HEALTH CONSULTATION 2

BANK AVENUE LANDFILL SITE
(Methane Gas & Vapor Intrusion Concerns)

ST. BERNARD, HAMILTON COUNTY, OHIO

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Prepared by:

Ohio Department of Health
Health Assessment Section

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SUMMARY

Introduction

At the request of the Ohio EPA and the Hamilton County General Health District, the Health Assessment Section (HAS) at the Ohio Department of Health evaluated recent sampling results from sub-slab soil gas, soil, and groundwater testing conducted by the Ohio EPA at a number of residential properties along Bank Avenue in October 2011. The HAS reached separate conclusions regarding Ohio EPA's recent sub-slab sampling results and soil and groundwater sampling.

Conclusion 1

HAS concludes that the levels of non-methane volatile organic compounds (VOCs) found in soil gas under Bank Avenue homes at the Bank Avenue Landfill site are not expected to harm people's health as specific VOCs were either not detected or detected below levels of health concern.

Basis for decision

The sub-slabs and/or crawl spaces of seven homes on Bank Avenue were sampled by the Ohio EPA on October 6, 2011. In general, VOCs were not detected or found at very low levels in soil gas. Based on the sampling conducted by Ohio EPA in October 2011, HAS finds that the VOC levels found in or under these homes are below levels of health concern. The chlorinated solvents trichloroethylene (TCE) and tetrachloroethylene (PCE) were detected at levels below health-based sub-slab screening levels. Although chloroform, a disinfection byproduct, was detected under two homes, its presence does not appear to be related to landfill gas generated by the former landfill area.

Next steps

Operation of an effective landfill gas extraction system is advised to prevent the landfill gas from entering adjacent homes. Additional sub-slab sampling is recommended to determine the source of chloroform detected under two homes.

Conclusion 2

HAS concludes that volatile and semi-volatile organic compounds found in soil and groundwater at Bank Avenue properties will not harm people's health. The reason for this is that people are not being exposed to the chemicals buried at the depths below the ground surface where these chemicals occur.

Basis for decision

Volatile and semi-volatile organic compounds, including elevated levels of some polycyclic aromatic compounds (PAHs), were found in subsurface soils on some properties at depths of 4 to 8 feet below the ground surface. People are unlikely to come into direct contact with these chemicals as they are buried at depth beneath the ground surface. PAHs fix to soil particles and are unlikely to migrate as vapors into nearby residences. Low permeability sandy clay soils make up the upper 2 feet of soils underlying most of the homes on Bank Avenue and appear to mitigate, at least to some extent, vapor intrusion under these residences.

Next steps

Additional sub-slab and indoor air monitoring is advised. This additional sampling should include the dichlorobenzene and trichlorobenzene compounds detected in subsurface soils under residential properties.

Conclusion 3

Elevated methane levels at or exceeding 100% of the Lower Explosive Limit (LEL) for methane detected in subsurface soil borings on residential properties pose a potential physical hazard to residents living adjacent to the landfill.

Basis for decision

Samples from soil boreholes indicated methane at or above the LEL at five locations at depths ranging in depth from 7 - 20 feet below the ground surface. Elevated levels of methane were detected at two boring sites within 20 to 40 feet of an occupied residence. Several other methane readings in excess of 100% of the LEL were detected at other boring locations that were likewise close to residences. Methane gas in excess of its lower explosive limit (= 5 percent methane by volume) can ignite and explode in a confined space. Methane was not detected in sub-slab soil gas under homes or in the indoor air within the homes by the Ohio EPA. However, a future health threat may exist due to the close proximity of the residences to explosive levels of methane discovered in subsurface soils on these residential properties.

Next steps

The source or sources of the methane detected in subsurface soils under these residences adjacent to the landfill need(s) to be identified, isolated and/or contained, or removed. Periodic sub-slab and indoor air monitoring is advised. The explosive gas alarms installed in the homes of adjacent properties should continue to be calibrated and maintained to ensure the adequate protection of the buildup of methane gas from buried waste materials. Sub-slab samples under area homes should be analyzed for methane.

For more information

For more information about hazardous substances identified in this report, including health effects, please see HAS chemical fact sheets available on-line at: http://www.odh.ohio.gov *(go to "H" and "Health Assessment Section")* or please see ATSDR ToxFAQs, available at: http://www.atsdr.cdc.gov/toxfaq.html. You may also call HAS at 614-466-1390 for more information on this site.

BACKGROUND AND STATEMENT OF ISSUES

Site Location and Description

The Bank Avenue Landfill Site is a closed waste disposal site located east of Interstate 75 and south of Bank Avenue in St. Bernard, Hamilton County, Ohio (Figure 1). The waste disposal facility operated from about 1950 through the late 1970s and closed in 1985. The property is now a grassed over city park. Twelve residences in the Bank Avenue Subdivision are within 200 feet of the property line with the closed landfill. Beginning in 1994, the City of St. Bernard found methane gas levels at the site above the lower explosive limit (LEL). Despite remedial efforts by the City, explosive levels of methane continue to be detected at the facility property line and under adjacent residential properties.

In December 2009, Ohio EPA requested U.S. EPA's assistance in sampling sub-slab soil gas for methane and non-methane volatile organic compounds (VOCs) under the potentially impacted residences immediately adjacent to the former landfill. The U.S EPA sampled the sub-slabs or crawl spaces of eight homes most likely to be affected by landfill gases originating from the former St. Bernard Landfill in December 2009 and again in February 2010. The chemicals of concern were either not detected or detected at very low levels. All VOC detections were below the recommended health-based screening levels, although in a few cases sub-slab and indoor air levels were very close to these screening values. HAS, under a cooperative agreement with ATSDR, evaluated the sample results collected by U.S. EPA from homes near the former St. Bernard Landfill in a health consultation (HAS 2010). In April 2010, the City of St. Bernard agreed to conduct three additional rounds of residential vapor intrusion sampling. Through its contractor, the City of St. Bernard resampled Bank Avenue homes in April, July, and November 2010 and January 2011.

The present health consultation evaluates recent sampling results from additional sub-slab soil gas and soil and groundwater sampling conducted by the Ohio EPA at Bank Avenue residents' properties in October 2011.

