Rachel's Environment & Health News
#226 - Toxic Gases Emitted From Landfills
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A recent report[1] from California state government takes a fresh look at a problem that has been ignored for years: toxic gases released from landfills. Solid waste landfills and hazardous waste landfills both emit toxic gases into the surrounding air. U.S. EPA (Environmental Protection Agency) published its opinion back in 1982 that air pollution from landfills is a significant problem but said it would have to ignore the problem because no one knew how to get a handle on it.[2] So far as we know, EPA has never said another word on the subject. University researchers reported almost a decade ago that landfills emit airborne toxins into the local environment, but until now no one has defined the extent of the problem.

Under California state law (Health and Safety Code Section 41805.5) all solid and hazardous waste landfills must be tested for toxic gas emissions. The California Air Resources Board (CARB) selected 10 toxic gases for measurement; they selected these particular gases because they are known to have ill effects (particularly cancer) on humans who are exposed for extended periods. The ten toxic gases they tested for are: vinyl chloride, benzene, ethylene dibromide, ethylene dichloride, methylene chloride, perchloroethylene, carbon tetrachloride, 1,1,1-trichloroethane (methyl chloroform), trichloroethylene, and chloroform. In addition, landfill gas samples were also analyzed for oxygen, nitrogen, methane, and carbon dioxide.

The CARB summarized their findings this way:

1) One or more of the 10 toxic chemicals could be measured in gases emitted from 240 out of 356 landfills tested; in other words, 67% of the tested landfills emitted one or more of the toxic gases.

2) Hazardous waste landfills and municipal solid waste landfills appeared to be similar in their ability to produce toxic gases.

3) In many cases, but not all, toxic gases escaping from landfills could be measured at the property line, the legal boundary of the landfill.

4) Methane at concentrations greater than the regulatory limit of 5% was found to be migrating offsite underground at approximately 20% of the landfills. Methane is a naturally-occurring gas created by the decay of organic matter inside a landfill. As methane is formed, it builds up pressure and then begins to move through the soil, following the path of least resistance; often it moves sideways for a time before breaking through to the surface of the ground. Methane is lighter than air and is flammable. If it enters a closed building and the concentration builds up to about 15% in the air, a spark or a flame is likely to cause a serious explosion. For this reason, landfill designers sometimes install a set of pipes full of holes like a swiss cheese to provide a known pathway for the methane to escape through; such systems are sometimes successful and sometimes not.

The new California study does not go into great detail, but it certainly provides evidence that toxic gases are likely to be measurable in the air near landfills. For example, of 340 California landfills studied, more than half had measurable airborne releases of benzene (average: 2.5 parts per million [ppm]), methylene chloride (average: 4.8 ppm), perchloroethylene (average: 1.1 ppm), 1,1,1-trichloroethane (average 650 parts per billion [ppb]), and trichloroethylene (average: 840 ppb). Nearly half had releases of vinyl chloride (average: 2.2 ppm). Methane was found at three quarters of all landfills tested. At half of these, the concentration was 10% or less. In the other half, the concentration varied from 11% to 73%. These were measurements at the ground surface of the cap of the landfill.

Another set of measurements was taken at the property boundary of each of 288 landfills, to see if toxic gases could be detected in the "ambient" outdoor air. At 57% of these landfills, 1,1,1-trichloroethane was detected (maximum: 51 ppb); at 49%, perchloroethylene was detected (maximum: 269 ppb); at 45%, methylene chloride (maximum: 1.3 ppm); at 40%, benzene (maximum: 500 ppb); at 32%, trichloroethylene (maximum: 130 ppb); at 22%, carbon tetrachloride (maximum: 15 ppb); at 13%, chloroform (maximum: 32 ppb).

In all, off-site migration of gases, including methane, was detected at 83% of all the 288 landfills. It's enough to make you think twice before buying a home near a landfill, or before you sit by silently while someone else builds a new landfill near your home, farm, church, or school.

Actually, this is not the first time landfill gas emissions have been reported--it's just the first time anyone has looked at several hundred landfills to see how they behave in general. A Princeton University study of the Monument Street Landfill in Baltimore[3] reported in 1983 that toxic gases were escaping through the methane venting system, which had been installed to prevent methane from escaping through the cracks in Baltimore streets. Toxic gases were escaping right along with the methane (which had a concentration of 7%), in the following peak concentrations: 1,1-dichloroethane (3.9 ppm); 1,1,1-trichloroethane (1.1 ppm); trichloroethylene (4.9 ppm); ethylbenzene (10.4 ppm). In that study, a Gaussian air pollution dispersion model was used to gauge the human exposure, which was estimated to be 7 micrograms of ethylbenzene per cubic meter of air 100 yards downwind from the landfill property line, and 0.14 micrograms of ethylbenzene per cubic meter of air 1000 yards downwind from the property line (assuming stable atmospheric conditions). These are not trivial exposures- especially near a landfill surrounded by a residential community. Proposals to "flare" the methane (set it on fire and allow it to burn continuously) were considered but were rejected until such time as a proper study could be done to learn what additional toxic byproducts would be created by the flame. Such a study was never done.

James Craner[4] has described a study conducted in 1983 by the New Jersey Department of Environmental Protection (DEP) at Waste Management's Parklands Landfill in Bordentown, NJ, in which the DEP measured toxic gases inside a high school near the landfill. Craner also described methods and apparatus suitable for measuring toxic air emissions from landfills, so that any unit of government that became interested in the problem could take its own measurements. The system does require access to a gas chromatograph/mass spectrometer (GC/MS). Except for that critical (and expensive) piece of equipment, Craner's system of measurement is relatively inexpensive.

--Peter Montague

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[1] Lynton Baker, Renee Capouya, Carole Cenci, Renaldo Crooks, and Roland Hwang, The Landfill Testing Program: Data Analysis and Evaluation Guidelines. Sacramento, CA: California Air resources Board [1102 Q Street, P.O. Box 2815, Sacramento, CA 95812], September, 1990. 104 pgs. Free. Also get: Jay Emerson, Suggested Control Measures for Landfill Gas Emissions (Sacramento, CA: California Air Resources Board, September, 1990). Also free.

[2] U.S. Environmental Protection Agency, "Hazardous Waste Management System; Permitting Requirements for Land Disposal Facilities--Part II," FEDERAL REGISTER Vol. 47 No. 143 (July 26, 1982), pgs. 32274-32388.

[3] Roy Albert, Robert Harris, Joseph Highland, Dennis McLaughlin, Peter Montague, and Eric Wood. REVIEW AND EVALUATION OF THE MONUMENT STREET (BALTIMORE) LANDFILL [PU/CEES Report #154]. (Princeton, NJ: Center for Energy and Environmental Studies, School of Engineering/Applied Science, Princeton University, April, 1983.) 289 pgs.

[4] James A. Craner, "Monitoring Air Emissions of Volatile Organic Pollutants From Landfills: A Technical and Policy Analysis and The Design, Construction, and Operation of a Landfill Air Sampling System." (Princeton, NJ: Chemistry Department, Princeton University, May 11, 1984.) [Unpublished "Senior Thesis" submitted in partial fulfillment of requirements for a B.A. degree. 330 pgs.]

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