LETTER HEALTH CONSULTATION

CITY PARK SOIL DATA REVIEW
LOWER DARBY CREEK AREA SUPERFUND SITE:
CLEARVIEW LANDFILL

PHILADELPHIA, DELAWARE AND PHILADELPHIA COUNTIES, PENNSYLVANIA

February 20, 2013, 2013

Prepared by:

Pennsylvania Department of Health
Division of Environmental Health Epidemiology

Health Consultation: A Disclaimer

The Pennsylvania Department of Health (PADOH) Health Assessment Program (HAP) collaborates with the Agency for Toxic Substances and Disease Registry (ATSDR), the lead federal public health agency, to prepare health consultation documents which determine if exposure to contaminants can harm people's health as well as prevent and reduce exposures and illnesses. A health consultation is a written response to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material, and considers the levels of hazardous substances at a site, whether people might be exposed to contaminants, by what pathways, and what potential harm the substances might cause to them. In order to prevent or mitigate exposures, a consultation may lead to specific actions and recommendations, 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; conducting health studies; characterizing demographics; recommending changes/additions to related Commonwealth of Pennsylvania policies/regulations, improving quality of life; and/or providing health education for health care providers and community members.

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. While this health consultation was supported by funds from a cooperative agreement with the ATSDR, it has not been reviewed and cleared by ATSDR. More information about ATSDR is available online at www.atsdr.cdc.gov.

The conclusions and recommendations presented in this health consultation document are based on an analysis of the environmental sampling data and information made available to the PADOH within a limited time frame. The availability of additional sampling data, new information and/or changes in site conditions could affect the conclusions and recommendations presented in this document. PADOH will consider reviewing additional future data related to the site, if made available and deemed appropriate.

pennsylvania
DEPARTMENT OF HEALTH

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

From: Christine Lloyd, Pennsylvania Department of Health (PADOH), Division of Environmental Health Epidemiology

Subject: Review of surface soil data collected in the City Park, adjacent to the Lower Darby Creek Area (LDCA), Clearview Landfill

As part of the 2010 Remedial Investigation (RI) for the LDCA and Clearview Landfill, EPA collected surface soil samples in the Eastwick City Park ('City Park'), located adjacent to the Clearview landfill. Limited area contamination and/or landfill debris is located in the subsurface areas of the City Park (EPA 2011a). Previous surface samples collected in the City Park indicated a few localized samples with elevated levels of lead, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyl (PCB) Aroclor 1260 in the surface soils in the northern part of the City Park, behind the Recreational Center. The presence of soil contamination is likely from historical landfill activities and/or sediment deposition from the nearby Darby and Cobb Creeks. Based on recommendations from PADOH, in 2011, EPA collected additional soil samples for lead, PAHs, and PCBs in the City Park behind the Recreational Center. PADOH made this recommendation due to the past soil sampling in the City Park showing isolated "hot spots", or localized areas of elevated levels of some contaminants. This additional sampling was performed to thoroughly characterize the surface soil and the potential for exposure among those children who play there. Results from the soil sampling were used by EPA to identify and refine areas for the removal action conducted from November 2011 to September 2012 and are part of a larger cleanup effort addressing contamination in the Clearview and Folcroft Landfills and the nearby waterways (EPA, 2012). The purpose of this letter health consultation (LHC) is to evaluate the additional surface soil samples collected in the City Park behind the Recreational Center and provide conclusions on potential exposures and relevant public health recommendations.

PADOH reviewed the additional surface soil sample data collected for lead, PAHs, and PCBs by EPA in the City Park near the Recreational Center. Based on this evaluation, PADOH concludes that exposures to the detected levels of contaminants are not expected to harm people's health, especially children who may play at the City Park. Recreational exposures to surface soil are a potential exposure pathway in the City Park because of the identified contamination in the soil. However, based on the sampling data there is not an indication of widespread contamination in the surface soil. Potential exposures to soil may be reduced in some areas that are covered by a grass layer or other vegetation. Conversely, there is a potential for increased exposure in areas with bare soil that lacks a vegetative cover. EPA is planning to conduct additional remedial activities in the City Park that will likely reduce recreational exposures to contaminated soil.

