# Letter Health Consultation

Eastwick Community Indoor Air Evaluation

LDCA SITE CLEARVIEW LANDFILL
(LOWER DARBY CREEK AREA SUPERFUND SITE)

PHILADELPHIA, DELAWARE AND PHILADELPHIA COUNTIES, PENNSYLVANIA

**Prepared by**
**Pennsylvania Department of Health**

OCTOBER 1, 2012

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

## Health Consultation:  A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

You May Contact ATSDR TOLL FREE at
1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

LETTER HEALTH CONSULTATION

Eastwick Community Indoor Air Evaluation

LDCA SITE CLEARVIEW LANDFILL
(LOWER DARBY CREEK AREA SUPERFUND SITE)

PHILADELPHIA, DELAWARE AND PHILADELPHIA COUNTIES, PENNSYLVANIA

Prepared By

Pennsylvania Department of Health
Division of Environmental Health Epidemiology
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

To: Josh Barber, Remedial Project Manager, US Environmental Protection Agency (EPA) Region 3

From: Christine Lloyd, Pennsylvania Department of Health, Health Assessment Program, Division of Environmental Health Epidemiology

Subject: Indoor air vapor intrusion analysis for the Eastwick community and follow-up recommendations

In 2010 and 2011, the US Environmental Protection Agency (EPA) performed a vapor intrusion investigation to assess whether landfill gases, including volatile organic compounds (VOCs), from the Clearview Landfill (‘the site’) are impacting the nearby community. Vapor intrusion is the movement of gas vapors into indoor air of structures located over groundwater contamination. Indoor air, sub-slab soil gas, and outdoor ambient air samples were collected from homes and a recreational center located near the former Clearview Landfill. The Pennsylvania Department of Health (PADOH) reviewed the EPA sampling data, as part of the site remedial investigation/feasibility study (RI/FS) and prepared this letter health consultation (LHC). PADOH evaluated whether VOCs detected in the indoor air pose a public health threat to area residents and visitors. The purpose of this LHC is to summarize PADOH’s evaluation and to provide relevant public health conclusions and recommendations.

The Clearview Landfill, Lower Darby Creek Area Superfund site is located in Delaware County on the Philadelphia County border. The Eastwick neighbourhood and the Eastwick Recreational City Park (the city park) are located in Philadelphia County, adjacent to the Clearview Landfill. Some of the Eastwick homes and the Eastwick Recreational City Park are located within the historic landfill footprint (former landfill areas). The recreational center (in the city park) is also located in the historical landfill footprint and the center is used by children and adults (Figure 1).

PADOH concludes the levels of the VOCs detected in the indoor air of the Eastwick homes and the recreational center were low and exposures to VOCs in the indoor air are not expected to harm people’s health. The RI/FS determined that groundwater in the Eastwick neighborhood contained few, if any, VOCs**.** Based on the levels of VOCs detected in the indoor air of the homes and calculated estimated exposure doses, the levels were not high enough to cause adverse non-cancerous health effects to residents or occupants. Theoretical cancer risk, based on the indoor air levels and exposure doses, were low. However, past exposures are unknown because the indoor air was not sampled in the past. The air results evaluated in this LHC and EPA’s subsurface vapor intrusion model showed a lack of significant vapor intrusion. It does not appear that gases are accumulating underneath the homes or recreational center.

PADOH recommends EPA continue its efforts to clean up the site while taking the appropriate measures to ensure there is no spread of contamination to those areas where people live and could be affected. EPA is collecting additional groundwater data in 2012 in and around the landfill. If the RI of the groundwater determines the extent of the contamination is present in areas where it could present a current potential exposure risk or at levels that are increasing beyond what is currently understood, EPA should take actions to ensure the community is not and will not be impacted. Actions may include additional sampling for vapor intrusion of the surrounding Eastwick neighborhood. PADOH will consider reviewing additional sampling data, if requested by EPA.

PADOH worked under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR and PADOH's top priority is to ensure residents living near the former Clearview Landfill have the best information to safeguard their health. More information about ATSDR is available online at www.atsdr.cdc.gov. For questions or concerns about the Clearview site, please contact the Pennsylvania Department of Health, Division of Environmental Health Epidemiology at (717) 787-3350.

## Background and Statement of Issues

The Clearview Landfill is one of two landfills that make up the Lower Darby Creek Area Superfund site. The Clearview Landfill (the Landfill) is located along the eastern bank of Darby and Cobbs Creeks, at 83rd Street and Buist Avenue. It was an unpermitted Philadelphia municipal waste landfill that operated between the late l950s and early 1970s. A 1953 aerial photograph showed a 3.3-acre area with debris and earthen mounds north and south of an access road leading into the landfill from Buist Avenue. It also showed that the landfill was situated on and surrounded by wetlands, and several small unnamed streams were present north and west of the landfill. In addition, junked vehicles, debris, and dark-toned material were visible east of the landfill along Buist Avenue. The 1965 aerial photograph indicated that Clearview Landfill had significantly expanded and covered approximately 55.5 acres with substantial filling activities in the northern and eastern portions of the landfill. The former wetlands and streams have been filled, altering their courses to flow along the eastern border of the landfill, south to Darby Creek. As depicted in an aerial photograph taken in 1973 when Clearview Landfill was closed, the landfill had expanded to the east and bordered Buist Avenue, and covered approximately 65 acres. The Landfill was officially closed in 1973; however, it has been used for other waste disposal operations since the closure [EPA, 2011a].

EPA has conducted multiple sampling events since 2001, at the site to identify the nature and extent of the contamination. Sampling included the Eastwick City Park and the Eastwick neighborhood right-of-ways, and the former Landfill. VOCs, and methane and other landfill-related gases have been detected in soil gas samples from the Clearview Landfill, the city park and the Eastwick Neighborhood. Detected methane gas concentrations were lower than those usually detected at active or recently closed landfills. The highest levels of VOCs were detected in the central and southern portions of the Landfill. VOC levels were comparatively lower in the city park and almost negligible in the Eastwick Neighborhood.

In 2011, EPA finalized a RI/FS for the site which included groundwater sampling. A groundwater mound (or high water table) exists under the landfill and produces radial groundwater flow away from the landfill. Regionally, groundwater flows southwest towards the Delaware River. Locally near the landfill, groundwater flows radially toward Darby and Cobbs Creeks, south below the southern industrial area, and east below the Eastwick neighborhood. EPA did not identify a VOC plume migrating from the landfill to the community. The RI/FS determined that groundwater in the Eastwick neighborhood contained few, if any, VOCs. During the RI/FS, EPA evaluated groundwater conductivity~~,~~ which is expected to represent approximate landfill leachate concentrations. It is expected that the generation of landfill leachate has reached a relatively steady state and EPA does not expect significant increases in groundwater or soil gas contamination. [EPA. 2011a]. EPA detected a plume of 1, 4-dioxane, but 1, 4-dioxane is not a compound that would present a vapor intrusion concern. EPA is collecting additional groundwater data in 2012 in and around the landfill [EPA, 2012a].

