Health Consultation

ALTON PARK SITE # 2

TENNESSEE AVENUE AND RAILROAD OVERPASS
TAX PARCELS 1550 M 009, 1550 M 010, AND 1550 N 002

CHATTANOOGA, HAMILTON COUNTY, TENNESSEE

Prepared by the
Tennessee Department of Health

NOVEMBER 18, 2009

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

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners 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 or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Foreword

This document summarizes an environmental public health investigation performed by Environmental Epidemiology of the State of Tennessee Department of Health. Our work is conducted under a Cooperative Agreement with the federal Agency for Toxic Substances and Disease Registry. In order for the Health Department to answer an environmental public health question, several actions are performed:

Evaluate Exposure: Tennessee health assessors begin by reviewing available information about environmental conditions at a site. We interpret environmental data, review site reports, and talk with environmental officials. Usually, we do not collect our own environmental sampling data. We rely on information provided by the Tennessee Department of Environment and Conservation, U.S. Environmental Protection Agency, and other government agencies, businesses, or the general public. We work to understand how much contamination may be present, where it is located on a site, and how people might be exposed to it. We look for evidence that people may have been exposed to, are being exposed to, or in the future could be exposed to harmful substances.

Evaluate Health Effects: If people could be exposed to contamination, then health assessors take steps to determine if it could be harmful to human health. We base our health conclusions on exposure pathways, risk assessment, toxicology, cleanup actions, and the scientific literature.

Make Recommendations: Based on our conclusions, we will recommend that any potential health hazard posed by a site be reduced or eliminated. These actions will prevent possible harmful health effects. The role of Environmental Epidemiology in dealing with hazardous waste sites is to be an advisor. Often, our recommendations will be actions items for other agencies. However, if there is an urgent public health hazard, the Tennessee Department of Health can issue a public health advisory warning people of the danger, and will work with other agencies to resolve the problem.

If you have questions or comments about this report, we encourage you to contact us.

Please write to: Environmental Epidemiology
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1st Floor Cordell Hull Building
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Or call us at: 615-741-7247 or toll-free 1-800-404-3006 during normal business hours

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SUMMARY

INTRODUCTION

The Tennessee Department of Health's Environmental Epidemiology Program (EEP) wrote this health consultation based on the request of Ms. Yuen Lee with the Chattanooga-Hamilton County Regional Planning Agency (CHCRPA). The purpose of this health consultation is to document our review of supplied environmental soil and groundwater sampling data collected from the potential Brownfield site Tennessee Avenue and Railroad Overpass (Alton Park Area 2). This site consists of three tax (property) parcels in Chattanooga, Hamilton County, TN. All three parcels grouped together form a roughly rectangular shaped property bordered on the north by an active railroad, on the west by Tennessee Avenue, on the south by a strip mall shopping center, and on the east by undeveloped properties.

All data supplied for this health consultation was compared to residential and industrial health screening values provided by the Agency for Toxic Substance and Disease Registry (ATSDR) and the Environmental Protection Agency (EPA). Screening levels are chemical concentrations based on toxicology below which no adverse health effects are predicted to occur. When a screening level is exceeded, it does not immediately indicate that people would be expected to develop adverse health effects. Instead, it simply means that the potential health risk requires further investigation.

Ensuring the wellbeing of those living in, working in, or visiting the city of Chattanooga is a priority of the Tennessee Department of Health (TDH), Environmental Epidemiology Program (EEP).

CONCLUSIONS

EEP reached eight important conclusions in this health consultation:

Conclusion 1

EEP concludes that there are multiple physical hazards at the site that could harm the health of adults or children.

Basis for Conclusion

Scattered debris and mounds of asphalt, concrete, soil, and scattered glass were observed throughout the majority of the site. Additionally, the site is bordered by an active railroad. Heavy vegetation is present throughout the site.

Next Steps

Upon proper site closure, access to the debris would be prevented. The owner of the property, the City of Chattanooga, should restrict access to the site or post signs that warn the site contains physical hazards.

Conclusion 2	EEP concludes that contact with metals, pesticides, and volatile organic compounds (VOCs) in the surface soil of the Tennessee Avenue and Railroad Overpass site (Alton Park Site #2) is not expected to harm the health of adults or children.
Basis for Conclusion	All identified concentrations of metals (arsenic and lead), pesticides and VOCs in the surface soil at the site were below the levels expected to harm the health of adults and children.
Next Steps	No actions are planned with respect to these chemicals in surface soils at the site. If the site is closed in accordance with the TDEC dump closure rules, it can then be redeveloped into a green space area for the community.

Conclusion 3	EEP concludes that contact with polycyclic aromatic hydrocarbons (PAHs) in the surface soil at the site is not expected to harm the health of adults or children.
Basis for Conclusion	Calculated theoretical risk below one in one million (10^{-6}) is considered insignificant. However, risk assessors consider calculated theoretical risks that are less than one in one thousand (10^{-4}) to be low and within the acceptable range. Risks for adults and children from exposure to metals and PAHs are within acceptable ranges (less than 10^{-4}) as determined by U.S. Environmental Protection Agency and the Agency for Toxic Substances and Disease Registry.
Next Steps	No actions are planned with respect to these chemicals in surface soils at the site. If the site is closed in accordance with the TDEC dump closure rules, it can then be redeveloped into a green space area for the community.

Conclusion 4	EEP concludes that contact with pesticides, polychlorinated biphenyls (PCBs), and VOCs in the subsurface soil of the site is not expected to harm the health of adults or children.
Basis for Conclusion	Given the worst case scenarios, the conservatively estimated theoretical risk for adults and children exposed to PCBs and VOCs in the subsurface soil of the site is in the acceptable range. Access to subsurface soils at the site would be eliminated if the site is properly closed in accordance with the Tennessee Department of Environment and Conservation (TDEC) open dump closure regulations. Additionally, institutional controls could be placed on the property to further prevent future contact with site subsurface soils.

Next Steps

No actions are planned with respect to these chemicals in surface soils at the site. If the site is closed in accordance with the TDEC dump closure rules, it can then be redeveloped into a green space area for the community.

Conclusion 5

EEP concludes that contact with PAHs in the subsurface soil of the site is not expected to harm the health of adults or children.

Basis for Conclusion

Calculated theoretical risk below one in one million (10^{-6}) is considered insignificant. However, risk assessors consider calculated theoretical risks that are less than one in one thousand (10^{-4}) to be low and within the acceptable range. Given the worst case scenarios, the conservatively estimated theoretical risk for adults and children exposed to PCBs and VOCs in the subsurface soil of the site is in the acceptable range.

Additionally, if the site is properly closed and institutional controls placed on the property, access to the subsurface soils would be prevented.

Next Steps

No actions are planned with respect to these chemicals in surface soils at the site. If the site is closed in accordance with the TDEC dump closure rules, it can then be redeveloped into a green space area for the community.

Conclusion 6

EEP concludes that drinking groundwater that contains lead from the site is not expected to harm the health of adults or children, because no one is using the groundwater as a source for drinking eater and it is unlikely that groundwater will be used as a source for drinking water in the future.

Basis for Conclusion

Given the worst case scenario, the conservatively estimated theoretical risk for adults and children exposed to lead the groundwater is in the acceptable range of between one-in-a-million (10^{-6}) risk to less than one-in-ten thousand (10^{-4}).

Also if the site is properly closed in accordance with TDEC regulations, access to site groundwater would be prevented. Institutional controls could also be placed on the site to further eliminate any future exposure potential to site groundwater.

Next Steps

No actions are planned with respect to these chemicals in surface soils at the site. If the site is closed in accordance with the TDEC dump closure rules, it can then be redeveloped into a green space area for the community.

Conclusion 7	EEP concludes that drinking the volatile organic compound (VOC) naphthalene in the groundwater is not expected to harm people's health. No one is using the groundwater as a source for drinking eater and it is unlikely that groundwater will be used as a source for drinking water in the future.
Basis for Conclusion	The concentrations of naphthalene are below the established ATSDR RMEG for naphthalene. Additionally, once the site is properly closed, any contact to site groundwater will be eliminated. Therefore, the naphthalene in the site groundwater is not expected to be a health concern. Groundwater at the site is not currently used for drinking water. Again, if the site is properly closed in accordance with TDEC regulations and institutional controls placed on the site, access to site groundwater would be eliminated as would any harm to the health of adults and children.
Next Steps	No actions are planned with respect to these chemicals in surface soils at the site. If the site is closed in accordance with the TDEC dump closure rules, it can then be redeveloped into a green space area for the community.

Conclusion 8	EEP concludes that drinking the volatile organic compound (VOC) 1,2,4-trimethylbenzene in the groundwater is not expected to harm people's health. No one is using the groundwater and it is unlikely that groundwater will be used as a source of drinking water in the future.
Basis for Conclusion	Given the worst case scenario, the conservatively estimated theoretical risk for adults and children exposed to the VOC 1,2,4-trimethylbenzene in the groundwater is higher than the acceptable range. Groundwater at the site is not currently used as drinking water. Again, if the site is properly closed in accordance with TDEC regulations and institutional controls placed on the site, access to groundwater would be permanently eliminated as would any harm to the health of adults and children.
Next Steps	No actions are planned with respect to these chemicals in surface soils at the site. If the site is closed in accordance with the TDEC dump closure rules, it can then be redeveloped into a green space area for the community.

FOR MORE INFORMATION

If you have any questions or concerns about your health, you should contact your healthcare provider. For more information on this site and others, call EEP at 615-741-7247 or toll-free 1-800-404-3006 during normal business hours.

Introduction

Ms. Yuen Lee, Director of Information & Research with the Chattanooga-Hamilton County Regional Planning Agency (CHCRPA) contacted the Tennessee Department of Health's (TDH), Environmental Epidemiology Program (EEP) about the potential redevelopment of three parcels of property. The three parcels are located immediately east of Tennessee Avenue and the railroad overpass in the Alton Park neighborhood of South Chattanooga. The property parcels were the subject of Phase 1 and Limited Phase 2 Environmental Site Assessments funded by U.S. Environmental Protection Agency (EPA) Brownfield Grants. The CHCRPA is gathering information from the community on what redevelopment uses would be acceptable to the community. Initial suggestions were for some type of recreational or public use. The location of the property is shown in Figures 1 and 2. With the redevelopment of this property in mind, EEP has been involved with meetings, discussions, and planning with stakeholders. EEP was supplied environmental sampling data to review. EEP was asked to provide guidance in understanding the scope of potential remediation efforts based on current and historical land use. The purpose of this health consultation is to document this review and the associated findings.

Background

The property at Tennessee Avenue and the railroad overpass site has been identified as a potential Brownfield site by CHCRPA. A Brownfield site is a property in which the expansion, redevelopment, or reuse may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant (EPA 2007). To be able to reuse such property, the EPA developed the Brownfield Program in 1995 which allows interested parties to apply for money to clean up the contaminated area so that it is safe for community members to use (EPA 2007).

The site is located at 3732 Tennessee Avenue and West 40th Street in Chattanooga, Hamilton County, Tennessee, and is identified as Tax Parcels 155O M 009, 155O M 010, & 155O N 002. The three tax parcels that comprise the site will be discussed collectively. The property is undeveloped and totals approximately 9.45 acres (Figures 2 and 3). Another undeveloped property borders the site to the east. Railroad tracks border the subject property to the north. Tennessee Avenue and commercial sites border the property to the west. Commercial establishments, such as a strip mall shopping center and undeveloped land, border the site to the south. The site slopes toward the railroad tracks to the north and is densely wooded and overgrown (Figure 3).

Various piles of refuse, asphalt, concrete, and scattered debris were observed on the property (Aquaterra 2009a). These observations suggested that the site had a history of being used as a dumping site. The environmental consultants retained by CHCRPA to conduct environmental investigations at the site interviewed Mr. John Nolen of the EPA to determine the historical use of the property. Mr. Nolan identified the subject property as the West 40th Street Landfill. The West 40th Street Landfill was first assessed by EPA and TDEC in 1985 for an unknown reason. It was assigned a low priority action level. The site was later inspected by TDEC and EPA in 1986 and was assigned a "no further remediation action planned" status. The EPA has the West

40th Street Landfill site listed as an archive site with no further remediation action planned. Because the site was used as a landfill, there is a potential for the site to be contaminated with volatile organic compounds (VOCs), metals, and polycyclic aromatic hydrocarbons (PAHs).

A site visit conducted by the Chattanooga-Hamilton County Health Department on May 7, 2009, revealed that much of the site was wooded. There was debris scattered across it, and it had signs of people using the site as their temporary residence. Overall the site resembled an overgrown junkyard. Piles of broken asphalt were scattered about the site (Figure 4) as are old tires, broken glass, and trash. The glass is located mainly in the southeastern corner of the site. A pile of discarded slag material is present in the northwestern portion of the site. In addition to trash, an accessible drainage ditch conveying runoff water runs along the railroad tracks along the northern boundary of the site (Figure 5).

It was noted by Aquaterra during the Phase 2 Limited Environmental Site Assessment (ESA) that the landfill did not appear properly closed. Homeless people appeared to be living on the property. Because the dump does not appear to be properly closed, there is potential exposure for anyone who enters this property. The environmental consultant that performed the Phase 2 ESA recommended that the site should be closed in accordance with the Tennessee Division of Solid Waste Management (DSWM) open dump closure regulations and guidelines. They also recommended that a notice be placed on the deed stating that a dump is present on the property. Further deed restrictions recommended to the CHCRPA included restricting the use of groundwater from the site and restricting excavation below the depth of a future soil cap that would be placed on the site for proper closure (Aquaterra 2009b).

