LETTER HEALTH CONSULTATION

PHILADELPHIA GAS WORK PASSYUNK SITE
REVIEW OF SOIL GAS SAMPLING DATA

PHILADELPHIA, PHILADELPHIA COUNTY, PENNSYLVANIA

May 17, 2013

Prepared by:

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Room 933 | Health and Welfare Building 625 Forster Street | Harrisburg, PA 17120-0701

May 17, 2013

Palak Raval-Nelson, PhD, MPH
Philadelphia Department of Health
Director, Environmental Health Services
321 University Avenue
Philadelphia, PA 19104

Re: Review of soil gas sampling data collected near the Philadelphia Gas Works (PGW) Passyunk site

Dear Dr. Raval-Nelson:

The Pennsylvania Department of Health (PADOH) received a request from the Philadelphia Health Department (PHD) to assist and review soil gas sampling data collected in the community near the PGW Passyunk facility and PGW Porter FTD Station ('the site'). The PADOH has prepared this letter health consultation (LHC) to address potential public health exposures and issues related to the soil gas sampling near the site. PADOH worked on this evaluation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR provides technical assistance and funding to PADOH to help identify and evaluate environmental health threats to communities using the best science, taking responsive public health actions, and providing trusted health information. This LHC was supported by funds from a cooperative agreement with the ATSDR but has not been published by ATSDR.

Background and Statement of issues

In March 2013, the PADOH and ATSDR Region 3 were contacted by PHD regarding a soil gas investigation conducted by PGW in the neighborhood near the PGW Passyunk Plant in Philadelphia (Figure 1). Previous sampling on the PGW Passyunk Plant since 2003 has shown elevated levels of benzene in the shallow groundwater under the PGW Passyunk and PGW Porter FTD Station. The previous studies showed off-site transport of benzene in groundwater towards the residential community located southeast of the site (PGW, 2013).

From 2010 to 2012, on-site soil gas investigations were conducted at the site to confirm the past data showing on-site soil vapors of benzene. A groundwater to indoor air model, based on on-site soil gas data, showed potential indoor air levels of benzene below the Pennsylvania Department of Environmental Protection (PADEP) and U.S. Environmental Protection Agency (EPA) risk levels. However, it was determined given the extent of the groundwater impacts, the potential for soil vapor intrusion, and the presence of underground utilities in the site area, that PGW should conduct an off-site soil gas investigation. In 2012, PGW conducted soil gas sampling for volatile organic compounds (VOCs) to investigate the potential residential groundwater to soil gas exposure

pathway for the community located southeast of the site. The purpose of this letter is to review the sampling data collected for chloroform and benzene in the community and to make public health conclusions and recommendations to reduce or mitigate any public exposures.

Evaluation Process

ATSDR Comparison Values (CVs) are chemical and media-specific concentrations in air, soil, and drinking water that are used to identify environmental contaminants at hazardous waste sites that require further evaluation. CVs incorporate assumptions of daily exposure to the chemical each day. CVs are conservative and non-site specific. CVs are based on health guidelines with uncertainty or safety factors applied to ensure that they are adequately protective of public health. The comparison of environmental data with ATSDR CVs is one of the first steps in the public health assessment process. The results of this screening step give health assessors an understanding of the priority contaminants at a site.

When a contaminant is detected at a concentration less than its respective CVs, exposure is not expected to result in health effects and it is not considered further as part of the public health assessment process. It should be noted that contaminants detected at concentrations that exceed their respective CVs do not necessarily represent a health threat. Instead, the results of the CV screening identify those contaminants that warrant a more detailed, site-specific evaluation to determine whether health effects are expected to occur. CVs are not intended to be used as environmental clean-up levels. If an ATSDR CV is not available for a particular chemical, the environmental data will be screened with CVs developed by other sources including EPA and PADEP. The following is a list of CVs used to evaluate this site (ATSDR, 2005):

- ATSDR's Cancer Risk Evaluation Guide (CREG);
- ATSDR's Minimum Risk Levels (MRLs);
- EPA's Reference Concentrations (RfCs);
- PADEP's Media Specific Concentration (MSC).