Background and Statement of Issues

The Clearview Landfill, LDCA Superfund site is located in Delaware and Philadelphia Counties. The Clearview Landfill is one of two landfills that make up the LDCA. The other landfill is the Folcroft Landfill. The Eastwick Recreational City Park ('the City Park') is located adjacent to the Clearview Landfill and encompasses approximately 4.32 acres. The City Park currently contains public recreation facilities, including tennis courts, basketball courts, playgrounds and walking paths (EPA, 2011a). The Recreational Center (in the City Park) is also located in the historical landfill footprint and the center is used by children and adults (EPA, 2012) (Figure 1).

The Clearview 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 the former wetlands and streams have been filled, altering their courses to flow along the eastern border of the landfill, south to Darby Creek. The landfill continued to expand to the east, near Buist Avenue. The Landfill was officially closed in 1973; however, it has been used for other waste disposal operations since the closure.

The Clearview Landfill site was listed to the National Priorities List (NPL) in 2001 and a Remedial Investigation (RI) at the Site has been conducted (EPA, 2011a). Since 2001, EPA has conducted multiple sampling events 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 (EPA, 2011a). In general, the City Park has one to two feet (thicker in places) fill soil. In some areas, particularly the northern open field of City Park, there is only a very thin soil fill cover, and wastes visibly protrude at ground surface. As part of the RI and Feasibility Study (FS), EPA is evaluating potential response actions for the site to reduce potential exposures to site contamination (EPA, 2011b).

Previous surface soil sampling in the northern part of the City Park near the Recreational Center, as part of the RI in 2010, detected a few samples with elevated lead and PAH concentrations. Two elevated lead levels were detected behind the Recreational Center. Overall, lead in soil levels ranged from non-detected to 8450 ppm. The EPA's standard for lead in bare soil in play areas is 400 mg/kg by weight and 1,200 mg/kg for non-play areas (EPAa). PAHs benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3- cd)pyrene were detected in the surface soil of the northern part of the City Park. PAH levels ranged from non-detect to 4 ppm. The primary PAH detected was benzo(a)pyrene, with the highest concentration of 4 ppm located in the northern part of City Park. The distribution and frequency of elevated surface soil results indicated that the park is not contaminated with lead but that there is a potential contamination hot spot behind the recreation center (EPA, 2010). However, based on this data, PADOH recommended EPA collect additional surface soil samples in the City Park, behind the recreation center, to characterize the extent of the contamination. This LHC reviews that additional surface sampling data collected in the City Park.

Soil Sampling Investigation

In July to August 2011, EPA performed a soil sampling investigation in the City Park for lead, PAHs, and PCBs, based on previous recommendations from PADOH that past soil sampling in the City Park contained isolated "hot spots", or localized areas of elevated levels of some contaminants. This additional sampling was performed to thoroughly characterize the surface soil in the City Park, and the potential for exposure among those children who play there. For this sampling event, EPA divided the City Park into Decision Units (DU's). Four DU's are located in the park, ranging from 0.3 to 2 acres. EPA focused the soil sampling efforts on DU 2, since previous soil investigations indicated the presence of lead, PAHs, and PCBs. In addition, EPA concentrated on areas with the highest potential for direct contact (e.g., areas with little vegetation, RI data showing contamination, and other factors that might result in direct contact with soil).

EPA utilized a multi-incremental sampling (MIS) technique. Within each DU, a specified number of surface soil samples were collected, to a depth of 3 inches. The number of increments per DU depended on the size of the DU, but there were at least 50 increments in each DU. The entire mass of these increments were combined to make one sample. An approximate number of 100 increments were collected within each DU. Two replicate soil samples from DU-01 (i.e., triplicate samples) were collected. In addition, EPA also collected discrete samples from each DU. A total of 14 discrete soil samples were collected during the sampling event. Discrete soil samples were collected from DUs within targeted areas. The purpose of the discrete samples was to obtain additional information from certain DUs or core intervals (that demonstrate staining or other unique factors) that may be indicative of elevated levels of contamination, and to obtain samples along the outer edges of the DUs that are suspected to likely represent the edge of contamination. Discrete samples were collected by using a 5-point composite from within the soil core. Discrete samples were processed and analyzed by the laboratory in the same manner as the MIS samples. The EPA-assigned laboratory prepared (i.e., dry, sieve, grind, and sub-sample) the samples in accordance with SW-846 Method 8330b. After preparation, the soil samples were analyzed for PAHs using SW-846 High Performance Liquid Chromatography Method 8270C with extraction method SW-846 Method 3550B, for lead using SW-846 Inductively Coupled Plasma-Mass Spectrometry Method 6020A with extraction method SW-846 Method 3050B, and for PCBs using SW-846 8082 Gas Chromatography with extraction method SW-846 3550C (EPA, 2012).