Area Geology and Hydrogeology

The underlying geology in the area appears to be a mix of glacial soils and man-made fill at the edge of the Mill Creek valley, including sand and gravel stringers, silts and clays, and, at depth, thicker layers of lake-deposited clays (Walker 1986). Residents obtain their drinking water from the Greater Cincinnati Water Works, the local public water supply.

Closed Bank Avenue Landfill

The City of St. Bernard operated a landfill/dump at the site of the current Ludlow Grove Park from 1958 until 1978. Prior to being a landfill, the current park area was a vegetable farm and orchard. Landfilling operations consisted of the open dumping of waste in low areas north of the berm of the former Miami and Erie Canal (City of St. Bernard 1991). The original land surface had an elevation of 495 feet above Mean Sea Level (MSL). The current park area has an elevation of between 516 and 520 feet above MSL, indicating between 20 and 30 feet of wastes

within the landfill. In the 1991 report, the wastes disposed of in the landfill are described as "cans, burned refuse from the city incinerator, construction debris, stoves, refrigerators, tires, empty oil drums, soap manufacturing by-products, grass-clippings, tree limbs, and kitchen wastes." However, there were no detailed records of what was disposed in the dump when it was in operation, nor detailed maps showing the full extent of the fill. Following cessation of waste disposal activities in the late 1970's, the entire surface of the landfill was covered with 3-5 feet of silty clay from off-site sources and graded to its present surface which now supports a grass cover (City of St. Bernard 1991).

An account of the landfill and its history compiled by the Ohio Department of Transportation (Authorization Request Application, 2010) provided anecdotal evidence that "more than municipal waste was placed in the landfill", with drums, appliances, and other materials alleged to have been disposed there. This report also cites a previous Ohio EPA report (Preliminary Assessment, 1984) that indicates that the foot print of the fill extended under "the existing Bank Avenue Park, as well as two residential properties" on the west end of Bank Avenue. The homes in the Bank Avenue sub-division evidently were built between 1985 and 1995. Areas at the east end of Bank Avenue sub-division are described as being the sites of small warehouses and factories that were demolished by the city in the early 1980's.

Due to the detection of explosive levels of methane gas in the landfill, since 1991 the facility has implemented a number of corrective actions to try and mitigate the production and off-site migration of methane gas in the landfill (ODOT 2010). The current system utilizes a series of six extraction pods which provide six controlled zones where subsurface vacuums are applied along the entire perimeter of the landfill adjacent to the occupied residences. There are 18 explosive gas monitoring probes located at the landfill property boundary (CEC 2011).

Impacted Community

The Bank Avenue Landfill site borders an urban density, residential community of primarily single-family homes. Six homes on the south side of Bank Avenue directly abut the northern boundary of the closed landfill and are most likely to be impacted by landfill gas. The City of St. Bernard installed explosive gas alarms (or combustible gas indicators or methane detectors) in the potentially impacted residences in 2001 (Ohio EPA 2009a). These residences are 1-story, split-level, and 2-story homes built around 1983 and all but two have basements.

Ohio EPA 2011 Sampling Event

In the summer of 2010, the City of St. Bernard, with oversight from the Ohio EPA, expanded the landfill gas extraction system adjacent to the Bank Avenue dump site. During the course of the digging of a trench along the property line between the residences and the former city dump, Ohio EPA staff observed the presence of drummed waste all along the boundary between the residences and the former landfill. A concentration of drums set out in rows was unearthed immediately south of one of the residences along the cul-de-sac at the west end of Bank Avenue (Ohio EPA staff, personal communication, 2011). As a result of concerns regarding the presence of these wastes proximal to occupied homes, the Ohio EPA agreed to conduct a more extensive investigation of these properties in 2011. Ohio EPA staff mobilized at the Bank Avenue Landfill

site in October 2011 and sampled sub-slab soil gas (or air in crawl spaces) at seven (7) homes along Bank Avenue. In addition, the Ohio EPA collected soil and groundwater samples from 23 soil borings on these same properties.

DISCUSSION

Exposure Pathways

In order for people to be exposed to elevated levels of chemical contaminants, they must first come into physical contact with the contaminated groundwater, soils, soil gas, or air. To come into contact with the contaminated media, there must be a completed exposure pathway. A completed exposure pathway consists of five main parts, all of which must be present for a chemical exposure to occur.

A **completed exposure pathway** consists of five main parts:

1. **A Source of Contamination** (a chemical release, landfills, and others);
2. **Environmental Transport** (the way chemicals move away from the source through air, water, soil, food chain);
3. **Point of Exposure** (a place where people come into physical contact with the chemical, e.g., soil, air, groundwater, surface water, sediment, food);
4. **Route of Exposure** (how people come into physical contact with the chemical, e.g., breathing, drinking, eating, touching); and
5. **A Population at Risk** (people likely to come into physical contact with site-related chemicals).

People could come in contact with contaminants by:

- Drinking water containing the chemical (ingestion),
- Skin contact (dermal), and
- Breathing air containing the chemical vapors (inhalation).

The existence of a completed pathway does not necessarily mean that a public health hazard existed in the past, exists currently, or is likely to exist in the future. Physical contact with a chemical contaminant does not necessarily result in adverse health effects. A chemical's ability to affect a resident's health is also controlled by a number of factors including:

- How much of the chemical a person is exposed to (dose).
- How long a person is exposed to the chemical (duration of exposure).
- How often a person is exposed to the chemical (frequency).
- The toxicity of the chemical of concern (how a chemical affects the body).