The ATSDR MRL is an estimate of human exposure to a hazardous substance that is unlikely to have an appreciable risk of adverse non-cancer health effects over a specified route and duration of exposure. CREGs are media-specific CVs that are used to identify concentrations of cancer-causing substances that are unlikely to result in an increase of cancer rates in an exposed population. ATSDR develops CREGs using EPA's cancer slope factor inhalation unit risk (IUR), a target risk level (10^{-6}), and default exposure assumptions. The target risk level of 10^{-6} represents a theoretical risk of 1 excess cancer cases in a population of 1 million. The ATSDR MRL and CREG values are not regulatory levels (ATSDR, 2005).

No sub-slab or indoor air samples were collected in the residential community near the site, and therefore PADOH cannot directly evaluate potential indoor air levels for the nearby residents. However, for this evaluation PADOH used the EPA's recommended vapor attenuation factor (for soil gas to indoor air) of 0.1 to screen the soil gas data collected in the community. An attenuation factor is a way of estimating potential indoor air levels based on levels observed in the sub-slab sampling data. EPA conservatively assumes that shallow soil gas (e.g., sub-slab gas and soil gas measured at 5 feet or less from the base of the foundation) intrudes into indoor spaces with an attenuation factor of 0.1 This recommended value is the approximate 95th percentile of the observed sub-slab attenuation factors in the 2008 National Vapor Intrusion Database for the subset

of data with indoor air concentrations above typical background levels where sub-slab concentrations are greater than one order of magnitude (10X) above the target indoor air concentrations. These buildings (where sub slab levels are 10x above target indoor air concentrations) should generally be subjected to further investigation for possibly unacceptable exposure levels in indoor air. For example, to evaluate the potential for soil gases to migrate, PADOH multiplied the ATSDR CVs by 10 to arrive at a sub-slab screening level that takes into account EPA's 0.1 attenuation factor (EPA, 2002).

However, even with reliable soil gas sample results, there is some uncertainty in selection of the soil gas to indoor air attenuation factor. There is potential uncertainty in both the soil gas data, due to a host of factors including seasonal variation, depth to groundwater, soil type, preferential pathways and the attenuation factor estimate. Given these factors, soil gas data may underestimate sub-slab and indoor air levels. Therefore, EPA considers the collection of sub-slab and concurrent indoor air samples the preferred method when groundwater levels of VOCs exceed screening values. According to the EPA Vapor Intrusion Draft Guidance, sampling of foundation air (e.g., sub-slab and/or crawlspace air) provides a direct measure of the potential for exposures from vapor intrusion. When collected in conjunction with indoor air sampling, foundation samples can be used to identify the exposures that originate from vapor intrusion and distinguish those due to background sources (EPA, 2001).

Off-Site Soil Gas Sampling and Results

In December 2012, soil gas points were installed at twenty-two off- site locations in the community. Soil gas samples were ultimately collected from sixteen residential locations; with one duplicate soil gas sample collected (Figure 2). The sampling points were installed by first coring the concrete pavement using a 4-inch diameter diamond core drill bit and then installing 1.5-inch diameter boring to the target depth of approximately 7.5 feet using a rotary hammer drill. Each sample point was constructed using a stainless steel soil gas implant installed at the target depth along with an appropriate length of inert sample tubing extending to ground surface. A sand filter pack, consisting of clean and dry quartz sand, was placed around the implant extending approximately 4-10 inches above the top of the implant, and the remainder of the boring was sealed with a minimum of three feet of hydrated bentonite to provide a competent seal for the sample point. A 3-inch diameter flush-mount cover was installed at the surface of the existing pavement and concreted in place in order to complete the installation. Samples are to be obtained and analyzed using EPA Method TO-15 for volatile organic compounds (SSi, 2013).

PADOH reviewed the off-site soil gas sampling data collected in the community (Table 1). Chloroform was detected in all the off-site samples, except one (sample V18). During the soil gas investigation, chloroform was detected in the residential sampling data at a maximum concentration of 140 $\mu g/m^3$ (sample locationV03). Applying the soil gas to indoor air attenuation factor described above results in a soil gas screening value for the ATSDR MRL of 980 $\mu g/m^3$, ATSDR CREG of 0.43 $\mu g/m^3$, and PADEP MSC of 4.4 $\mu g/m^3$. Therefore, the maximum soil gas concentrations exceed the ATSDR CREG and PADEP MSC screening values. Benzene was detected in six off-site soil gas samples with a maximum concentration of 23 $\mu g/m^3$ (sample location V16). Using the soil gas to indoor air attenuation factor, the screening level in soil gas for benzene is 96 $\mu g/m^3$ (ATSDR's MRL), 1.3 $\mu g/m^3$ (ATSDR CREG) and 27 $\mu g/m^3$(PADEP MSC). The concentration of benzene in soil gas exceeds the ATSDR CREG screening value but is below the ATSDR MRL.

