Health Consultation

SEVEN OUT, LLC FACILITY

WAYCROSS, WARE COUNTY, GEORGIA
EPA ID: GAN000407811

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Georgia Department of Public Health

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Agency for Toxic Substances and Disease Registry

Contents

Statement of Issues

The Georgia Department of Public Health (DPH) published a health consultation in January 2014 investigating the potential risk for residents of Waycross, Georgia to get cancer and other illnesses from exposure to contaminants found in Folks Park (also known as Mary Street Park). Residents expressed concerns that exposure to elevated levels of polycyclic aromatic hydrocarbons (PAHs) found in one soil/sediment sample obtained from a drainage canal that runs through Folks Park may have originated from the Seven Out, LLC Superfund site (Figure 1). In the health consultation, DPH concluded that exposure to the levels of PAHs found in Folks Park was unlikely to result in adverse health effects.

DPH's conclusions were based on a single sample from Folks Park collected by a resident. The levels of PAHs found in the sample corresponded to soil sample results found at the Seven Out site by the U.S. Environmental Protection Agency (EPA) in 2004. There are no recent sample data from Seven Out; therefore, DPH recommended that EPA conduct additional soil/sediment sampling in the drainage ditch directly south of Seven Out (runoff from the site) and downgradient, where the confluence of the drainage ditch joins a drainage canal that flows through Folks Park, to determine if elevated levels of PAHs are present in off-site soil/sediment.

This document is a follow-up health consultation to review the results of sampling data collected by EPA on December 19, 2013. The purpose of this health consultation is to determine if elevated levels of PAHs are present in soil and/or sediment at Seven Out and nearby drainage canals exist at levels that are a public health hazard.

Facility Background and Site History

The Seven Out property is located at 901 Francis Street in south Waycross, Georgia. Seven Out consists of a tank farm, an abandoned office building and a small warehouse. The site originally had 37 tanks ranging from 8,000 to 44,000 gallons in volume (Figure 2). The tanks were on approximately one-half acre of concrete within a short concrete containment berm and were located adjacent to a public road in an area frequented by the public. Access to the site is unrestricted. An office building is located south of the tank containment area and a fenced lot that contains a warehouse is located to the south and east of the office building. The warehouse contained several drums, totes, and dry bags of material [1, 2]. Most of the tank structures were removed in November 2013 [3].

Historically, the facility operated as an industrial wastewater treatment facility from 2002 to 2004. Industrial wastewater was treated in a batch mode where solids were precipitated for removal from the wastewater. Sodium hydroxide, aluminum sulfate, ferric acid, and sulfuric acid were used to precipitate the solids, which were sent to a filter press for concentration and drying. The pressed solids were sent to the Broadhurst Environmental landfill in Screvin, Georgia. The treated wastewater was discharged to the City of Waycross publically owned treatment works (POTW) using the City's wastewater collection system [1].

The treatment process was generally unsuccessful and effluents regularly exceeded the requirement of the facility's wastewater discharge permit. Seven Out received several Notices of Violation and an Administrative Order from the City of Waycross over their short operational history. On March 1, 2004, the City of Waycross disconnected the facility's connection to the POTW. The facility discontinued processing wastewater, although it still received shipments. These incoming wastewater shipments were stored in four rented portable tanks (frac tanks) that were placed on the adjoining property owned by CSX. Shortly thereafter and since that time, Seven Out ceased all operations without discharging the remaining waste in storage. The State of Georgia, Department of Natural Resources, Environmental Protection Division (EPD) determined the facility to be incorrectly storing hazardous waste and out of compliance with State of Georgia regulations [1, 2].

EPD referred Seven Out to the EPA for a Removal Site Evaluation. In August 2004, EPA sampled the tanks at the request of the EPD. Because EPA noted discolored soil in some areas near the tank farm, soil samples were collected from a drainage ditch near the containment area, an area adjacent to the rented frac tanks, and along the south wall of the containment area. An emergency action was initiated by EPA on January 27, 2005 while inspecting the site during the Removal Site Evaluation. Under the emergency response action, pumpable liquids in the tanks and standing water in the secondary containment area were removed to mitigate the threat of release [2]. Discolored soil outside the tank farm was not removed.

From August 28 to September 1, 2006, EPD collected samples from the site and the surrounding area as part of a site inspection. EPD's findings were submitted to EPA's Superfund Assessment Program where it was determined that the Seven Out site did not qualify for further remedial site assessment because of the lack of releases to groundwater, surface water, and soil pathways [2].

Following the 2005 emergency action, several tanks still contained a significant volume of unpumpable sludges and rainwater began collecting again in the secondary containment area, causing deterioration of the tanks still holding material. An Administrative Order was signed on July 30, 2008, between EPA and Seven Out respondents (consisting of several generators that previously sent waste to the facility) to conduct a time-critical removal action to remove all remaining waste materials from the site. EPA conducted oversight of all removal activities. Over the course of the removal action, 300,000 gallons of rainwater was discharged to the Waycross POTW, 905 tons of non-hazardous solid wastes (sludge) were sent to an off-site landfill for disposal, and 3,900 gallons plus another 108 tons (sludge) were sent off-site to a permitted hazardous waste treatment and disposal facility. All on-site tanks were decontaminated by pressure washing, and all piping was vacuumed out and disconnected. The Seven Out clean-up effort was completed on July 2009, and EPA issued a notice of completion letter on November 16, 2009 [2, 4].

Site Drainage

Seven Out lies in an area of minimal flooding outside the 100-year and 500-year flood zones. Surface water runoff from the site flows into a drainage ditch south of the tank farm and north of the CSX railroad tracks. The drainage ditch continues west, roughly parallel to the railroad tracks for approximately 1200 feet into an unnamed drainage canal. This drainage canal flows northeast for approximately 5000 feet, flowing through Folks Park and underground through the city center after which it emerges at Lee Avenue and Memorial Drive (Hwy. 23). Water then flows east for less than 1000 feet, and then joins the Waycross City Drainage Canal. The City Drainage Canal flows northeast for approximately 3 miles before joining the Satilla River [2].

Area Demographics

Using 2010 U.S. Census data, the federal Agency for Toxic Substances and Disease Registry (ATSDR) calculated population information for individuals living within a 1-mile radius beyond the property boundary of Seven Out. The population within one mile of the perimeter of Seven Out is approximately 5,743 people in 2,983 households. In this population are 1,185 women of child-bearing age, 577 elderly persons, and 739 children below age six. Figure 1 shows detailed demographic information.

Environmental Data Sampling and Analyses

On November 14, 2013, EPA and their contractor, Tetra Tech, met in Waycross for site reconnaissance to visually assess suitable sampling locations for a planned sampling event. A total of two soil sampling locations and six sediment sampling locations were identified. The goal of the sampling design was to generate data that could be used to confirm or refute the possibility that Seven Out has contributed, or is currently contributing, to contamination in the drainage ditch directly south of the facility and in the downgradient drainage canal that flows through Folks Park.

EPA determined that an incremental sampling methodology (ISM) would be applied to the extent possible to five discrete areas along the drainage ditch and drainage canal up gradient and down gradient of Seven Out. ISM consists of dividing the sampled area into discrete areas, or decision units (DUs), and collecting 30 to 100 aliquots of sediment from each DU. All increments are homogenized in the field and the entire sample is sent to the laboratory for analysis. The laboratory then performs another homogenization and analyzes the sample [5].

EPA, Tetra Tech, and DPH collecting sediment samples along the drainage canal in December

On December 19, 2013, soil and sediment was collected at the Seven Out site, drainage ditch and drainage canal for the assessment in determining the presence or absence of PAH contamination along the drainage pathways of the facility. EPA, Tetra Tech, Ware County Health Department, and DPH personnel conducted the field sampling [3]. A total of 10 sediment samples and two soil samples were taken. Thirty-increment samples were taken in 8 of 10 samples from each decision unit (DU-1 through DU-5), except the Seven Out drainage trench (DU-2), where a 15-increment sample was taken, and a 5-point composite sediment sample taken at the confluence where the Seven Out drainage ditch flows into the drainage canal that runs through Folks Park (Figure 3). The increment sampling consisted of ten sampling locations spaced at roughly equal intervals along the length of the decision unit. Two composite soil samples were collected; one from a small concrete trench along the eastern side of Seven Out, and one from outside the southern containment wall of the Seven Out site in the same location as the sample collected during the 2004 EPA removal assessment. All sampling results are presented in Appendix A. The sediment increments, and soil composites collected were placed in a stainless steel pan, homogenized, placed in a glass jar, and stored in an ice cooler for laboratory shipping [3]. Table 1 summarizes the December 19, 2013 sampling event.

Table 1: EPA Sampling Design and Summary (Figure 3)

Sample Location	Sample Type	Number of Increments or Composites	Number of Samples	Sample Depth (below ground surface)
Decision Unit 1 (DU-1)	Sediment	30-increment ISM	1	0 to 3 inches
Decision Unit 2 (DU-2)	Sediment	15-increment ISM	1	0 to 3 inches
Decision Unit 3 (DU-2)	Sediment	30-increment ISM	3	0 to 3 inches
Decision Unit 4 (DU-2)	Sediment	30-increment ISM	3	0 to 3 inches
Decision Unit 5 (DU-2)	Sediment	30-increment ISM	1	0 to 3 inches
Confluence Drainage Canal and Ditch	Sediment	5-point composite	1	0 to 3 inches
Concrete Trench	Soil	5-point composite	1	0 to 6 inches
South Containment Wall Area	Soil	5-point composite	1	0 to 6 inches

DU-1: The sediment sample was collected as a drainage ditch background sample to access contamination levels upgradient of the Seven Out site.

DU-2: The sediment sample was collected from the small drainage trench running between the Seven Out facility and the drainage ditch that served as the main drainage pathway for Seven Out runoff. This sample was intended to assess water entering the drainage ditch from the Seven Out facility.