Results

PADOH reviewed the soil sampling data collected in the City Park. Table 1 presents a summary of data, which includes the mean contaminant concentration for each DU and the maximum contaminant concentration during the sampling event. The next step in the PADOH evaluation process is to compare the sampling data against available screening values for soil. PADOH used two sources to screen the soil data.

First, the ATSDR Comparison Values (CVs) were the primary screening value for the City Park soil data. ATSDR CVs include a cancer risk evaluation guide (CREG) and a Reference Dose Media Evaluation Guide (RMEGs). CREGs are media-specific comparison values 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 (CSF), a target risk level (10^{-6}), and default exposure assumptions. RMEGs represent concentrations of substances (in water, soil, and air) to which humans may be exposed without experiencing adverse non-cancerous health effects (ATSDR, 2005). The second screening values were EPA's Regional Screening Levels (RSLs) for residential soil. EPA residential soil RSLs are risk-based values used for screening level/preliminary remediation at Superfund sites. Soil RSLs are set concentration limits using carcinogenic or systemic toxicity values and are developed for carcinogenic effects, based on a target risk of 10^{-6}, and non-carcinogenic effects (EPAc). It is important to note that ATSDR and EPA do not have screening values for acenaphthylene and benzo(k)fluoranthene, and phenanthrene.

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 (ATSDR, 2005).

Lead - Lead was detected in all surface soil samples collected from the four DUs, including the MIS and composite samples with a maximum concentration of lead at 240 milligrams per kilogram (mg/kg) or parts per million (ppm) and a mean concentration of 150 ppm. None of the detected concentrations exceeded the EPA Region 3 RSL of 400 mg/kg for residential soil**. Therefore, PADOH would not expect exposures to these levels to harm people's health.**

PCBs – PCB Aroclor 1260 was the only isomer detected in surface soil in the City Park. Aroclor 1260 was detected in every DU at low concentrations. The maximum concentration was 0.084 ppm. ATSDR does not have a CV for PCB Aroclor 1260. None of the detected concentrations exceeded the EPA Region 3 RSL of 0.22 ppm for residential soil. **Therefore, PADOH would not expect exposures to these levels to harm people's health.**

PAHs - Sixteen PAHs were detected in surface soil but only five PAHs were detected in the City Park above CVs or RSLs. These include, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-C,D)pyrene, and were detected throughout the City Park study area. In general, PAH concentrations were uniformly distributed throughout the entire City Part study area, and no particular DU stood out as being more or less impacted. The following is a summary of the PAH soil data that exceeded CVs or RSLs:

- Benzo(a)pyrene, which is EPA's primary risk driver for PAHs, exceeded the ATSDR CREG CV of 0.096 ppm in all DUs. The EPA RSL is 0.015 ppm. The maximum concentration benzo(a)pyrene was 1.0 ppm. The mean values in DU 01 were 0.74 ppm and 0.829 ppm in DU 02. Discrete samples collected in DU 03 and DU 04 showed levels of 0.42 ppm and 0.59 ppm, respectively.

- Benzo(a)anthracene was detected at a maximum level of 0.97 ppm, which exceeds the EPA RSL of 0.15 ppm. ATSDR does not have a CV for benzo(a)anthracene. The mean

concentration in DU 01 (0.657 ppm) and DU 02 (0.784 ppm) and discrete samples in DU 03 (0.42 ppm) and DU 04 (0.59 ppm) exceeded the EPA RSL.