According to Aquaterra, the CHCRPA's consultant, there may be limited economically-viable future uses for the site. Site use is limited due to potential excessive costs for removal of the solid waste from the former onsite landfill. Potential uses would include converting the site to green space once proper dump closure activities are complete. Another use would be converting a portion of the site devoid of waste to commercial use (along Tennessee Avenue) with the remaining portion converted to green space. It was the consultant's opinion that no structures should be built on the site because of potential subsidence and the related foundation issues associated with the waste and fill material present (Aquaterra 2009).

Discussion

Potentially Exposed Populations

There were two potentially exposed populations identified for the site. One is the reported trespassers who are using the site as their home. This homeless population was noted by the environmental consultants who performed the Phase 2 ESA. Chemicals with concentrations above health comparison values will be evaluated for this trespasser resident scenario. A second potentially exposed population depends on the site's future use which has not yet been finalized. If the site is used for a future green space park, potentially exposed populations include both children and adults who would play at the future park or would attend events at the green space. Similar to the trespasser scenario, adults and children using the park may be exposed to soil and/or groundwater containing chemicals.

Exposure Assessment

The term chemical of concern (COC) is often applied when the concentration of a screening level, such as a cancer risk evaluation guide (CREG), an Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk level (MRL), or an EPA regional screening level (RSL), is exceeded. Chemicals of concern require further investigation. With the identification of a chemical of concern, the potential chemical exposure scenario, including exposure potential, dose, duration, and frequency, needs to be thoughtfully considered.
People have to come into physical contact with contaminated soils and/or groundwater and there must be a *completed exposure pathway* for adverse health effects to occur. A completed exposure pathway consists of five main parts including:

1. a source of the chemical in the environment;
2. a means for the chemical to migrate from its source to the soil;
3. a place where people come into contact with the chemical;
4. a pathway (route) by which people come into contact with the chemical such as ingesting, touching, or breathing; and,
5. people who could potentially be exposed (receptor population).

Pathways are also characterized based on whether the exposure occurred in the past, is occurring in the present, or may occur in the future.

Physical contact with chemicals present at the Alton Park Site #2 in the environment by itself does not necessarily mean that a person would develop adverse health effects. The chemical's ability to affect public health is also controlled by a number of other factors, including:

- how much chemical a person is exposed to (dose)
- how long a person is exposed to the chemical (duration)
- how often a person is exposed to the chemical (frequency)
- the person's age
- the person's diet and nutritional habits.

Past health effects at the site can only be qualitatively evaluated because of the limited number of samples collected from the top 0 to 6 inches of soil. Most of the site is well-vegetated (Aquaterra 2009b). Vegetative cover is an effective barrier in limiting exposure to contaminated soils. Past health effects are thought to be relatively minor due to the vegetative cover. Current health effects are more easily evaluated. Right now, incidental ingestion of soil and dermal contact with the soil are not expected to be major pathways of exposure because the site is well vegetated and people who use the site will be wearing shoes and clothing which provide a simple yet efficient barrier to dermal exposure. However, if the vegetative cover is worn away with frequent use, which it most likely will be along an access path to or within the property, then incidental ingestion and dermal contact may occur. There are trespassers that use the property. It was noted during the Phase 2 ESA that homeless people live on the property (Aquaterra 2009b). Therefore, both chemical and the physical hazards developed through historic dumping are a concern for any trespassers living on the property.

Inhalation of metals or polycyclic aromatic hydrocarbons (PAHs) is not believed to be a major pathway of exposure at this site. This is because most of the metals identified are at depth and the PAHs identified at this Brownfield site are high molecular weight compounds. As such, the PAHs present on-site do not readily volatilize. Even if volatilization were to occur, the contaminated soil is located on or below the ground surface whereas the breathing zone is several feet above ground surface. Over an area of this size, any PAHs that volatilize into the air are likely to be diluted, wind-mixed, and not detectable. Unless the site is excavated, trespassers using the site will not be exposed to significant concentrations of these chemicals.
Exposure to groundwater by trespassers or future green space users is not thought to be a concern. Groundwater occurs in the subsurface at the site. It is unknown if groundwater seeps migrate across the ground surface at the site. If seeps are found to occur and are found be impacted with site-related chemicals, this exposure to trespassers and future site users will have to be removed. While performing the Phase 2 investigation activities, Aquaterra found no evidence of seeps (Dallas Whitmill, personal communication, July 28, 2009). Therefore, without evidence of seeps, there was no obvious way identified on site that trespassers could access groundwater. No wells will be installed at the site; therefore, future recreational users will not have access to groundwater.

The CHCRPA's consultant recommended that the former West 40th Street Landfill at the Alton Park Site #2 be properly closed in accordance with the Tennessee Department of Environment and Conservation's Division of Solid Waste Open Dump Closure Regulations (Aquaterra 2009b). These regulations state that the site can be closed by placing two feet of compacted soil and one foot of suitable vegetative cover material (soil) or a synthetic membrane liner capable of meeting certain permeability restrictions with the one foot of vegetative cover soil. With placement of these materials, access to the impacted soil at the site is eliminated. The deed to the property would also be amended to state there is a dump present on the property. Further restrictions could also be placed on the property deed to prevent groundwater use and to prevent excavation through the soil cap thickness (Aquaterra 2009b). In addition to these deed restrictions, a site maintenance plan that will ensure the public's health and safety should be instituted by the City of Chattanooga so as to maintain the usefulness of the future green space now and into the future.

Health Comparison Values

Scientists today cannot precisely determine at what level a particular chemical in the environment presents a clear and predictable risk to human health. Sometimes scientists in various government and private agencies disagree on the amount of a chemical necessary to harm a person. At this time, predicting risk from exposure to chemicals in the environment is based on the professional judgments of scientists skilled in toxicology, pharmacology, biochemistry, and other similar disciplines. A collection of studies, opinions, and experiments on chemical exposure makes up what is referred to as the environmental literature.

The Agency for Toxic Substances and Disease Registry (ATSDR), an agency under the Centers for Disease Control and Prevention (CDC), is charged by Congress with providing support in the assessment of any health hazard posed by Superfund or other hazardous waste sites. For non-carcinogenic effects of toxic chemicals, ATSDR derives a minimal risk level (MRL) for each

chemical using the environmental literature as the basis for their predictions of a level of that chemical this is without appreciable risk.

MRLs are derived from 'no observed adverse effects levels' (NOAELS) or from 'lowest observed adverse effects levels' (LOAELs). NOAELS are the highest tested dose of a chemical that has been reported to have no harmful health effects on people or animals. A LOAEL is the lowest test dose of a chemical that has been reported to cause harmful human health effects in people or animals.

From these MRLS, ATSDR has derived health guidance values, often called EMEGs (environmental media evaluation guidelines) for soil, air, and water. EMEGs serve as a screening guidance to help scientists look more closely at the people who might be exposed to harmful levels of chemicals. To use these screening levels we must know how much of a chemical someone is exposed to, for how long the exposure has been or will be occurring, how frequent the exposure is or will be, and the age of the exposed person. If concentrations are below the EMEG for a particular chemical, scientists can be reasonably certain that no adverse health effects will occur in people who are exposed.

If ATSDR does not have a published EMEG for a particular chemical, EEP uses EPA's health guidance values.

EPA is mandated to publish toxicity information that is very similar to ATSDR's MRLs and EMEGs. EPA's reference dose (RfD) and reference concentration (RfC) are analogous to ATSDR's MRL. One difference is that ATSDR must use information that is published, while EPA may use results of studies that are not published. There are other policy decisions that may result in ATSDR and EPA deriving different MRLs, RfDs, and RfCs for the same exposure frequencies. In addition, ATSDR derives EMEGs for chronic, intermediate, and acute exposure frequencies. Chronic exposure is defined as one year or more. Intermediate exposure is defined as 15 to 364 days. Acute exposure is defined as 14 days or less. EPA-derived RfDs and RfCs are for chronic or lifetime exposure.

If a chemical is a probable or known carcinogen, EPA derives a cancer-risk value for the chemical. EPA uses data from animal studies (and human epidemiology studies, if they are available) to extrapolate from high doses with known carcinogenic end points to very low doses using complex models. Often EPA assumes there is no threshold; that is, any exposure will result in some risk of cancer. This is an assumption that is valid in some cases and not in others, but for most chemicals we lack sufficient data to know the validity of the assumption. EPA then uses one of several models to determine the slope of the 95% upper confidence level of the extrapolated response at low concentrations. This derived slope factor is the number that represents the theoretical risk of excess cancer from exposure to the chemical in question per unit dose (EPA 1992). It is important to note that the cancer risk value is a statistically-derived number representing an upper 95% confidence level of a theoretical straight line predicting one extra cancer case in one million people, when the background lifetime risk of cancer is one in two for men and one in three for women (ACS 2005). ATSDR may publish a guidance value called a Cancer Risk Evaluation Guide (CREG) that equates to a theoretical risk of one excess cancer in a million people and is derived from EPA's slope factor.

When a health guidance value is exceeded, it does not immediately indicate that people would be expected to develop adverse health effects. Instead, it means that the potential health risk requires further investigation.

These health guidance values can be used for a variety of purposes. They should not be used for certain things. Examples of how guidance values can be properly and improperly used are outlined below.

Health guidance values may be properly used as:

- screening values to identify substances/chemicals of concern at hazardous waste sites that need further investigation into the toxicology of the substances,
- substance-specific trigger levels to identify possible need for further investigation of potential exposure scenarios,
- identification of populations at potential risk, and
- computation of other health guidance values.

Health guidance values should not be used as:

- threshold levels for a toxic effect,
- predictors of toxicity at any given level above the health guidance value,
- absolute values (since there is an inherent area of uncertainty surrounding the values),
- screening values for all effects and populations (without first evaluating the relevance of the critical effect upon which the health guidance value is based).

Environmental Sampling Conducted

Aquaterra Engineering, LLC (Aquaterra) performed subsurface soil sampling on November 20, and 21, 2008, at 9 locations across the site (Figure 3). To do so, four subsurface soil samples were collected. Four test pits and two soil borings, later converted into groundwater monitoring wells, were advanced. Subsurface soil grab samples were collected at selected depth intervals.

Surface soil sampling was performed on June 4, 2009. Surface soil samples were collected at a depth of 6-inches below the ground surface. Surface soil samples were collected to randomly assess the discontinuous soil cover and the fill and debris at the site (Aquaterra 2009a). In addition, surface soil samples were collected so that any potential adverse effects to people from the surface soils, if any, would be determined.

Subsurface soil samples were collected from test pits at a minimum of 6 feet and a maximum of 12 feet below ground surface (bgs) in an effort to describe the native soils beneath the fill and debris at the site. Specifically, test pit soil samples were collected from depths of 6 to 8 feet, 8 to 10 feet, and 10 to 12 feet bgs. Many of the samples were collected at depths composed of fill material. Fill material identified at the site included metal, wire, pipe, wood, glass, concrete, bricks, plastic, and construction debris. The fill and debris were measured to be a maximum of 12 feet in depth in the areas of investigation (Aquaterra 2009a). Soil samples were also

collected from two groundwater monitoring well borings installed on the property. These samples were collected from depths much greater than the test pit soil samples. Well boring samples were collected from depths of 34 to 36 feet bgs in the upgradient well and from 42 to 44 feet bgs in the downgradient well (Aquaterra 2009a).

Surface soil samples collected were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), eight Resource Conservation and Recovery Act (RCRA) metals, polychlorinated biphenyls (PCBs), pesticides, and herbicides.

All subsurface soil samples collected as part of the site investigation were tested for the following groups of chemicals: VOCs, SVOCs, RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), polychlorinated biphenyls (PCBs), pesticides, and herbicides.

Two groundwater monitoring wells were installed. Groundwater samples were collected from each well. Groundwater samples were collected and tested for the same chemicals as the soil samples (Aquaterra 2009a).

Results

Results of the Phase 2 ESA suggested the site has been contaminated from previous activities that took place when the site was used as the West 40th Street Landfill. There may also have been illegal dumping happening more recently at the site. The individual chemicals in site soil and groundwater will be evaluated in this section.

The surface and subsurface soil contaminant concentrations for the various chemicals identified were compared to the Agency for Toxic Substances and Disease Registry (ATSDR) child and adult health screening EMEGs and CREGs. In cases where ATSDR did not have an established EMEG or CREG, they were compared to the EPA Regional Screening levels (RSLs). The groundwater contaminant concentrations for VOCs were also compared to ATSDR's RMEGs and CREGs as well as EPA's Maximum Contaminant Levels (MCLs) for drinking water, where established.

Surface Soil Results

Concentrations of arsenic ranged from 7.1 to 12 mg/kg in the four surface soil samples (Figure 3). All of these concentrations were below ATSDR's EMEG in soil of 20 milligrams per kilogram (mg/kg). Results are shown in Table 1. Table 1 also lists the data for each surface soil sample where a metal or pesticide was identified and the EMEG, CREG, and EPA Regional Screening Level (RSL) comparison values.

Lead was detected in only one surface soil sample at a concentration of 410 milligrams per kilogram (mg/kg). Results are shown in Table 1. This level is slightly above EPAs regional screening level for residential soil.

No PCBs were identified in site surface soils.