To evaluate the potential of vapor migration from the landfill towards the nearby community, EPA performed vapor intrusion/indoor air analysis modeling (by Johnson-Ettinger soil-gas to indoor air modeling) with available soil gas data from monitoring wells and soil borings installed in the Park (Figure 1) [EPA, 2011b]. Overall, VOC concentrations in soil gas were low and the modeling screening indoor analysis showed calculated indoor air VOCs level to be insignificant. The modeling results suggest that only two VOCs would be above their respective EPA screening numbers in the indoor air. It was also determined during the RI, that the majority of homes in the nearby community do not have basements. In 2010 and 2011, EPA conducted a screening assessment to further evaluate if landfill gases and/or VOCs are impacting nearby residents. The assessment consisted of screening indoor and outdoor ambient air with handheld air monitors and follow up sampling of the indoor and outdoor air [EPA, 2011a].

**<u>Vapor Intrusion Investigation</u>**

EPA's vapor intrusion assessment was conducted in two phases: Phase 1 included monitoring indoor and ambient air with handheld instruments to detect general landfill gases and VOCs. These instruments included a Photovac MicroFID (flame ionization detector) for methane screening; Rae Systems ppbRAE (photoionization detector) for total VOC screening; Landtec GEM 2000 Plus (landfill gas analyzer) for carbon dioxide, methane, oxygen, and lower explosion levels (LEL); and a Rae Systems MultiRAE Plus (multiple gas meters with photoionization detector) for measuring total VOCs, oxygen, LEL, hydrogen sulfide and carbon monoxide [EPA, 2011b] The parameters measured were methane, oxygen, carbon dioxide, general volatile organic compounds, and the flammable or explosive limits of combustible gases in air. Phase 1 was conducted to monitor air quality in two separate rounds: in May and June 2010 (Round 1), and December 2010 and February 2011 (Round 2). Phase 2 consisted of collecting sub-slab soil vapor, indoor and outdoor air samples from locations where migration of landfill gases was suspected.

Based on proximity to the former landfill and access granted by the homeowners, twenty-two locations were assessed during Round 1, including 21 homes and the recreation center. Sixteen locations and the recreation center were assessed during Round 2; the locations included the 13 homes that had been previously assessed during Round 1, as well as two new residences, based on proximity to the landfill and access [EPA, 2011b].

During their assessment, if gas vapors were detected and indicated that there was a potential for vapor intrusion into the homes, EPA then conducted Phase 2. The parameters measured, as part of the Phase 2 vapor intrusion evaluation were methane and VOCs (Table 1). During Phase 2, EPA collected air samples using specialized equipment (Summa canisters) over a 24-hour period. Samples were analyzed per EPA method TO-15. TO-15 is used to test for a specific set of VOCs (see the information online for details: http://www.epa.gov/ttnamti1/files/ambient/airtox/to-15r.pdf). EPA performed simultaneous testing of both the sub-slab (underneath the building floor) air and the indoor air (homes or recreational center) for about 24 hours. Phase 2 sampling was conducted at 10 locations, including 9 residences and the recreational center. Three samples were taken for the indoor air of the recreational center, but the number of samples taken in the homes varied [EPA, 2011b]. PADOH evaluated the 2010-2011 air data for this LHC.

PADOH determined that the pathway of exposure for the occupants of the homes and the recreational center is inhaling (breathing) air potentially contaminated with landfill gases and/or VOCs that may have migrated from the landfill by way of vapor intrusion into the indoor air. This is a potential pathway of exposure because of the identified contamination in the soil and groundwater. There may also be contributions of gas vapors from household products, cooking, and chlorinated drinking water.

PADOH assumed that the sampling results represented the normal indoor air levels (i.e., the results represent a snapshot in time corresponding to typical indoor contaminant concentrations). However, landfill gas may have a more exaggerated seasonal effect than other vapor intrusion because of seasonal changes that can affect factors driving pressure driven gas flow: temperature; moisture content and distribution ; rate and form of microbial activity, e.g. aerobic/anaerobic; hydraulic characteristics. Landfill gas production will tend to drop below 10–15ºC. This may result in a seasonal pattern of waste decomposition and gas production. [Scottish EPA, 2004] However, because buildings and homes are more tightly closed in the winter months this could represent a worst case scenario for vapor intrusion in homes [Interstate Technology Regulatory Council, 2007].

**Background indoor air concentrations**

A complicating factor in evaluating vapor intrusion sampling data is the potential presence of some of the same VOCs due to the wide use in household chemicals and other products, such as cigarette smoke, paint, building materials, wood stoves, scented candles, floor wax, perfumes, pesticides, off-gassing from new furniture, commonly emitted solvents (i.e. tetrachloroethylene (PCE)) and automotive exhaust from an attached garage. In some cases, these background contributions exceed health-based screening levels.

According to EPA's technical report on background levels of VOCs in indoor air, site-specific indoor air samples are likely to detect chemicals from other sources (Table 2). EPA compiled a technical report based on 15 indoor air studies conducted between 1990 and 2005. Indoor air concentrations were measured in residences that are not expected or known to be located over contaminated soil or groundwater or that have effective vapor intrusion mitigation systems in place. The VOCs most commonly detected in indoor air due to background sources include benzene, toluene, ethylbenzene, and xylenes (BTEX), along with chlorinated solvents, such as chloroform, carbon tetrachloride, PCE, 1,1,1-trichlorethane, and trichloroethylene. For example, benzene ranged from non-detect to 29 $\mu g/m^3$, with the $50^{th}$ percentile ranging from non-detect to 4.7 $\mu g/m^3$. In contrast, vinyl chloride, 1,1dichloroethylene, cis1,2 dichloroethylene, and 1,1-dichloroethane was rarely detected in background indoor air in the studies. [EPA, 2001] Table 3 provides a description of the sources of typical background VOC's in indoor air.

**Exposure Dose Calculations and Cancer Risk**

Exposure to volatile chemicals due to vapor intrusion does not necessarily mean that health effects will occur. The type and severity of health effects a person might experience due to contact with a contaminant depend on the exposure concentration (how much), the frequency and/or duration of exposure (how often and/or how long), the route(s) of exposure (breathing, eating, drinking, and/or skin contact), and the multiplicity of exposure (exposure to more than one contaminant). Once exposure occurs, characteristics such as age, sex, nutritional status, genetics, lifestyle, and health status of the individual influence how the contaminant is absorbed, distributed, metabolized, and excreted. Together, these factors and characteristics determine the health effects that may occur.

Since some chemicals exceeded comparison values for cancerous effects, PADOH calculated a theoretical cancer risk for residents and visitors to the recreational center. Cancer risk is based on an adjusted dose (from the exposure scenarios described below), chemical-specific EPA Inhalation Unit

Risk (IUR) and years of exposure. For residential exposures, PADOH calculated theoretical cancer risk for children 0 to 5 years, 6 years to 14 years, and adults. For the recreational center, a cancer risk for the most susceptible age group (6 to 8 years) was also calculated.