- Benzo(b)fluoranthene exceeded EPA's RSL of 0.38 ppm, in all DUs. The maximum concentration during the sampling event was 1.6 ppm. The mean in DU 01 was 1.08 ppm and 1.26 ppm in DU 02. Discrete samples in DU 03 and DU 04 were 0.66 ppm and 0.9 ppm, respectively. ATSDR does not have a CV for benzo(b) fluoranthene

- Dibenzo(a,h)anthracene was present at a maximum concentration of 0.17 ppm The EPA RSL is 0.015 ppm ATSDR does not have a CV for dibenzo(a,h)anthracene. DU 01 (mean of 0.102 ppm), DU 02 (mean of 0.118 ppm), DU 03 (discrete sample concentration of 0.079 ppm), and DU 04 (discrete concentration of 0.12 ppm) exceeded the EPA RSL.

- Indeno(1,2,3-c,d)pyrene in the City Park surface soil exceeded the EPA RSL of 0.15 ppm in all DUs. ATSDR does not have a CV for indeno(1,2,3-c,d)pyrene. The maximum concentration during the sampling event was 0.52 ppm. The mean in DU 01 was 0.34 ppm and 0.395 ppm in DU 02. Discrete samples in DU 03 and DU 04 were 0.23 ppm and 0.3 ppm, respectively.

Discussion

Urban Background Soil Concentrations

PAHs are a group of chemicals that are formed during the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances, such as tobacco and charbroiled meat. PAHs are ubiquitous in the environment, especially in urban soil. Anthropogenic combustion processes are a major source of PAHs in soils, especially in urban areas (ATSDR, 1995). PADOH reviewed typical urban soil background levels from four reference sources (ATSDR, 1995; MassDEP, 2002; NJDEP, 1997; Bradley, LN, Magee, BH& Allen, SL, 1994) (Table 2). For examples, across the four references studies, typical soil levels of benzo (a) pyrene range from 0.65 – 1.32 ppm. These levels are within the range of PAH concentrations observed during the surface soil sampling at the City Park.

Exposure Pathway

The potential exposure pathway at the City Park is likely recreational exposures to soil via incidental ingestion of soil. The presence of contaminated soil represents a past and current exposure pathway. The presence of a grass layer over the soil would reduce potential exposures. Conversely, areas with bare soil could result in increased exposures to soil. EPA is considering potential remedial actions at the site and therefore will reduce potential future exposures.

Exposure Dose and Cancer Risk

The U.S. Department of Health and Human Services (DHHS) has determined that benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene are known animal carcinogens. Researchers have reported increased incidences of skin, lung, bladder, liver, and stomach cancers, in exposed laboratory animals. In humans, increased incidences of lung, skin, and bladder cancer have been associated with occupational exposure to

PAHs (ATSDR, 1995). However, currently EPA has only completed a quantitative cancer risk assessment for benzo(a)pyrene. The CSF for benzo(a)pyrene is 7.3 mg/kg/day. Due to a lack of cancer assessment for other carcinogenic PAHs, EPA and other researchers have developed a relative potency approach using benzo(a) pyrene as the indicator compound in evaluating PAH toxicity. By using this approach, the cancer potency of the other PAHs can be evaluated based on their relative potency to benzo(a) pyrene. To determine the toxicity of the mixture of five PAHs identified above, the maximum detected concentration of each PAH was multiplied by a Relative Potency Factor (RPF) in order to determine its toxicity relative to that of benzo(a)pyrene (ATSDR, 1995). (Table 3)

Next, PADOH calculated an estimated cancer risk for visitors to the Recreational Center based on the total PAH concentration relative to benzo (a) pyrene. An adjusted exposure dose is calculated, based on the concentration of contaminant, amount of soil ingested, and body weight. PADOH used the following to calculate an exposure dose (ATSDR 2005).

$$D = (C \times IR \times EF \times CF) / BW$$

Where: D = exposure dose (mg/kg/day); C = contaminant concentration; (mg/kg); IR = intake rate of contaminated soil (mg/day); EF= exposure factor (unit less); CF = conversion factor (10^{-6} kg/mg); and BW = body weight (kgs)