Chlordane, a pesticide, was detected in surface soil samples SS-3 and SS-4 (Figure 3). Other pesticides, including 4,4-DDE, 4,4-DDT, and dieldrin, were detected only in surface soil sample SS-4. Concentrations of these compounds are shown in Table 1.

Analytical results of the surface soil samples collected also indicated SVOC concentrations above the applicable TDEC and EPA action levels. Chemicals such as benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno (1,2,3,-cd)pyrene were identified. Table 2 shows the analytical results of the samples tested.

Surface soil samples were not analyzed for VOCs, in part because no VOCs were identified above screening levels in subsurface soils.

Subsurface Soil Results

Analytical results of the subsurface soil samples collected from the test pits (Figure 3) during the completion of the limited Phase 2 ESA indicated concentrations above the applicable TDEC and EPA action levels for lead, dieldrin, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno (1,2,3,-cd)pyrene. Analytical results of the subsurface samples collected from the soil interval immediately above groundwater during the completion of the Phase II ESA indicated no concentrations above the applicable health guidance levels for any SVOC's, VOC's, RCRA metals, pesticides, herbicides, and PCB parameters analyzed.

Table 3 lists the data for each subsurface soil sample where a metal, PCB, or pesticide constituent was identified and the respective ATSDR EMEG, CREG, and EPA RSL comparison values. Arsenic and lead were identified in 5 of 9 subsurface soil samples collected having concentrations above their respective comparison values. No PCBs were identified above their applicable health comparison values in subsurface soil samples. Dieldrin was identified in one sample at a concentration above its residential RSL comparison value.

Table 4 lists the subsurface soil data for each sample where a PAH constituent was identified as well as the CREG and RSL comparison values and the PAH toxicity equivalency factors. Benzo[a]pyrene is the only PAH that has an ATSDR EMEG or CREG. Of the 9 soil samples tested, 6 had concentrations of PAHs.

Table 5 lists the VOCs in soil for each sample. No VOCs were detected above any comparison values in the 9 samples tested.

Groundwater Results

Groundwater sampling from wells installed (Figure 3) during the limited Phase 2 ESA indicate the presence of lead, naphthalene, and 1,2,4-trimethylbenzene above applicable ATSDR, TDEC and/or EPA action levels.

Table 6 lists the groundwater data for metals, PCBs, pesticides, and herbicides and the CREG, tap water RSL, and EPA MCL comparison values. Table 7 lists VOCs and SVOCs identified in groundwater in addition to respective health comparison values.

Chemicals of Concern (COC)

The chemicals of concern (COC) at the site are those chemicals that are present in surface soil, subsurface soil, and groundwater in concentrations that exceed their comparison or screening values. The screening values referenced are for residential exposure to bare soil. These screening values are often derived from a scenario of constant, daily exposure over a lifetime. The Tennessee Avenue and the railroad overpass site (former 40th Street Landfill property) reportedly has adequate ground vegetative cover. Worn paths may be present throughout the site. The likely exposure scenario is daily and fairly constant for resident trespassers who use the site. As mentioned earlier, when a measured environmental chemical concentration exceeds a health screening level, it does not indicate that people would be expected to develop adverse health effects. It does mean that any exposure scenarios, including exposure potential pathways, duration, and frequency, need to be thoughtfully considered.

Each chemical that is identified as a COC at the site, either in surface soil, subsurface soil, or groundwater, is evaluated more fully to understand if it is a concern based on potential site re-use.

For surface soil, the metals, arsenic and lead, are COPCs. The PAHs benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno (1,2,3,-cd)pyrene are also chemicals of potential concern as are the pesticides chlordane and dieldrin.

For subsurface soils, the metal, lead, and the pesticides chlordane and dieldrin were identified as COPCs. Additionally, PAH compounds including benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno (1,2,3,-cd)pyrene.

Groundwater contains the following COPCs: lead, naphthalene, and 1,2,4-trimethylbenzene.

Toxicity of Chemicals of Potential Concern

Polycyclic Aromatic Hydrocarbons (PAHs) Discussion

Polycyclic aromatic hydrocarbons, commonly called PAHs, are a group of chemicals derived following the incomplete combustion of organic materials such as coal, oil, gas, wood, garbage, tobacco or meat. PAHs usually are found as complex mixtures of chemicals rather than just as individual chemicals. Many of the PAHs are ever-present in the environment. PAHs occur naturally or can be manufactured. More than 100 types of PAHs are known to exist throughout the environment, including in the air, water, and soil. Only a few of these PAHs are known to be harmful. The ATSDR Toxicological Profile (1995) is an excellent source of information on the toxicology and epidemiology of polycyclic aromatic hydrocarbons.

PAHs including benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene, and indeno[1,2,3-c,d]pyrene, have caused tumors in laboratory animals through inhalation, ingestion, and long-term dermal exposure. Studies of people showed that some individuals exposed, by inhaling or by skin contact, for long periods of time to mixtures that contain PAHs and other compounds can

develop cancer (ATSDR 1995). The observed effect level for carcinogenic endpoints is much, much lower than for non-cancer endpoints. Thus, it is commonplace to focus on the potential cancer effects of PAHs.

There are many uncertainties in the toxicological assessment of PAHs. It is known that different PAHs have different toxic potencies. A Toxicity Equivalency Quotient Factor (TEQ) methodology has been developed that combines the relative toxicities of individual potentially carcinogenic PAHs in relation to benzo[a]pyrene, the PAH determined to be the most hazardous (EPA 2004). Tables 2 and 4 contain TEQ values for each PAH compound identified in surface and subsurface soils, respectively. TEQ totals above 0.1 mg/kg may be harmful to humans.

Volatile Organic Compounds (VOCs) Discussion

Volatile Organic Compounds are a variety of carbon-containing chemicals that readily evaporate into air at typical room temperatures. Many VOCs are man-made. They are used in a wide variety of products such as paint, cleaning supplies, pesticides, building materials, petroleum fuels, and office equipment such as copiers and printers. Such products emit VOCs as gases which can be released during use and, to some degree, when stored. VOCs are also common groundwater contaminants (EPA 2009). Because VOCs readily evaporate into the air, there is potential for the resulting vapors to enter nearby buildings through foundation cracks, holes in concrete floors, and small gaps around pipes and utility lines whenever VOCs are in groundwater or soil. This is referred to as vapor intrusion (EPA 2004).

Some VOCs may have short and long term adverse health effects depending on their toxicity. Immediate adverse health effects include eye, nose, and throat irritation as well as headaches, loss of coordination, nausea, and memory impairment. More long-term VOC exposure can result in damage to the liver, kidneys, and central nervous system. Additionally, some VOCs are known to cause cancer in animals and some are suspected or known to cause cancer in humans. As with other pollutants, the extent and nature of the health effect depends on many factors such as dose, duration, and frequency of exposure (EPA 2009).

Naphthalene was detected in a groundwater sample from the site. A discussion of naphthalene follows. Naphthalene, also known as mothballs, moth flakes, white tar, and tar camphor, is a VOC that was detected in MW-2. When it is a solid, naphthalene is white and has a strong, although not unpleasant, smell. Naphthalene vapors readily burn when mixed with air. It is a natural component of fossil fuels such as petroleum and coal and is produced when burning tobacco or wood. The main use of naphthalene is to make other chemicals used in making polyvinyl chloride (PVC) plastics. It is also used to make moth repellents, toilet deodorant blocks, dyes, leather tanning agents, and the insecticide carbaryl (ATSDR 2005).

Small amounts of naphthalene will dissolve into the bloodstream once it enters the body. The blood will then carry the naphthalene to the liver and other organs which will break the chemical down, allowing it to pass through the body. Removal is expected to occur within 1 to 3 days (ATSDR 2005).

Exposure to a large amount of naphthalene could damage or destroy red blood cells. This could result in a shortage of red blood cells until the body can replace those which have been destroyed. This shortage of red blood cells is known as hemolytic anemia. Symptoms of hemolytic anemia include tiredness, loss of appetite, restlessness, and pale skin. Exposure to a large amount of naphthalene could also cause nausea, vomiting, diarrhea, blood in the urine, and yellow skin. Animals which have swallowed large amounts of naphthalene have sometimes developed cataracts (cloudiness) in their eyes. Although it is not certain whether exposure to naphthalene also causes cataracts in humans, the possibility does exit. Additionally, when exposed to naphthalene vapors everyday for 2 years, naphthalene has been shown to damage the lining of the nose and lungs of mice and rats. Some exposed rats have also developed nose tumors and some female rats have developed lung tumors. When mice and rats were given food contaminated with naphthalene for 13 weeks, there was a decrease in body weight but no tumors or other tissue changes were identified. Furthermore, no tumors were identified in a 2-year study in which rats were fed naphthalene at a dose of 41 mg/kg-day. Based on these findings, the EPA considers naphthalene to be a possible human carcinogen (ATSDR 2005).

Surface Soil Chemicals of Potential Concern (COPC)

Arsenic has a chronic exposure (greater than 365 days) EMEG of 200 parts per million (ppm) for an adult and 20 ppm for a child. Its CREG is 0.5 mg/kg. The background level of arsenic in Tennessee soils is 10 mg/kg (TDEC 2001), with a range of 0.1 to 120 mg/kg. This background value is only slightly greater than the average background arsenic concentration in U.S. soils (Shacklette and Boerngen 1984) of 7.2 mg/kg. The range of arsenic in the surface soil samples was from 7.1 to 12 mg/kg with an arithmetic mean of 9.5 mg/kg. This is well within the range of background concentrations of arsenic in Tennessee soils. Therefore, arsenic is will not be evaluated further.

Lead is present in surface soils in a range of concentrations from 22 to 410 mg/kg. The arithmetic mean of the four samples collected is 188.5 mg/kg. The concentration of 410 mg/kg is slightly above its EPA residential soil RSL of 400 milligrams per kilogram (mg/kg). The EPA residential RSL of 400 mg/kg is established to protect the health of residents and is based on a residence being occupied 350 days per year, 24 hours per day, during a lifetime of 70 years. The background level of lead in Tennessee soils is 45 mg/kg. The Tennessee background value is over twice the reported average value for normal U.S. soils reported by Shacklette and Boerngen (1984) of 19 mg/kg. With only one sample slightly exceeding the EPA residential RSL for lead and the mean of 189 mg/kg which is less than the residential RSL, lead will not be evaluated further.

The pesticides, chlordane, 4,4-DDE, 4,4-DDT, and dieldrin, were detected in 2 of the 4 samples collected. Concentrations of chlordane, 4,4-DDE, 4,4-DDT, and dieldrin in the 2 samples were all below ATSDR chronic EMEG or CREG comparison values. Therefore, while these chemicals are present in the surface soil, their concentrations are such that they would not harm the health of trespassers using the site and will not be evaluated further.

The PAHs identified in the surface soil of the site, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene, exceeded the ATSDR CREG of 0.1 mg/kg toxicity equivalency. Inhalation of PAHs is not believed to be a major

pathway of exposure at the site. This is because the PAHs identified at this site are high molecular weight compounds. As such, the PAHs present on-site do not readily volatilize. Even if volatilization were to occur, the contaminated soil is located on or below ground surface whereas the breathing zone is several feet above ground surface. Over an area of this size, any PAHs that volatilize into the air are likely to be diluted, wind-mixed, and not detectable.

Similar to the inhalation of PAHs, dermal contact with the PAHs at the site is also not expected to be a major pathway for exposure. Some dermal absorption of PAHs may occur through direct contact with skin. However, PAHs bind to organic matter in the soil, which decreases its bioavailability through skin absorption (ATSDR 1998).

Using the detected concentrations and one-half the detection limit for constituents reported as non-detect, the toxicity equivalency concentrations for the entire site ranged from 0.0000165 to 1.1 mg/kg (Table 2) with an arithmetic mean of 0.467 mg/kg. The concentration range for benzo[a]pyrene (B[a]P) was <0.033 (non-detect) to 1.1 mg/kg with an arithmetic mean of 0.523 mg/kg. These values exceed the ATSDR health screening CREG for a one-in-a-million (10^{-6}) excess cancer risk of 0.1 mg/kg (ATSDR 2004). Thus B[a]P equivalents in the surface soil at the site are a public health concern.

Future site redevelopment and remediation may be undertaken. Redevelopment as a future green space is the most feasible remedial option and would require closure of the site in accordance with TDEC landfill closure guidelines. These guidelines typically include installing a two-foot thick cap of soil over the site. With installation of the soil cap, any concentrations of chemicals in the surface soils would be buried and not available for exposure to humans. Careful and constant site maintenance would be required to ensure that public health would not be adversely affected.

Subsurface Soil Chemicals of Potential Concern (COPCs)

Using the detected concentrations and one-half the detection limit for constituents reported as non-detect, the total arsenic concentration for all 9 subsurface soil samples ranged from 0.5 mg/kg (non-detect) to 8.9 mg/kg with an arithmetic mean of 3.97 mg/kg. ATSDR's EMEG for arsenic is 20 mg/kg. The background level of arsenic in Tennessee soils is 10 mg/kg (TDEC 2001). This background value is only slightly greater than the average background arsenic concentration in U.S. soils (Shacklette and Boerngen 1984) of 7.2 mg/kg. All 9 arsenic sample results at the site are lower than ATSDR's EMEG and the Tennessee soils background concentration. Therefore, arsenic will not be considered further. Redevelopment of the site for recreational purposes would require proper closure of the site. Site closure would render subsurface soils inaccessible to those using the site.