Other factors affecting a chemical's likelihood of causing adverse health effects upon contact include the resident's:

1. Past exposure to toxic chemicals (occupation, hobbies, etc.)
2. Smoking, drinking alcohol, or taking certain medications
3. Current health and nutritional status

4. Age and gender
5. Family medical history

Vapor Intrusion Pathway

Vapor intrusion is the movement of vapor-phase chemicals from underground soil and groundwater into the indoor air of homes and commercial buildings. Volatile organic compounds (VOCs) can vaporize from contaminated groundwater or soil and migrate as a gas through the soils to the indoor environment of nearby buildings. At the Bank Avenue Landfill site, gases are produced within the landfill and can move or migrate through pore spaces within the soils and waste materials. Gases that are lighter than air move upward through the landfill soil and waste toward the ground surface. If upward movement is inhibited by cover material, such as compacted clay soils or caps, the gases can migrate horizontally to other areas within the landfill or to areas outside the landfill. Explosive levels of methane gas were detected in subsurface soils underlying residential properties in close proximity to the St. Bernard landfill during the course of this investigation. Other landfill gases, including common byproducts of landfill waste decomposition, may also move through the soil underground and enter homes or utility corridors on or adjacent to the landfill. A number of volatile organic compounds, including benzene, chlorobenzene, and trichloroethylene have been identified in the landfill gas at the boundary of the former Bank Avenue Landfill. In 2009 and 2010, several of these same chemicals were found at low levels in the sub-slab soil gas under some Bank Avenue homes. Many of the chemicals of concern were either not detected or detected at very low levels in the sub-slab soil gas. None exceeded health-based action levels, although in a few cases sub-slab levels were close to the screening levels for either TCE or 1,2,4-trimethylbenzene. Chemicals detected in the sub-slab soil gas were also detected in the indoor air of one Bank Avenue home, indicating a potentially completed exposure pathway; however, the concentrations were below health-based screening values for both sub-slab soil gas and the indoor air (HAS 2010).

Groundwater Pathway

Groundwater is the water that occurs below the surface of the earth in pore-spaces in rock layers and soil deposits. Groundwater supplies water to wells and springs and is a substantial source of water used in the United States. About thirty percent of the Ohio population drinks water from a community water system that uses groundwater. Groundwater detected at depths of 16 to 22 feet below the ground surface at some locations at the Bank Avenue Landfill site showed low levels of volatile organic compounds at or below federal drinking water standards. However, no one is currently using this water as a source of drinking water.

Soil Pathway

Semi-volatile organic compounds including polycyclic aromatic compounds (PAHs) were found on some properties at 2 to 8 feet below the ground surface. People are unlikely to contact these chemicals directly and these types of chemicals are unlikely to migrate as vapors into nearby residences.

Evaluation of Ohio EPA Sampling Results

Sub-slab and Crawl Space Sampling

The sub-slab soil gas and/or crawl space indoor air of seven homes on Bank Avenue were sampled by the Ohio EPA on October 6, 2011 (Figure 2). In general, non-methane VOCs were not detected or found at very low levels. The table below indicates the comparison values used by ODH as screening levels during the public health assessment process. These values are concentrations of a substance that are unlikely to cause harmful (adverse) health effects in exposed people. Most of screening values were taken from the U.S. EPA OSWER 2002 Vapor Intrusion Guidance at a 10^{-4} risk. Benzene and toluene levels were derived from ATSDR's more conservative chronic-duration (more than 1 year) inhalation minimal risk levels (MRLs) for these chemicals. MRLs are estimates of daily human exposure to a hazardous substance that are not expected to cause harmful (adverse) health effects (excluding cancer) over a specified period of time. Screening levels for tetrachloroethylene and vinyl chloride were taken from the U.S. EPA Regional Screening Level (RSL) Summary Table (November 2011) and adjusted to a 10^{-4} cancer risk. A factor of 10 was applied to the indoor air values to obtain the sub-slab soil gas values. HAS used a screening level of 0.4 ppb for trichloroethylene (TCE) for evaluating residential indoor air at vapor intrusion sites, including the Bank Avenue Landfill site. This comparison value is the same as the recent (2011) U.S. EPA Reference Concentration (RfC) of 0.4 ppb. This concentration was multiplied by a factor of 10 to obtain the sub-slab screening level of 4 ppb.

There were no site-related VOCs detected in the sub-slab soil gas at levels of potential health concern at the Bank Avenue Landfill site. Most of the chemicals of concern were either not detected or below levels of health concern, except for chloroform under the laundry room in one of the seven homes sampled. Chloroform was not previously detected in sub-slab soil gas in 2009 or 2010, was not detected in on-site landfill gas, and is not likely to be site-related. Its presence may be attributed to the use of laundry bleach in the laundry areas as it is a common disinfection byproduct. A background sample and other samples have detections of acetone and methylene chloride; however, these are most likely laboratory artifacts as these chemicals are commonly used in the laboratory to clean glassware. There are low levels of the chlorinated VOCs TCE and PCE in sub-slab soil gas under three of the homes: TCE at 0.74 – 2.2 ppb (Screening Value = 4.0 ppb), and PCE at 4.0 – 4.6 ppb (Screening Value = 60 ppb). These results compare well with results obtained in previous sub-slab sampling by the U.S. EPA (Dec 2009; Feb 2010) and the City of St. Bernard (Aug, July, Nov 2010, Jan 2011). TCE levels have been detected in one of the houses tested by all three agencies, with detections occurring right below the sub-slab screening value in three (3) of the seven (7) samples collected and right at the screening value for TCE (4.0 ppb) in the January 2011 sampling. There is currently no evidence of a non-methane vapor intrusion hazard associated with these properties.

Table 1. Chemicals Detected in Sub-slab Soil Gas of Five Bank Avenue Homes in October 2011

Chemical of Concern	*Range of Detections (ppb)*	*Frequency of Detections*	*# Above Screening Value*	*Sub-slab Screening Value (ppb)*	*Type/Criteria*
2-Butanone (MEK)	ND – 5.2	2/10	0	3,400	OSWER/NC
Benzene	ND	0/10	0	30	ATSDR/NC x 10
Chlorobenzene	ND – 1.1	1/10	0	130	OSWER/NC
Chloroform	ND – 110	3/10	1	22	OSWER/C 10^{-4}
Cis-1,2-Dichloroethylene	ND	0/10	0	88	OSWER/NC
Hexane	ND – 1.8	1/10	0	570	OSWER/NC
Tetrachloroethylene (PCE)	ND – 4.6	4/10	0	60	EPA RSL 10^{-4}
Toluene	ND – 8.0	8/10	0	800	ATSDR/NC x 10
Trichloroethylene (TCE)	ND – 2.2	5/10	0	4	EPA RfC x 10
1,2,4-Trimethylbenzene	ND	0/10	0	12	OSWER/NC
1,3,5-Trimethylbenzene	ND	0/10	0	12	OSWER/NC
Vinyl chloride	ND	0/10	0	60	EPA RSL 10^{-4}