For recreational exposures, PADOH calculated theoretical cancer risk for children 0 to 5 years, 6 years to 11 years, 12 to 17 years and adults 18 years and older. EPA Exposure Factors Handbook (EPA 2011c), serves as a primary source for the recommended soil ingestion values and body weights. Based on the EPA Exposure Factors Handbook, PADOH assumed an intake rate of soil for children and adolescents of 100 mg/day and adults of 50 mg/day. Further assumptions by PADOH for theoretical cancer calculations include a body weight of 17 kilograms (kgs) for ages 0 to 5 years, 32 kgs for 6 years to 11 years, 64 kgs for 11 to 17 years and 80 kgs for adults. Exposure duration is assumed to be 9 months out of the year, since the ground would be frozen in winter, reducing exposures to surface soil. In addition, EPA has identified 13 chemicals with a mutagenic mode of action (MOA). Benzo(a)pyrene has been identified as a chemical with potential mutagenic MOA. Therefore, age-dependent adjustment factors (ADAFs) are used to 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, 2005). A 3-fold adjustment is used for ages 2 to <16 years. No adjustment for ages 16 and older.

Next, based on the maximum total PAH concentration relative to benzo(a)pyrene, PADOH calculated an estimated cancer risk for PAHs at the site (Table 4) The following equation is used to calculate an estimated cancer risk.

$$\text{Cancer Risk} = \text{Age-specific adjusted dose} \times \text{CSF} \times \text{Age-specific \# years} / 78 \text{ years}$$

The estimated cancer risk, based on total PAH concentrations relative to benzoin(a)pyre, is 1.01 E-05 for ages 0 to 5 years, 5.36 E-06 for 6 to 11 years, 2.68 E-06 for 12 to 17 years and 4.29 E-06 for 18 and older, respectively. In other words, 1.35E-05 is equal to 1.35 extra cases of cancer, above current background levels of cancer, could occur in 100,000 exposed people. These values fall within EPA's acceptable risk range for cancer exposures and therefore do not represent a public health concern.

Excess cancer risks that range between 1E-06 and 1E-04 are generally considered to be acceptable (EPAc). The estimated cancer risk caluculations are based on the maximum concentrations of PAHs, and therefore represent the worst case scenario.

Conclusions and Recommendations

Based on a review of the surface soil sample data collected by EPA in the City Park near the Recreational Center, PADOH concludes that exposures to the detected levels of contaminants (PCB's, PAHs and lead) are not expected to harm people's health. PADOH supports EPA's removal and remedial efforts at the site. PADOH will consider reviewing additional environmental sampling data, if requested, and issuing a public health conclusion. To reduce any potential exposures, PADOH recommends that visitors to the City Park minimize any surface soil disturbance and do not trespass on the landfill. PADOH recommends that visitors to the City Park take the following steps to reduce their potential exposure to surface soil, as much as possible:

- Establish a clean hands policy – children should wash their hands when coming in from playing outside and before eating.
- Discourage children from playing in the bare soil.
- Do not eat or smoke in areas with contaminated soil.
- Avoid tracking soil into the house on shoes, clothing and by household pets. Ask family members to remove their shoes by the door, and frequently bathe your pets as they could also track contaminated soil into your home.
- Regularly conduct damp mopping and damp dusting of surfaces. Dry sweeping and dusting could increase the amount of lead-contaminated dust in the air.

Sincerely,

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Figure 1- Site map showing the location of the Clearview Landfill