For lead, using the detected and non-detect concentrations, for the 9 soil samples, concentrations ranged from 4.7 to 940 mg/kg with an arithmetic mean of 188.91 mg/kg. As mentioned previously, the background level of lead in Tennessee soils is 45 mg/kg. The Tennessee background value is over twice the reported average value for normal U.S. soils reported by Shacklette and Boerngen (1984) of 19 mg/kg. The single lead concentration of 910 mg/kg at location TP-4 from 8 to 10 feet bgs exceeds both the EPA residential RSL of 400 mg/kg and industrial RSL of 800 mg/kg. This was the only sample to exceed these comparison values.

Evaluating the site using the average lead concentration of 189, lead should not be concern for health effects of lead at the site. Redevelopment of the site for recreational purposes would require proper closure of the site. Site closure would render subsurface soils inaccessible to those using the site. Therefore, lead will not be evaluated further.

Only one pesticide, dieldrin, was detected in 1 of the 9 samples collected. Concentrations of dieldrin in the one sample were below the applicable ATSDR chronic EMEG s. The dieldrin concentration was equal to the EPA RSL of 0.03 mg/kg. Dieldrin in subsurface soil will not be evaluated further.

When looking at the PAHs identified in the subsurface soil of the site, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceeded the respective ATSDR CREG toxicity equivalency comparison value of 0.1 mg/kg at several locations (Table 2). Therefore, based on the potential cancer risk due to exposure to benzo(a)anthracene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, and benzo(a)pyrene, these 4 PAHs are considered chemicals of concern.

Worst-case scenarios can be evaluated by focusing on the contaminated areas of the site. Soil samples were taken at a total of 9 discreet depths. Of the 3 soil samples where PAHs were detected, the total PAH concentration ranged from 0.27 to 11 mg/kg with an arithmetic mean of 3.01 mg/kg. Soil sampling locations TP-1 from 6 to 8 feet bgs, TP-3 from 10 to 12 feet bgs, and TP-4 from 10 to 12 feet bgs had total PAH concentrations exceeding the average with location TP-3 being more than twice the average. This test pit location is in the site's east-central portion and near the toe of the northern sloping topography. No PAH-contaminated soil was detected at depth in the southern portion of the site (Figure 3). The PAH toxicity equivalency of the 9 soil samples ranged from 0.000165 to 6.7 mg/kg with an arithmetic mean of 0.11 mg/kg (Table 10). Soil sampling location TP-3 from 10 to 12 feet bgs had PAH toxicity equivalencies exceeding this average. This sample location had one toxicity equivalency value nearly five times the average toxicity equivalency concentration (Table 9). The ATSDR B[a]P CREG is 0.1 mg/kg. Therefore PAHs could be of concern if people were exposed to them.

As with surface soils, inhalation of PAHs in subsurface soils is not believed to be a major pathway of exposure at the site. This is because the PAHs identified are high molecular weight compounds and do not readily volatilize. Even if volatilization were to occur, the contaminated soil is located well below ground surface. The concentrations of PAHs in subsurface soils would not be encountered by individuals using the site, especially if the former dump site is closed in accordance with the TDEC DSWM regulations.

The PAHs are not absorbed. Some dermal absorption of PAHs may occur through direct contact with skin. However, PAHs bind to organic matter in the soil, which decreases its bioavailability through skin absorption. Dermal contact with the PAHs in subsurface soil at the site is also not expected to be a pathway for exposure because they will be inaccessible when the site is properly closed.

VOCs in subsurface soil samples were all below their respective ATSDR comparison values, where established. VOCs, where detected above method detection limits, were detected in very minor concentrations. Therefore, VOCs are not COPCs in subsurface soil of the site.

Groundwater Chemicals of Potential Concern (COPCs)

Lead was detected at a concentration of 0.029 milligrams per liter (mg/L) in MW-2, one of the two wells installed at the site. Lead was not detected in the second well (detection limit of 0.005 mg/L). The EPA Maximum Contaminant Level (MCL) for lead in drinking water is 0.015 mg/l. Since lead was detected in MW-1 above the EPA MCL, it would be of concern if anyone were drinking the groundwater.

The VOC naphthalene in the groundwater at both MW-1 and MW-2 at the site exceeded the EPA cancer and non-cancer health effects RSLs. Naphthalene concentrations in the groundwater samples range from 7.7 to 14 micrograms per liter (µg/L). In the absence of an EMEG, ATSDR develops reference dose media evaluation guides (RMEGs) for chemicals. The RMEG for naphthalene is 200 µg/L. Therefore, the concentration in MW-2 of 14 µg/L is below the ATSDR RMEG and should not be a health concern to anyone drinking the groundwater.

It is unlikely that anyone will be drinking groundwater from the site at any point in the future as there are no wells installed on the site for drinking purposes. The Brownfield site is within the area serviced by municipal water. The monitoring wells installed as part of the Phase 2 ESA have been properly abandoned. As part of the potential redevelopment of the site as community green space, restrictions will be placed such that no site groundwater will be used as a drinking water source.

It is unknown if there is the possibility of groundwater seeps migrating across the ground surface at the site. Investigators attempted to locate and sample onsite seeps but none were located. If any such seeps are identified in the future and found to be impacted with site-related chemicals, the exposure to trespassers and future site users must be evaluated.

Calculating an Intake Dose

As stated previously in this health consultation, there are trespassers that use the site as their place of residence. Even though the people using the site should not be on the property, there are legal implications for the owner of the property if a person becomes harmed while on the property either from physical hazards or chemical hazards.

To determine if people are at an increased risk of adverse health effects from a chemical, a health investigator will often calculate the dose received when various exposure scenarios are considered. This is done to evaluate the exposure potential of chemicals identified in concentrations above their comparison or screening values. The following equation can determine the amount of a contaminant a person ingests by incidentally eating contaminated soil:

$$Dose = \frac{Concentration \times AmountEaten \times FractionIngested \times ExposureDuration \times ExpFrequency}{BodyWeight \times AveragingTime}$$

For a site resident/trespasser that is living at the site in a temporary or crude permanent structure, taking the maximum concentration of a contaminant coupled with a 10 hour per day exposure duration would make a worst case scenario example. Standard assumptions of 70 kg adult body weight and a 2-year exposure duration were incorporated (given the transient nature of the homeless, this is a long period of time to reside in one area). The amount of soil incidentally ingested is also a standard assumption of 100 mg/day for adults. In this scenario, exposure to contaminated soil happens for 10 hours every day, 365 days a year. Assuming exposure for 2 years for adults, this equals a total exposure (averaging time) of 730 days for an adult resident/trespasser.

It is unlikely that any children would be trespassing and using this site as a residence. However, children may visit the site to explore. Therefore a worst-case child exposure is calculated based on standard assumptions of 16 kg child body weight and 10-year exposure duration. The amount of soil incidentally ingested is also a standard assumption of 200 mg/kg for children. We can assume the fraction ingested was 1 or all soil eaten is of maximum contaminant concentration, a worse-case scenario. Also, it is assumed that complete contaminant absorption occurs by the human body. The exposure scenario for a child trespasser (not living at the site) assumes an exposure to contaminated soil for 4 hours per day 200 days per year for 10 years.

The appendix shows calculated intake doses for chemicals of concern at the site. Intake doses are calculated for surface soil ingestion of metals (arsenic and lead) as well as dermal contact with surface soils containing arsenic and lead. PAH intake doses were also calculated for surface soils. These intake doses were evaluated to determine if a worst-case scenario will affect resident trespassers while they live at the site. Dermal contact doses were also evaluated because of the possibility of contact with surface soils as site residents/trespassers may not have access to bathing facilities and hence soil may adhere longer to their clothes and bodies. Both ingestion of and dermal contact with site soils containing PAHs should not harm the health of adults or children. The risks for both ingestion and dermal contact were within the risk range deemed acceptable by both ATSDR and EPA (EPA 1991).

For subsurface soil, intake doses were calculated for the metals arsenic and lead as well as PAHs as a worst-case scenario. Contact with subsurface soil at the site would be achieved through digging or excavation. There is no evidence at the site to show that this is a current exposure pathway. Subsurface soil is buried beneath site surface soils. Subsurface soil metals and PAHs are not expected to affect human health, especially if the site will be capped and closed in accordance with TDEC regulations and ultimately redeveloped as green space. The site will have to be closed in accordance with the TDEC Dump Closure Regulations, which require a low permeability barrier to prevent precipitation from moving downward through the waste material dumped onsite. The barrier can either be a synthetic liner or 2 feet of compacted soil. In addition to this low permeability cap, 1 foot of vegetative cover soil will also be required. The vegetative cover soil will be thick enough to support grass which must be maintained. With the proper closure of the site through the installation of a soil cap, the routes of exposure for humans to contact concentrations of metals in the subsurface soils will be removed.

Groundwater intake doses were calculated for lead and the VOCs naphthalene and 1,2-trimethylbenzene as a worst-case scenario. Like subsurface soil, there will be very limited

opportunity for people to come into contact with groundwater containing concentrations of site-related chemicals. As discussed above, redevelopment will consist of proper closing of the site according to accepted closure regulations. The pathway for exposure of individuals to groundwater will be eliminated once the site is properly closed.

As stated previously, there is not a completed exposure pathway for groundwater ingestion at the site. No wells were identified onsite other than the monitoring wells installed for site evaluation. These wells are locked and protected by a steel casing when they are not being sampled. Trespassers do not have access to groundwater. When the site is redeveloped into green space, he likely remedial option will include covering the site with a low permeability cap and establishing a sustained vegetative cover. The cap will prevent access to groundwater. Additionally, there will likely be an institutional control such as a restriction placed on the ability to use groundwater from the site for any purpose.

Physical Hazards

As mentioned earlier, a site visit was conducted by the Chattanooga-Hamilton County Health Department on May 7, 2009. The visit revealed that much of the site was wooded. There was debris scattered across it, and it had signs of people using the site as their temporary residence. Piles of broken asphalt were scattered about the site (Figure 4) as are old tires, broken glass, and trash. The glass is located mainly in the southeastern corner of the site. A pile of discarded slag material is present in the northwestern portion of the site. In addition to trash, an accessible drainage ditch conveying runoff water runs along the railroad tracks along the northern boundary of the site (Figure 5).

There was also evidence of trespassers using the site as their temporary residence (Figure 6). It appears that water stands or is transported across the surface of the site when there are heavy rains as was the case when the site was visited (Figure 7). Access to the site is not controlled allowing people to trespass across the site. All materials dumped onsite are easily accessible to the public and any children who may use the site.

Children's Health Considerations

In the preparation of this public health document, the health and wellbeing of children was thoughtfully considered. Even though it is highly unlikely that children are residing on the property, children may explore areas of the property. The health effects of the site on children are discussed.

In communities faced with environmental contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposure to hazardous substances (ATSDR 1997, 1998). Children's bodily systems are still developing. These systems can sustain permanent damage if toxic exposure levels are high enough during critical growth stages. Children also eat more food, drink more liquids, and breathe more air in proportion to their body weight. This lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body size. Behavior patterns of children as well as their limited ability to understand environmental public

health can also result in more exposure to hazardous substances. Because children are dependent on adults for access to housing, medical care, and risk identification, adults need as much information as possible to make informed decisions regarding their children's health (ATSDR 1997a).

Therefore, the hand-to-mouth behavior of young children requires special attention. Toddlers will sometimes display pica behavior. Older children and teenagers are likely to be the main population using this area for recreational purposes. In addition to incidental ingestion, metals, pesticides, and PAHs adhered to soils can travel on clothes and pets into homes. Thus, the outdoor activities of children and teenagers, in relation to playing at the site, require thoughtful consideration.

Metals and PAHs will adhere to soil particles. Adults and children could therefore be exposed to metals and PAHs at the Tennessee Avenue and Railroad Overpass (Alton Park Area 2) site by getting the soil on their skin. Consequently, the lack of bathing facilities available to residents/trespassers at the site requires special attention. Soil will likely stay on trespassers hands longer because they have no facilities to wash and clean their hands.

In addition to incidental ingestion, metals and PAHs adhered to soils can travel on clothes and pets into homes. Thus, outdoor activities of adults and any children trespassing onto the site require consideration. That said, the worst-case scenario for child exposure to metals and PAHs in soil was calculated and did not show a problem.

Children could be exposed to 1,2,4-trimethylbenzene at the Tennessee Avenue and Railroad Overpass (Alton Park Area 2) site by drinking the groundwater. The worst-case scenario would be for children to be exposed to 1,2-trimethylbenzene in drinking water as the concentration in one well was over twice its non-cancer EPA RSL.

Although unique health risks associated with exposure to metals, PAHs, and 1,2,4-trimethylbenzene were not identified for children at this site, careful consideration of their wellbeing is still appropriate.

That said, any contact of chemicals contained in on-site soils by a child will have been mitigated by proper closure of the site in accordance with the TDEC DSWM dump closure regulations. Dump closure regulations state the site would have to be covered with 2 feet of clean, compacted, low permeability soils (or alternative low density polyethylene membrane) and a 1 foot thick vegetative cover soil layer. With proper closure there will be no access to the contaminated soils below. This engineering control and the associated land use restrictions will prevent contact to the subsurface chemicals and eliminate any future exposure routes. Redevelopment into a green space is the most viable alternative for this site.

Community Concerns

A meeting regarding potential Brownfield sites in the City of Chattanooga was held on September 25, 2007. At this community meeting, 10 potential Brownfield sites were identified and discussed. Participants were then asked to rank these sites in order of priority. The

Tennessee Avenue and Railroad Overpass (Alton Park Area 2) site was ranked second and was since selected to undergo the Phase I and II ESAs (Aquaterra 2009a and 2009b).