DU-3: Three sediment samples were collected from the section of the drainage ditch running from downgradient of the drainage trench to the railroad tracks west of the Seven Out facility. These samples were intended to assess contamination levels downgradient of the Seven Out site, but immediately upgradient of the drainage canal.

DU-4: Three sediment samples were collected from the drainage canal upgradient of the confluence with the drainage ditch. These samples were intended to assess contamination levels in the drainage canal upgradient of the confluence with the drainage ditch.
DU-5: The sediment sample was collected from the drainage canal between the Highway 82 overpass and Folks Street. This sediment sample was intended to assess possible contamination in the drainage canal downgradient of the confluence with the drainage ditch.
Confluence of the drainage ditch with the drainage canal: This sample was collected between the railroad overpass and the Highway 82 overpass. This sample was intended to assess contamination at the confluence of the drainage canal and the drainage ditch.
Concrete Trench: This soil sample was collected from a small concrete trench along the eastern side of the Seven Out property. Although the trench does not appear to be the main drainage pathway for the majority of the site, it does appear to capture some runoff from the northeast portion of the site.
South Containment Wall: This sample was collected outside the southern containment wall in the same location as the soil sample collected during EPA's 2004 removal assessment. This sample was collected to compare PAH concentrations detected in 2004 with current concentrations.

Collected samples were shipped to Test America, in Arvada, CO where they followed ISM protocol when processing the samples. Test America analyzed soil and sediment samples for PAHs using EPA Method 8270C. Analytical results were validated by Tetra Tech in accordance with the associated EPA SW-846 methods and the EPA National Functional Guidelines for Superfund Organic Methods Data Review[1] [3].

Exposure Pathway

When a hazardous substance is released to the environment, people are not always exposed to it. Exposure happens when people breathe, eat, drink, or have skin contact with a contaminant. Several factors determine whether health effects occur, and the type and severity of health effects associated with exposure to chemicals. Such factors include chemical concentration, frequency and duration of exposure, route of exposure (e.g., ingestion, inhalation) and cumulative exposures (i.e., the combination of chemicals and routes of exposures). Once exposure takes place, individual characteristics such as age, sex, nutritional status, genetics, lifestyle, and health status influence how that person absorbs, distributes, metabolizes, and excretes the chemical. These characteristics, together with the exposure factors discussed above and the toxicological effects of the substance, determine whether and which health effects may result.

In order for any environmental contaminant to be a health concern, the contaminant must be present at a high enough concentration to cause potential harm and there must be a completed route of exposure to people. A pathways analysis considers five principle elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and a receptor population. Completed exposure pathways are those in which all five elements are present, and indicate that exposure to a contaminant has occurred in the past, is presently occurring, or will occur in the future. DPH regards people who come into contact with contamination as exposed. It should be noted that the identification of an exposure pathway does not imply that health effects will occur. Exposures may, or may not be substantive. Thus, even if exposure has occurred, human health effects may not necessarily result [6].

[1] EPA-540-R-08-01, June 2008. This document is designed to provide guidance on determining the usability of analytical data generated through the Contract Laboratory Program (CLP) Statement of Work (SOW) SOM01.2 and any future editorial revisions of SOM01.2.

In general, people can be exposed to contaminants through ingesting soil and food, drinking water, inhaling vapors and dust, and by skin contact. Site-specific conditions were considered in evaluating PAHs in the soil at the Seven Out facility and in sediment in the drainage ditch and drainage canal. Exposure to these contaminants can occur primarily as accidental ingestion of soil and/or sediment and by dermal contact with soil and sediment.

Evaluation Process

DPH utilized a two-stage approach in the assessment of the soil/sediment data from Seven Out and the related drainage canals. The first step involves a review of EPA's recent sampling data and the selection of contaminants that may warrant further evaluation, based on the potential for exposure to these contaminants to result in adverse health effects. DPH examines the types and concentrations of contaminants, which are then screened with health-based comparison values generally established by ATSDR and EPA. Comparison Values (CVs) are concentrations of a contaminant that can reasonably (and conservatively) be regarded as harmless to human health, assuming default conditions of exposure. CVs include ample uncertainty factors to ensure protection of sensitive populations. Because CVs do not represent thresholds of toxicity, exposure to contaminant concentrations above CVs will not necessarily lead to adverse health effects [6]. DPH then considers how people may come into contact with the contaminants. Because the level of exposure depends on the route, frequency, and duration of exposure and the concentration of contaminants, this exposure information is essential to determine if a public health hazard exists.

The next step in the evaluation process involves an in-depth health-effects evaluation of the contaminants detected in the site media (in this case, soil and sediment) above their respective CVs. The primary focus of this effort is to evaluate the potential for the contaminant(s) to produce cancer and non-cancer health effects as a result of human exposure. A more detailed description of both steps of the evaluation process is presented in Appendix B.

DPH used a conservative approach to evaluate whether contaminants from Seven Out and the drainage ditch or canal pose a possible health concern. Contaminants of concern (from the contaminants detected in soil and sediment) were determined by employing a screening process. In general, health-based CVs or screening values used include EPA Regional Screening Levels (RSLs) for residential soil and ATSDR cancer risk evaluation guides (CREGs). CVs such as the RSL and CREG offer a high degree of protection and assurance that people are unlikely to be harmed by contaminants in the environment. Therefore, DPH is evaluating only the contaminants found above a CV in either soil or sediment from the various sampling locations. For chemicals that cause cancer, the CVs represent levels that are calculated to increase the estimated risk of cancer by about one additional cancer in a million people exposed.

Results

Chemicals of Concern

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are a group of chemicals that result from the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances, such as tobacco and charbroiled meat. Exposure can occur through air, water, soil, or food. While there are several hundred different PAHs, they are usually present in mixtures and are generally not used commercially. Exposure to these chemicals usually occurs as an exposure to mixtures of PAHs and not as individual chemicals. PAHs released to soil adsorb (bind) to soil and sediment, and most do not easily dissolve in water or volatilize to air. PAHs enter the air from motor vehicle exhaust, residential and industrial furnaces, tobacco smoke, volcanoes, agricultural burning, residential wood burning, and wildfires. Seasonal variations in exposure to PAHs are known to occur. The soil and water near industrialized areas can contain elevated concentrations of PAHs. Foods that contain PAHs include smoked, charcoal-broiled, and roasted foods and on plant foods that may become contaminated by atmospheric deposition [7].

Health effects experienced from exposure to PAHs depend on the magnitude, duration, and route of exposure as well as the chemical properties of the PAH mixture. Most of our understanding of how PAHs can affect health is based on toxicological studies of animals. It is not clear whether PAHs cause short-term health effects. Skin irritation and sensitization is well documented in studies of anthracene and benzo[a]pyrene [7].

There are far more animal studies than human studies available for evaluating chronic toxicity to PAHs. Occupational studies of workers exposed to high levels of PAHs have demonstrated that inhalation or dermal exposure can result in lung and skin cancer. Most animal studies of health effects from oral exposures to PAHs demonstrated adverse impacts to most organ systems (respiratory, cardiovascular, gastrointestinal, etc.) and cancer, but only at very high concentrations for mice and rats dosed orally by gavage[2] [7].

Soil

Table 2 summarizes the analytical results from the soil samples collected by EPA during the December 2013 assessment outside the southern containment wall of the Seven Out facility and the concrete trench located along the eastern side of the facility. A column showing the PAH results from the June 2004 evaluation is shown for comparative purposes.

[2] introduction into the stomach via a tube

Table 2: Soil Sample Results above the Lowest Health Based Comparison Values from Outside the Seven Out Containment Wall

Contaminant	SCW Sample Mean (mg/kg)	SC Sam Ran (mg/kg)	2004 SCW (mg/kg)	CT Sample (mg/kg)	Comparison Value (mg/kg)	Type of CV
Benzo[a]anthracene	**1.85**	**1.6 - 2.1**	**2.4**	0.06	0.15	RSL
Benzo[a]pyrene	**1.95**	**1.8 – 2.1**	**2.8**	**0.08**	0.015, 0.096	RSL, CREG
Benzo[b]fluoranthene	**3.1**	**3.1**	**1.8**	0.13	0.15	RSL
Dibenz(a,h)anthracene	**0.425**	**0.41 – 0.44**	**0.65**	**0.016**	0.015	RSL
Indeno[1,2,3-cd]pyrene	**1.65**	**1.6 – 1.7**	**3.0**	0.06	0.15	RSL

Bold values exceed lowest comparison value
SCW: South containment wall
CT: Concrete trench
mg/kg: milligrams per kilogram (parts per million)
CV: comparison value
RSL: EPA Regional Screening Level for residential soil (June 2011). RSLs are integrated screening levels that incorporate cancer risk from inhalation, ingestion, and dermal exposures yielding a cancer risk of one in a million exposed people over a lifetime or a non-cancer risk not exceeding a hazard quotient of 1.
CREG: Cancer Risk Evaluation Guide (ATSDR 3/8/13)
Source: Tetra Tech. *Francis Street Assessment Letter Report of Soil Sample Results from Francis Street Site (Seven Out), Waycross, GA*. February 2014.

Soil sample results from outside the south containment wall area of the Seven Out facility show that benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenz(a,h)anthracene, and indeno[1,2,3-cd]pyrene exceeded CVs. Soil sample results the concrete trench of the Seven Out facility show that benzo[a]pyrene and dibenz(a,h)anthracene exceeded CVs. Therefore, DPH further evaluated the potential for adverse non-cancer and cancer health effects of these PAHs. Because CVs such as the RSL and CREG offer a high degree of protection and assurance that people exposed to levels at or below these CVs are unlikely to be harmed contaminants found in this soil, DPH will not evaluate the remaining PAHs that did not exceed their lowest CV for potential adverse non-cancer and cancer health effects.