Source: Ohio EPA 2011

ppb = parts per billion
CV = Comparison Value
C = cancer
NC = noncancer
ND = Not Detected
10^{-4} = cancer risk of 1 in 10,000

Table 2. Chemicals Detected in Indoor Air in Crawl Spaces of Two Bank Avenue Homes in October 2011

Chemical of Concern	*Range of Detections (ppb)*	*Frequency of Detections*	*# Above Screening Value*	*Indoor Air Screening Value (ppb)*	*Type/Criteria*
2-Butanone (MEK)	ND	0/2	0	340	OSWER/NC
Benzene	ND	0/2	0	3	ATSDR/NC
Chlorobenzene	ND	0/2	0	13	OSWER/NC
Chloroform	ND	0/2	0	2.2	OSWER/C 10^{-4}
Cis-1,2-Dichloroethylene	ND	0/2	0	8.8	OSWER/NC
Hexane	ND	0/2	0	57	OSWER/NC
Tetrachloroethylene (PCE)	ND	0/2	0	6	EPA RSL 10^{-4}
Toluene	ND – 2.3	1/2	0	80	ATSDR/NC
Trichloroethylene (TCE)	ND	0/2	0	0.4	EPA RfC
1,2,4-Trimethylbenzene	ND	0/2	0	1.2	OSWER/NC
1,3,5-Trimethylbenzene	ND	0/2	0	1.2	OSWER/NC
Vinyl chloride	ND	0/2	0	6.0	EPA RSL 10^{-4}

Source: Ohio EPA 2011

ppb = parts per billion
CV = Comparison Value
C = cancer
NC = noncancer
ND = Not Detected
10^{-4} = cancer risk of 1 in 10,000

Soil Borings under Residential Properties

Man-made fill, chiefly construction and demolition debris (C & D), crushed drums, and other types of solid waste (cinders, foundry sand, brick, concrete, asphalt, wood, glass, and shingles) were found in the upper 8 feet of soil under residential properties on Bank Avenue. A number of discolored soil zones, mostly at 4-8 feet bgs, were also detected in these borings. These soil zones often correlated with increased levels of organic chemical compounds as detected by field chemical sensing devices. The Ohio EPA collected soil samples at various depths for further analysis when areas of suspected contamination were encountered.

West end properties adjacent to the cul-de-sac had elevated VOCs detected in the 4-8-foot bgs interval: 1,4-dichlorobenzene at 53.4 parts per million (ppm); 1,2,4-trichlorobenzene at 352 ppm; 1,2,3-trichlorobenzene at 40.2 ppm; and the semi-volatile organic compound naphthalene at 80.8 ppm (Figure 3). Although elevated, none of these compounds exceeded ATSDR health-based soil comparison values. None of these VOCs detected in the sub-surface soils were detected in the sub-slab soil gas samples collected under the homes on the same properties.

Elevated levels of semi-volatile polycyclic aromatic hydrocarbons (PAHs) were detected in sub-surface soil samples in east end properties – also from the 4-8-foot bgs interval (See Figure 4).

Levels individually and collectively exceeded ATSDR health-based soil standards but as these compounds were detected 4-8 feet bgs, there is no completed exposure route. People are unlikely to come into direct contact these chemicals as they are buried at depth beneath the ground surface. In addition, low permeability sandy clay soils appear to make up the upper 2 feet of soils underlying most of the homes on Bank Avenue (Ohio EPA well logs). The presence of such a clay-rich layer may reduce the likelihood of the migration of vapor-phase contaminants into nearby residences. PAHs in the soil are not volatile but largely fix to the soil particles and do not move. They slowly break-down in the soil with time to other less toxic organic compounds.

Perched Off-Site Groundwater

In October 2011, the Ohio EPA collected groundwater samples from residences' yards at the Bank Avenue Landfill site at depths of 16 to 22 feet below the ground surface. Low levels of volatile organic compounds, including trace levels of chlorinated VOCs TCE at 2.15 ppb and its break-down products cis-1,2-dichloroethene at levels up to 16.5 ppb and vinyl chloride at levels up to 2 ppb were detected in perched groundwater samples collected 16-22 feet bgs from under some of the east end properties. Benzene, toluene and chlorinated VOCs were also detected at very low levels (< 1.0 ppb, except for chlorobenzene at 30.6 ppb) from perched groundwater samples collected from the same depths under west end properties. No one is currently using this water as a drinking water source. VOC levels detected in the off-site groundwater do not appear to be concentrated enough to serve as a source of vapor phase VOCs.

Public Health Implications

Methane

Methane is a colorless, odorless, tasteless gas. It occurs in nature as natural gas and from coal gas and the decay of vegetation and other organic matter. It can be a significant fire and explosion hazard, forming explosive mixtures with air. Methane is explosive between its lower explosive limit (LEL) of 5 percent by volume in air and its upper explosive limit (UEL) of 15 percent by volume in air. At these levels, there is a proper ratio of methane to oxygen in air to allow for combustion to occur and an explosion hazard to exist if an ignition source is present in a confined indoor space. Typically, methane is detected using a combustible gas meter having a scale with readings from 0 - 100 percent of the LEL, where a reading of 100 percent corresponds to the lower explosive limit.

Review of the soil boring logs provided by Ohio EPA to HAS staff indicated that Ohio EPA field crews detected elevated methane levels at depth in many of the soil borings drilled into Bank Avenue properties in October 2011. Samples from soil boreholes (ranging in depth from 4 - 20 feet) detected methane at or above the LEL in five locations (See Table 3). Methane was detected at 100% of the LEL for methane at the seven (7) foot level in boring SB-12 and 40% of the LEL was detected at the 4-8 foot level in boring SB-14, both at the west end of Bank Avenue near the cul-de-sac (Figure 5). These boring sites are within 20 to 40 feet of an occupied residence. Methane readings in excess of 100% of the LEL were detected in boreholes of boring sites SB-8, SB-17, SB-20, and SB-21 (Figures 5 & 6). These boreholes are likewise proximal to residences. The elevated methane levels in these off-site residential properties indicate that the

off-site migration of methane from the dump to residences or the generation of methane derived from waste in soils under these properties remains a significant public health concern in spite of recent efforts to mitigate methane gas levels at the property line between these homes and the dump. All of the homes that abut the landfill are currently equipped with methane alarms.