In conclusion, PADOH's review of the off-site soil gas data showed some samples contained concentrations of chloroform and benzene exceeding the ATSDR CREG CV, based on soil gas to indoor air attenuation factors. Exceeding a screening value indicates that more detailed and site-specific evaluation is needed and does not necessarily represent a health threat. PADOH is not able to determine based on soil gas sampling results alone if indoor air concentrations of these chemicals inside residential homes at this site are of public health concern.

On-Site Sub-Slab Sampling and Results

In December 2012, two sub-slab soil gas samples were collected on-site at the PGW Porter Station building in order to evaluate the potential soil gas exposure pathway (Table 2). PADOH reviewed this data, however the Occupational Safety and Health Administration (OSHA) is lead agency in addressing occupational exposures. On-site sampling was performed, as described above. The results of the sub-slab data showed the maximum levels of chloroform (99 $\mu g/m^3$) were below the soil gas screening levels of 980 $\mu g/m^3$ (based on the ATSDR MRL). However, using the sub-slab attenuation factor, this concentration exceeds the ATSDR's CREG of 0.43 $\mu g/m^3$ and 9.2$\mu g/m^3$ (based on the PADEP MSC in the industrial setting). Trichloroethylene (TCE) was also detected in one sub-slab sample at a concentration of 56 $\mu g/m^3$. Applying the sub-slab to indoor air attenuation factor and the EPA RfC of 2 $\mu g/m^3$, this concentration of TCE exceeds the 20 $\mu g/m^3$screening value. TCE was non-detect in the off-site residential soil gas samples. One sub-slab sample result (2.7 $\mu g/m^3$) for vinyl chloride exceeded the ATSDR CREG value of 1.1 $\mu g/m^3$, after applying the attenuation factor. Vinyl chloride was not detected in the off-site soil gas sampling. Exceeding a screening value indicates that more detailed, site-specific evaluation is needed and does not necessarily represent a health threat. Based on the limited on-site sub-slab samples, with the exception of one sub-slab sample of TCE and chloroform, the concentrations of contaminants collected during the on-site sub-slab sampling are below screening values.

In conclusion, PADOH's review of the on-site sub-slab data showed one sample contained concentrations of TCE, chloroform and vinyl chloride exceeding the ATSDR CREG CV, based on sub-slab to indoor air attenuation factors. Exceeding a screening value indicates that more detailed and site-specific evaluation is needed and does not necessarily represent a health threat. PADOH is not able to determine based on sub-slab sampling results alone if indoor air concentrations of these chemicals inside buildings on this site are of public health concern for onsite workers or to off-site residents.

Discussion

Exposure to contaminants of concern is determined by examining human exposure pathways. An exposure pathway has five parts:

1. A source of contamination (e.g., industrial facilities utilizing hazardous materials),
2. An environmental medium such as water, soil, or air that can hold or move the contamination,
3. A point at which people come in contact with a contaminated medium (e.g., private residential well water),
4. An exposure route, such as drinking well water from the same aquifer that is close to the industrial facility, and

5. A population who could come in contact with the contaminants.

An exposure pathway is eliminated if at least one of the five parts is missing and will not occur in the future. For a completed pathway, all five parts must exist and exposure to a contaminant must have occurred, is occurring, or will occur (ATSDR, 2005). Some off-site soil gas and on-site sub gas results showed concentrations of VOC's above ATSDR screening values. For this LHC, indoor air for residential homes near the site is considered a completed exposure pathway. However, residential indoor air samples were not collected, and therefore PADOH cannot evaluate this pathway.

Evaluating the vapor intrusion pathway into buildings can be difficult. While indoor air sampling provides the most direct measure of whether contaminants are migrating into homes at levels of concern, background sources in indoor air from household and consumer products can make this evaluation difficult. In urban areas, ambient sources can be present in indoor air (PADEP, 2002).