Further assumptions by PADOH for theoretical cancer calculations, regarding the residents in the homes, included: 1) a young child would be most vulnerable; 2) the estimated exposure factors for young children (0 to 5 years) was based on 24 hours per day, 7 days per week, and 50 weeks per year out of the total possible 24 hours per day, 7 days per week, and 52 weeks per year for 6 years; 3). the estimated exposure factor for children ages 6 years to 14 years and adults were based on 16 hours per days, 5 days per week over 50 weeks per year and on the weekends 24 hours per day, 2 days per week over 50 weeks (out of the total possible 24 hours per day, 7 days per week, and 52 weeks over 8 for children and 30 years for adults).

PADOH's assumptions regarding the occupants of the recreational center included: 1) a school age child (ages 6 to 8 years) would be most vulnerable; and 2) the estimated exposure would be in the summer for 8 hours per day, 5 days per week, 12 weeks per year and during the school year for 4 hours per day, 5 days per week, 40 weeks out of the total possible 24 hours per day, 7 days per week, and 52 weeks per year for 3 years.

EPA has identified certain chemicals that have a mutagenic mode of action (MOA) for carcinogenesis. Age-dependent adjustment factors (ADAFs) address the potential for differential potency associated with exposure during early life (less than 16 years of age) from chemicals with a mutagenic MOA. [EPA, 2005a] The only chemical at the site identified to have a mutagenic MOA is benzene and the following ADAFs were applied when calculating cancer risk for children:

- a 10-fold adjustment for ages 0 - <2 years;
- a 3-fold adjustment for ages 2 - <16 years;
- no adjustment for ages 16 years and older.

## Results and Discussion

PADOH reviewed the indoor air, outdoor air, and sub-slab sampling data for the residential homes and the recreational center. The following is a summary of PADOH's evaluation and conclusions of the data:

1) The maximum levels (in the residential homes) of three VOCs (benzene, chloroform, and PCE) were above their ATSDR CVs and were also detected at in the sub-slabs underneath the homes. (Table 4-5) Sampling data for indoor air were below ATSDR CVs for non-cancerous health effects, and therefore additional analysis of non-cancerous health effects is not needed. Three VOCs, including benzene, chloroform and PCE, exceed their ATSDR cancer risk evaluation guide (CREG). The VOCs are commonly found in household products, chlorinated drinking water, and outdoor air, as described in the Background Air Sources Section. Methane was not detected in the indoor air samples. Additional information used to assess these VOCs detected in the indoor air and sub-slab is as follows:

    a) Benzene was detected in the recreational center at levels above the CVs and was detected at similar levels in the sub-slab. Benzene is known to cause cancer in humans [ATSDR, 2007}.

The maximum levels of benzene detected in one of the homes and in the recreational center were 5.3 micrograms per cubic meter ($\mu g/m^3$) and 0.72 $\mu g/m^3$, respectively. The corresponding levels of benzene found in the sub-slab were 1.1 $\mu g/m^3$and 0.75 $\mu g/m^3$, for the home and recreational center, respectively. The maximum benzene ambient (outdoor) air level near the Eastwick homes was 1.5 $\mu g/m^3$. The levels of benzene also fall within the typical background concentrations for ambient air.

b) The maximum levels of chloroform detected in one home and in the recreational center were 1.7 $\mu g/m^3$ and 1.6 $\mu g/m^3$, respectively. Chloroform was not detected in these sub-slab samples. The average background level of chloroform that a person might be exposed to on a typical day by breathing air ranges from 0.16 to 0.42 $\mu g/m^3$in rural areas and 0.5 $\mu g/m^3$to 16.7 $\mu g/m^3$in urban areas. Chloroform is found in chlorinated water and consumer products such as air deodorizers and cleaning products. It is also found in some foods such as soft drinks, dairy products, and grains. Chloroform is a probable human carcinogen, based on animal data [ATSDR, 1997a].

c) The maximum level of PCE found in the indoor air of the homes was 2.8 $\mu g/m^3$ but was not detected in sub-slab samples of these homes. PCE was not detected in the indoor air of the recreational center. The levels were within average background levels of PCE in urban air of 5.33 $\mu g/m^3$ and rural air of 1.08 $\mu g/m^3$. PCE can be found in dry cleaner, water repellents, silicone lubricants, fabric finishers, spot removers, wood cleaners, insecticides, and adhesives. PCE is classified as a probable carcinogen, based on liver tumors in laboratory animals [ATSDR, 1997b]

2) Two VOCs were detected above ATSDR CREG CVs, but were not detected in the sub-slab underneath the homes. (Table 4) These included 1,3-butadiene and 1,2-dichloroethane. These VOCs cause cancer in test animals [EPA, 2005; ATSDR, 2009; ATSDR, 2001]. These VOCs are commonly found in indoor and outdoor air from household use [ATSDR, 2009; ATSDR, 2001]. The following is a summary of 1,3-butadiene and 1,2-dichloroethane results and information:

   a) The maximum level of 1,3-butadiene detected in one of the homes tested was 1.3 $\mu g/m^3$, but sub-slab levels were below CVs. 1,3-butadiene is used to make plastics, acrylics and synthetic rubber including for tires on cars and trucks. The average background amount of 1,3-butadiene in the air is between 0.88 $\mu g/m^3$ in rural settings and 2.2 $\mu g/m^3$ in urban air. [ATSDR, 2009]

   b) The maximum level of 1,2-dichloroethane detected was 1.2 $\mu g/m^3$ in the one of the homes tested, but sub-slab levels were below CVs. 1,2-dichloroethane has been detected in urban air at levels ranging from 0.049 to 1.0 $\mu g/m^3$. 1,2-dichloroethane is used to make a variety of plastics and vinyls, including polyvinylchloride (PVC) water pipes and household vinyl furnishings. [ATSDR, 2001]

3) A few VOC's were detected in the sub-slab samples at higher concentrations (above EPA's Region 3 RSL screening levels of soil gas) than levels in the indoor air. (Table 5). Given the overall vapor intrusion sampling data, it does not appear gases are accumulated beneath the homes or recreational center. The following is a summary of the data:

   a) Dichlorodifluoromethane (Freon 12), was found in the sub-slab samples underneath the recreational center (270 $\mu g/m^3$), but was detected at 4.8 $\mu g/m^3$ in the indoor air. ATSDR does not have a CV for Freon 12. This indoor air level would not represent a health hazard and would screen out using the EPA RSL of 100 $\mu g/m^3$ [EPA, 2011]. This VOC is not known to cause cancer and is sometimes detected near where refrigerators are or were [EPA, 2005b].