It is interesting to note that PAH levels at outside the south containment wall have not changed much since EPA's 2004 sampling event. For most PAHs, their levels are approximately 50% of the levels found in 2004.

Sediment

Table 3 summarizes the analytical results from sediment samples collected in DU-1 through DU-3 (see Figure 3).

Table 3: Sediment Sample Results above the Lowest Health Based Comparison Values from DU-1, DU-2, and DU-3

Contaminant	DU-1 (mg/kg)	DU-2 (mg/kg)	DU-3 Sample Mean (mg/kg)	DU-3 Sample Range (mg/kg)	Comparison Value (mg/kg)	Type of CV
Benzo[a]anthracene	**0.37**	**0.32**	**0.18**	**0.18 - 0.19**	0.15	RSL
Benzo[a]pyrene	**0.58**	**0.39**	**0.29**	**0.28 - 0.29**	0.015, 0.096	RSL, CREG
Benzo[b]fluoranthene	**1.5**	**0.76**	**0.66**	**0.63 - 0.69**	0.15	RSL
Dibenz(a,h)anthracene	**0.15**	**0.087**	**0.076**	**0.075 - 0.078**	0.015	RSL
Indeno[1,2,3-cd]pyrene	**0.6**	**0.34**	**0.28**	**0.27 - 0.29**	0.15	RSL

Bold values exceed lowest comparison value
DU-1: in drainage ditch upgradient of Seven Out that serves as a background sample
DU-2: drainage pathway from Seven Out to drainage ditch
DU-3 drainage ditch, south and downgradient of Seven Out
mg/kg: milligrams per kilogram (parts per million)
CV: comparison value
RSL: EPA Regional Screening Level for residential soil (June 2011). RSLs are integrated screening levels that incorporate cancer risk from inhalation, ingestion, and dermal exposures yielding a cancer risk of one in a million exposed people over a lifetime or a non-cancer risk not exceeding a hazard quotient of 1.
CREG: Cancer Risk Evaluation Guide (ATSDR 3/8/13)
Source: Tetra Tech. *Francis Street Assessment Letter Report of Soil Sample Results from Francis Street Site (Seven Out), Waycross, GA*. February 2014.

Sample results, including the background sample in DU-1 through DU-3 show that benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenz(a,h)anthracene, and indeno[1,2,3-cd]pyrene exceeded CVs; therefore, DPH further evaluated the potential for adverse non-cancer and cancer health effects of PAHs. Because CVs such as the RSL and CREG offer a high degree of protection and assurance that people exposed to levels at or below these CVs are unlikely to be harmed contaminants found in this sediment, DPH will not evaluate the remaining PAHs that did not exceed their lowest CV for potential adverse non-cancer and cancer health effects.

It is important to note that background levels found in DU-1 are higher (in some cases, double) that the levels of PAHs found in DU-2 and DU-3. This suggests that Seven Out is not the source of PAH contamination found in the downgradient drainage canal that flows through Folks Park.

Table 4 summarizes the analytical results from sediment samples collected in DU-4 through DU-5 (see Figure 3).

Table 4: Sediment Sample Results above the Lowest Health Based Comparison Values from DU-4, and DU-5

Contaminant	DU-4 Sample Mean (mg/kg)	DU-4 Sample Range (mg/kg)	DU-5 (mg/kg)	Comparison Value (mg/kg)	Type of CV
Benzo[a]pyrene	**0.027**	**0.023 – 0.035**	**0.015**	0.015, 0.096	RSL, CREG

Bold values exceed lowest comparison value
DU- 4: drainage canal, upgradient of confluence with drainage ditch
DU-5: drainage canal, downgradient of confluence with drainage ditch
mg/kg: milligrams per kilogram (parts per million)
CV: comparison value
RSL: EPA Regional Screening Level for residential soil (June 2011). RSLs are integrated screening levels that incorporate cancer risk from inhalation, ingestion, and dermal exposures yielding a cancer risk of one in a million exposed people over a lifetime or a non-cancer risk not exceeding a hazard quotient of 1.
CREG: Cancer Risk Evaluation Guide (ATSDR 3/8/13)
Source: Tetra Tech. *Francis Street Assessment Letter Report of Soil Sample Results from Francis Street Site (Seven Out), Waycross, GA*. February 2014.

Sample results show that benzo[a]pyrene is the only PAH that exceeded CVs in both the DU-4 and DU-5 samples; therefore, DPH further evaluated the potential for adverse non-cancer and cancer health effects of benzo[a]pyrene. Because CVs such as the RSL and CREG offer a high degree of protection and assurance that people exposed to levels at or below these CVs are unlikely to be harmed contaminants found in this sediment, DPH will not evaluate the remaining PAHs that did not exceed their lowest CV for potential adverse non-cancer and cancer health effects.

The sample results show that the level of benzo[a]pyrene in the drainage canal upgradient of the confluence with the drainage ditch are higher than benzo[a]pyrene levels downgradient of the confluence with the drainage ditch. This also suggests that Seven Out is not the source of PAH contamination found in the drainage canal that runs through Folks Park.

Non-cancer Health Effects

PAH exposure usually occurs as a mixture of PAHs. Being in the same family of chemicals, PAHs are also metabolized and excreted similarly in the body. Therefore, DPH estimated cumulative exposure doses for all PAH's (found above their respective CVs) as a prudent and conservative approach to assess the potential for adverse health effects from exposure through accidental ingestion of soil or sediment and from direct contact with sediment.

In 1993, EPA provided guidance for quantitatively assessing exposure to PAHs [8]. This guidance provides a systematic approach to the way PAHs can be evaluated as benzo[a]pyrene (the most toxic PAH) toxic equivalents. The benzo[a]pyrene-toxic equivalent (BaP-TE) is a derived concentration of the 7 most common PAHs with their specific concentrations adjusted for their toxicity relative to benzo[a]pyrene (BaP). These specific PAHs and relative toxicities (expressed as toxic equivalent factors; TEFs) are as follows:

PAH compound	TEF
Benzo[a]pyrene	1
Benz[a]anthracene	0.1
Benzo[b]fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenz(a,h)anthracene	1
Indeno[1,2,3-cd]pyrene	0.1

BaP-TE equals the sum of the individual concentrations multiplied by their respective TEF. Cumulative exposure doses were evaluated and estimated as BaP-toxic equivalents where their respective concentrations found in soil and sediment are adjusted for their toxicity relative to benzo[a]pyrene.

In addition, DPH accounted for differences in the bioavailability of PAHs from ingestion and dermal contact. Numerous studies have determined that the relative oral bioavailability of PAHs from soil is less than 100% [5]. Reported PAH absorption (from ingestion) values range from 17% to 66% (in mice, rats, and swine) and have a cumulative PAH absorption of 40% [9]. Similarly, cumulative dermal absorption values for PAHs were reported to be 10% [10].

The SCW and concrete trench soil samples, as well as sediment samples collected from DU-1 through DU-3 were collected in an industrialized area of Waycross; thus located on private property. Frequent or routine exposures to on-site soils at Seven Out and sediment in the drainage ditch are not expected to occur. It is possible that trespassers or visitors may access this site, although exposure to soil from ingestion or exposure to sediment from ingestion or direct (dermal) contact is expected to be infrequent.
The sediment samples collected from DU-4 and DU-5 were collected in an area of mixed industrial and residential use. This evaluation considered exposure to sediment via incidental ingestion and dermal (direct) contact by children wading or playing in the drainage canal, although this activity is also expected to be infrequent.

For estimating exposure doses, DPH used a very conservative exposure scenario. The exposure dose calculations are based on 6 to <11 year old children wading or playing in the drainage ditch or drainage canal where the samples were obtained. Exposure dose calculations from exposure to soil at the Seven Out site from incidental ingestion are also based on 6 to <11 year old children accessing the site. Because frequent or routine exposures to on-site soils at Seven Out and sediment in the drainage ditch are not expected to occur, DPH assumed exposure to occur one day per month. DPH also assumed that children's exposure to sediment from wading or playing in the drainage canal would occur two days per month. For estimating oral exposure doses, DPH used the U.S. mean soil and dust ingestion rate for 6 to <11 year old children[3] of 100 milligrams (mg) for each day of exposure, and assumed that they weigh the U.S. mean 6 to <11 year old child weight[4] of 31.9 kilograms (kg). In addition, an oral ingestion absorption rate of 100% and a dermal absorption rate of 10% were used to estimate exposure doses. Estimated dermal exposure

[3]U.S. EPA analysis of NHANES 1999-2006 data.

[4]U.S. EPA analysis of NHANES 1999-2006 data.

doses were negligible and did not add to the cumulative total exposure doses. Table 5 shows the estimated exposure doses that children may have incurred under the exposure scenarios established for this health consultation.

Table 5: Estimated Cumulative Exposure Doses for Children Ages 6 through 10 Years Old from Incidental Ingestion of Soil at Seven Out and Incidental Ingestion and Dermal Absorption of Sediment in DU-1 through DU-3 and DU-4 through DU-5

Location	Contaminants	Cumulative Estimated Exposure Dose mg/kg/day	Proposed EPA Oral RfD* mg/kg/day
South Containment Wall Area	BaP-TE	0.0000003	0.0003
Concrete Trench	BaP-TE	0.00000001	0.0003
DU-1 through DU-3	BaP-TE	0.0000002	0.0003
DU-4 through DU-5	BaP-TE	0.000000009	0.0003

mg/kg/day: milligrams per kilogram per day
*The proposed oral reference dose (RfD) is based on the most current research on benzo[a]pyrene, considered to be the most toxic member of the of the PAH group of chemicals. EPA released a public comment draft on September 30, 2013 of their reassessment of benzo[a]pyrene initially published in EPA' Integrated Risk Information System (IRIS) in 1987.