At another community meeting held on August 10, 2009, the results of the Phase I and II ESAs were presented and discussed. At this meeting, EEP presented the potential health effects (Appendix) from chemicals found to be in soil and groundwater present at the site.

Site Considerations

The idea of Tennessee Avenue and Railroad Overpass (Alton Park Area 2) being a potential Brownfield site has merit. Although the site's reuse has not been finalized, redevelopment options for the site include a community-use facility, such as a green space (park) setting.

Determining the site's reuse early in the redevelopment process can help to ensure that proper cleanup measures are implemented and correspond with the goal of the property's reuse. To determine the property's appropriate reuse, it is essential to identify the presence and extent of contamination (EPA 2006). Contamination was suspected at the site because of the dumping and trash that is readily visible. The presence of waste materials and trash scattered across the site noted in the Phase I Environmental Site Assessment was a recognized environmental condition (REC) at the site. A REC is considered when there are potential concentrations of hazardous waste or petroleum products are present onsite.

Based on the remedial action plan, property cleanup is conducted depending on the type, quantity, and toxicity of contamination found onsite (EPA 2006). Cleanup activities for the site could include groundwater remediation as well as soil remediation and debris removal.

Overall, ensuring the public health and safety needs to be a main concern when considering future uses of this site. Planning to maintain incomplete exposure pathways that will minimize potential exposure scenarios needs to be a priority. Any construction that removes the exposure pathway to soil and groundwater at the site is a reasonable option and should be considered during the planning process. Such construction should be inspected regularly to ensure that they remain effective in protecting human health and the environment. Pathway removal would occur if the site was properly closed in accordance with the TDEC open dump closure regulations.

If the site is not redeveloped, a method to eliminate entry to the site by trespassers should be seriously considered.

Conclusions

EEP reached eight important conclusions in this health consultation:

EEP concludes that there are multiple physical hazards at the site that could harm the health of adults or children. Scattered debris and mounds of asphalt, concrete, soil, and scattered glass were observed throughout the majority of the site. Additionally, the site is bordered by an active railroad. Heavy vegetation is present throughout the site.

EEP concludes that contact with pesticides, volatile organic compounds (VOCs), and metals in the surface soil of the Tennessee Avenue and Railroad Overpass site (Alton Park Site #2) is not expected to harm the health of adults or children. All identified metals and pesticides were below the levels expected to harm the health of adults and children.

EEP concludes that contact with polycyclic aromatic hydrocarbons (PAHs) in the surface soil of the site is not expected to harm the health of adults or children. Given the worst case scenarios, the conservatively estimated theoretical risk for adults and children exposed to pesticides in the surface soil of the site is in the acceptable range.

EEP concludes that contact with metals, pesticides, polychlorinated biphenyls (PCBs), and VOCs in the subsurface soil of the site is not expected to harm the health of adults or children. All identified VOCs, pesticides, metals, and PCBs were below the levels expected to harm the health of adults and children. Additionally if the site is closed according to TDEC DSWM regulations, any persons using the site will not contact subsurface soil.

EEP concludes that contact with PAHs in the subsurface soil of the site is not expected to harm the health of adults or children. Given the worst case scenario, the conservatively estimated theoretical risk for adults and children exposed to PAHs in the subsurface soil of the site is in the acceptable range. Additionally if the site is closed according to TDEC DSWM regulations, anyone using the site will not contact subsurface soil.

EEP concludes that drinking groundwater from the site containing lead is not expected to harm the health of adults or children. Given the worst case scenario, the conservatively estimated theoretical risk for adults and children exposed to lead in the groundwater is in the acceptable range. Once the site is properly closed, any contact with site groundwater will be eliminated along with a potential future exposure.

EEP concludes that the volatile organic compound (VOC) naphthalene in the groundwater at the site may harm the health of adults or children, if groundwater is used as drinking water. The concentrations of naphthalene are below the established ATSDR RMEG for naphthalene. Additionally, once the site is properly closed, any contact to site groundwater will be eliminated. Therefore, the naphthalene in the site groundwater is not expected to be a health concern.

EEP concludes that the volatile organic compound (VOC) 1,2,4-trimethylbenzene in the groundwater at the site is may harm the health of adults or children, if the groundwater is used for drinking. Given the worst case scenario, the conservatively estimated theoretical risk for

adults and children exposed to the VOC 1,2,4-trimethylbenzene in the groundwater is outside the acceptable range. Again, once the site is closed, any contact with site groundwater will be eliminated through proper closure and institutional controls, therefore 1,2,4-trimethylbenzene is not expected to be a health concern.

Recommendations

The main focus of this health consultation is to protect the health of children and adults who come into contact with the Tennessee Avenue and Railroad Overpass (Alton Park Area 2) site. With that in mind, the following recommendations are believed to be appropriate based on EEP's review of the sampling data.

- Access to the site should be controlled to prevent trespassing and temporary residence by trespassers.

- Warning signs should be posted along site boundaries to inform trespassers of potential site hazards.

- Proper closure of the site should be undertaken. The site should be closed in accordance with the TDEC open dump closure regulations prior to redevelopment.

Proper closure could include removing the top 24 inches of soil in the areas that will be accessible after redevelopment of the site or completely covering Tax Parcel 167C H 002 with 24 to 36 inches of clean fill soil and vegetative cover such that any potential exposure pathway will be eliminated. All construction, demolition, and earth moving activities should be performed in a manner that does not create potentially harmful site conditions. The implementation of a maintenance plan by the City of Chattanooga so as to maintain the usefulness of the site now and into the future can demonstrate thoughtful consideration to protecting public health.

- If the site is not properly closed within 1 year, a more permanent control of access to the site should be considered.

Public Health Action Plan

The public health action plan for the Tennessee Avenue and Railroad Overpass (Alton Park Area 2) site contains a list of actions that have been or will be taken by EEP and other agencies. The purpose of the public health action plan is to ensure that this health consultation identifies public health hazards and offers a plan of action designed to mitigate and prevent harmful health effects that result from breathing, eating, drinking, or touching hazardous substances in the environment. Included is a commitment on the part of EEP to follow up on this plan to ensure that it is implemented.

Public health actions that have been taken include:

- Phase I Environmental Health Assessment of the site conducted by Aquaterra, LLC in 2008 at the request of CHCRPA

- Phase II Environmental Health Assessment of the site conducted by Aquaterra, LLC in 2008 and further work conducted in 2009 at the request of CHCRPA.

- Chattanooga-Hamilton County Health Department site visit.

- Discussion of health aspects of the site with concerned stakeholders at a public meeting in the Alton Park community on August 10, 2009.

- TDH EEP health consultation

Public health actions that will be taken include:

- Any additional sampling at the site will be the responsibility of the City of Chattanooga.

- Any site remediation activities will also be the responsibility of the City of Chattanooga.

- TDH EEP will provide copies of this health consultation to state, federal, and local government, academia, environmental groups, community groups, and others interested in the Tennessee Avenue and Railroad Overpass (Alton Park Area 2) site.

- TDH EEP will maintain dialogue with ATSDR, EPA, TDEC, CHCRPA, the City of Chattanooga, and other interested stakeholders to safeguard public health and to prevent people from future exposure to PCBs, PAHs, and VOCs at the Tennessee Avenue and Railroad Overpass (Alton Park Area 2) site.

- TDH EEP will be available to review additional environmental data, as requested.

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Tables and Figures

Table 1. Metals, PCBs, Pesticides, and Herbicide soil sample analytical results for surface soil samples collected at the Tennessee Avenue and Railroad Overpass (Alton Park Site #2), Chattanooga, Hamilton County, TN.

Sample ID	Sample Depth	Metals								PCBs	Pesticides				Herbicides
		Arsenic	Barium	Cadmium	Chromium	Lead	Selenium	Silver	Mercury	PCB 1260	Chlordane	4,4-DDE	4,4-DDT	Dieldrin	Herbicides
SS-1	6”	**7.1**	50	<1.2	13	280	<5.0	<2.5	0.024	NA	<0.20	<0.020	<0.020	<0.020	Non Detected
SS-2	6”	**12**	96	2.9	17	62	<1.0	<0.50	<0.020	NA	<0.20	<0.020	<0.020	<0.020	
SS-3	6”	**9.3**	63	1.9	25	22	<1.0	<0.50	0.043	NA	0.026	<0.020	<0.020	<0.020	
SS-4	6”	**9.7**	390	2.0	18	**410**	<1.0	<0.50	0.076	NA	0.042	0.033	0.055	0.023	
ATSDR CREG (mg/kg)		0.5	NE	NE	NE	NE	NE	NE	NE	0.4	2	2	2	0.04	various
ATSDR EMEG (Child/Adult) (mg/kg)		20/200	10,000/ 100,000	10/100	NE	NE	300/ 4,000	300/ 4,000	NE	NE	30/400	NE	30/400	3/40	various
EPA Region 3 Residential RSLs (mg/kg)		0.39	15,000	70	280	400	390	390	3.1	0.22	1.6	1.4	1.7	0.03	various

Notes:
ATSDR CREG – Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide Concentration for 1 excess cancer in 1,000,000
ATSDR EMEG - Agency for Toxic Substances and Disease Registry Cancer Environmental Media Evaluation Guide Concentration for chronic (greater than 365 day) exposure for child and adult.
RSLs – US Environmental Protection Agency Region 3 Regional Screening Values, May 2008.
mg/kg – milligrams per kilograms
Bold indicates exceedance of health comparison value
NA – Constituent not analyzed.
NE – Health comparison value not established for chemical.

Table 2. Polycyclic aromatic hydrocarbon (PAH) soil sample analytical results where 2 out of 4 surface soil samples were identified as having PAH concentrations above health comparison values at the Tennessee Avenue and Railroad Overpass (Alton Park Site #2), Chattanooga, Hamilton County, TN.

Sample ID	Sample Depth	Semi-Volatile Organic Compounds (SVOCs)													
		Ace-naphthalene	Anthracene	Benzo(a)-anthracene	Benzo(b) fluoranthene	Benzo(k)-fluoranthene	Benzo(g,h,i) -perylene	Benzo(a)-pyrene	Chrysene	Dibenz(a,h)-anthracene	Fluor-anthene	Fluorene	Indeno(1,2,3-cd)pyrene	Phene-anthrene	Pyrene
SS-1	6”	0.089	<0.033	**1.2**	**1.3**	0.45	0.31	**0.88**	1.2	**0.18**	2.4	0.059	**0.30**	2.0	2.0
SS-2	6”	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033
SS-3	6”	<0.033	<0.033	0.10	0.13	0.48	<0.033	**0.094**	0.086	<0.033	0.18	<0.033	<0.033	0.092	0.020
SS-4	6”	<0.33	0.46	**1.3**	**1.8**	0.79	0.42	**1.1**	1.2	<0.033	3.0	<0.33	**0.35**	1.9	3.1
PAH Toxicity Equivalency Factors		0.001	0.01	0.1	0.1	0.01	0.01	1	0.001	1	0.001	0.001	0.1	0.001	0.001
ATSDR CREG (mg/kg)		NE	NE	NE	NE	NE	NE	0.1	NE	NE	NE	NE	NE	NE	NE
ATSDR EMEG (Child/Adult) (mg/kg)		3,000/ 40,000	NE	NE	NE	NE	NE	NE	NE	NE	2,000/ 30,000	2,000/ 30,000	NE	NE	2,000/ 20,000
EPA Region 3 RSLs (Residential/ Industrial) (mg/kg)		3,400/ 33,000	17,000/ 170,000	0.15/2.1	0.15/2.1	1.5/21	NE/NE	0.015/ 0.21	15/210	0.015/ 0.21	2,300/ 22,000	2,300/ 22,000	0.15/2.1	NE/NE	1,700/ 17,000

Notes:
ATSDR CREG – Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide Concentration for 1 excess cancer in 1,000,000
ATSDR EMEG - Agency for Toxic Substances and Disease Registry Cancer Environmental Media Evaluation Guide Concentration for chronic (greater than 365 day) exposure for child and adult.
RSLs – US Environmental Protection Agency Region 3 Regional Screening Values, May 2008.
mg/kg – milligrams per kilograms; **Bold** indicates exceedance of health comparison value; NE – Health comparison value not established for chemical.

Table 3. Metals, PCBs, Pesticides, and Herbicide soil sample analytical results for subsurface soil samples at the Tennessee Avenue and Railroad Overpass (Alton Park Site #2), Chattanooga, Hamilton County, TN.