b) A residential sub-slab sample had levels of bromodichloromethane of 1.7µg/m$^3$ and was not detected in the indoor air samples of this home. ATSDR currently does not have a CV for bromodichloromethane. Applying EPA's attenuation factor (from the sub-slab results) would result in a hypothetical indoor air concentration of 0.17 µg/m$^3$ which exceeds EPA RSL of 0.066 µg/m$^3$. Bromodichloromethane is classified as a probable human carcinogen, based on data in animals. [ATSDR, 1989]. Using EPA's IUR of 3.75 x 10$^{-5}$ and an indoor air concentration of 0.17 µg/m$^3$ the theoretical cancer risk would be 6.4 x 10 $^{-6}$. EPA generally classifies this level of excess cancer risk as low. [EPAb]_Most bromodichloromethane is formed as a by-product when chlorine is added to water-supply systems.

c) Chloroform was detected in three residential homes, with a maximum sub-slab level of 15µg/m$^3$ and a corresponding indoor air concentration of 1.4 µg/m$^{3.}$ These levels are below the ATSDR MRL CV for chloroform of 100 µg/m$^3$ but exceed the ATSDR CREG CV of 0.04. Chloroform was included in a calculation of theoretical cancer risk, as described below.

d) PCE was found in one residential sub-slab samples at 8.7 µg/m$^3$ but was not detected in the indoor air samples of that home. If EPA's attenuation factor is applied, the air result for this VOC is 0.87 µg/m3 [EPA, 2011b]. These levels are below the ATSDR MRL CV for non-cancerous effects of 270 µg/m$^3$ and the ATSDR CREG CV of 3.8µg/m$^3$ used to screen for cancerous health effects.

e) A residential sub-slab sample showed levels of benzene at 7.8 µg/m$^3$ while indoor concentrations were at 2 µg/m$^3$. These levels of benzene are below the ATSDR MRL C V for non-cancerous effects of 10 µg/m$^3$ but exceed the ATSDR CREG CV of 0.1 µg/m$^3$. Benzene was also included in the calculation of theoretical cancer risk.

4) Two other VOCs , 1,2,4-trimethylbenzene (1,2,4-TMB) and 1,3,5-trimethylbenzene (1,3,5-TMB), were detected, but do not have ATSDR CVs. (Table 4) TMBs are mainly present as a gasoline additive in motor vehicle and aviation fuels and mixed hydrocarbon solvents. Other uses of TMB are mainly in the industrial setting and include solvent in coatings, cleaners, pesticides, pharmaceuticals and dyes, and printing and inks. [EPA, 1994] These VOCs were not detected in the sub-slab underneath the homes [EPA, 2011a]. The maximum concentration of 1,2,4-TMB and 1,3,5-TMB in the indoor air of the homes were 5.2 µg/m$^3$ and 1.6 µg/m$^3$, respectively. For non-cancerous health effects, EPA has a RSL of 7.3 µg/m$^3$ and a provisional Reference Concentration (RfC) for 1,2,4-TMB of 7 µg/m$^3$ [EPA, 2011; EPA, 2012b] EPA does not have an RfC or RSL for 1,3,5-TMB and therefore the 1,2,4-TMB provisional RfC and RSL values were used as surrogates to screen the 1,3,5-TMB levels. The maximum levels are below the RSL and RfC. Furthermore, these VOCs have not been classified as carcinogens [EPA, 2011].
5) PADOH calculated a**theoretical cancer risk**, based on likely exposure scenarios, in the residential homes and recreational center, as described in the Exposure Dose Calculations and Caner Risk Sections. (Table 6) For the calculation of cancer risk, PADOH included VOCs detected in indoor air above ATSDR CV's, are classified as a carcinogen or potential carcinogen, and have an EPA IUR value. These VOCs include benzene, chloroform, 1,3-butadiene, and 1,2-dichloroethane. The highest theoretical cumulative cancer risk applying EPA's MOA ADAF, was for residential children aged 0 to 5 years. PADOH used the maximum concentration, which represents the worst case scenario. The cancer risk was 4.3E-05, or an extra 4.3 excess cancer cases in 1000,000

exposed. EPA generally classifies excess cancer risks that range between 1E-06 to 1E-04 as acceptable or low. [EPAb]

6) EPA detected several VOCs at low levels in the outdoor air near the homes. These VOC levels were within normal background levels (Table 7).

In 2013, EPA plans to select a remedy for the landfill. Several options, including various cover systems are being evaluated by EPA as part of the Superfund process. EPA will present the various remedial alternatives that were evaluated to the public and recommend a preferred alternative prior to the selection of the final remedy. During the construction of the remedy, EPA will monitor the site to determine if landfill gas generation is occurring.

## Conclusions and Recommendations

**Overall, the levels of the VOCs detected in the indoor air of the Eastwick homes and the recreational center were low and exposures to VOCs in the indoor air are not expected to harm people's health. The air results evaluated in this LHC and EPA's subsurface vapor intrusion model showed a lack of significant vapor intrusion. However, past exposures are unknown because the indoor air was not sampled in the past.** Based on the levels of VOCs detected in the indoor air of the homes the levels were not high enough to cause adverse non-cancerous health effects, for the residents or occupants. Theoretical cancer risks for residents and occupants (both children and adults) were low. After reviewing the vapor intrusion sampling data, it does not appear that gases are accumulating underneath the homes or recreational center.

PADOH recommends EPA continue its efforts to clean up the site while taking the appropriate measures to ensure there is no spread of contamination to those areas where people live and could be affected. In 2012, EPA will be collecting additional groundwater sampling data at the site as part of the RI for the groundwater operable unit. If the RI of the groundwater determines the extent of the contamination is present in areas where it could present a current potential exposure risk or at levels that are increasing beyond than what is currently understood, EPA should take actions to ensure the community is not and will not be impacted. Actions may include additional sampling for vapor intrusion of the surrounding Eastwick neighborhood. PADOH will consider reviewing additional future sampling data, if requested by EPA.

Sincerely,

Christine Lloyd, MS
Epidemiology Program Specialist, Health Assessment Program
Division of Environmental Health Epidemiology

**References**

[ATSDR, 1989]. Agency for Toxic Substances and Disease Registry (ATSDR). 1989. Toxicological Profile for Bromodichloromethane. Atlanta, Georgia: U.S. Department of Health and Human Services. http://www.atsdr.cdc.gov/toxprofiles/tp129.pdf

[ATSDR, 1997a] Agency for Toxic Substances and Disease Registry (ATSDR). -1997a. Toxicological Profile for chloroform. September 1997. Atlanta, Georgia: U.S. Department of Health and Human Services. http://www.atsdr.cdc.gov/toxprofiles/tp6.pdf.

[ATSDR, 1997b] Agency for Toxic Substances and Disease Registry (ATSDR). -1997b. Toxicological Profile for tetrachloroethene. September 1997. Atlanta, Georgia: U.S. Department of Health and Human Services. http://www.atsdr.cdc.gov/ToxProfiles/tp18.pdf.