Because ATSDR health-based guidelines, known as minimal risk levels (MRLs) are not available for the PAHs found in this investigation, DPH used EPA's currently proposed health guideline known as a reference dose (RfD) for benzo[a]pyrene (considered to be the most toxic member of the PAH group of chemicals). RfDs are estimates of daily human exposure, including exposure to sensitive subpopulations that are likely to be without appreciable risk of adverse health effects during a lifetime (70 years) of exposure. These guidelines are derived from experimental data using the lowest observed adverse effects levels (LOAELs) found in the experimental group of animals (or no observed adverse effects levels [NOAELs]), and adjusted downward using uncertainty factors (margins of safety).

To estimate an exposure level below which effects from benzo[a]pyrene exposure are not expected to occur, the lowest organ/system-specific RfD (3×10^{-4} mg/kg/day) is being proposed as the overall reference dose for benzo[a]pyrene. This value, based on induction of neurobehavioral changes in rats exposed to benzo[a]pyrene during a susceptible life-stage is supported by several animal and human studies [11, 12]. There is evidence in humans and animals that benzo[a]pyrene induces developmental neurotoxicity. In addition to the persistent reductions in cognitive ability observed in epidemiology studies of prenatal PAH exposure, the two epidemiology studies that examined benzo[a]pyrene-specific measures observed effects on neurodevelopment and behavior in young children. Altered learning and memory, motor activity, anxiety-like behavior, and electrophysiological changes have also been observed in animals following oral and inhalation exposure to benzo[a]pyrene [11].

The lowest dose identified (LOAEL) to cause harmful effects and the endpoint used for the RfD derivation was 0.09 mg/kg/day based on a study of rat pups who were given daily doses of benzo[a]pyrene through a period of rapid brain development (post-natal days 5-11) where observed increased latency in negative geotaxis, increased motor activity in the open field test, decreased anxiety-like behaviors in the elevated plus maze test, and impaired performance in the Morris water maze test as measured by an increase in latency time to find a hidden platform were observed [12]. These effects were not observed in adolescent pups. To derive the chronic oral RfD, EPA divided the LOAEL of 0.09 mg/kg/day by an uncertainty factor of 300. The uncertainty factor used in the RfD determination included 10x for interspecies variation, 10x for human variability, and 3x for a database uncertainty factor from many animal studies, resulting in a proposed RfD of 0.0003 mg/kg/day [11].

It is important to know that the estimated PAH exposure doses in people who come into contact with soil or sediment at the Seven Out site and related drainage ditch and drainage canal will be compared to EPA's chronic oral RfD of 0.0003 mg/kg/day. An easy way to determine if the estimated dose is less than or greater than the MRL is to determine a hazard quotient (HQ) for BaP-TE's. The HQ is derived by dividing the estimated BaP-TE dose by the RfD. Whenever the HQ is below 1, then the estimated dose is below the RfD and non-cancerous harmful effects are not expected. When the HQ exceeds 1, then the estimated dose exceeds the RfD. The HQ for 6 to <11 year old children coming into contact with the cumulative BaP-TE from soil at Seven Out, and incidentally ingesting this soil using the assumed exposure scenario is 0.001 (1.0×10^{-3}). This estimated exposure dose from BaP-TE is approximately 1,000 times below the RfD. The HQ for 6 to <11 year old children coming into contact with the cumulative BaP-TE from sediment in DU-1 through DU-3, and incidentally ingesting this sediment using the assumed exposure scenario is 0.0007 (7.0×10^{-4}). The estimated exposure dose from BaP-TE is approximately 70,000 times below the RfD. The HQ for 6 to <11 year old children coming into contact with the cumulative BaP-TE from sediment in DU-4 through DU-5, and incidentally ingesting this sediment using the assumed exposure scenario is 0.00003 (3.0×10^{-5}). The estimated exposure dose from BaP-TE is approximately 300,000 times below the RfD. **Therefore, DPH has determined that people, including children, coming into contact with PAHs found in soil at the Seven Out site and with sediment in the drainage ditch and drainage canals are highly unlikely to experience adverse non-cancer health effects from this exposure.**

Cumulative Cancer Risk

The EPA Guidelines for Carcinogen Risk Assessment (1986) categorizes benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenz(a,h)anthracene, and indeno[1,2,3-cd]pyrene as probable human carcinogens although inadequate human evidence and sufficient evidence from animal studies exists [13]. The National Toxicology Program has made the scientific recommendation that these PAHs are reasonably anticipated to be carcinogenic [14]. The International Agency for Research on Cancer (IARC) categorizes benzo[a]pyrene as carcinogenic to humans; dibenz(a,h)anthracene as probably carcinogenic to humans with limited human evidence but sufficient evidence in animals; and benzo[a]anthracene benzo[b]fluoranthene, and indeno[1,2,3-cd]pyrene as possibly carcinogenic to humans with limited human evidence and less than sufficient evidence in animals [15]. IARC, NTP, and EPA also list chemical mixtures (e.g., soot, coke-oven emissions, coal tars), which contain PAH chemicals, as known carcinogens.

Lung, genitourinary, and skin cancers have been reported in occupational settings, where the amount of PAH exposure is much greater than it is in the general population [7].

The estimated risk for cancer from exposure to contaminants is usually calculated by multiplying the exposure dose by a cancer potency factor; usually EPA's corresponding cancer slope factor $(mg/kg/day)^{-1}$ for a carcinogen. This cancer slope factor (CSF) is equivalent to the 95% upper-bound lifetime cancer risk to an individual, rather than the average risk, suggesting that cancer risk is actually lower, perhaps by several orders of magnitude. EPA and the broader scientific community consider a cancer risk range of between one in a million to one in ten thousand (10^{-6} to 10^{-4}) as an acceptable range. That means that it is used by EPA for evaluation of human food-chain exposures because it provides assurance that risk is not underestimated. An increased cancer risk of one in a million or less is generally considered an insignificant increase in cancer risk.

Exposure to a cancer-causing chemical, even at low concentrations, is assumed to be associated with some increased risk of cancer for evaluation purposes. To estimate lifetime cancer risk from PAH exposure to soil at the Seven Out site and to sediment found in the drainage ditch and drainage canal, DPH estimated cumulative cancer risk and used an exposure period of 70 years (12 years as a child and 58 years as an adult). The estimated cumulative cancer risk is based on exposure to soil and sediment for all PAHs found above a CV under the exposure scenario used in this health consultation. Table 6 shows the estimated cumulative cancer risk for people exposed to PAHs found in the soil at Seven Out and in the drainage ditch and drainage canal where EPA sampled in December 2013. Cancer risk was based on the exposure scenario used in this health consultation.

Table 6: Estimated Cancer Risks from Cumulative Exposure to all PAHs Found Above a Comparison Value from Incidental Ingestion of Soil at Seven Out and Incidental Ingestion and Dermal Absorption of Sediment in both DU-1 through DU-3 and DU-4 through DU-5

Location	Contaminants	Estimated Cumulative Cancer Risk
South Containment Wall Area	Benzo[a]anthracene, Benzo[a]pyrene, Benzo[b]fluoranthene, Dibenzo(a,h)anthracene, Indeno[1,2,3-cd]pyrene	1.8×10^{-6}
Concrete Trench	Benzo[a]pyrene, Dibenzo(a,h)anthracene	7.2×10^{-8}
DU-1 through DU-3	Benzo[a]anthracene, Benzo[a]pyrene, Benzo[b]fluoranthene, Dibenzo(a,h)anthracene, Indeno[1,2,3-cd]pyrene	1.2×10^{-6}
DU-4 through DU-5	Benzo[a]pyrene	6.4×10^{-8}

The estimated cumulative cancer risk is based a lifetime of exposure to the PAHs listed in the above table. This includes 12 years of exposure as a child and 58 years exposure as an adult. The EPA cancer slope factors (CSF's) used to estimate cancer risk for include $(0.73\ mg/kg/day)^{-1}$ for benzo[a]anthracene, $(7.3\ mg/kg/day)^{-1}$ for benzo[a]pyrene, $(0.73\ mg/kg/day)^{-1}$ for benzo[b]fluoranthene, $(7.3\ mg/kg/day)^{-1}$ for dibenzo(a,h)anthracene, and $(0.73\ mg/kg/day)^{-1}$ for indeno[1,2,3-cd]pyrene

To give the excess cancer risk context, it should be noted that the lifetime risk in the United States of being diagnosed with cancer in an individual from all causes is slightly less than 1 in 2 for men (50,000/100,000) and a little more than 1 in 3 for women (33,000/100,000) [16]. For more general information on cancer, see Appendix C.

The estimated cumulative lifetime excess cancer risk from exposure to PAHs at levels found above CVs in soil at the Seven Out site and in related drainage pathways range from approximately 6 in 100,000,000 people to 2 in 1,000,000 people exposed to these same levels. **Therefore, because EPA and the broader scientific community consider a cancer risk range of between one in a million to one in ten thousand (10^{-6} to 10^{-4}) as an acceptable range, people, including children, exposed to soil at the Seven Out site and to sediment in DU-1 through DU-5 are not at an elevated risk for cancer from this exposure.**

Child Health Considerations

In communities faced with contamination of the water, soil, air, or food, DPH recognizes that the unique vulnerabilities of infants and children demand special emphasis. Due to their immature and developing organs, infants and children are usually more susceptible to toxic substances than are adults. Children are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are also more likely to encounter dust, soil, and contaminated vapors close to the ground. Children are generally smaller than adults, which results in higher doses of chemical exposure because of their lower body weights relative to adults. In addition, the developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.

This health consultation uses child-specific exposure factors, such as body weights, intake rates, and skin exposure areas, as the basis for calculating exposures to contaminants found in soil and sediment (Appendix B). Because the resulting exposure doses for children are higher than adult exposure doses would be, they represent the basis for the following public health conclusions and recommendations.