Ohio EPA also tested for combustible gas with an instrument calibrated for methane at the sub-slab ports in the homes before conducting VOC sampling and did not detect methane in the sub-slab soil gas under the homes. Methane was not detected in any sub-slab, crawl space or indoor air monitoring. On a morning when one of the combustible gas alarms went off in a home and the fire department was onsite, methane was not detected indoors (C. Mellon, personal communication, Dec 2011). Although methane does not currently pose a hazard in the homes, concerns about future health threats exist due to the close proximity of the residences to explosive levels of methane discovered underground on the residents' properties.

Table 3. Methane Readings in Soil Boreholes

Chemical of Concern	*Range of Detections (% LEL)*	*Frequency of Detections*	*Depth Range (feet)*	*# At or Above the LEL*
Methane	0 – 100+	12/23	4-20	5/23

Source: Ohio EPA 2011

Volatile Organic Compounds (VOCs)

The screening values developed for this site are based on a hypothetical exposure scenario that assumes a long-term exposure of an individual, e.g., for 24 hours a day, 350 days per year for 30 years. Based on Ohio EPA's sampling results, measurements of non-methane VOCs under people's homes did not exceed sub-slab screening values except for chloroform under the laundry area at one home, which is most likely a byproduct of chlorine disinfection (see Table 1). Sub-slab sampling performed by the U.S. EPA in 2009 and 2010 also showed either no detects for VOCs or concentrations below screening values (HAS 2010). VOCs were not detected in the indoor air samples collected from Bank Avenue crawl spaces, except for a trace of toluene in one home (see Table 2). Although trace amounts of VOCs were found in the groundwater 16-18 feet below the ground surface, this groundwater is not a source of drinking water and unlikely to be a source for vapor intrusion.

Semi-Volatile Organic Compounds

Chemicals detected in residential soils at depth include PAHs, which are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat (ATSDR 1995). Urban soils usually contain measurable amounts of PAHs, primarily from airborne fallout from car and truck exhaust, residential burning of wood, and industrial sources. Documented levels of PAHs in soil near oil refineries have been as high as 200 parts per million (ppm). Levels in soil samples obtained near cities and areas with heavy traffic were typically less than 2 ppm (ATSDR 2009, IARC 1973). PAHs have a low degree of acute toxicity to humans. The carcinogenicity of certain PAHs is well established in laboratory animals. Researchers have reported increased

incidences of skin, lung, bladder, liver, and stomach cancers, as well as injection-site sarcomas, in exposed lab animals. Increased incidence of lung, skin, and bladder cancer have been associated with occupational exposures to PAHs in humans (ATSDR 2009). Benzo(a)pyrene is classified by the International Agency for Research on Cancer (IARC) as carcinogenic to humans (IARC 2010).

A maximum detected concentration of benzo(a)pyrene (37.4 ppm) in soil was found at one Bank Avenue location (Figure 4). At least sixteen other PAHs, such as benzo(a)anthracene (39.4 ppm), were found in this same soil sample, which was collected at a depth of 4 to 8 feet. The ATSDR cancer risk evaluation guide (CREG) for benzo(a)pyrene is 0.1 ppm. Although the levels of benzo(a)pyrene and other PAHs are elevated at depth in two lots, contaminant levels in the top 3 inches of soil are of most concern because this is where exposure is likely to occur. Subsurface soils from 1 to 2 feet may also serve as an exposure point for some residents under some conditions, such as gardening or landscaping. However, it is unlikely that contact with the subsurface soil will occur at depths of greater than 2 feet except for those individuals involved in excavation.

Community Concerns

On December 10, 2009, U.S. EPA held a meeting with seven impacted residents along Bank Avenue in St. Bernard, Ohio, and included HAS staff. Discussions included the explosive levels of methane at the site boundary and the presence of non-methane VOCs, including known and probable human carcinogens, such as benzene and trichloroethylene, in soil gas in the landfill. ODH HAS discussed the chemicals of concern and their potential to impact the residents' health. The meeting facilitated U.S EPA's efforts to obtain access agreements which would allow them to collect soil gas, sub-slab soil gas, and indoor air samples from these properties. On March 30, 2010 another meeting was held with the impacted residents whose homes were sampled by the U.S. EPA to discuss the results of the U.S. EPA sampling. The U.S. EPA and HAS indicated that based on sampling, there was no public health threat posed by the soil gas migration from the Bank Avenue Landfill at the current time. At a public meeting on December 20, 2011, representatives from ODH and Ohio EPA presented sampling results from the Bank Avenue area of St. Bernard. HAS gave a summary of the conclusions in this heath consultation, based on the Ohio EPA's October 2011 environmental sampling results. HAS addressed questions from residents and their attorneys regarding their properties and Ohio EPA's findings.

Child Health Issues

Children can be at a greater risk of developing illness due to exposure to hazardous chemicals because of their smaller stature and developing body systems. Children are likely to breathe more air and consume more food and water per body weight than are adults. Children are also likely to have more opportunity to come into contact with environmental pollutants due to being closer to the ground surface and taking part in activities on the ground such as, crawling, sitting, and lying down on the ground.

CONCLUSIONS

1. The levels of non-methane volatile organic compounds (VOCs) detected in and under Bank Avenue homes sampled by the Ohio EPA are not likely to harm people's health at the current time. The reason for this is that VOCs were either not detected or detected below levels of health concern. Consistent with previous sub-slab soil gas sampling collected from under homes along Bank Avenue adjacent to the old dump site, no site-related, non-methane VOCs were detected at levels of potential health concern. There is currently no evidence of a vapor intrusion hazard at this site.

2. HAS concludes that volatile and semi-volatile organic compounds detected in soil and groundwater at Bank Avenue properties will likely not harm people's health. The reason for this is that people are not being exposed to the chemicals at the depths below the ground surface where these chemicals were found. Elevated levels of some VOCs and a number of semi-volatile PAH compounds were detected in soils 4-8 feet bgs under residences along the south side of Bank Avenue adjacent to the former dump site. Although the levels detected exceeded health-based standards for some of these chemicals, as this contamination is buried 4-8 ft bgs, there currently is no completed exposure pathway connecting residents with these compounds. Soil borings from these residential properties did detect the presence of man-made wastes, including construction and demolition debris, cinders, crushed drummed waste and other types of solid waste in the upper 8-10 feet of soil under these properties.