[ATSDR, 2001] Agency for Toxic Substances and Disease Registry (ATSDR). 2001 Toxicological Profile for 1,2-dichloroethane. September 2001. Atlanta, Georgia: U.S. Department of Health and Human Services. http://www.atsdr.cdc.gov/ToxProfiles/tp38.pdf.

[ATSDR, 2007] Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for benzene. August 2007. Atlanta, Georgia: U.S. Department of Health and Human Services. http://www.atsdr.cdc.gov/ToxProfiles/tp3.pdf.

[ATSDR, 2009] Agency for Toxic Substances and Disease Registry (ATSDR). 2009. Toxicological Profile for 1,3-butadiene. September 2009. Atlanta, Georgia: U.S. Department of Health and Human Services. http://www.atsdr.cdc.gov/ToxProfiles/tp28.pdf

[CDC, 2011] Centers for Disease Control and Prevention (CDC), 2011. National Institute of Occupational Health and Safety (NIOSH) Guide to Chemical Hazards. Webpage last updated August 2011, last reviewed January 2012. http://www.cdc.gov/niosh/npg/.

[EPAa]. US Environmental Protection Agency. Regional Screening Levels. http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search

[EPAb]. US Environmental Protection Agency Region 8. Risk Characterization http://www.epa.gov/region8/r8risk/hh_risk.html

[EPA, 1994]. US Environmental Protection Agency. Chemfacts for Trimethylbenzenes. August 1994. http://www.epa.gov/chemfact/s_trimet.txt

[EPA, 2001] Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance). December 2001. http://www.epa.gov/waste/hazard/correctiveaction/eis/vapor.htm

[EPA, 2005a] US Environmental Protection Agency (EPA). 2005. Handbook for Implementing the Supplemental Cancer Guidance at Waste and Cleanup Sites. http://www.epa.gov/oswer/riskassessment/sghandbook/index.htm

[EPA, 2005b] U.S Environmental Protection Agency (EPA). 2005. Integrated Risk Information System. http://www.epa.gov/IRIS/.

[EPA, 2011a] U.S. Environmental Protection Agency Region 3 (EPA). Remedial Investigation Report for Lower Darby Creek. http://epa.gov/reg3hwmd/npl/PASFN0305521/ri/Report.pdf

[EPA, 2011b] U.S. Environmental Protection Agency Region 3 (EPA). Indoor Ambient Air Monitoring, Vapor Intrusion Sampling, and Assessment Report for Lower Darby Creek Area Site, Clearview Landfill Operable Unit (OU-1)., Philadelphia, Pennsylvania

[EPA. 2012a]. U.S. Environmental Protection Agency (EPA). Supplemental Groundwater Investigation for Lower Darby Creek Area. July 2012. http://www.epa.gov/reg3hwmd/npl/PASFN0305521/reports/RI%20Addendum/Part_1-Supplemental_GW_Investigation.pdf

[EPA, 2012b] U.S. Environmental Protection Agency, Region Screening Level (RSL) Summary Table. May 2012. EPA, Philadelphia, Pennsylvania. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/resair_sl_table_run_MAY2012.pdf

[Interstate Technology Regulatory Council, 2007]. Vapor Intrusion Pathway: A Practical Guideline. January 2007. http://www.itrcweb.org/Documents/VI-1.pdf

[Scottish EPA, 2004] Scottish Environmental Protection Agency, 2004. Guidance on the Management of Landfill Gas. http://www.environment-agency.gov.uk/static/documents/Business/lf_tgn_03_888494.pdf

**Authors, Technical Advisors**


Pennsylvania Department of Health Author:

Pauline Risser-Clemens, MS
Epidemiology Program Specialist
Health Assessment Program
Division of Environmental Health Epidemiology

Christine Lloyd, MS
Epidemiology Program Specialist
Health Assessment Program
Division of Environmental Health Epidemiology

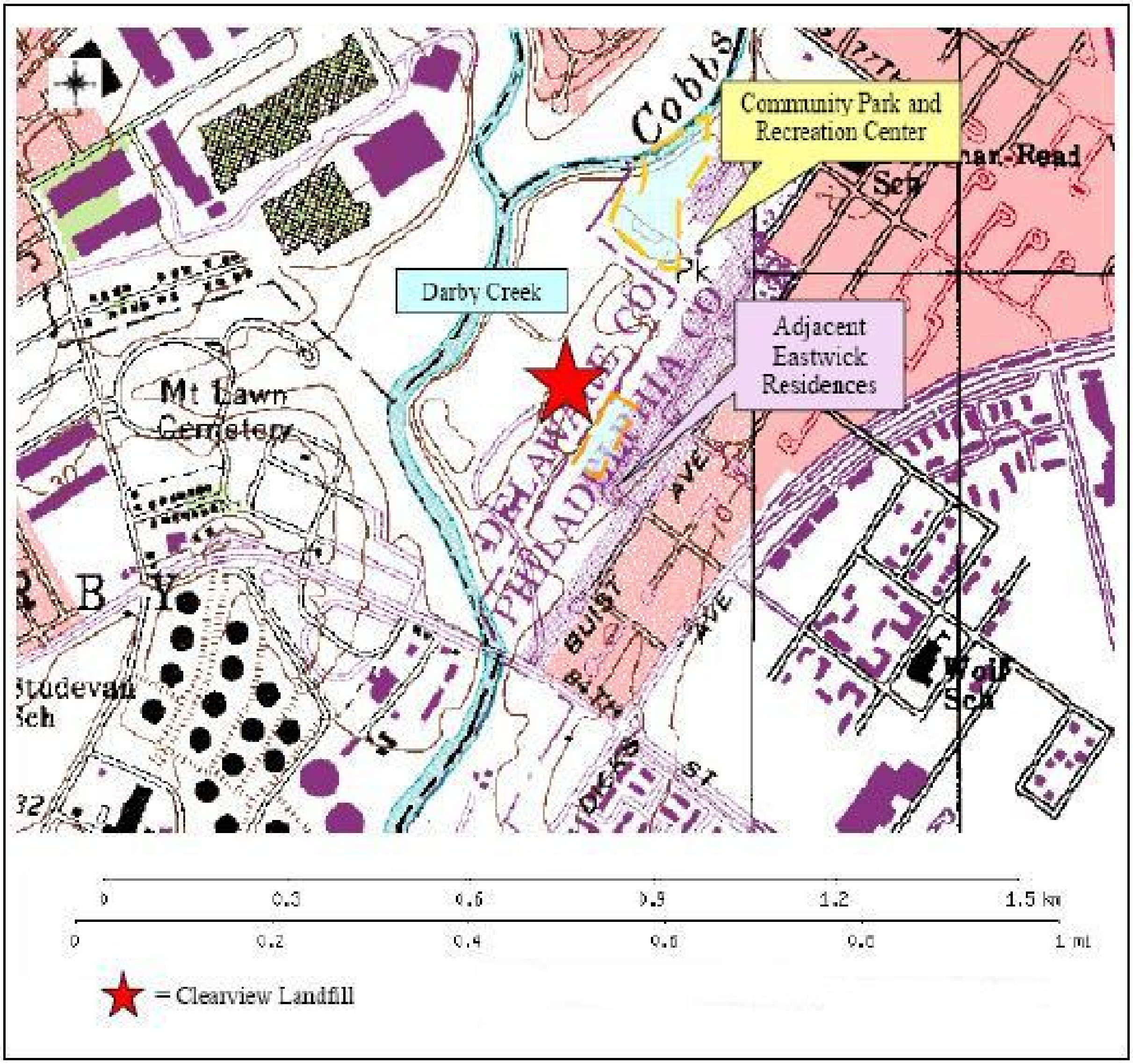
Pennsylvania Department of Health Reviewer:

Farhad Ahmed, MBBS, MPH
Principle Investigator
Health Assessment Program
Division of Environmental Health Epidemiology

Agency for Toxic Substances and Disease Registry Reviewer:

Jennifer Freed, MPH, REHS/RS
Technical Project Officer
Division of Health Assessment and Consultation
Department of Health and Human Services

Figure 1:Map of the Clearview Landfill Site and adjacent residential area and recreation center



## Tables

**Table 1-** List of VOCs Detected and evaluated in EPA's soil-gas subsurface vapor intrusion model for potential vapor intrusion into nearby Eastwick buildings

| ***Volatile Organic Compound*** |
|---|
| Acetone |
| Benzene |
| Butadiene |
| Bromomethane |
| 2-Butanone |
| Carbon disulfide |
| Chloroethane |
| Chloroform |
| Chloromethane |
| 1,4-Dichlorobenzene |
| cis-1,2-Dichloroethene |
| Dichlorodifluoromethane |
| 1,1-Dichloroethane |
| 1,2-Dichloroethane |
| 1,2-Dichloro-1,1,2,2-tetrafluoroethane |
| Ethylbenzene |
| 4-Ethyltoluene |
| Methyl-tertiary butyl ether (MTBE) |
| Styrene |
| Tetrachloroethene (PCE) |
| Toluene |
| 1,1,1-Trichloroethane |
| Trichloroethylene (TCE) |
| Trichlorofluoromethane |
| 1,1,2-Trichloro-1,2,2-trifluoroethane |
| 1,2,4-trimethylbenzene |
| 1,3,5-trimethylbenzene |
| Xylenes (total) |
| Vinyl acetate |
| Vinyl chloride |
| Source: U.S Environmental Protection Agency Region 3 Remedial Investigation Report, Attachment I. (June 2009) finalized May 2011. [EPA, 2011a] |

**Table 2** – Summary of EPA's technical report on typical background levels in indoor air *

**Ranges of Summary Statistics for Background Indoor Air Concentrations of Common VOCs Measured in North American Residences between 1990 and 2005 (all concentrations expressed in $\mu g/m^3$)**

| Compound | Number of Studies | Number of Samples | Range % Detect | Total % Detects | RL Range | Range of 50th% | N* | Range of 75th% | N | Range of 90th% | N | Range of 95th% | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Benzene | 14 | 2,615 | 31–100 | 91.1 | 0.05–1.6 | <RL–4.7 | 14 | 1.9–7.0 | 9 | 5.2–15 | 11 | 9.9–29 | 5 |
| Carbon tetrachloride | 6 | 1248 | 1–100 | 53.5 | 0.15–1.3 | <RL–0.68 | 6 | <RL–0.72 | 3 | <RL–0.94 | 5 | <RL–1.1 | 2 |
| Chloroform | 11 | 2,278 | 9–100 | 68.5 | 0.02–2.4 | <RL–2.4 | 11 | <RL–3.4 | 7 | <RL–6.2 | 9 | 4.1–7.5 | 5 |
| Dichloroethane, 1,1- | 2 | 682 | 1 | 1 | 0.08–0.25 | <RL | 2 | <RL | 2 | <RL | 2 | <RL | 2 |
| Dichloroethane, 1,2- | 7 | 1,432 | 1-25 | 13.8 | 0.08–2.0 | <RL | 7 | <RL–0.08 | 6 | <RL–0.4 | 7 | <RL–0.2 | 4 |
| Dichloroethylene, 1,1- | 2 | 475 | 7-45 | 13 | 0.01–0.25 | <RL | 2 | <RL-0.37 | 2 | <RL-0.8 | 2 | 0.7 | 1 |
| Dichloroethylene, cis 1,2- | 3 | 875 | 1–9 | 4.9 | 0.25–2.0 | <RL | 3 | <RL | 3 | <RL | 3 | <RL–1.2 | 3 |
| Ethylbenzene | 10 | 1,484 | 26–100 | 85.7 | 0.01–2.2 | 1–3.7 | 10 | 2–5.6 | 5 | 4.8–13 | 7 | 12–17 | 3 |
| Methyl tert-butyl ether (MTBE) | 4 | 502 | 9–70 | 54.5 | 0.05–1.8 | 0.025–3.5 | 4 | 0.03–11 | 4 | 0.03–41 | 4 | 71–72 | 2 |
| Methylene chloride | 8 | 1,724 | 29–100 | 79.1 | 0.12–3.5 | 0.68–61 | 8 | 1.0–8.2 | 6 | 2.0–510 | 8 | 2.9–45 | 4 |
| Tetrachloroethylene | 13 | 2,312 | 5–100 | 62.5 | 0.03–3.4 | <RL–2.2 | 13 | <RL–4.1 | 8 | <RL–7 | 10 | 4.1–9.5 | 5 |
| Toluene | 12 | 2,065 | 86–100 | 96.4 | 0.03–1.9 | 4.8–24 | 12 | 12–41 | 7 | 25–77 | 9 | 79–144 | 4 |
| Trichloro-1,2,2-trifluoroethane, 1,1,2- (Freon 113) | 3 | 600 | 1–56 | 37.5 | 0.25–3.8 | <RL–0.5 | 3 | <RL–1.1 | 3 | <RL–1.8 | 3 | <RL–3.4 | 2 |
| Trichloroethane, 1,1,1- | 9 | 1,877 | 4–100 | 53.4 | 0.12–2.7 | <RL–5.9 | 9 | <RL–7 | 7 | <RL–68 | 8 | 3.4–28 | 5 |
| Trichloroethylene | 14 | 2503 | 1–100 | 42.6 | 0.02–2.7 | <RL–1.1 | 14 | <RL–1.2 | 9 | <RL–2.1 | 11 | 0.56–3.3 | 5 |
| Vinyl chloride | 4 | 1484 | 0–25 | 9.2 | 0.01–0.25 | <RL | 4 | <RL | 4 | <RL–0.04 | 4 | <RL–0.09 | 4 |
| Xylene, m/p- | 10 | 1,920 | 52–100 | 92.9 | 0.4–2.2 | 1.5–14 | 10 | 4.6–21 | 7 | 12–56 | 9 | 21–63.5 | 4 |
| Xylene, o- | 12 | 2,004 | 31–100 | 89.0 | 0.11–2.2 | 1.1–3.6 | 12 | 2.4–6.2 | 7 | 5.5–16 | 9 | 13–20 | 4 |