Conclusions

DPH evaluated current and future exposure to levels of PAHs found in soil and sediment at the Seven Out site and related drainage pathways. This evaluation included an estimation of cumulative exposure doses from oral ingestion found in soil at Seven Out and oral ingestion and dermal absorption of contaminants found in sediment located in the related drainage pathways from recent samples submitted by EPA for analysis.

1. DPH concludes that people, including children coming into contact with PAHs found in soil at the Seven Out site and with sediment in the drainage ditch and drainage canals are highly unlikely to experience adverse non-cancer health effects from this exposure.

2. DPH concludes that that people, including children coming into contact with PAHs found in soil at the Seven Out site and with sediment in the drainage ditch and drainage canals are not at an elevated risk for cancer from this exposure.

Recommendation

There are no recommendations.

Public Health Action Plan

1. DPH will provide health education to residents.

2. As additional data become available, DPH will review the information and take appropriate actions to protect public health.

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Report Preparers and Reviewers

This Health Consultation for the Seven Out Site was prepared by the Georgia Department of Public Health (DPH) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication.

Authors

Franklin Sanchez, REHS
Health Assessor
Chemical Hazards Program
Georgia Department of Public Health

Noreen Gerette Kloc, MPH Candidate
Chemical Hazards Program
Georgia Department of Public Health

Reviewer

Jane Perry, MPH
Director
Chemical Hazards Program
Georgia Department of Public Health

Figures and Appendices

Figure 1: Site Location and Demographics

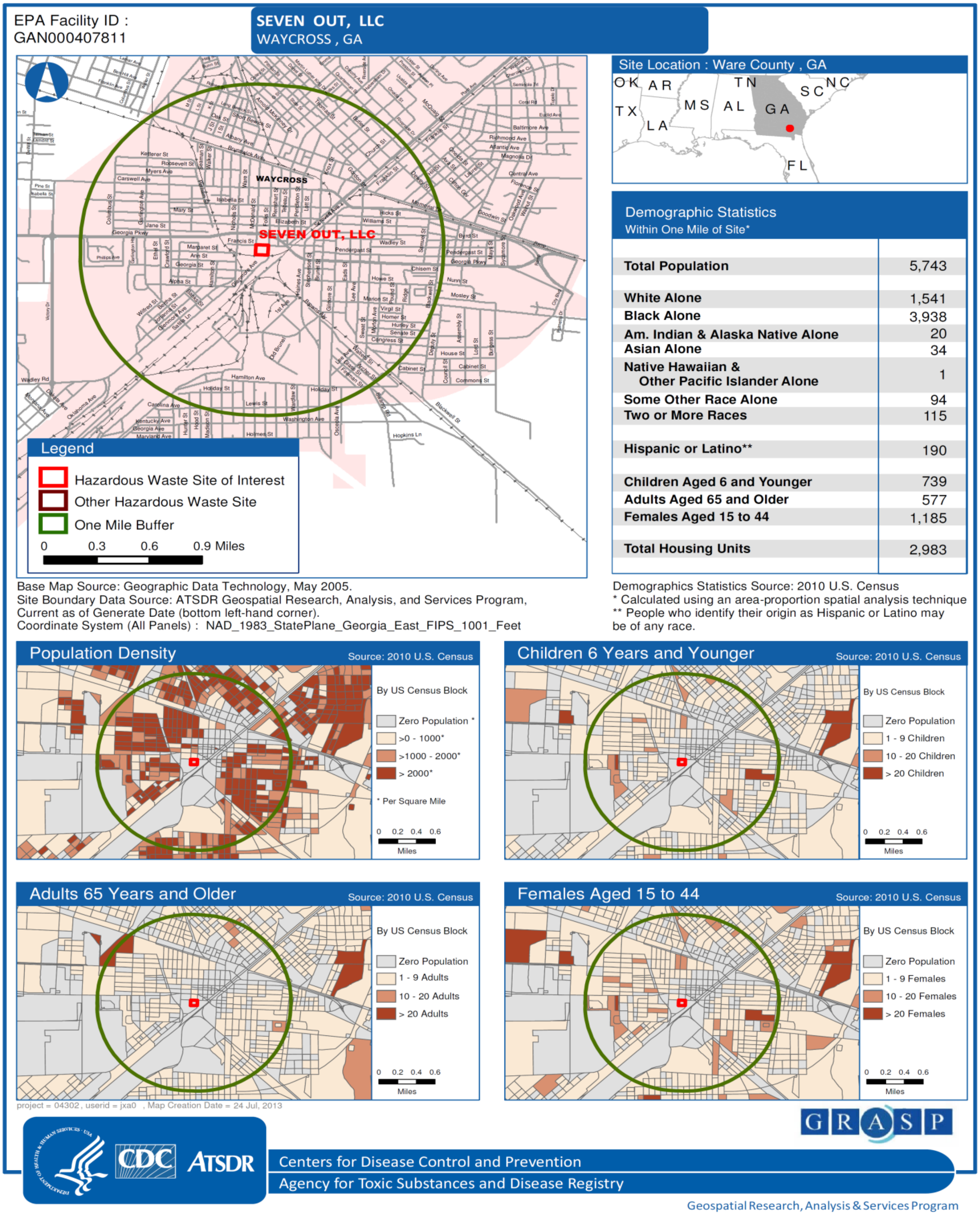


Figure 2: Site Description

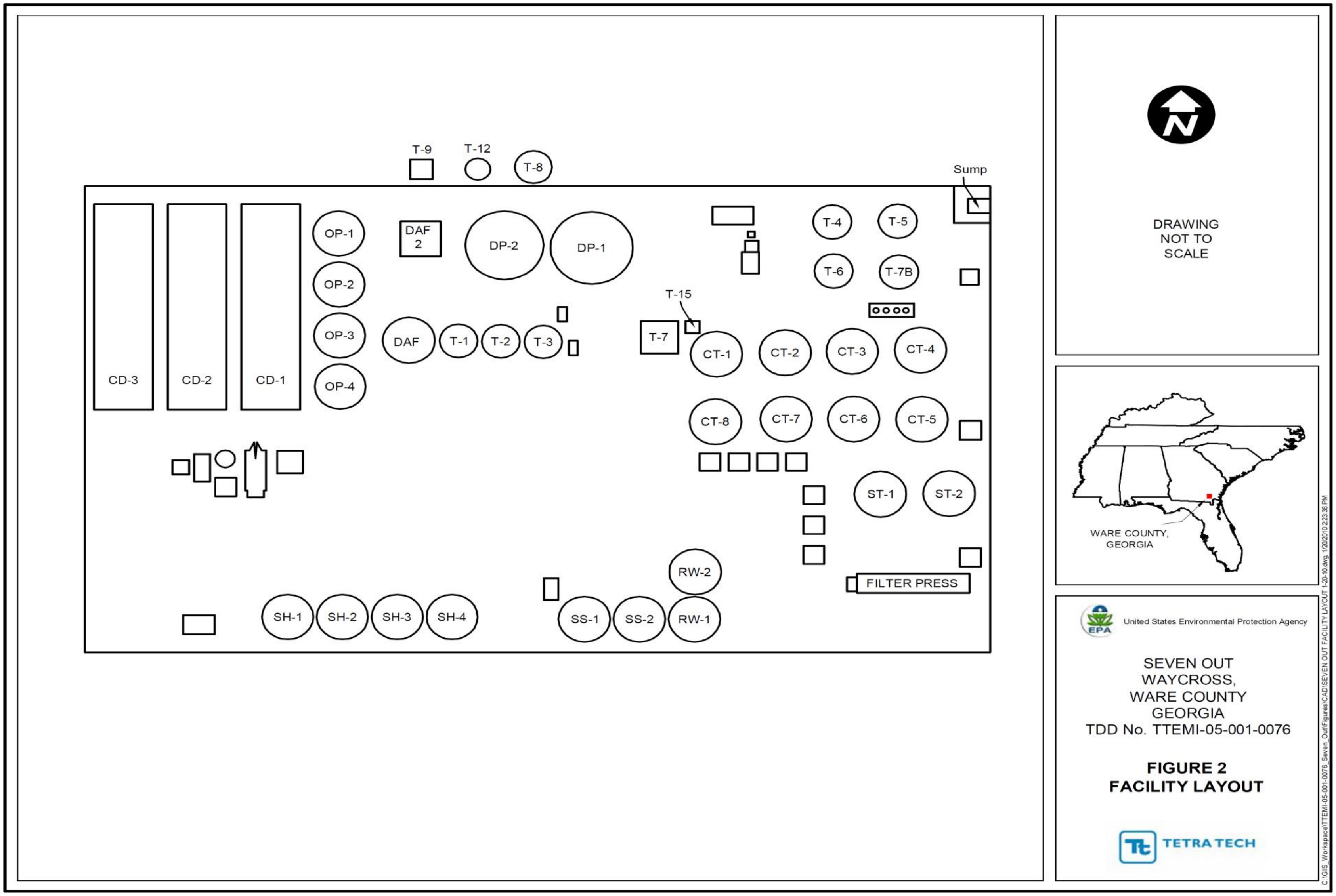
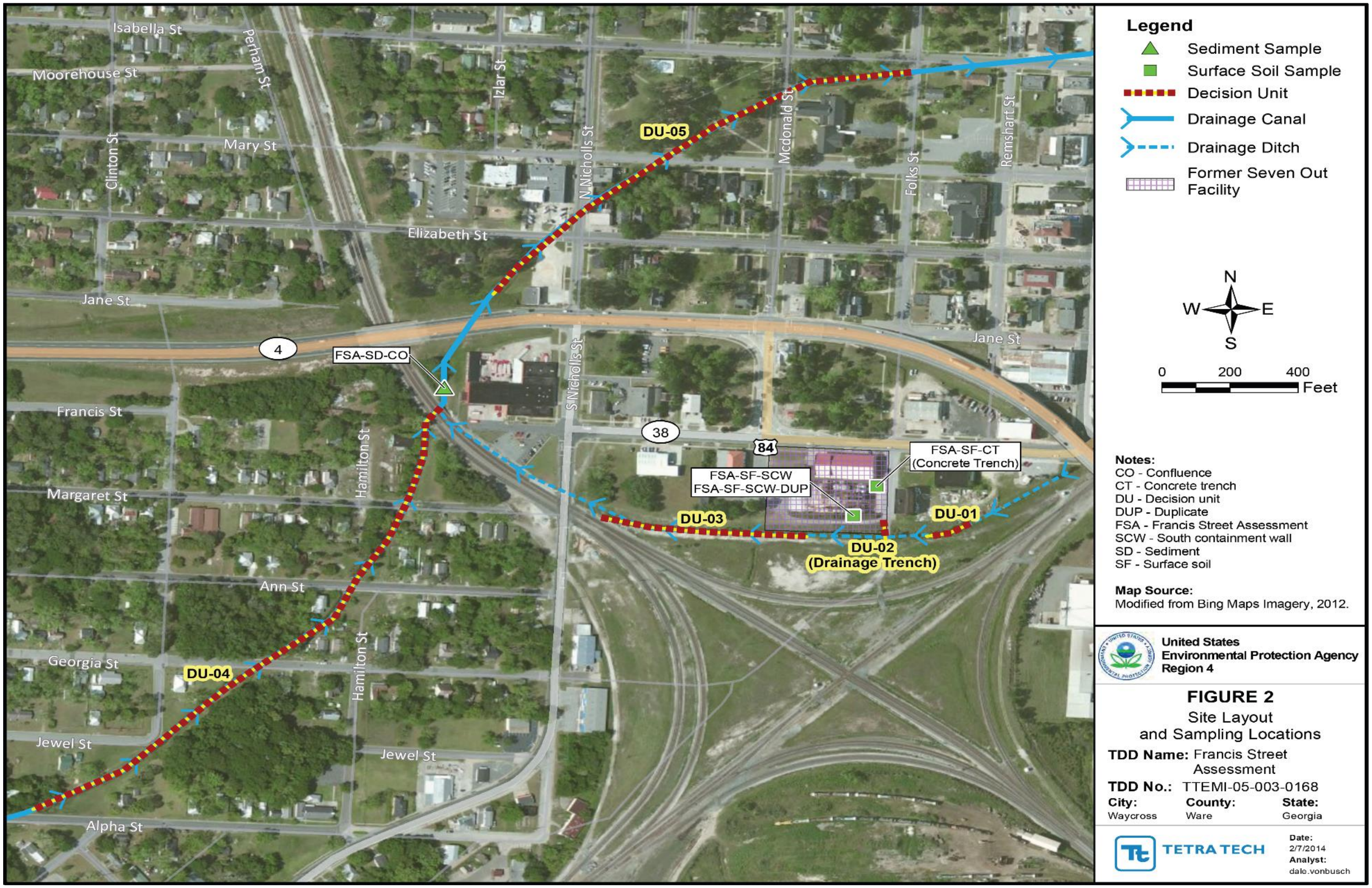