Sample ID	Sample Depth	Metals								PCBs	Pesticides	Herbicides
		Arsenic	Barium	Cadmium	Chromium	Lead	Selenium	Silver	Mercury	PCB 1260	Dieldrin	Herbicides
MW-1	34-36'	<5.0	110	<1.2	16	6.7	8.40	1.10	<0.020	<0.017	<0.02	None Detected
MW-2	42-44'	<5.0	31.0	<1.2	9.8	8.8	5.10	1.00	<0.020	<0.017	<0.02	
TP-1	6-8'	**8.9**	28	<1.2	17.0	44.0	9.40	<0.50	0.065	<0.017	<0.02	
TP-1	10-12'	**7.2**	20.0	<1.2	11.0	16.0	6.70	<0.50	0.08	<0.017	<0.02	
TP-2	10-12'	<5.0	82.0	1.2	13.0	4.7	8.20	<0.50	<0.20	<0.017	<0.02	
TP-3	8-10'	**3.5**	310.0	0.78	10.0	350.0	2.60	0.81	0.08	<0.017	**0.03**	
TP-3	10-12'	**2.5**	50.0	0.7	20.0	50.0	1.10	<0.50	0.05	<0.017	<0.02	
TP-4	8-10'	**5.6**	300.0	1.9	39	**940.0**	6.70	<0.50	<0.020	<0.017	<0.02	
TP-4	10-12'	<1.0	160.0	1.5	19.0	280.0	5.0	<0.50	0.21	0.086	<0.02	
ATSDR CREG (mg/kg)		0.5	NE	NE	NE	NE	NE	NE	NE	0.4	0.04	various
ATSDR EMEG (Child/Adult) (mg/kg)		20/200	10,000/ 100,000	10/100	NE	NE	300/4,000	300/4,000	NE	NE	3/40	various
EPA Region 3 Residential RSLs (mg/kg)		0.39	15,000	70	280	400	390	390	3.1	0.22	0.03	various

Notes:
ATSDR CREG – Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide Concentration for 1 excess cancer in 1,000,000
ATSDR EMEG - Agency for Toxic Substances and Disease Registry Cancer Environmental Media Evaluation Guide Concentration for chronic (greater than 365 day) exposure for child and adult.
RSLs – US Environmental Protection Agency Region 3 Regional Screening Values, May 2008.
mg/kg – milligrams per kilograms; **Bold** indicates exceedance of health comparison value; NE – Health comparison value not established for chemical.

Table 4. Polycyclic aromatic hydrocarbon (PAH) soil sample analytical results where 3 out of 9 soil samples were identified as having PAH concentrations above health comparison values at the Tennessee Avenue and Railroad Overpass (Alton Park Site #2), Chattanooga, Hamilton County, TN.

Sample ID	Sample Depth	Semi-Volatile Organic Compounds (SVOCs)											
		Anthracene	Benzo(a)-anthracene	Benzo(b) fluoranthene	Benzo(k)-fluoranthene	Benzo(g,h,i)-perylene	Benzo(a)-pyrene	Chrysene	Dibenz(a,h)-anthracene	Fluor-anthene	Indeno(1,2,3-cd)pyrene	Phene-anthrene	Pyrene
MW-1	34-36'	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033
MW-2	42-44'	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033
TP-1	6-8'	<0.16	**0.32**	**0.34**	<0.16	<0.16	**0.27**	0.32	<0.16	0.69	<0.16	0.37	0.53
TP-1	10-12'	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.068	<0.033	0.048	0.047
TP-2	10-12'	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033
TP-3	8-10'	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16
TP-3	10-12'	0.48	**7.9**	**11**	**2.6**	2.1	**6.7**	7	**0.62**	15	**2.5**	1.8	10
TP-4	8-10'	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66
TP-4	10-12'	<0.66	**0.77**	**1.1**	<0.66	<0.66	**0.78**	0.83	<0.66	1.8	<0.66	1.1	1.4
PAH Toxicity Equivalency Factors		0.01	0.1	0.1	0.01	0.01	1	0.001	1	0.001	0.1	0.001	0.001
ATSDR CREG (mg/kg)		NE	NE	NE	NE	NE	0.1	NE	NE	NE	NE	NE	NE
ATSDR EMEG (Child/Adult) (mg/kg)		NE	NE	NE	NE	NE	NE	NE	NE	2,000/ 30,000	NE	NE	2,000/ 20,000
EPA Region 3 RSLs (Residential/Industrial) (mg/kg)		17,000/ 170,000	0.15/2.1	0.15/2.1	1.5/21	NE/NE	0.015/ 0.21	15/210	0.015/ 0.21	2,300/ 22,000	0.15/2.1	NE/NE	1,700/ 17,000

Notes:
ATSDR CREG – Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide Concentration for 1 excess cancer in 1,000,000
ATSDR EMEG - Agency for Toxic Substances and Disease Registry Cancer Environmental Media Evaluation Guide Concentration for chronic (greater than 365 day) exposure for child and adult.
RSLs – US Environmental Protection Agency Region 3 Regional Screening Values, May 2008.
mg/kg – milligrams per kilograms
Bold indicates exceedance of health comparison value
NE – Health comparison value not established for chemical.

Table 5. Volatile Organic Compound (VOC) subsurface soil sample analytical results where no soil samples were identified as having VOC concentrations above health comparison values at the Tennessee Avenue and Railroad Overpass (Alton Park Site #2), Chattanooga, Hamilton County, TN

Sample ID	Sample Depth	Volatile Organic Compounds (VOCs)							
		Acetone	**sec-Butyl-benzene**	**n-Butyl-benzene**	**tert-Butyl-benzene**	**p-Isopropyl-toluene**	**Naphthalene**	**1,2,4-Trimethyl-benzene**	**1,2,3-Trimethyl-benzene**
MW-1	34-36'	<0.25	<0.005	<0.005	<0.005	<0.005	<0.025	<0.005	<0.005
MW-2	42-44'	<0.25	<0.005	<0.005	<0.005	<0.078	<0.025	<0.005	<0.005
TP-1	6-8'	<0.25	<0.005	<0.005	<0.005	<0.005	<0.025	<0.005	<0.005
TP-1	10-12'	<0.25	<0.005/ <0.005	<0.005/ 0.005	<0.005/ 0.005	<0.005	<0.025	<0.005/ 0.005	0.0076/ <0.005
TP-2	10-12'	<0.25	<0.005	<0.005	<0.005	<0.005	0.025	<0.005	<0.005
TP-3	8-10'	<0.25	<0.005	<0.005	<0.005	<0.005	0.025	<0.005	<0.005
TP-3	10-12'	0.29	<0.005	<0.005	<0.005	<0.005	<0.025	0.0053	<0.005
TP-4	8-10'	<0.25	<0.005	<0.005	<0.005	<0.005	<0.025	<0.005	<0.005
TP-4	10-12'	<0.25	<0.005	<0.005	<0.005	<0.012	0.04	<0.005	<0.005
ATSDR CREG (mg/kg)		NE	NE	NE	NE	NE	NE	NE	NE
ATSDR EMEG (Child/Adult) (mg/kg)		50,000/ 600,000	NE	NE	NE	NE	1,000/ 10,000	NE	NE
EPA Region 3 RSLs (Residential/Industrial) (mg/kg)		61,000/ 610,000	NE/NE	NE/NE	NE/NE	NE/NE	NE/NE	67/280	NE/NE

Notes:
ATSDR CREG – Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide Concentration for 1 excess cancer in 1,000,000
ATSDR EMEG – Agency for Toxic Substances and Disease Registry Cancer Environmental Media Evaluation Guide Concentration for chronic (greater than 365 day) exposure for child and adult.
RSLs – US Environmental Protection Agency Region 3 Regional Screening Values, May 2008.
mg/kg – milligrams per kilograms; **Bold** indicates exceedance of health comparison value; NE – Health comparison value not established for chemical.
<0.005/<0.005 – Original sample / Duplicate sample results

Table 6. Metals, PCBs, Pesticides, and Herbicide groundwater sample analytical results where 1 out of 2 groundwater samples were identified as having a metal concentration above health comparison values at the Tennessee Avenue and Railroad Overpass (Alton Park Site #2), Chattanooga, Hamilton County, TN. Results are reported in micrograms per liter (µg/L).

Sample ID	Sample Date	Metals			PCBs	Pesticides	Herbicides
		Barium	Chromium	Lead			
MW-1	11/21/2008	830	<10.0	<5.0			
MW-1 Dup	11/21/2008	650	<10.0	<5.0			
MW-2	11/21/2008	230	25	**29**			
Rinsate	11/20/2008	<5.0	<10.0	<5.0	None	None	None
ATSDR CREG (µg/L)		NE	NE	NE			
ATSDR EMEG (Child/Adult) (µg/L)		2,000/7,000	NE	NE	Detected	Detected	Detected
EPA MCLs (µg/L)		2,000	100	15			
EPA Region 3 Regional Screening Levels Cancer/Non-cancer (µg/L)		NE/7,300	110	NE/NE			

Notes:
µg/L – micrograms per liter
ATSDR CREG – Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide Concentration for 1 excess cancer in 1,000,000
ATSDR EMEG - Agency for Toxic Substances and Disease Registry Cancer Environmental Media Evaluation Guide Concentration for chronic (greater than 365 day) exposure for child and adult.
EPA MCLs – EPA Maximum Contaminant Levels for individual chemical in micrograms per liter.
Bold indicates exceedance of health comparison value
NE – Health comparison value not established for chemical.

Table 7 Volatile Organic Compounds (VOCs) and Semi-Volatile Organic Compounds (SVOCs) groundwater sample analytical results where 2 out of 2 groundwater samples were identified as having a VOC concentration and 1 out of 2 groundwater samples were identified having a SVOC concentration above health comparison values at the Tennessee Avenue and Railroad Overpass (Alton Park Site #2), Chattanooga, Hamilton County, TN.

Sample ID	Sample Date	Volatile Organic Compounds (VOCs)					SVOCs
		Naphthalene	1,2,4-Trimethyl-benzene	1,2,3-Trimethyl-benzene	1,2,5-Trimethyl-benzene	Xylenes, total	Naphthalene
MW-1	11/21/2008	**11**	**19**	6.7	5.8	29	**4.2**
MW-1 Dup	11/21/2008	**7.7**	14	5	4.5	21	**4.9**
MW-2	11/21/2008	**14**	**30**	10	9	44	**9.6**
Rinsate	11/20/2008	<5.0	<1.0	<1.0	<1.0	<3.0	<1.0
ATSDR CREG (µg/L)		NE	NE	NE	NE	NE	NE
ATSDR EMEG (Child/Adult) (µg/L)		200/700	NE	NE	NE	2,000/7,000	200/700
EPA MCLs (µg/L)		NE	NE	NE	NE	10,000	NE
EPA Region 3 Regional Screening Levels Cancer/Non-cancer (µg/L)		0.14/6.2	NE/15.0	NE/NE	NE/NE	200	0.14/6.2

Notes:
ATSDR CREG – Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide Concentration for 1 excess cancer in 1,000,000
ATSDR EMEG - Agency for Toxic Substances and Disease Registry Cancer Environmental Media Evaluation Guide Concentration for chronic (greater than 365 day) exposure for child and adult.
µg/L – micrograms per liter
Bold indicates exceedance of health comparison value
NE – Health comparison value not established for chemical.

Table 8. Total PAHs and PAH toxicity equivalency by surface soil sample location at the Tennessee Avenue and Railroad Overpass (Alton Park Site #2), Chattanooga, Hamilton County, TN.

Sample Location	Sample Depth	Total PAHs (mg/kg) by Location	PAH Toxicity Equivalency (mg/kg) by Location
SS-1	0-6 inches	12.3689	1.1934
SS-2	0-6 inches	—	—
SS-3	0-6 inches	1.182	0.1222
SS-4	0-6 inches	15.4295	1.4709
All PAH-Contaminated Surface Soil Sample Locations		28.9804	2.7865
Entire Surface Soil at Site		29.6734	2.8661

Table 9. Total PAHs and PAH toxicity equivalency in subsurface soil samples by sample location at the Tennessee Avenue and Railroad Overpass (Alton Park Site #2), Chattanooga, Hamilton County, TN.

Sample Location	Sample Depth	Total PAHs (mg/kg) by Location	PAH Toxicity Equivalency (mg/kg) by Location
MW-1	34 to 36 ft bgs	—	—
MW-2	42 to 44 ft bgs	—	—
TP-1	6 to 8 ft bgs	0.284	0.3379
TP-1	10 to 12 ft bgs	0.163	0.000775
TP-2	10 to 12 ft bgs	—	—
TP-3	8 to 10 ft bgs	—	—
TP-3	10 to 12 ft bgs	67.7	9.55
TP-4	8 to 10 ft bgs	—	—
TP-4	10 to 12 ft bgs	7.78	0.9721
All PAH-Contaminated Sample Locations		75.927	10.861
Entire Site		83.752	12.776

FIGURE 1. USGS topographic map showing the site of the Tennessee Avenue and Railroad Overpass property Chattanooga, Hamilton County, TN