While background sources in indoor air can make the evaluations complex, indoor air sampling provides the most direct estimate of potential inhalation exposures to residents (EPA, 2001). The use of the multiple lines of evidence approach in evaluating vapor intrusion sampling data is the preferred method. This process involves evaluating more than one set of samples to determine the extent of vapor contamination and the potential for exposure (New York State Department of Health, 2005). The multiple lines of evidence used includes the source of the contaminants, indoor air data, sub-slab (or crawl-space) soil gas data, concurrent outdoor air data, groundwater data, site geology and history, building construction, trends over time and attenuation factors (Interstate Technology Regulatory Council, 2007).

Due to groundwater migration patterns and internal home features such as heating ventilation and air condition (HVAC) systems and the type of basement (e.g. slab on grade, dirt crawl space, etc.), on-site sub-slab results may not be representative of potential sub-slab and/or indoor air levels in the nearby residential homes. Buildings and utilities can create preferential pathways for migration of volatile compounds from groundwater into indoor air. Naturally occurring preferential pathways may include fractured geology or very permeable soils located between a relatively shallow source of contamination and a building. Manmade preferential pathways may include utilities conduits or subsurface drains that are directly connected to a building and a source of vapors. In highly developed residential areas, extensive networks of subsurface utility conduits could significantly influence the migration of contaminants (EPA, 2001). Furthermore, indoor air in buildings is subject to building to spatial and temporal variability (PADEP, 2002). EPA recommends that buildings with significant preferential pathways be evaluated closely even if they are further than 100 feet from the contamination (EPA, 2001).

Chloroform is commonly found in laboratory environments, which can pose interference problems in sampling analyses. The use of field blanks is extremely important to correct for chloroform that might have diffused into the sample during shipping and storage. Other interferences include those volatile compounds that have similar retention times in the various GC columns used. This problem is often eliminated by analyzing the samples with two different types of GC columns such that the retention times will not be coincidental in both columns. Mass spectrometric detection can also help to overcome interferences resulting from incomplete chromatographic resolution (ATSDR 1997, EPA 1986). PADOH was not provided any quality assurance/quality control (QA/QC) sampling

results to evaluate for this site's sampling investigations. In addition, PADEP has indicated the PGW currently does not use chloroform as part of site operations.

Based on preliminary groundwater and soil gas findings and the potential for off-site impacts, it is PADOH's understanding that PGW is planning in 2014 to install on-site engineering controls to address the on-site groundwater. The on-site system will be part of a pilot study to address on-site groundwater and reduce potential off-site impacts. The system will be constructed of a sparge curtain or similar form to limit off-site transport of soluble benzene (PGW, 2013). This groundwater system will potentially reduce concentrations of VOCs in groundwater and the migration of these volatiles into soil gas and indoor air. Groundwater near the site is believed to flow towards the south to southwest. PADEP is currently exploring the possibility of future groundwater investigations in the area. Although not indoor air samples, groundwater samples collected in the adjacent community can aid in evaluation of contaminant migration patterns.

Conclusions

PADOH reviewed the one round of off-site soil gas sampling and on-site sub-slab sampling. Based on this review, PADOH concludes the following for the site:

- Overall, the levels of VOCs detected in the off-site soil gas and on-site sub-slab investigations were non-detect to low.
- The maximum concentrations of chloroform and benzene in the off-site residential soil gas data exceeded the ATSDR CREG CV, based on a soil gas to indoor air attenuation factor.
- Exceeding the ATSDR CREG value does not necessarily indicate a public health threat but a need for a more site-specific evaluation.
- PADOH is not able to determine, based on soil gas sampling results provided, if indoor air concentrations of these chemicals inside residential homes at this site are of public health concern. Sub-slab or indoor air samples were not collected in the residential community. Indoor air sampling provides the most direct estimate of potential inhalation exposures to residents.
- For the limited on-site sub-slab sampling, with the exception of one sub-slab sample of TCE, chloroform and vinyl chloride, the concentrations of contaminants collected during the on-site sub-slab sampling were below screening values.
- PADOH is not able to determine based on sub-slab sampling results provided if indoor air concentrations of these chemicals inside buildings on this site are of public health concern for onsite workers.
- PGW's plans to implement engineering controls onsite in 2014 that will likely decrease groundwater contamination and potentially lessen the likelihood for vapor intrusion into onsite commercial buildings and offsite residential homes nearby.

Recommendations

- PADOH recommends that PGW continue to monitor the groundwater for contamination near the PGW facility.
- PADOH recommends that PGW and/or PADEP consider collecting indoor air and sub-slab soil samples in the homes adjacent to the PGW site to better characterize the potential for residential exposures via vapor intrusion from contaminated groundwater. If future

sampling includes QA/QC samples such as trip blanks and duplicates, this will be helpful in further evaluating the continued chloroform detections.