Figure 3: Site Sampling Locations



Appendix A: Soil and Sediment Sample Results

Table 1 displays the PAH results from soil samples collected by the EPA from the Francis Street (Seven Out LLC) facility during the December 2013 assessment.

Table 1: Corresponding PAHs in Sample Results from the Francis Street (Seven Out LLC) Concrete Trench and South Containment Wall

Contaminant	2013 Sample Francis Street – Concrete Trench[a] mg/kg	2013 Sample Francis Street - South Containment Wall[a] mg/kg	2013 Sample Francis Street - South Containment Wall Duplicate[a] mg/kg
2-Fluorobiphenyl	0.027	0.014	0.015
2-Methylnaphthalene	0.039	0.56	0.47 J+
Acenaphthene	0.011 J+	0.13 J	0.054 J+
Acenaphthylene	0.035	0.57	0.69 J+
Anthracene	0.022	0.76	0.56 J+
Benzo[a]anthracene	0.058	**1.6**	**2.1**
Benzo[a]pyrene	**0.077 J+**	**1.8**	**2.1**
Benzo[b]fluoranthene	0.13 J+	**3.1**	**3.1**
Benzo[g,h,i]perylene	0.063	1.4	1.5
Benzo[k]fluoranthene	0.043	1.1	1.1
Chrysene	0.075 J+	2.3	2.8
Dibenz(a,h)anthracene	**0.016**	**0.44**	**0.41 J+**
Fluoranthene	0.16 J+	4.8	5.3
Fluorene	0.014 J+	0.36 J+	0.12 J+
Indeno[1,2,3-cd]pyrene	0.064	**1.6**	**1.7**
Naphthalene	0.076	0.54	0.40 J+
Nitrobenzene-d5	0.034	0.015	0.019
Phenanthrene	0.094 J+	3	4.2
Pyrene	0.160 J+	4.5	5.8

Bold values exceed lowest comparison value
mg/kg: milligrams per kilogram (parts per million)
CV: comparison value

J: The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample
J+: The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample and may be biased high
[a]Source: Tetra Tech Francis Street Assessment Letter Report of Soil Sample Results from Francis Street (Seven Out LLC), Waycross, GA, December 2013; Laboratory: Test America, Arvada, CO.
[b]RSL: EPA Regional Screening Level for residential soil (June 2011). RSLs are integrated screening levels that incorporate cancer risk from inhalation, ingestion, and dermal exposures yielding a cancer risk of one in a million exposed people over a lifetime or a non-cancer risk not exceeding a hazard quotient of 1.

Table 2 displays the PAH results from sediment samples collected by the EPA from the Francis Street (Seven Out LLC) drainage ditch during the December 2013 assessment.

Table 2: Corresponding PAHs in Soil/Sediment Sample Results from the Francis Street (Seven Out LLC) drainage ditch Decision Unit 1[1], Decision Unit 2[2] and Decision Unit 3[3]

Contaminant	2013 Sample Decision Unit 1[a] mg/kg	2013 Sample Decision Unit 2[a] mg/kg	2013 Sample Decision Unit 3[a] Replicate A mg/kg	2013 Sample Decision Unit 3[a] Replicate B mg/kg	2013 Sample Decision Unit 3[a] Replicate C mg/kg
2-Fluorobiphenyl	0.0095	0.012	0.012	0.011	0.012
2-Methylnaphthalene	0.11	0.13	0.073 J	0.044	0.048
Acenaphthene	0.012 J	0.021 J	0.008 J	0.0083	0.0086
Acenaphthylene	0.2	0.15	0.1	0.093	0.095
Anthracene	0.23	0.14	0.1	0.11	0.11
Benzo[a]anthracene	**0.37**	**0.32**	**0.19**	**0.18**	**0.18**
Benzo[a]pyrene	**0.58**	**0.39**	**0.29**	**0.28**	**0.29**
Benzo[b]fluoranthene	**1.5**	**0.76**	**0.67**	**0.63**	**0.69**
Benzo[g,h,i]perylene	0.54	0.31	0.26	0.24	0.27
Benzo[k]fluoranthene	0.43	0.24	0.21	0.2	0.22
Chyrysene	0.51	0.42	0.27	0.25	0.26
Dibenz(a,h)anthracene	**0.15**	**0.087**	**0.075**	**0.075**	**0.078**
Fluoranthene	0.58	0.79	0.34	0.31	0.31
Fluorene	0.021 J+	0.032	0.013	0.011	0.011
Indeno[1,2,3-cd]pyrene	**0.6**	**0.34**	**0.29**	**0.27**	**0.29**
Naphthalene	0.085 J+	0.12	0.053	0.039	0.044
Nitrobenzene-d5	0.011	0.014	0.018	0.012	0.014

Phenanthrene	0.23	0.48	0.014 J	0.095	0.087
Pyrene	0.67	0.78	0.4	0.37	0.37
Terphenyl-d14	0.017	0.02	0.018	0.017	0.015

[1]Decision Unit 1; in drainage ditch up gradient of Seven Out LLC
[2]Decision Unit 2; drainage pathway from Seven Out LLC to drainage ditch
[3]Decision Unit 3; drainage ditch, down gradient of Seven Out LLC
Bold values exceed lowest comparison value
mg/kg: milligrams per kilogram (parts per million)
CV: comparison value
J: The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample
J+: The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample and may be biased high
[a]Source: Tetra Tech Francis Street Assessment Letter Report of Soil Sample Results from Francis Street (Seven Out LLC), Waycross, GA, December 2013; Laboratory: Test America, Arvada, CO.
[b]RSL: EPA Regional Screening Level for residential soil (June 2011). RSLs are integrated screening levels that incorporate cancer risk from inhalation, ingestion, and dermal exposures yielding a cancer risk of one in a million exposed people over a lifetime or a non-cancer risk not exceeding a hazard quotient of 1.

Table 3 displays the PAH results from sediment samples collected by the EPA from the Francis Street drainage canal during the December 2013 assessment.