* Data from EPA's Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. http://www.epa.gov/waste/hazard/correctiveaction/eis/vapor.htm

**Table 3-** Common Volatile Organic Compounds Found in Residential Indoor Air and Some Sources

| ***Chemical*** | ***Common Volatile Organic Compound (VOC) Sources*** |
|---|---|
| Benzene | Benzene is a natural part of crude oil, gasoline, and cigarette smoke. Benzene is also used to make other chemicals, which are then used to make plastics, resins, and nylon and synthetic fibers. It is used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. |
| 1,3-butadiene | Butadiene is used to make plastics including acrylics. About seventy-five percent of the manufactured 1,3-butadiene is used to make synthetic rubber including for tires on cars and trucks. |
| Chloroform | Chloroform is found in chlorinated water and consumer products such as air deodorizers and cleaning products. It is also found in some foods such as soft drinks, dairy products, and grains. |
| Dichlorodifluoromethane | It is also called Freon 12. It is commonly used as a refrigerant, aerosol propellant, and solvent. |
| 1,2-dichloroethane | Dichloroethane is used to make a variety of plastics and vinyls, and vinyl chloride, including polyvinylchloride (PVC) water pipes. It is used to make household vinyl furnishings. |
| Tetrachloroethene (PCE) | Used in dry cleaning solutions and metal degreasers. Also found in water repellents, silicone lubricants, fabric finishers, spot removers, wood cleaners, insecticides, and adhesives. |
| 1,2,4-Trimethylbenzene | Used to make dyes and drugs. It is found in gasoline, certain paints, and cleaners. |
| 1,3,5-Trimethylbenzene | Found in gasoline treatments, valve cleaners, mark/spot remover, floor wax, varnishes, paints, and pesticides. It is a diesel exhaust component. |
| Sources: Agency for Toxic Substances and Disease Registry Toxicological Profiles (online at: http://www.atsdr.cdc.gov/toxprofiles/index.asp) and Centers for Disease Control and Prevention, National Institute of Occupational Health and Safety (NIOSH) Guide to Chemical Hazards (online at http://www.cdc.gov/niosh/npg/). | |

**Table 4-** Indoor Air Samples Results (micrograms per cubic meter ($\mu g/m^3$)) for the Eastwick Recreational Center and Eastwick Homes

| | ***Volatile Organic Compound (VOC)*** | ***Maximum Result*** | ***Area of Sample*** | ***ATSDR CV / CV Type (Non-cancer)*** | ***ATSDR CV / CV Type (Cancer)*** |
|---|---|---|---|---|---|
| *Eastwick Homes Tested* | Benzene*† | 5.3 | Saturn Place | 10/chronic MRL | 0.1/CREG |
| | 1,3-butadiene | 1.3 | Mars Place | 200/acute MRL | 0.03/CREG |
| | Chloroform*† | 1.7 | Mars Place | 100/chronic MRL | 0.04/CREG |
| | 1,2-Dichloroethane* | 1.2 | Mars Place | 2,000/ chronic MRL | 0.04/CREG |
| | Tetrachloroethene (PCE)† | 2.8 | Mars Place | 270/chronic MRL | 3.8/CREG |
| | 1,2,4-trimethylbenzene* | 5.2 | Mars Place | 7.3+ | N/A |
| | 1,3, 5-trimethylbenzene* | 1.6 | Mars Place | N/A | N/A |
| *Recreational Center* | Benzene | 0.72 | City Park | 10/chronic MRL | 0.1/CREG |
| | Chloroform† | 1.6 | City Park | 100/chronic MRL | 0.04/CREG |

ATSDR CV = Agency for Toxic Substances and Disease Registry comparison value
CREG = ATSDR's cancer risk evaluation guide for this chemical; CV is in the cancer category
MRL= ATSDR's Minimum risk level CV for non-cancer
N/A = ATSDR does not have a comparison value; therefore, another standard may be used.
* = The maximum results were from the indoor air of the same building.
† = This same chemical showed up in the sub-slab sampling of homes on the same street.
+ = The EPA regional screening level (RSL) of 1,2,4-trimethylbenzene was used as an alternate screening number.
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/resair_sl_table_run_MAY2012.pdf
Source of VOC maximum result levels: U.S Environmental Protection Agency Region 3 Phase 2 (2010 and 2011) indoor air sample data results

**Table 5-** Sub-Slab Sample Results ( microgram per cubic meter ($\mu g/m^3$) from Underneath the Eastwick Recreational Center and Eastwick Homes Tested

| | Contaminant | Maximum Results in the Sub-slab Samples | Detected in Indoor Air? | Indoor Air Results | Indoor Air modeled Results After EPA Attenuation + | Comparison Value | Is Chemical a Carcinogen? |
|---|---|---|---|---|---|---|---|
| ***Eastwick Homes Tested**** | Benzene† | 7.9 | Yes | 2 | | 10- ATSDR chronic MRL<br>0.1 -ATSDR CREG | Yes |
| | Bromodichloromethane | 1.7 | No | | 0.17 | 0.066 - EPA RSL | Yes |
| | Tetrachloroethylene (PCE) | 8.7 | No | | 0.87 | 300 - ATSDR chronic MRL<br>0.02 -ATSDR CREG | Yes |
| | Chloroform† | 15 | Yes | 1.4 | | 100 - ATSDR chronic MRL<br>0.04 -ATSDR CREG | Yes |
| ***Eastwick Recreational*** | Benzene† | 0.75 | Yes | 0.72 | | 10- ATSDR chronic MRL<br>0.1 -ATSDR CREG | Yes |
| | Dichlorodifluoromethane (Freon 12)** | 270 | No | | 27 | 100 - EPA RSL | No |

* = Samples were taken from underneath the building; ports were drilled in the floor to underneath the slab for the testing. The samples were taken using Summa canisters and simultaneously with testing of the building's indoor air. Analysis was performed using EPA Method TO15.
+ = The U.S. Environmental Protection Agency (EPA) attenuate the sub-slab results per their model.
† = This chemical showed up in the indoor air sample results of homes on the same street (the recreational center levels are very low). Chloroform is a common contaminant to air often associated with chlorinated water.
** = This chemical did not show up in the indoor air sampling, but the level indicates that there could be future vapor intrusion into the indoor air of buildings. Dichlorodifluoromethane is not very toxic in air; generally, this VOC is detected near where refrigerators are or were used.

