfill

2025

THANK YOU