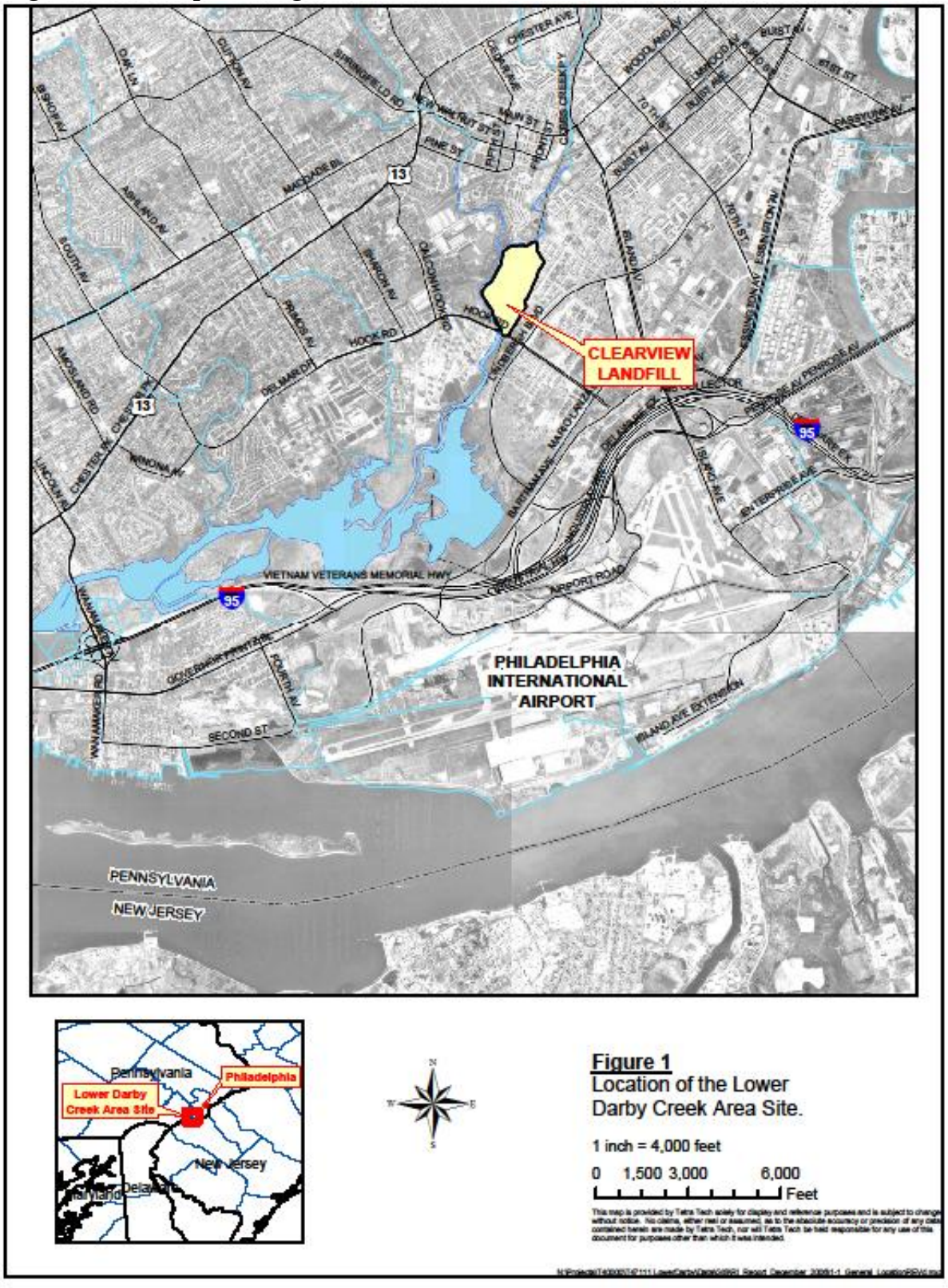

Table 1 - Summary of surface soil sample results for the City Park, adjacent to the Clearview Landfill

Contaminant	Maximum Concentration during sampling event (ppm)	DU01 Mean (ppm)	DU02 Mean (ppm)	DU03* (ppm)	DU04* (ppm)	ATSDR CV (ppm)	EPA RSL Residential (ppm)**
Acenaphthene	0.091	0.054	0.068	0.041	0.053	42000 RMEG	4700 [1]
Acenaphthylene	0.072	0.052	0.058	0.028	0.042	-	-
Anthracene	0.26	0.153	0.192	0.120	0.150	120 CREG	17000 [2]
Aroclor 1260	0.084	0.073	0.030	0.035	0.036	-	0.220 [1]
Benzo(a)anthracene	0.97	0.657	0.784	0.420	0.590	-	0.15 [1]
Benzo(a)pyrene	1	0.740	0.829	0.450	0.620	0.096 CREG	0.015 [1]
Benzo(b)fluoranthene	1.6	1.083	1.262	0.660	0.900	-	0.38 [1]
Benzo(g,h,i)perylene	0.6	0.397	0.459	0.250	0.360	-	-
Benzo(k)fluoranthene	0.59	0.457	0.490	0.250	0.340	-	1.5 [1]
Chrysene	1.1	0.803	0.872	0.450	0.630	-	15 [1]
Dibenzo(a,h)anthracene	0.17	0.102	0.118	0.079	0.120	-	0.015 [1]
Fluoranthene	1.7	1.150	1.322	0.700	0.950	28,000 RMEG	2300 [2]
Fluorene	0.093	0.050	0.066	0.043	0.053	28,000 RMEG	2300 [2]
Indeno(1,2,3-cd)pyrene	0.52	0.340	0.395	0.230	0.300	-	0.15 [1]
Lead	240	150	178	120	160	400±	400 [2]
Naphthalene	0.066	0.042	0.042	0.031	0.039	14,000 RMEG	3.6 [1]
Phenanthrene	1.1	0.713	0.861	0.500	0.650	-	-
Pyrene	2.2	1.400	1.545	1.000	1.400	21,000 RMEG	1700 [2]