3. Elevated methane levels at or exceeding 100% of the lower explosive limit (LEL) for methane (= 5% methane by volume) detected in soil borings from residential properties pose a continuing potential physical hazard to residents living adjacent to the landfill. Methane was not detected in sub-slab soil gas under the homes or in indoor air within the homes by the Ohio EPA. However, a future health threat may exist due to the close proximity of the residences to explosive levels of methane discovered underground in soils on the residents' properties.

RECOMMENDATIONS

1. Conduct additional sub-slab sampling of area homes focusing on levels of TCE, dichlorobenzene, trichlorobenzene, chloroform, and methane in this sub-slab soil gas.

2. Continue to seek solutions that will reduce or eliminate methane levels under the residential properties.

3. Regularly inspect and maintain combustible gas alarm systems in homes adjacent to the landfill.

PUBLIC HEALTH ACTION PLAN

1. HAS will review additional data for the Bank Avenue Landfill Site as needed.

PREPARERS OF THE REPORT

Health Assessment Section
John Kollman, Environmental Specialist
Robert C. Frey, Chief

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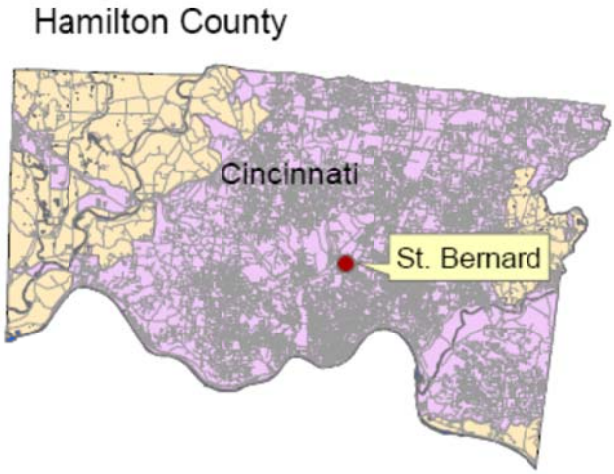
Figure 1. Bank Avenue Landfill Site Location Map

Residential area in St. Bernard, Ohio (aerial view).



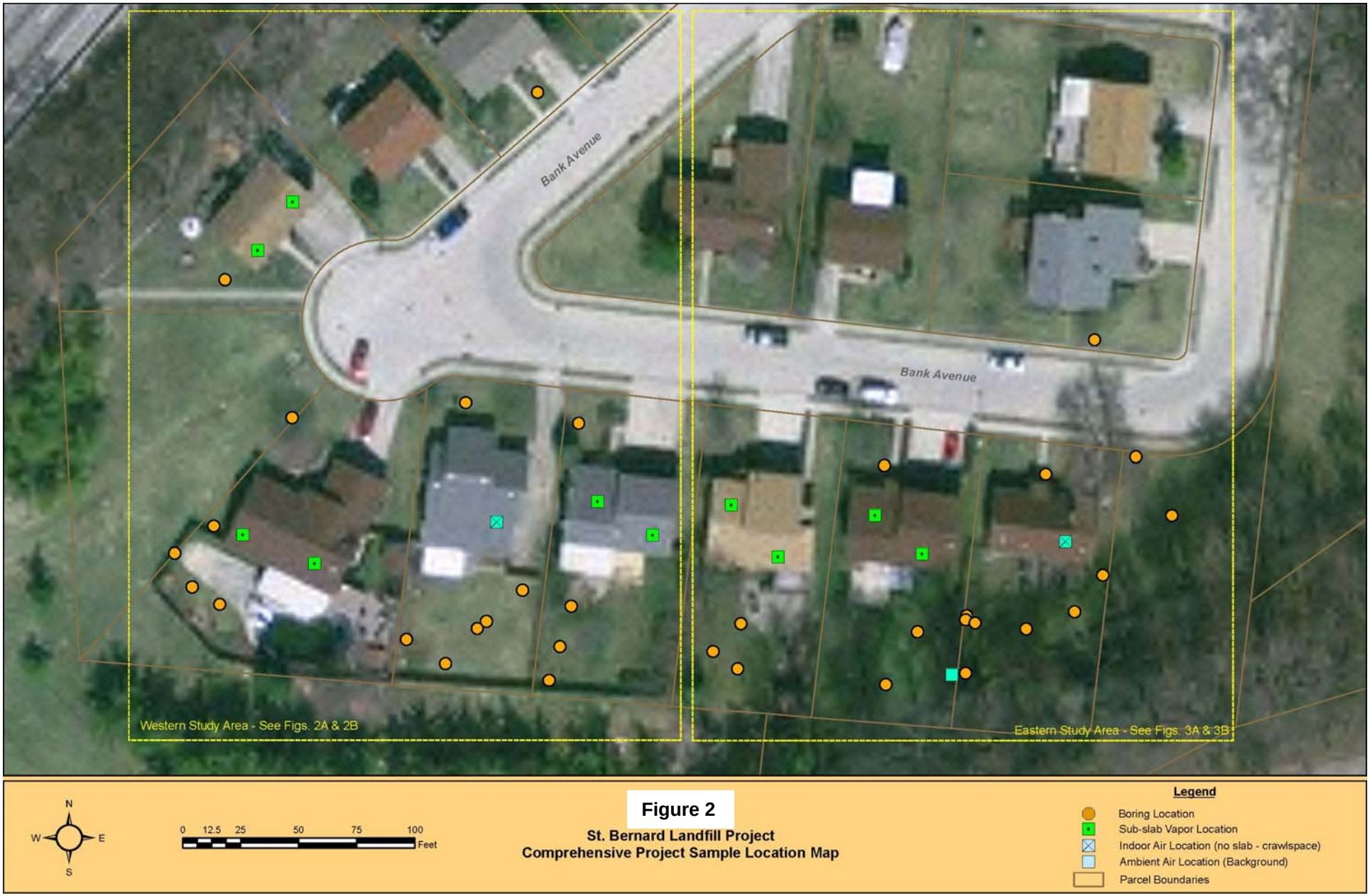


Figure 2

St. Bernard Landfill Project
Comprehensive Project Sample Location Map

Source: Ohio EPA 2011

Figure 3
St. Bernard Landfill Project
Western Portion of Study Area
Soil Boring Sample Results