- PADOH recommends that PGW continue to implement plans for onsite engineering controls, and consider post engineering controls environmental sampling to verify the effectiveness of these controls.
- PADOH recommends that PADEP and PGW continue to inform and educate the residents about soil gas sampling and the potential for any exposures in the community. PADOH and ATSDR, along with your staff at PHD, are available to provide support in this regard, as requested.

PADOH appreciates the opportunity to work with your agency in evaluating the data for this site. For questions or concerns about this review, please contact the PADOH, Division of Environmental Health Epidemiology, at (717) 787-3350 or e-mail at chlloyd@pa.gov

Sincerely,

Christine Lloyd
PADOH
Division of Environmental Health Epidemiology

Cc:
Steve Sinding- PADEP, Southeast Regional Office
Lora Werner - ATSDR, Region 3
Michael Jones - PGW

References

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PGW (2013). Letter to PADEP, summarizing Act 2 Soil Vapor Results for PGW Passyunk Plant and PGW Porter FTD Station. February 13, 2013.

SSi (2013). Silar Services, Inc. (SSi) for PGW. Soil Gas Sampling and Analysis Report. January 2013.

Figure 1- Site map showing the location of the site and adjacent residential properties.

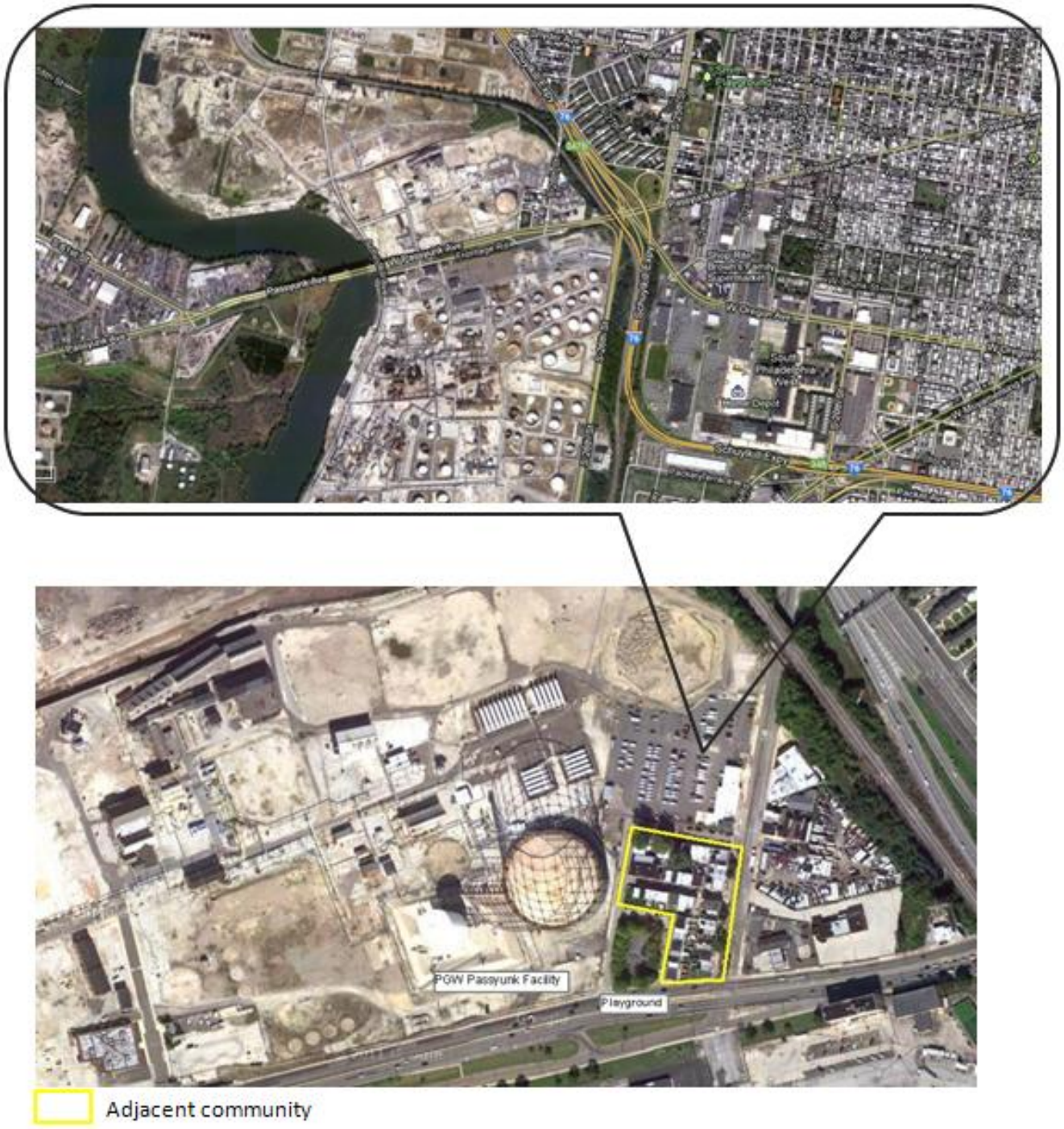

Figure 2 – Locations of soil gas sampling in the residential community adjacent to the PGW site.