Table 3: Corresponding PAHs in Soil/Sediment Sample Results from the Francis Street (Seven Out LLC) drainage canal Decision Unit 4[1]

Contaminant	2013 Sample Decision Unit 4[a] Replicate A mg/kg	2013 Sample Decision Unit 4[a] Replicate B mg/kg	2013 Sample Decision Unit 4[a] Replicate C mg/kg
2-Fluorobiphenyl	0.013	0.012	0.013
2-Methylnaphthalene	0.0033 J	0.0041J	0.0042 J
Acenaphthene	0.0007 J	0.0012 J	0.0014 J
Acenaphthylene	0.0044 J	0.0053	0.0066
Anthracene	0.0043 J	0.0054	0.0061
Benzo[a]anthracene	0.016 J	0.016	0.024
Benzo[a]pyrene	**0.023 J**	**0.024**	**0.035**
Benzo[b]fluoranthene	0.039 J	0.039	0.053
Benzo[g,h,i]perylene	0.022 J	0.022	0.03
Benzo[k]fluoranthene	0.013 J	0.012	0.017
Chyrysene	0.021 J	0.021	0.031
Dibenz(a,h)anthracene	0.0053 J	0.006	0.0073

Fluoranthene	0.029 J	0.028	0.038
Fluorene	0.0022 J	0.0026 J	0.003 J
Indeno[1,2,3-cd]pyrene	0.022 J	0.022	0.03
Naphthalene	0.0041 J	0.0053	0.0058
Nitrobenzene-d5	0.013	0.013	0.014
Phenanthrene	0.01	0.0092	0.012
Pyrene	0.032 J	0.035	0.041
Terphenyl-d14	0.019	0.015	0.016

[1]Decision Unit 4; drainage canal, up gradient of confluence with drainage ditch
Bold values exceed lowest comparison value
mg/kg: milligrams per kilogram (parts per million)
CV: comparison value
J: The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample
J+: The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample and may be biased high
[a]Source: Tetra Tech Francis Street Assessment Letter Report of Soil Sample Results from Francis Street (Seven Out LLC), Waycross, GA, December 2013; Laboratory: Test America, Arvada, CO.
[b]RSL: EPA Regional Screening Level for residential soil (June 2011). RSLs are integrated screening levels that incorporate cancer risk from inhalation, ingestion, and dermal exposures yielding a cancer risk of one in a million exposed people over a lifetime or a non-cancer risk not exceeding a hazard quotient of 1.

Table 4 displays the PAH results from sediment samples collected by the EPA from the Francis Street drainage canal during the December 2013 assessment.

Table 4: Corresponding PAHs in Soil/Sediment Sample Results from the Francis Street (Seven Out LLC) drainage canal Decision Unit 5[1] and Confluence Data[2]

Contaminant	2013 Sample Confluence Data[a] mg/kg	2013 Sample Decision Unit 5[a] mg/kg
2-Fluorobiphenyl	0.013	0.013
2-Methylnaphthalene	0.0022 J	0.0039 J+
Acenaphthene	0.0095	0.0009 J+
Acenaphthylene	0.0012 J	0.0027 J+
Anthracene	0.0018 J	0.0026 J+
Benzo[a]anthracene	0.0045 J	0.013 J+
Benzo[a]pyrene	0.006	**0.015 J+**
Benzo[b]fluoranthene	0.01	0.02 J+

Benzo[g,h,i]perylene	0.0054	0.012 J+
Benzo(k)fluoranthene	0.003 J	0.008 J+
Chyrysene	0.0068	0.016 J+
Dibenz(a,h)anthracene	0.0048	0.0031 J+
Fluoranthene	0.01	0.02 J+
Fluorene	0.017	0.0017 J+
Indeno[1,2,3-cd]pyrene	0.0051	0.011 J+
Naphthalene	0.0033 J	0.0036 J+
Nitrobenzene-d5	0.015	0.013
Phenanthrene	0.006	0.0061 J+
Pyrene	0.014	0.027 J+
Terphenyl-d14	0.017	0.022

[1]Decision Unit 5; drainage canal, down gradient of confluence with drainage ditch
[2]Confluence Data; point where drainage ditch meets with the drainage canal
Bold values exceed lowest comparison value
mg/kg: milligrams per kilogram (parts per million)
CV: comparison value
J: The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample
J+: The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample and may be biased high
[a]Source: Tetra Tech Francis Street Assessment Letter Report of Soil Sample Results from Francis Street (Seven Out LLC), Waycross, GA, December 2013; Laboratory: Test America, Arvada, CO.
[b]RSL: EPA Regional Screening Level for residential soil (June 2011). RSLs are integrated screening levels that incorporate cancer risk from inhalation, ingestion, and dermal exposures yielding a cancer risk of one in a million exposed people over a lifetime or a non-cancer risk not exceeding a hazard quotient of 1.

Appendix B: Explanation of Evaluation Process

Step 1--The Screening Process

In order to evaluate the available data, DPH used comparison values (CVs) to determine which chemicals to examine more closely. CVs are contaminant concentrations found in a specific environmental media (air, soil, water, sediment, and food) and are used to select contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of environmental media that someone may inhale or ingest each day. CVs are generated to be conservative and non-site specific. The CV is used as a screening level during the public health assessment (PHA) or health consultation process. CVs are not intended to be environmental clean-up levels or to indicate that health effects occur at concentrations that exceed these values.

CVs can be based on either carcinogenic (cancer-causing) or non-carcinogenic effects. Cancer-based CVs are calculated from the U.S. Environmental Protection Agency's (EPA) oral cancer slope factors for ingestion exposure, or inhalation risk units for inhalation exposure. Non-cancer CVs are calculated from ATSDR's minimal risk levels, EPA's reference doses for ingestion, or EPA's reference concentrations for inhalation exposure. When a cancer and non-cancer CV exist for the same chemical, the lower of these values is used as a conservative measure.

Step 2--Evaluation of Public Health Implications

The next step in the evaluation process is to take those contaminants that are above their respective CVs and further identify which chemicals and exposure situations are likely to be a health hazard. Separate child and adult exposure doses (or the amount of a contaminant that gets into a person's body) are calculated for site-specific scenarios, using assumptions regarding an individual's likelihood of exposure to contaminants found at Seven Out and related drainage pathways. A brief explanation of the calculation of estimated exposure doses used in this health consultation is presented below.

Ingestion of contaminants present in soil at the Seven Out site and in sediment found in the drainage ditch and drainage canal. Exposure doses for the consumption of contaminants present in soil were calculated using the measured concentration of PAHs in milligrams per kilogram (mg/kg) of soil. The following equation is used to estimate the exposure doses resulting from ingestion of contaminated soil:

$$ED = \frac{C \times TEF \times IR \times EF \times CF}{BW}$$

where;

ED = exposure dose from incidental ingestion (mg/kg/day)
C = contaminant concentration in soil or sediment (mg/kg)
TEF= toxic equivalent factor for the given PAH
IR = incidental ingestion rate (100 mg/day for 6 to<11 year old children)
EF= exposure factor (based on frequency of exposure, exposure duration, and time of exposure). The exposure factor used for exposure to soil at Seven Out and exposure to sediment found in DU-1 through DU-3 in this analysis was 0.033. This exposure factor assumes that exposure is occurring for one day per month, 12 months per year. The exposure factor used for exposure to sediment found in DU-4 through DU-5 in this analysis was 0.066. This exposure factor assumes that exposure is occurring two days per month, 12 months per year.
CF = soil/sediment conversion factor (10^{-6} kg/mg)
BW = body weight (based on the average body weight of a child aged 6<11 years old (31.9 kg)

For example, the following is an estimated exposure dose for 6 to <11 year old child incidentally ingesting soil outside the south containment wall at Seven Out with a benz[a]anthracene of 1.85 mg/kg:

$$ED = \frac{1.85 \text{ mg/kg} \times 0.1 \times 100 \text{ mg/day} \times 0.033 \times 10^{-6} \text{ kg/mg}}{31.9 \text{ kg}}$$

$= 1.9 \times 10^{-8}$ mg/kg/day (or 0.00000002 mg/kg/day) benzo[a]anthracene

Dermal absorption of contaminants present in sediment the drainage ditch and drainage canal. Exposure doses from dermal absorption of contaminants present in sediment were calculated using the measured concentration of contaminants in milligrams per kilogram (mg/kg) found in sediment. The following equation is used to estimate the exposure doses resulting from dermal absorption of PAHs in sediment:

$$ED = \frac{C \times TEF \times BA \times TSA \times EF \times CF}{BW}$$

where;

ED = exposure dose from dermal absorption (mg/kg/day)

C = contaminant concentration (mg/kg)

TEF = toxic equivalent factor for the given PAH

BA = a chemical-specific absorption or bioavailability factor (unitless). The bioavailability factor used for PAH dermal absorption was 0.10 (or (10%)

TSA = total soil adhered in milligrams (exposed skin surface area x soil adherence value). For children, we used the mean of the 50^{th} percentile cumulative body surface area of male and female between the ages of 6 to <11 years old is 9,310cm^2. The fraction of total body surface area for the face is 0.04, arms (0.123), forearms (0.0554), hands (0.053), and lower legs (0.115) was used for dermal exposure dose calculations. Therefore, 3,634 cm^2 was used for the total body-surface area potentially exposed to contaminants found in soil at the Seven Out site and in sediment in DU-1 through DU-5. The body part-specific soil adherence factor (assuming face, forearm, hands, and lower leg exposure) for children playing in soil used for dermal exposure calculations is the geometric mean of 0.04 mg/cm^2.

EF = exposure factor (based on frequency of exposure, exposure duration, and time of exposure). The exposure factor used for exposure to sediment found in DU-1 through DU-3 in this analysis was 0.033. This exposure factor assumes that exposure is occurring for one day per month, 12 months per year. The exposure factor used for exposure to sediment found in DU-4 through DU-5 in this analysis was 0.066. This exposure factor assumes that exposure is occurring two days per month, 12 months per year.

CF = sediment conversion factor (10^{-6} kg/mg)

BW = body weight (based on the average body weight of a child aged 6<11 years old (31.9 kg)

For example, the following is an estimated exposure dose for 6 to <11 year old child wading and playing in the drainage ditch located south of the Seven Out facility with a benz[a]anthracene of 0.18 mg/kg:

$$ED = \frac{0.18 \text{ mg/kg} \times 0.1 \times 0.1 \times [3634 \text{ cm}^2 \times 0.04 \text{ mg/cm}^2] \times 0.033 \times 10^{-6} \text{ kg/mg}}{31.9 \text{ kg}}$$

$$= \mathbf{2.7 \times 10^{-10} \text{ mg/kg/day}}$$

Sources for factors used for skin surface area, exposed skin surface area, and the soil adherence factor:

1. U. S. Environmental Protection Agency. *Risk Assessment for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).* Final. July 2004.
2. U. S. Environmental Protection Agency. *Exposure Factors Handbook.* September 2011.