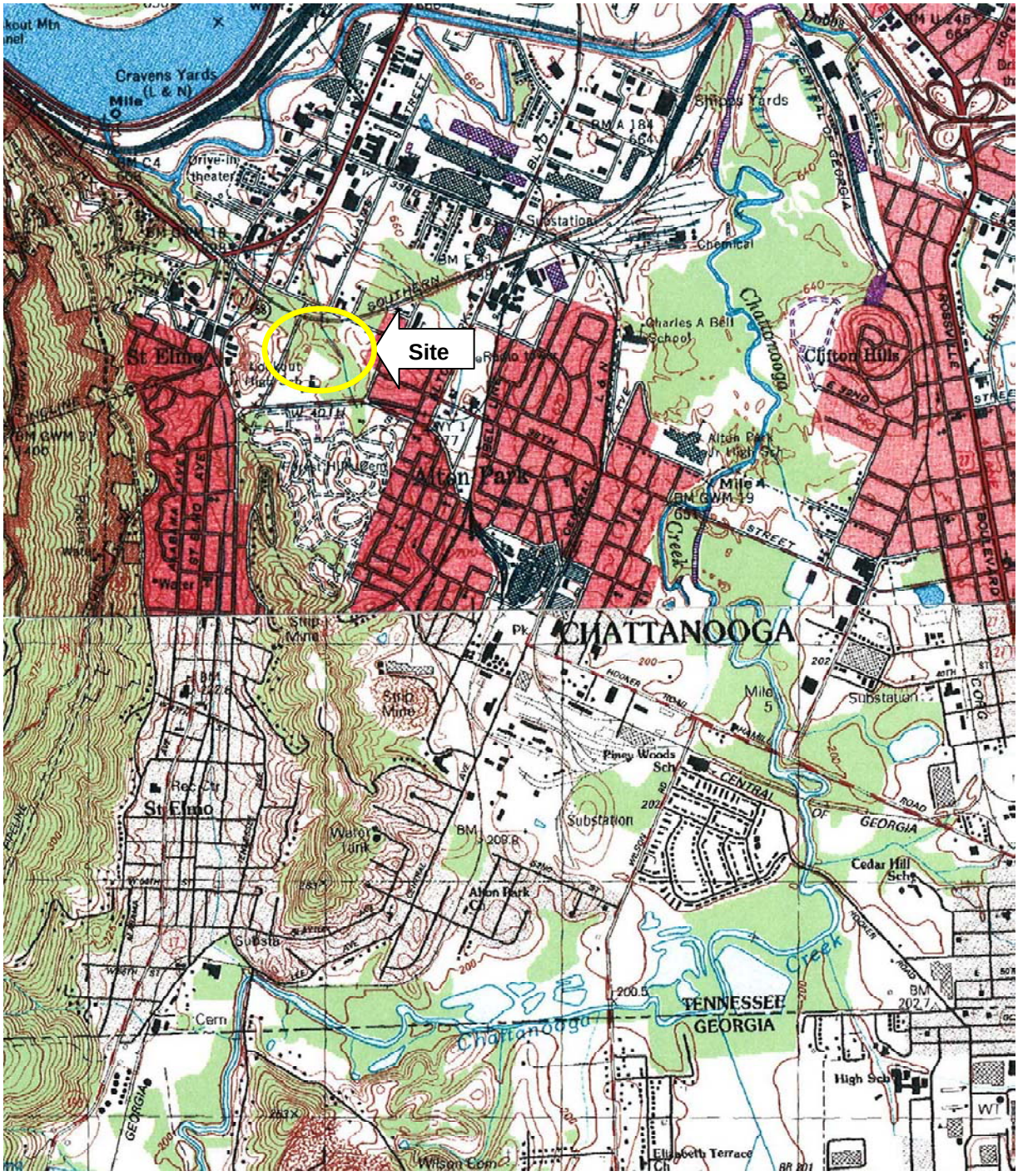

FIGURE 2. Aerial image showing the site of the Tennessee Avenue and Railroad Overpass site, Chattanooga, Hamilton County, TN. The areas where soil and groundwater samples were taken in 2008 are not noted. (Image credit: Google Earth 2007)

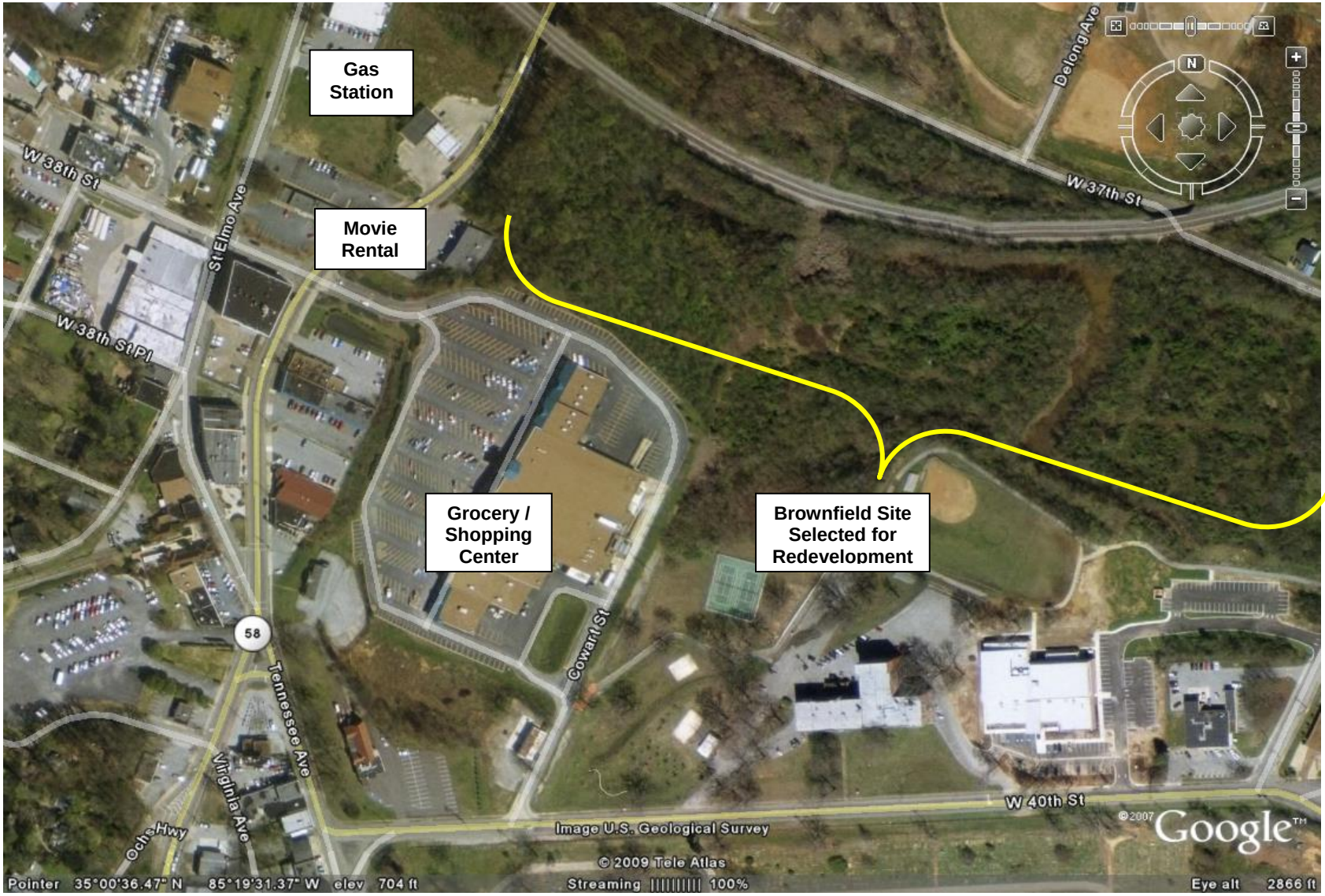

FIGURE 3. Aerial image showing sampling locations at the Tennessee Avenue and Railroad Overpass site, Chattanooga, Hamilton County, TN. The areas where soil and groundwater samples were taken in 2008 are noted. (Image credit: Aquaterra 2009b)

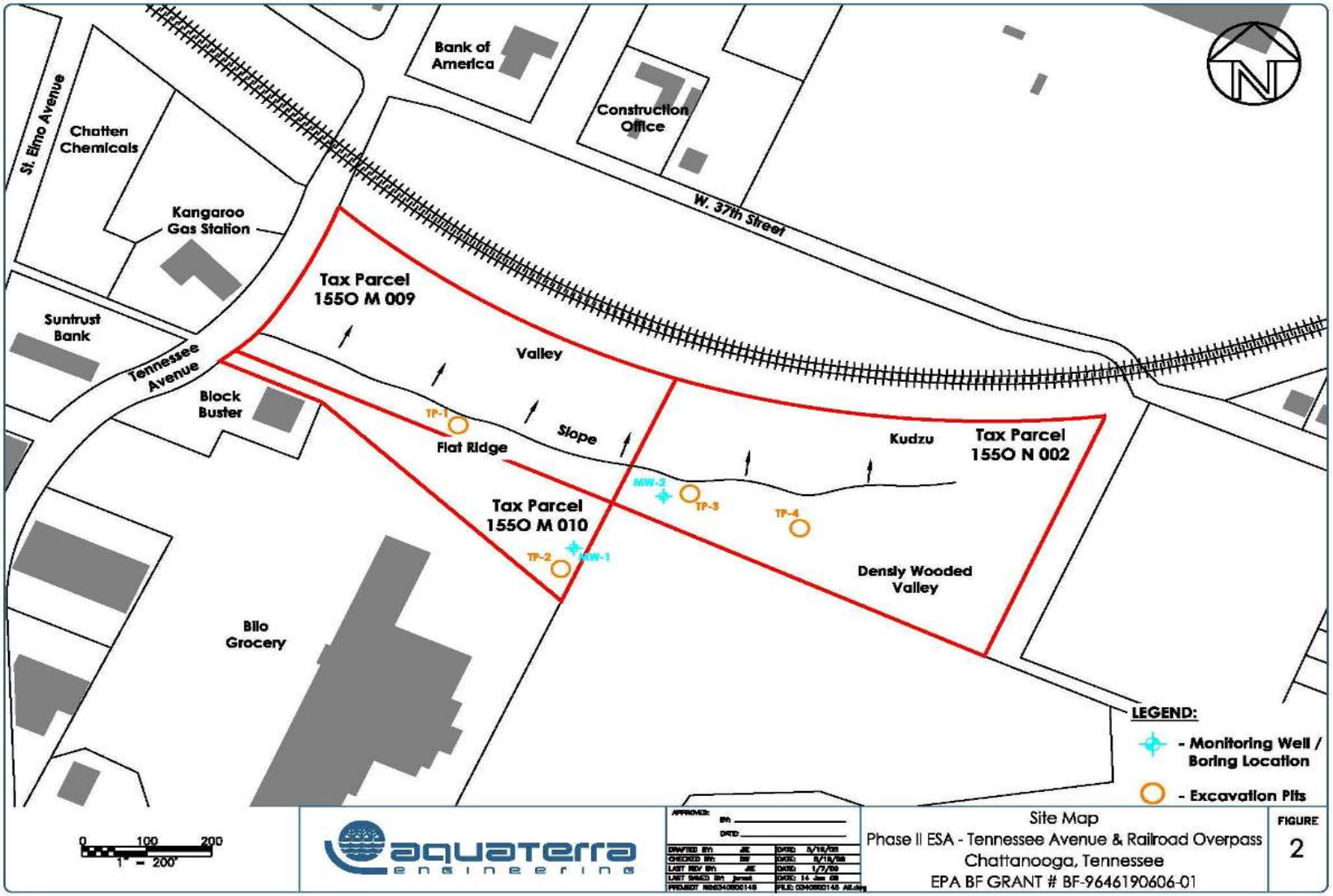

FIGURE 4. Photo of Site showing one of the many piles of asphalt present. Dumping was noted throughout site. (Image credit: S. Novak, Chattanooga and Hamilton County Health Department)

FIGURE 5. View of Site showing steep embankment along railroad track. (Image credit: S. Novak, Chattanooga and Hamilton County Health Department).

FIGURE 6. Photo of Site showing evidence of someone using the site as their temporary residence. (Image credit: S. Novak, Chattanooga and Hamilton County Health Department)

FIGURE 7. View of Site showing wet conditions in early may 2009. (Image credit: S. Novak, Chattanooga and Hamilton County Health Department).

Appendix

Calculating an Intake Dose

As stated previously in this health consultation, there are trespassers that use the site as their place of residence. Even though the people using the site should not be on the property, there are legal implications for the owner of the property if a person becomes harmed while on the property either from physical hazards or chemical hazards.

To determine if people are at an increased risk of adverse health effects from a chemical, a health investigator will often calculate the dose received when various exposure scenarios are considered. This is done to evaluate the exposure potential of chemicals identified in concentrations above their comparison or screening values. The following equation can determine the amount of a contaminant a person ingests by incidentally eating contaminated soil:

$$Dose = \frac{Concentration \times AmountEaten \times FractionIngested \times ExposureDuration \times ExpFrequency}{BodyWeight \times AveragingTime}$$

For a site resident/trespasser that is living at the site in a temporary or crude permanent structure, taking the maximum concentration of a contaminant coupled with a 10 hour per day exposure duration would make a worst case scenario example. Standard assumptions of 70 kg adult body weight and a 2-year exposure duration were incorporated (given the transient nature of the homeless, this is a long period of time to reside in one area). The amount of soil incidentally ingested is also a standard assumption of 100 mg/day for adults. In this scenario, exposure to contaminated soil happens for 10 hours every day, 365 days a year. Assuming exposure for 2years for adults, this equals a total exposure (averaging time) of 730 days for an adult resident/trespasser.

It is unlikely that any children would be trespassing and using this site as a residence. However, children may visit the site to explore. Therefore a worst-case child exposure is calculated based on standard assumptions of 100 kg child body weight and 10-year exposure duration. The amount of soil incidentally ingested is also a standard assumption of 200 mg/kg for children. We can assume the fraction ingested was 1 or all soil eaten is of maximum contaminant concentration, a worse-case scenario. Also, it is assumed that complete contaminant absorption occurs by the human body. The exposure scenario for a child trespasser (not living at the site) assumes an exposure to contaminated soil for 4 hours per day 200 days per year for 10 years.