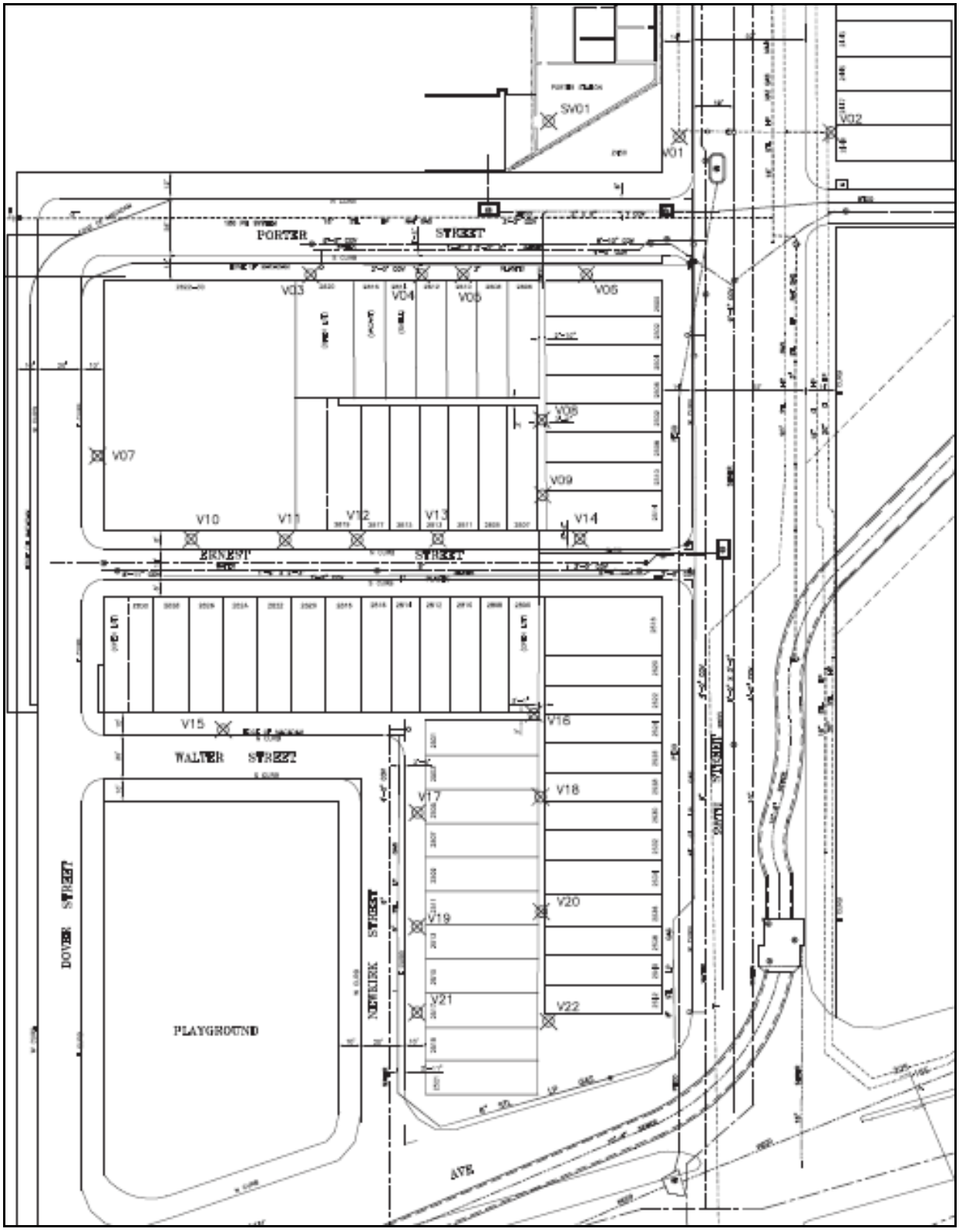

Table 1 – Off-site soil gas results (µg/m^3) collected in the community adjacent to the PGW Passyunk facility.

Contaminant	V01	V02	V03	V04	V05	V06	V08	V09	Indoor Air Screening Value	Soil Gas Screening Value*
Acetone	24	<24	<24	<24	<24	<24	<24	<24	31,000 [1]	310000
Benzene	<3.2	<3.2	6.6	<3.2	<3.2	<3.2	<3.2	<3.2	9.6 [1], 0.13 [2,] 2.7 [3]	96, 1.3, 27
Bromodichloromethane	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	49 [3]	490
2-Butanone (MEK)	<30	<30	<30	<30	<30	<30	<30	<30	5000 [4]	50000
Carbon Disulfide	<6.3	<6.3	17	<6.3	11	<6.3	<6.3	<6.3	930 [1]	9300
Carbon Tetrachloride	<6.4	<6.4	7.6	<6.4	<6.4	<6.4	<6.4	<6.4	190 [1], 0.17 [2]	1900, 1.7
Chloroform	8	66	140	11	23	36	9.8	7.4	98 [1], 0.043 [2], 0.44 [3]	980, 0.43, 4.4
Ethylbenzene	<4.4	<4.4	<4.4	<4.4	<4.4	6.3	<4.4	<4.4	260 [1]	2600
Methylene Chloride	<3.5	<3.5	<3.5	<3.5	<3.5	4.3	<3.5	<3.5	1000 [1], 100 [2]	10000, 1000
4-Methyl-2-pentanone	<8.3	<8.3	<8.3	<8.3	<8.3	<8.3	<8.3	<8.3	3000 [4]	30000
Tetrachloroethylene	8.1	12	<6.9	16	14	<6.9	<6.9	<6.9	270 [1], 3.8 [2]	2700, 38
1,1,1-Trichloroethane	<5.5	<5.5	<5.5	<5.5	<5.5	5.8	5.8	5.8	5000 [4]	50000