Source: The U.S. Environmental Protection Agency (EPA) Region 3 Phase 2 (2010 and 2011) indoor air sample data results.

**Table 6-** Increased theoretical cancer risk for VOCs in the Indoor Air, based on maximum indoor air concentrations and EPA's Inhalation Unit Risk (IUR)*

| | **Volatile Organic Compound (VOC)** | **Maximum Result (µg/m3)** | **IUR (µg/m3)-1** | **Cancer Risk ages 0-5** | **Cancer Risk ages 6-14** | **Cancer Risk adults** |
|---|---|---|---|---|---|---|
| ***Eastwick Homes Tested*** | Benzene**† | 5.3 | 7.80E-06 | 3.40E-05 | 1.03E-05 | 4.36E-07 |
| | 1,3-butadiene | 1.3 | 3.00E-05 | 3.21E-06 | 3.25E-06 | 4.11E-07 |
| | Chloroform**† | 1.7 | 2.30E-05 | 3.22E-06 | 3.26E-06 | 4.12E-07 |
| | 1,2-Dichloroethane* | 1.2 | 2.60E-05 | 2.57E-06 | 2.60E-06 | 3.29E-07 |
| | 1,2,4-trimethylbenzene** | 5.2 | N/A | | | |
| | 1,3, 5-trimethylbenzene** | 1.6 | N/A | | | |
| | **Total Cancer Risk** | | | 4.30E-05 | 1.95E-05 | 1.59E-06 |
| | | **Maximum Result (µg/m3)** | **IUR (µg/m3)-1** | **Cancer Risk ages 6-8** | | |
| ***Recreational Center*** | Benzene | 0.72 | 7.80E-06 | 1.08E-07 | | |
| | Chloroform† | 1.6 | 2.30E-05 | 2.37E-07 | | |
| | **Total Cancer Risk** | | | 3.45E-07 | | |

* Sample calculations for theoretical cancer risk are on the following page
** The levels fall within typical background levels for benzene in an urban environment [www.atsdr.cdc.gov].
† - The typical range for chloroform in the air in urban areas is 0.5 µg/$m^3$ to 16.7 µg/$m^3$ [www.atsdr.cdc.gov]. The levels fall within typical background levels.

Note: None of the other contaminants that were found in the indoor air were detected outdoors.

Source: The U.S Environmental Protection Agency Region 3 Phase 2 (2010 and 2011) outdoor air sample data results near the Clearview Landfill and Eastwick homes┼ In general, the EPA considers excess cancer risks that are below about 1 chance in 1,000,000 (1E-06) to be so small as to be negligible. http://www.epa.gov/region8/r8risk/hh_risk.html#cancer

**Calculations**

**Theoretical Increased Cancer Risk (adults)** = $\frac{C\ (\mu g/m^3) \times EF \times IUR\ (\mu g/m^3)^{-1} \times ED\ (yrs)}{AT\ (yrs)}$

C= Concentration, EF = Exposure Factor, IUR = Inhalation Unit Risk, chemical specific, ED = Exposure Duration, AT= averaging time (70 yrs)

EF (adults) = $\frac{(16 \text{ hours} \times 5 \text{ days} \times 50 \text{ weeks}) + (24 \text{ hours} \times 2 \text{ days} \times 50 \text{ weeks})}{24 \text{ hours} \times 7 \text{ days per week} \times 52 \text{ weeks}}$

= 0.73

Cancer Risk, adults (benzene)= $\frac{5.3\ \mu g/m^3 \times 0.73 \times 7.80E\text{-}06\ (\mu g/m^3)^{-1} \times 30 \text{ years}}{70 \text{ years}}$

= 4.3E-07 or 4.3 excess cancers in 10,000,000 exposed

**Theoretical Increased Cancer Risk (children)** =

$\frac{C\ (\mu g/m^3) \times EF \times IUR\ (\mu g/m^3)^{-1} \times ED\ (yrs) \times ADAF^{\pm}}{AT\ (yrs)}$

EF (children, 0 to 5yrs, residential ) = $\frac{(24 \text{ hours} \times 7 \text{ days} \times 50 \text{ weeks})}{24 \text{ hours} \times 7 \text{ days per week} \times 52 \text{ weeks}}$

= 0.96

EF (children, 6 to 14 yrs, residential) = $\frac{(16 \text{ hours} \times 7 \text{ days} \times 50 \text{ weeks}) + (24 \text{ hours} \times 2 \text{ days} \times 50 \text{ weeks})}{24 \text{ hours} \times 7 \text{ days per week} \times 52 \text{ weeks}}$

= 0.73

EF (6-8 yrs recreational) = $\frac{(8 \text{ hours day} \times 5 \text{ days} \times 12 \text{ weeks}) + (4 \text{ hours} \times 5 \text{ days} \times 40 \text{ weeks})}{24 \text{ hours} \times 7 \text{ days per week} \times 52 \text{ weeks}}$

=0.15

Cancer Risk, children 0-5 yrs (benzene) = $\frac{5.3\ \mu g/m^3 \times 0.96 \times 7.80E\text{-}06\ (\mu g/m^3)^{-1} \times 6 \text{ years} \times 10}{70 \text{ years}}$

= 3.4 E-05 or 3.4 excess cancers in 100,000 exposed

Cancer Risk, children 6-14 yrs (benzene) = $\frac{5.3\ \mu g/m^3 \times 0.73 \times 7.80E\text{-}06\ (\mu g/m^3)^{-1} \times 8 \text{ years} \times 3}{70 \text{ years}}$

=1.03 E-05 or 1.03 excess cancers in 100,000 exposed

Cancer Risk, children 6-8 yrs, recreational (benzene) =

$\frac{0.72\ \mu g/m^3 \times 0.15 \times 7.80E\text{-}06\ (\mu g/m^3)^{-1} \times 3 \text{ years}}{70 \text{ years}} \times 3$

= 1.08E-07 or 1.08 excess cancers in 10,000,000 exposed

± ADAF – Age dependent adjust factor used if a mutagenic compound, based on EPA's designation, for children. For example, the ADAF for benzene is 10 for children 0 to 2 years and 3 for children 3 years to 16 years.
http://www.epa.gov/oswer/riskassessment/sghandbook/chemicals.htm

**Table 7**- Maximum Levels Detected in the Outdoor Air

| | Contaminant | Maximum Outdoor Air Result (µg/m3) |
|---|---|---|
| ***Eastwick Homes Tested*** | Benzene | 1.5* |
| ***Eastwick Recreational*** | Benzene | 0.69* |
| | Dichlorodifluoromethane (Freon 12) | 3 |

*- The levels fall within typical background levels for benzene in an urban environment [www.atsdr.cdc.gov].

Note: None of the other contaminants that were found in the indoor air were detected outdoors.

Source: The U.S Environmental Protection Agency Region 3 Phase 2 (2010 and 2011) outdoor air sample data results near the Clearview Landfill and Eastwick homes.