Cumulative Exposure Doses

Cumulative exposure doses are expressed as the sum of all exposure doses to PAHs found above a comparison value in soil at the Seven Out site and in sediment found in DU-1 through DU-3 and in DU-4 through DU-5.

$$CED = ED_1 + ED_2 + ED_3 + ED_4, \text{ etc.}$$

where;

CED = cumulative exposure dose from incidental ingestion of soil or sediment containing more than one contaminant above a comparison value (mg/kg/day)
ED_1 = exposure dose from contaminant 1 (mg/kg/day)
ED_2 = exposure dose from contaminant 2 (mg/kg/day)
ED_3 = exposure dose from contaminant 3 (mg/kg/day)
ED_4 = exposure dose from contaminant 4 (mg/kg/day), etc.

For example, the cumulative exposure dose for a 6 to <11 year old child incidentally ingesting soil contaminated with benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenz(a,h)anthracene, and indeno[1,2,3-cd]pyrene outside the south containment wall at the Seven Out facility is calculated as follows:

CED = 1.91×10^{-8} mg/kg/day [benzo[a]anthracene] + 2.02×10^{-7} mg/kg/day [benzo[a]pyrene] + 3.2×10^{-8} mg/kg/day [benzo[b]fluoranthene] + 4.4×10^{-8} mg/kg/day [dibenz(a,h)anthracene] + 1.7×10^{-8} mg/kg/day [indeno[1,2,3-cd]pyrene]

= 3.14×10^{-7} (or 0.0000003) mg/kg/day

Non-cancer Health Risks

The doses calculated for exposure to individual chemicals are then compared to an established health guideline, such as an ATSDR minimal risk level (MRL) or an EPA reference dose RfD), in order to assess whether adverse health impacts from exposure are expected. Health guidelines are chemical-specific values that are based on available scientific literature and are considered protective of human health. Non-carcinogenic effects, unlike carcinogenic effects, are believed to have a threshold, that is, a dose below which adverse health effects will not occur. As a result, the current practice to derive health guidelines is to identify, usually from animal toxicology experiments, a no observed adverse effect level (NOAEL). This is the experimental exposure level in animals (and sometimes humans) at which no adverse toxic effect is observed. The values are summarized in ATSDR's *Toxicological Profiles (www.atsdr.cdc.gov/toxpro2.html).*The NOAEL is modified with an uncertainty (or safety) factor. The magnitude of the uncertainty factor considers various factors such as sensitive subpopulations (e.g., hildren, pregnant women, and the elderly), extrapolation from animals to humans, and the completeness of the available data. Thus, exposure doses at or below the established health guideline are not expected to cause adverse health effects because these guidelines are lower (and more human health protective) than doses that do not cause adverse health effects in laboratory animal studies.

For non-cancer health effects, RfDs were used in this health consultation. A direct comparison of site-specific exposures and doses to study-derived exposures and doses found to cause adverse health effects is the basis for deciding whether health effects are likely to occur. If the estimated exposure dose to an individual is less than the RfD, the exposure is unlikely to result in non-cancer health effects. If the calculated exposure dose is greater than the RfD, the exposure dose is compared to known toxicological values for the particular chemical and is discussed in more detail in the text of the health consultation.

It is important to consider that the methodology used to develop health guidelines does not provide any information on the presence, absence, or level of cancer risk. Therefore, a separate cancer risk evaluation is necessary for potentially cancer-causing contaminants detected at this site.

Cancer Risks

Exposure to a cancer-causing chemical, even at low concentrations, is assumed to be associated with some increased risk for evaluation purposes. The estimated risk for developing cancer from exposure to contaminants associated with the site was calculated by multiplying the site-specific doses by EPA's chemical-specific cancer slope factors (CSFs) available at *www.epa.gov/iris*. This calculation estimates an excess cancer risk expressed as a proportion of the population that may be affected by a carcinogen during a lifetime of exposure. For example, an estimated risk of 1×10^{-6} predicts the probability of one additional cancer over background in a population of 1 million. An increased lifetime cancer risk is not a specified estimate of expected cancers. Rather, it is an estimate of the increase in the probability that a person may develop cancer sometime in his or her lifetime following exposure to a particular contaminant under specific exposure scenarios. For children, the estimated excess cancer risk is not calculated for a lifetime of exposure, but from a fraction of lifetime; based on known or suspected length of exposure, or years of childhood.

Chemical	Cancer Slope Factor $(mg/kg/day)^{-1}$
Benzo[a]anthracene	0.73
Benzo[a]pyrene	7.3
Benzo[b]fluoranthene	0.73
Dibenz(a,h)anthracene	7.3
Indeno[1,2,3-cd]pyrene	0.73

Cumulative Cancer Risk Calculation

Cumulative cancer risks from incidental ingestion of soil contaminated with PAHs outside the south containment wall at Seven Out x CSF x years of exposure/70 years are calculated as follows:

Individual Chemical Cancer Risk

= 1.9×10^{-8} mg/kg/day x 0.73 $(mg/kg/day)^{-1}$ for **benzo[a]anthracene** x [12/70 + 58/70]
= **1.387×10^{-8}**

= 2.0×10^{-7} mg/kg/day x 7.3 $(mg/kg/day)^{-1}$ for **benzo[a]pyrene** x [12/70 + 58/70]
= **1.46×10^{-6}**

= 3.2×10^{-8} mg/kg/day x 0.73 $(mg/kg/day)^{-1}$ for **benzo[b]fluoranthene** x [12/70 + 58/70]
= **2.33×10^{-8}**

= 4.4×10^{-8} mg/kg/day x 7.3 $(mg/kg/day)^{-1}$ for **dibenz(a,h)anthracene** x [12/70 + 58/70]
= **3.21×10^{-7}**

= 1.7×10^{-9} mg/kg/day x 0.73 $(mg/kg/day)^{-1}$ for **indeno[1,2,3-cd]pyrene** x [12/70 + 58/70]
= **1.24×10^{-8}**

Cumulative Cancer Risk = Sum of Individual Chemical Cancer Risks

Therefore,

Cumulative Cancer Risk = $(1.4 \times 10^{-8}) + (1.4 \times 10^{-8}) + (2.3 \times 10^{-8}) + (3.2 \times 10^{-7}) + (1.25 \times 10^{-8})$
= **1.83×10^{-6}**

Appendix C: General Information on Cancer

Cancer will affect 1 in 2 men and 1 in 3 women in the United States, according to statistics collected by the Surveillance Epidemiology and End Results program at the National Cancer Institute [*www.seer.cancer.gov*]. Cancer is a group of more than 100 diseases characterized by uncontrolled growth and spread of abnormal cells. Different types of cancers have differing rates of occurrence, different causes and chances for survival. Therefore, we cannot assume that all the different types of cancers in a community or workplace share a common cause or can be prevented by a single intervention.

Cancers may be caused by a variety of factors acting alone or together, usually over a period of many years. Scientists estimate that most cancers are due to factors related to how we live, or lifestyle factors which increase the risk for cancer including: smoking cigarettes, drinking heavily, and diet (for example, excess calories, high fat, and low fiber). Other important cancer risk factors include reproductive patterns, sexual behavior, and sunlight exposure. A family history of cancer may also increase a person's chances of developing cancer.

Smoking is by far the leading risk factor for lung cancer. Smokers are about 20 times more likely to develop lung cancer than nonsmokers. People who don't smoke but who breathe the smoke of others also have a higher risk of lung cancer. A non-smoker who lives with a smoker has about a 20% to 30% greater risk of developing lung cancer. Workers exposed to tobacco smoke in the workplace are also more likely to get lung cancer. Exposure to radon, asbestos, arsenic, chromium, nickel, soot, tar, and other substances can also cause lung cancer. An increased risk for lung cancer has also been associated with personal or family history of lung cancer. Most people are older than 65 years when diagnosed with lung cancer.

Smoking tobacco is also an important risk factor for kidney cancer. Obesity and high blood pressure have also been linked to the disease. People with a family member who had kidney cancer have a slightly increased risk of kidney cancer. Also, certain hereditary conditions can increase the risk. Kidney cancer is about twice as common in men as in women, and is slightly more common among blacks than other races. Workplace exposure to asbestos, cadmium, some herbicides, benzene, and organic solvents, particularly trichloroethylene, has also been associated with an increased risk for kidney cancer.

While cancer occurs in people of all ages, new cases of most types of cancer rise sharply among people over 45 years of age. When a community, neighborhood, or workplace consists primarily of people over the age of 45 (and even more so over the age of 60), we would expect more cancers than in a neighborhood or workplace with people of younger ages. However, cancer is also the second leading cause of death in children.

Many people believe that cancer is usually caused by toxic substances in the home, community, or workplace. Although we do not know the exact impact now of environmental pollutants on cancer development, less than 10% of cancers are estimated to be related to toxic exposures – only 2 percent are attributed to environmental causes.

Since the 1970s when state cancer registries were first being organized, many public health scientists and residents hoped that anecdotal observations of clusters of cancer in the community might lead to prevention of new cases via discovery of specific causes of these cancers. Since then, thousands of investigations have taken place throughout the country, mainly conducted by state, local, or federal agencies. With one or two possible exceptions involving childhood cancers, none of these investigations have led to the identification of the causes of any of these possible clusters, even when a statistically elevated number of cancers in a geographic area could be documented. The Georgia Department of Public Health has developed strategies for active cancer surveillance. This systematic approach to monitoring cancer trends in our state will lead to more opportunities for prevention and control of cancer in Georgia.