Source: Ohio EPA 2011

Figure 4

St. Bernard Landfill Project
Eastern Portion of Study Area
Soil Boring Sample Results

N
W E
S

0 10 20 40 60 80 Feet

Legend

Soil Sample Location

SB Soil Boring

Source: Ohio EPA 2011

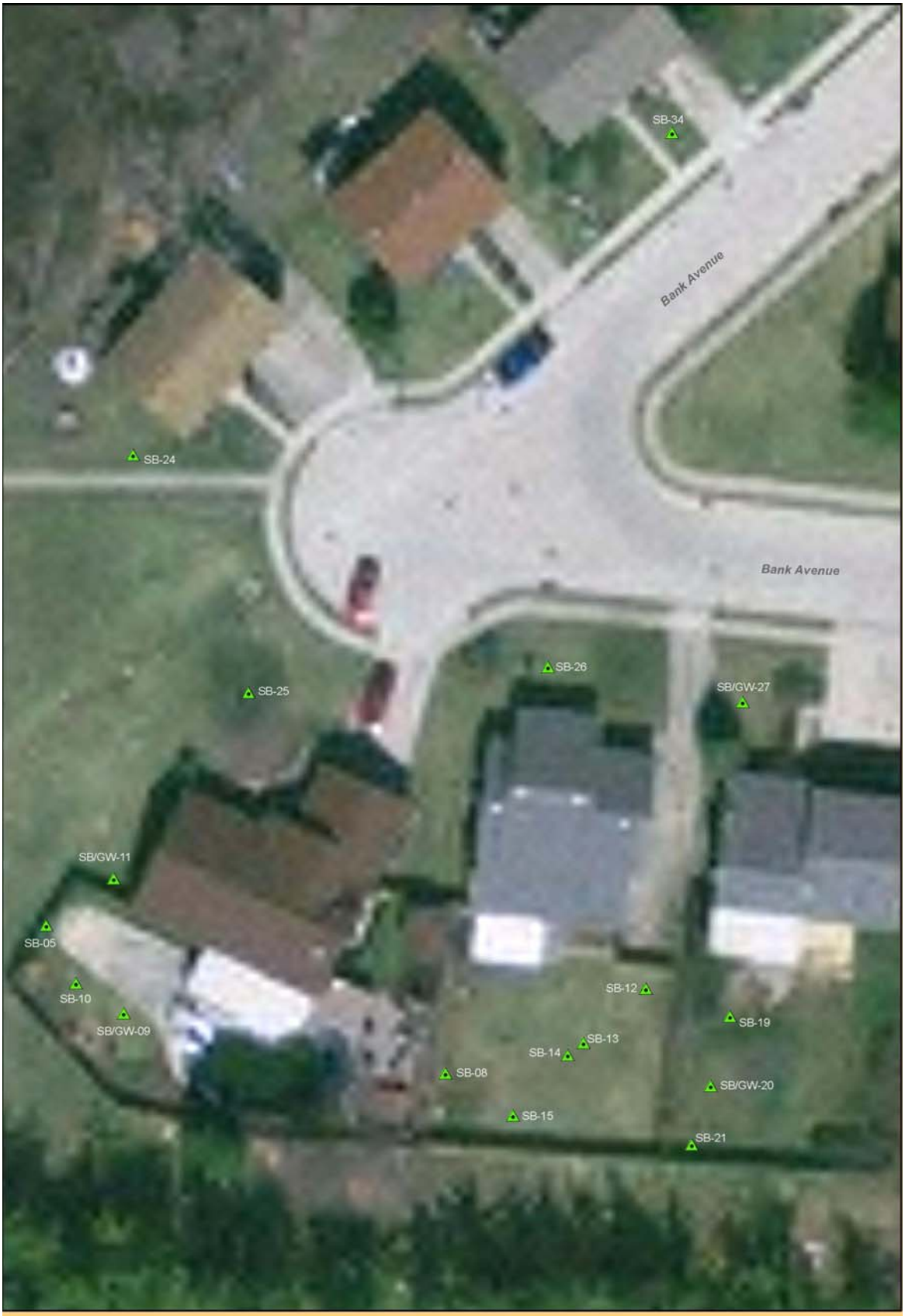


Figure 5
St. Bernard Landfill Project
Comprehensive Boring Location Map
Western Portion of Study Area

N W E S

0 10 20 40 60 80 Feet

Legend
Soil Boring Location
SB Soil Boring
GW Groundwater Sample

Source: Ohio EPA 2011

Figure 6
St. Bernard Landfill Project
Comprehensive Boring Location Map
Eastern Portion of Study Area

Source: Ohio EPA 2011

Bureau of Environmental Health
Health Assessment Section

"To protect and improve the health of all Ohioans"

Landfill Gas

Answers to Frequently Asked Health Questions

Municipal Solid Waste Landfills (MSWLF):

Private homes, business and industry all produce waste. The wastes we create are regulated as either hazardous waste or solid waste. It is the non-hazardous solid wastes that are often sent to a municipal solid waste landfill (MSWLF). Commonly called trash or garbage, the non-hazardous waste accepted at MSWLF include items such as paper products, food items, plastics, metals, glass and household items such as old furniture, appliances and household hazardous wastes. **Note:** For a listing of the common household hazardous wastes that can be taken to your local household hazardous waste collection events, visit the Ohio EPA household hazardous waste web site at: www.epa.ohio.gov/dhwm/recycpro.aspx

Ohio Environmental Protection Agency (OEPA) regulations require Ohio landfills to be designed and operated to prevent contamination from moving into the environment. The landfill design and operation system include a liner and a leachate (landfill water) collection systems. Landfills also monitor for methane gas and have gas collection systems.

What are landfill gases?