*****Only one sample collected in these areas, therefore no mean was calculated
**EPA RSL, November 2012 http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/master_sl_table_run_NOV2012.pdf
±ATSDR uses the EPA screening value for lead in residential soil of 400 ppm
- indicates there is no available screening value for this contaminant
RSL = EPA Regional Screening Level for residential soil
CREG = ATSDR Cancer Risk Evaluation Guide
RMEG = ATSDR Reference Dose Media Evaluation Guide
[1] Carcinogenic soil RSL
[2] Non-cancerous soil RSL

Values that exceed the EPA RSL or ATSDR CV

Table 2 – Typical urban background soil concentrations for PAHs

	ATSDR Toxicological Profile (ppm)	DEP Report -mean values from several studies (ppm)	New Jersey DEP Report - mean value (ppm)	New England Soils Study- mean value (ppm)
Benzo(a)pyrene	0.165-0.22	0.3-0.95	0.61	1.32
Benzo(a)anthracene	0.169-59	0.33-0.672	0.6	1.3
Benzo(b)fluoranthene	15-62	0.68-1.4	0.58	1.4
Dibenzo(a,h)anthracene		0.17-0.245	0.25	0.38
Indeno(1,2,3-C,D)pyrene	8-61	0.2-1.752	0.27	0.987

Table 3 – Total PAH concentrations relative to benzo (a) pyrene using cancer potency factors*

	Maximum concentration (ppm)	Cancer Potency Factor	PAH concentration relative to Benzo(a)pyrene (ppm)
Benzo(a)pyrene	1	1	1
Benzo(a)anthracene	0.97	0.145	0.14
Benzo(b)fluoranthene	1.6	0.167	0.27
Dibenzo(a,h)anthracene	0.17	1.11	0.19
Indeno(1,2,3-cd)pyrene	0.52	0.055	0.03
Total PAH concentration relative to benzo(a)pyrene			**1.63**

Table 4 – Estimated cancer risk for soil PAHs (exceeding screening values), based on total PAH concentration relative to benzo(a)pyrene.

	Ages 0 to 5 years		Ages 6 to11 years		Ages 12 to 17 years		Ages 18+years	
Contaminant of Concern	Exposure Dose (mg/kg/day)	Estimated Cancer Risk	Exposure Dose (mg/kg/day)	Estimated Cancer Risk	Exposure Dose (mg/kg/day)	Estimated Cancer Risk	Exposure Dose (mg/kg/day)	Estimated Cancer Risk
Total PAH concentration relative to benzo(a)pyrene	7.19E-06	1.01E-05	3.82E-06	5.36E-06	1.91E-06	2.68E-06	1.53E-06	4.291E-06

* ATSDR (1995)

Example calculations:
Benzo(a)anthracene concentration relative to benzo(a)pyrne
= Maximum concentration x cancer potency factor
= 0.97 ppm x 0.145 = 0.14 ppm

Exposure dose (children ages 0 to 5 years), total PAH concentration, relative to benzo(a)pyrene
=(total PAHconcentration relative x soil ingestion rate x exposure factor x conversion factor)/ body weight
=(1.63 mg/kg x 100 mg/day x 9 months/12 months x 1E-06)/ 17 kgs = 7.19E-06

Estimated cancer risk (children ages 0 to 5 years)
= (Exposure dose x cancer slope factor x #years exposed/78 years) x age-dependent adjustment factor
= 9.59E-06 x 7.3 mg/kg/day x 5 years/78 years) x 3 = 1.01E-05