Metals Dose

Surface Soil – Ingestion

At the Tennessee Avenue and Railroad Overpass site, arsenic is present in surface soils above Tennessee background soil concentrations and applicable health affects comparison values at the site. Arsenic is classified as a human carcinogen. The maximum arsenic concentration in surface soils was 12 mg/kg. The following is a worst-case scenario calculation for adult residents/trespassers and children trespassers, respectively, exposed to ingestion of arsenic at the site.

$$\frac{\frac{12mg}{kg}\times\frac{1kg}{10^6 mg}\times\frac{100mg}{day}\times 1\times\frac{10hrs}{day}\times\frac{1day}{24hrs}\times 2yrs\times\frac{365days}{yr}}{70kg\times 730days} = 7.1x10^{-6}\,\frac{mg}{kg\times day}$$

$$\frac{\frac{12mg}{kg}\times\frac{1kg}{10^6 mg}\times\frac{200mg}{day}\times 1\times\frac{4hrs}{day}\times\frac{1day}{24hrs}\times 10yrs\times\frac{200days}{yr}}{16kg\times 3{,}650days} = 1.4x10^{-5}\,\frac{mg}{kg\times day}$$

To determine if this worst case scenario dose is problematic for public health, a slope factor established by EPA as the slope factor for the carcinogenic effects of arsenic is 1.5E+00. A slope factor is a line derived from dose-response research outcomes that predicts a theoretical risk of excess cancers from exposure to the chemical. It has units of (mg/kg-day)-1 and when multiplied by the dose, provides a value for risk. The adult dose of $7.1x10^{-6}$ mg/kg-day produces a conservatively estimated theoretical risk of 1.1 excess cancers per 100,000 adults ($1.1x10^{-5}$). The child dose of $1.4x10^{-5}$ mg/kg-day produces a conservative estimate of theoretical risk of 2.1 excess cancers per 100,000 children ($2.1x10^{-5}$).

The risk assessment process aims for less than a one-in-a-million (10^{-6}) risk. Risk estimated to be less than one-in-ten thousand (10^{-4}) is often acceptable (EPA 1991). Therefore, given that the worst case scenario is in the acceptable range, lesser exposure scenarios would have even lower associated risk. For arsenic in surface soils at the site, there should be no harm to humans from contacting surface soil at the site.

Surface Soil – Dermal Contact

Often the ingestion pathway is the most critical when evaluating exposure to human health. For completeness, dermal contact with surface soil containing lead and arsenic in concentrations displayed at the site was evaluated to determine if a worst-case scenario will affect resident trespassers while they live at the site. There is the possibility of contact with surface soils as site residents/trespassers may not have access to bathing facilities and hence soil may adhere longer to their cloths and bodies. The following is a worst-case scenario calculation for adult residents/trespassers exposed to dermal contact of surface soils containing lead at the site.

For the worst-case scenario for arsenic, the maximum concentration of 12 mg/kg and a surface area for a male of 1.94 square meters are used.

$$\frac{\frac{12mg}{kg}\times\frac{1kg}{10^6 mg}\times\frac{0.0145mg}{m^2}\times 1.94m^2\times\frac{10hrs}{day}\times\frac{1day}{24hrs}\times 2yrs\times\frac{365days}{yr}}{70kg\times 730days} = 2.0x10^{-9}\,\frac{mg}{kg\times day}$$

Such a small dermal dose of arsenic will not harm the health of adults temporarily residing at the site.

For a child dose calculation, the maximum concentration of arsenic of 12 mg/kg and a surface area for a 9 to 12 year old child of 1.16 square meters is used.

$$\frac{\frac{12mg}{kg}\times\frac{1kg}{10^6 mg}\times\frac{0.0145mg}{m^2}\times 1.16m^2\times\frac{4hrs}{day}\times\frac{1day}{24hrs}\times 10yrs\times\frac{200days}{yr}}{16kg\times 3{,}650days}=1.2x10^{-9}\,\frac{mg}{kg\times day}$$

Again, such a small dermal dose of arsenic is not expected to affect the health of a child who would trespass onto the site to explore.

Subsurface Soil

Contact with subsurface soil at the site would be achieved through digging or excavation. There is no evidence at the site to show that this is an exposure pathway. Subsurface soil is buried beneath site surface soils. Subsurface soil metals and PAHs are not expected to affect human health, especially if the site will be capped and closed in accordance with TDEC regulations and ultimately redeveloped as green space. The site will have to be closed in accordance with the TDEC Dump Closure Regulations, which require a low permeability barrier to prevent precipitation from moving downward through the waste material dumped onsite. The barrier can either be a synthetic liner or 2 feet of compacted soil. In addition to this low permeability cap, 1 foot of vegetative cover soil will also be required. The vegetative cover soil will be thick enough to support grass which must be maintained. Therefore, the routes of exposure for humans to contact concentrations of metals in the subsurface soils at the site will be removed.

Groundwater

Like subsurface soil, there will be very limited opportunity for people to come into contact with groundwater containing concentrations of site-related chemicals. As discussed above, redevelopment of the site will consist of proper closing of the site according to accepted closure regulations. The pathway for exposure of individuals to groundwater will be eliminated once the site is properly closed. However, in this case, to determine if people are at an increased risk of adverse health effects from site contaminants, a health investigator will often calculate the dose received when various exposure scenarios are considered. For contaminated drinking water, the following equation can determine the amount of a contaminant a person ingests:

$$Dose=\frac{Concentration\times AmountDrank\times FractionIngested}{BodyWeight}$$

Assumptions of a 70 kg body weight for adults and a 16 kg body weight for an adult is standard. The amount of contaminated drinking water ingested is also a standard assumption of 2 Liter/day (L/day) for adults and 1 L/day for a child. We can assume the fraction ingested for both adults and children was 1 or all water drank is of maximum contaminant concentration. Also, it was assumed that complete contaminant absorption by the human body occurred in each case.

The maximum concentration of lead measured in groundwater was 29.0 µg/L. The following are worst-case scenario calculations for adult and children trespassers exposed to lead in groundwater at the site:

$$\frac{\frac{29\mu g}{L}\times\frac{1L}{10^3\mu g}\times\frac{2L}{day}\times 1}{70kg}=8.3x10^{-4}\,\frac{mg}{kg\times day}$$

$$\frac{\frac{29\mu g}{L}\times\frac{1L}{10^3\mu g}\times\frac{1L}{day}\times 1}{16kg}=1.8x10^{-3}\,\frac{mg}{kg\times day}$$

Again as for surface soil, to determine if this worst-case scenario dose is problematic for public health, a slope factor published by the California EPA is used for the carcinogenic effects of lead and is 0.0085. It has units of (mg/kg-day)-1 and when multiplied by the dose provides a value for risk. The adult dose of $8.3x10^{-4}$ mg/kg-day produces a conservatively estimated theoretical risk of 7 excess cancers per 1,000,000 adults ($7.0x10^{-6}$). The child dose using this slope factor produces a theoretical risk of 1.5 excess cancers in 100,000 children ($1.5x10^{-5}$). EPA and ATSDR consider these excess cancer risks within an acceptable range (EPA 1991).

PAH Intake Dose

Surface Soils - Ingestion

At the Tennessee Avenue and Railroad Overpass site, the maximum PAH toxicity equivalency concentration was measured to be 1.1 mg/kg (Table 2). The following is a worst-case scenario calculation for adults exposed to PAHs at the site:

$$\frac{\frac{1.1mg}{kg}\times\frac{1kg}{10^6mg}\times\frac{100mg}{day}\times 1\times\frac{10hrs}{day}\times\frac{1day}{24hrs}\times 2yrs\times\frac{365days}{yr}}{70kg\times 730days}=6.5x10^{-7}\,\frac{mg}{kg\times day}$$

The worst-case risk calculation for a child exposed to soil containing PAHs at the site is as follows:

$$\frac{\frac{1.1mg}{kg}\times\frac{1kg}{10^6mg}\times\frac{200mg}{day}\times 1\times\frac{4hrs}{day}\times\frac{1day}{24hrs}\times 10yrs\times\frac{200days}{yr}}{16kg\times 3{,}650days}=1.3x10^{-6}\,\frac{mg}{kg\times day}$$

To determine if this worst case scenario dose is problematic for public health, the EPA-established 7.3E+00 as the slope factor for the carcinogenic effects of benzo[a]pyrene. A slope factor is a line derived from dose-response research outcomes that predicts a theoretical risk of excess cancers from exposure to the chemical. It has units of $(mg/kg\text{-}day)^{-1}$ and when multiplied by the dose provides a value for risk. The adult dose of $4.7x10^{-6}$ mg/kg-day produces a conservatively estimated theoretical risk of 4.7 excess cancers per 1,000,000 adults ($4.7x10^{-6}$).

For a child the dose of $1.3x10^{-6}$ mg/kg-day produces a conservatively estimated theoretical risk of 9.5 excess cancers per 1,000,000 children ($9.5x10^{-6}$).

Given that the worst case scenario for both adults and children is in the acceptable range, there should be no effects to the health of adult residents or child trespassers to the site.

Subsurface Soils - Ingestion

Subsurface soil PAH concentrations are not expected to affect human health as the site will be capped if it is redeveloped as green space. The site will be closed in accordance with the TDEC Dump Closure Regulations which require a low permeability barrier to prevent precipitation from moving downward through the waste material dumped onsite. The barrier can either be a synthetic liner or 2 feet of compacted soil. In addition to this low permeability cap, 1 foot of vegetative cover soil will also be required. The vegetative cover soil will be thick enough to support grass which must be maintained. Therefore, the routes of exposure for humans to contact concentrations of PAHs in the subsurface soils at the site will be removed.

Even though the exposure to PAHs in subsurface soil will be mitigated through capping of the waste materials, a worst-case scenario calculation for adults contacting PAHs, specifically B[a]P, is shown below using the highest PAH equivalency concentration calculated for the site for completeness.

$$\frac{\frac{6.7mg}{kg}\times\frac{1kg}{10^6mg}\times\frac{100mg}{day}\times 1\times\frac{10hrs}{day}\times\frac{1day}{24hrs}\times 2yrs\times\frac{365days}{yr}}{70kg\times 730days}=4.0x10^{-6}\,\frac{mg}{kg\times day}$$

To determine if this worst case scenario dose is problematic for public health, the EPA-established 7.3E+00 as the slope factor for the carcinogenic effects of benzo[a]pyrene. A slope factor is a line derived from dose-response research outcomes that predicts a theoretical risk of excess cancers from exposure to the chemical. It has units of $(mg/kg\text{-}day)^{-1}$ and when multiplied by the dose provides a value for risk. The adult dose of $4.0x10^{-6}$ mg/kg-day produces a conservatively estimated theoretical risk of 2.9 excess cancers per 100,000 adults ($2.9x10^{-5}$). This risk is within the range deemed acceptable by EPA and ATSDR.

For children to come in to contact with subsurface soils, the equation below calculates a worst-case dose:

$$\frac{\frac{6.7mg}{kg}\times\frac{1kg}{10^6mg}\times\frac{200mg}{day}\times 1\times\frac{4hrs}{day}\times\frac{1day}{24hrs}\times 10yrs\times\frac{200days}{yr}}{16kg\times 3{,}650days}=7.6x10^{-6}\,\frac{mg}{kg\times day}$$

The child dose of $7.6x10^{-6}$ mg/kg-day produces a conservatively estimated theoretical risk of 5.5 excess cancers per 100,000 children ($5.5x10^{-5}$). This risk is within the range deemed acceptable by EPA and ATSDR.

VOC Dose

Surface and subsurface soil concentrations of VOCs were below applicable health-based comparison values. Hence, VOCs in soils are not a concern and are not evaluated.

Groundwater is impacted by naphthalene and 1,2,4-trimethylbenzene. Concentrations of these two compounds in the two site wells are above health comparison values.

It is unlikely that a temporary resident/trespasser to the site would have access to groundwater and drink it. However, as in the case for lead above, to determine if people are at an increased risk of adverse health effects from site contaminants, a health investigator will often calculate the dose received when various exposure scenarios are considered. For contaminated drinking water, the following equation can determine the amount of a contaminant a person ingests:

$$Dose = \frac{Concentration \times AmountDrank \times FractionIngested}{BodyWeight}$$

Assumptions of a 70 kg body weight for adults and a 16 kg body weight for a child is standard. The amount of contaminated drinking water ingested is also a standard assumption of 2 L/day for adults and 1 L/day for children. We can assume the fraction ingested was 1 or all water drank is of maximum contaminant concentration. Also, assume complete contaminant absorption by the human body.

1,2,4-trimethylbenzene is not classified as to its cancer-risk. The EPA RSL for the compound in groundwater is 15 µg/L, corresponding to a Hazard Index of 1. For one of the wells, the concentration of 1,2,4-trimethylbenzene is twice this screening level. Therefore, there is an increased risk for chronic, non-cancer health effects from drinking groundwater at the site.

As stated previously, there is not a completed exposure pathway for groundwater ingestion at the site. No wells were identified onsite other than the monitoring wells installed for site evaluation. These wells are locked and protected by a steel casing when they are not being sampled. Trespassers do not have access to groundwater. When the site is redeveloped into green space, he likely remedial option will include covering the site with a low permeability cap and establishing a sustained vegetative cover. The cap will prevent access to groundwater. Additionally, there will likely be an institutional control such as a restriction placed on the ability to use groundwater from the site for any purpose.

Certification

This Public Health Consultation: *Tennessee Avenue and Railroad Overpass (Alton Park Site #2), Chattanooga, Hamilton County, Tennessee*, was prepared by the Tennessee Department of Health Environmental Epidemiology under a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was prepared in accordance with the approved methodology and procedures that existed at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement Partner.

Technical Project Officer, CAT, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health assessment and concurs with the findings.

Team Leader, CAT, CAPEB, DHAC, ATSDR