Landfill gases are colorless vapors that are produced at solid waste landfills and other waste disposal sites where trash and garbage are buried in the ground and covered with dirt. Over time, the bacteria in the soils will break down (decompose) the organic wastes in the landfill. The by-product of these bacteria breaking down the garbage will produce gases, just as humans produce carbon dioxide gas when we breathe out the oxygen we take in. Volatile organic compound (VOC) gases can also be produced in a landfill when common household chemical products vaporize (turn from a solid or liquid into a gas).

The amount and type of gases created by a landfill depends on the amount of garbage buried in the landfill, the type of garbage buried, the age of the landfill, the size and depth of the landfill and the chemical environment within the landfill.

The gases created in a landfill will try to move through the landfill to reach the surface air. Once in the outdoor air, landfill gases will mix with the air and be carried by the surface winds. Wind speed, wind direction and barometric pressure can affect whether residents will come in contact with these landfill gasses. Because wind speed and wind direction change, the degree of the exposure to odors will be different from day to day. At locations near a landfill, landfill gases tend to be most noticeable in the early morning, when winds tend to be most gentle, providing the least mixing of air and dilution of the gas. Landfill gas production tends to be highest when the weather is hot and dry; it decreases with cooling temperatures or frequent rainfall.

Characteristics of landfill gases:

- Landfill gases try to move from higher pressure areas (areas deep within the landfill) to lower pressure areas (areas such as ground surface and off-site areas)
- Landfill gases easily move through loose sand or gravel soils and will be released to the air through any cracks it can find
- Landfill gases will take the path of least resistance, often following buried utility lines (water, electrical, or gas lines)
- At older, unlined landfills, the landfill cover (cap) will often cause gas to move out sideways under ground from the landfill. **Note:** A landfill cover or cap is usually made of clay or some other rainproof (impermeable) material
- Gases will usually move away from the decaying garbage, but it is difficult to predict the specific directions the gas will follow

What kinds of gases are found in a MSWLF?

Landfill gases are typically made up of hundreds of different types of gases. The main gases produced by a MSWLF are usually methane at 40-65% and carbon dioxide (CO_2) at 40-60%. CO_2 and methane are colorless and odorless gasses. Methane, at certain levels, can be flammable or even explosive and can pose a physical hazard. Since methane is lighter than air, it can pose a physical hazard if trapped in confined spaces of buildings, such as basements and crawl spaces

Other landfill gases are produced by bacteria breaking down organic material and are called reduced sulfur gases or sulfides (examples: hydrogen sulfide (H_2S), dimethyl sulfide and mercaptans). These gases *do* have odors and they give the landfill that familiar "rotting" smell. But hydrogen sulfide (H_2S) and non-methane VOCs make up a much smaller proportion of the landfill gas at less than 1%.

- **Methane** **40-65%**
- **Carbon dioxide (CO_2)** **40-60%**
- **Hydrogen sulfide (H_2S) and non-methane VOCs** **<1%**

How can we detect landfill gas?

Landfill gases are mostly invisible, but they can be detected in the environment by:

- ***Odors:*** Landfill gases commonly contain hydrogen sulfide (H_2S) gas which produces a foul, rotten egg odor. This H_2S odor can be detected at very low levels, levels much lower than those at which this chemical can cause toxic health problems. In contrast, potentially harmful VOCs have a distinctive, sweet, ether-like smell, but you cannot usually smell them in landfill gases because they are present at such low concentrations.
- ***Stressed or dead vegetation:*** Landfill gases will reduce the amount of oxygen in the soils. The lack of oxygen affects deep root growth and often results in the death of deep-rooted plants, especially trees. Soils with high levels of landfill gases will not grow vegetation or the vegetation will be stunted and limited to shallow-rooted plants.
- ***Landfill gas-monitoring probes:*** Landfill gas probes are narrow, hollow tubes inserted in the ground. There are holes in the sides of these tubes that allow gas vapors to flow into the tube. The tubes are then sealed to trap the gas. These sample results can show the type and amount of gas and whether it is at a level that can create a public health threat.

How can landfill gases affect my health and safety?

Under the right set of environmental conditions, landfill gas can be a potential health hazard to residents living close to a landfill. However, a person must be exposed to specific concentrations of chemicals and over a specific period of time before health effects can occur. The two types of health hazards include:

- ***Physical Hazard:*** The methane gas that typically makes up 40-65% of landfill gas is not toxic, but it can ignite and cause an explosion under specific conditions. The specific conditions include the right combination of methane and oxygen, plus a source of ignition (spark-fire). Methane can be explosive at concentrations that range from 5-15% methane per volume of air. At concentrations below 5%, methane levels are too low to ignite. At concentrations above 15%, methane levels are too rich and oxygen levels are too low to combust.
- ***Toxic Chemical Hazard:*** H_2S and VOCs like benzene, perchloroethylene (PCE), trichloroethylene (TCE) and vinyl chloride can be toxic to people if they are inhaled at certain concentrations. If concentrations are high enough, breathing these gases can cause breathing difficulties, nausea (upset stomach), dizziness, headaches and central nervous system problems. Breathing these gases at high concentrations for extended periods of time (years) can cause the development of specific types of cancer and other serious health problems.

How can we reduce landfill gas hazards?

Under state law, landfill owners and operators must monitor (methane) gas levels at their property boundaries and take action to protect occupied structures, such as homes, that are located within 1,000 feet of landfill waste placement (OAC Rule 3745-27-12). Containment and abatement can reduce the possible health hazards due to the movement of landfill gases off-site into nearby properties. Containment simply means to contain the landfill gasses on-site and not allow them to move off-site. Abatement means to remove, subtract from or completely stop the production of landfill gasses.

- ***Containment:*** Ohio landfills are required to contain the landfill waste and gases through impermeable bottom liners and an engineered cap or cover.
- ***Abatement:*** Landfill gas is vented from the interior of the landfill to the outside. This reduces gas pressure within the landfill and limits the ability of the gas to move off-site. Gas abatement can be done passively or actively, through:
  - Simple vents installed at points around the landfill, or
  - A pipe system that pumps the gas from the landfill to a central collection area.
  - The collected gasses can be simply released to the air, burned off in a flare, or collected to be used as a fuel resource (natural gas).

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For information on Ohio landfills:

Ohio Environmental Protection Agency web site at: www.epa.ohio.gov/dsiwm

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