1,2,4-Trimethylbenzene	<5.0	<5.0	<5.0	<5.0	<5.0	6.2	<5.0	<5.0	8.3 [3]	83
Toluene	5.7	7.3	7.3	6.1	5.7	19	7.4	5.3	300 [1]	3000
m, p-xylene	<8.8	<8.8	<8.8	<8.8	<8.8	27	<8.8	<8.8	220 (total) [1]	2200
o-xyelene	<4.4	<4.4	<4.4	<4.4	<4.4	9.3	<4.4	<4.4	220 (total) [1]	2200

[1] ATSDR Minimum Risk Level (MRL)
[2] ATSDR Cancer Risk Evaluation Guide (CREG)
[3] PADEP Media Specific Concentration (MSC) for indoor air in the residential setting
[4] EPA Reference Conentration (RfC)
* A sub-slab soil gas screening value = indoor air screening value x 10

Table 2 – On-site sub-slab results (µg/m^3) at the PGW Passyunk facility that exceed screening values.

Contaminant	Sub-slab 01	Sub-slab 02	Indoor Air Screening Value	Sub-slab Soil Gas Screening Value*
Chloroform	99	<4.9	98 [1], 0.043 [2], 0.92 [3]	980, 0.43, 9.2
Trichloroethylene	<5.5	56	2 [1], 0.24 [2], 0.72 [3]	20, 2.4, 7.2
Vinyl Chloride	<2.6	2.7	100 [4], 0.11 [2], 9.5 [3]	1000, 1.1, 95

[1] ATSDR Minimum Risk Level (MRL)
[2] ATSDR Cancer Risk Evaluation Guide (CREG)
[3] PADEP Media Specific Concentration (MSC) for indoor air in the industrial setting
* A sub-slab soil gas screening value = indoor air screening value x 10