Health Consultation

SWANN PARK, CITY OF BALTIMORE

296 WEST MCCOMAS STREET

BALTIMORE, MARYLAND

OCTOBER 22, 2007

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

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

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

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HEALTH CONSULTATION

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Prepared By:

Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation and
Division of Regional Operations

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FOREWORD

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the *Superfund* law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements. The public health assessment program allows the scientists flexibility in the format or structure of their response to the public health issues at hazardous waste sites. For example, a public health assessment could be one document or it could be a compilation of several health consultations - the structure may vary from site to site. Nevertheless, the public health assessment process is not considered complete until the public health issues at the site are addressed.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high risk groups within the community (such as the elderly, chronically ill, and people engaging in high risk practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries, to determine the health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further public health actions are needed.

Conclusions: The report presents conclusions about the public health threat, if any, posed by a site. When health threats have been determined for high risk groups (such as children, elderly, chronically ill, and people engaging in high risk practices), they will be summarized in the conclusion section of the report. Ways to stop or reduce exposure will then be recommended in the public health action plan.

ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Agency for Toxic Substances and Disease Registry
ATTN: Records Center
1600 Clifton Road, NE (Mail Stop E-60)
Atlanta, GA 30333

Summary

Recent soil sampling events at Swann Park, 296 West McComas Street, in South Baltimore Maryland have found elevated concentrations of inorganic arsenic and lead in surface and subsurface soil samples collected in April and June 2007. On April 19, 2007, on the recommendation of the Baltimore City Health Department and the Maryland Department of the Environment, the Baltimore City Recreation and Parks Department closed Swann Park. As an interim measure, the City Health Department then requested that the Agency for Toxic Substances and Disease Registry (ATSDR) evaluate potential arsenic exposures to users of the park and provide recommendations to protect public health, with the understanding that this evaluation would be updated when new site characterization information became available in a few months. ATSDR's first version of this report was published on June 13, 2007.

This updated report is significantly revised from the June 2007 version and incorporates public comments ATSDR received on our June report. This version also includes more comprehensive environmental sampling data from the site, site-specific bioaccessibility information provided by the Maryland Department of the Environment and Honeywell, and additional historical information provided by the City of Baltimore Swann Park Task Force. Readers should note that, on balance, the new information about the site—available after the June version of this report was published—has increased the ATSDR estimates of exposure doses from contamination in park soils. Two factors that contributed in particular to our updated findings are (1) the spatially-composited average concentration of arsenic across the playing fields and especially from one specific field (field 5; the June 2007 data is higher than the average arsenic concentrations calculated from the April 2007 data); and (2) the site specific assessment of the bioaccessiblity of arsenic in soil increased the level of arsenic bioavailability used in our dose calculations for users of the park (overall and field 5 specifically). Therefore, where ATSDR previously reported an overall finding of no public health hazard from exposures to site soils (with the exception of young children consuming large amounts), we now include the possibility (although unlikely) of skin effects for young children and teen athletes on field 5; and an estimated increased cancer risk for park workers, children, and coaches frequenting the site for time frames ranging from 14-30 years.

Swann Park is in an industrial area of south Baltimore and is directly adjacent to the former site of the Allied Chemical Corporation, Baltimore Plant (2000 Race Street). Until its recent closure, Swann Park was a highly used recreational facility. Activities at the Park included baseball, softball, football, soccer, and lacrosse, as well as general recreation and visitation by community members. In addition to park visitors, the Park workers were constantly engaged in field maintenance activities. All of these park activities may result in exposures to Park soil.

ATSDR screened all of the contaminants detected in the April and June 2007 Swann Park soil samples against environmental guidelines. Of the many contaminants detected in Swann Park soils only arsenic and lead were detected above their environmental guidelines. Normal park activities, such as field sports (baseball, football, etc.), and park maintenance have resulted in exposures to contaminated soil.

Based on predicted frequency of exposures to Swann Park soil, lead from Swann Park soil is not expected to produce any adverse health effects in children or adults. Kepone concentrations in soil were well below the chronic soil guideline but the maximum detected level was above the acute soil guideline for a child exhibiting pica behavior. However, adverse effects from

exposure to kepone following soil pica behavior are not expected due to conservative assumptions of both the exposure doses and screening value.

Some of the arsenic exposure doses for specific park activities resulted in doses that may produce adverse health effects. A child consuming about a teaspoon of soil in one sitting may experience temporary nausea, diarrhea, vomiting or stomach cramps. These acute effects are transient (short-term and unlikely to continue) and usually stop shortly after the arsenic is eliminated from the body. Long term health effects after years of repeated exposure, such as skin discoloration and lesions, may occur in young children ingesting 100 mg of soil for 150 or more days per year or teen athletes ingesting 100 mg of soil from field 5 for 250 or more days per year. *However, it is important to note that these types of skin effects have never been reported in children or adults living in the United States after exposures to arsenic-contaminated soils; the skin effects have been observed in people exposed to drinking water with high levels of inorganic arsenic.* Biological testing (i.e., urine) of individuals who previously played on the park is not indicated because exposure stopped when the park closed, and arsenic is excreted from the body within a few days after exposure.

Using similar health protective exposure assumptions to estimate cancer risk from exposure to arsenic in soil, park workers, adult coaches, and children also have a low to moderately increased risk of cancer (additional 2 in 10,000) if they ingested 100 mg of Swann Park soil for more than 182 days per year.

An evaluation of exposure dose estimates based on historic soil sampling (pre-1976 and 1976 data) would result in the same health conclusions as the 2007 soil data. That is, health protective estimates of arsenic doses using the same park activities (exposure scenarios) could produce similar adverse health effects. Also, there may have been an additional dose component from inhalation of airborne plant emissions when the plant was operating such that historical doses could be higher than predicted from exposure to soil contamination alone.

The predicted arsenic doses also result in low to moderately increased “theoretical excess lifetime cancer risk” for park workers, children, and adult coaches. Because the predicted arsenic doses and cancer risks are based on health protective assumptions, actual arsenic doses to the Swann Park community are expected to be lower than those predicted. However, the estimated exposure doses are possible, such that recent and historic exposure to Swann Park soil is considered a public health hazard.

Statement of Issues and Community Health Concerns

Statement of Issues

In response to community health concerns, the Commissioner of the Baltimore City Health Department contacted the Agency for Toxic Substances and Disease Registry (ATSDR) to request ATSDR advice and recommendations regarding public health exposures to the contamination in Swann Park. The Health Commissioner formally requested that ATSDR conduct a public health evaluation of arsenic exposures at Swann Park, Baltimore Maryland. The purpose of this document is to present the ATSDR evaluation of April and June 2007 soil sampling data and exposures to Swann Park soil to determine if anyone is likely to get sick from playing or working at Swann Park.

Based on historic and recent soil sample data from Swann Park, inorganic arsenic is the primary contaminant of concern. However, the April and June 2007 soil samples from Swann Park also included analyses of other metals, pesticides, and semi-volatile organic compounds (SVOCs). Consequently, this health consultation also evaluates the distribution and concentrations of those analytes to determine if they are present in Swann Park at concentrations of public health concern.

Community exposures to Swann Park soil are evaluated in a two-step process. The first step is to compare maximum measured chemical concentrations with soil screening levels or *environmental guidelines*.[1] Those analytes detected above their respective screening values are "contaminants of (public health) concern" and require further evaluation. The second step in the evaluation is to calculate potential exposure doses for each contaminant of concern and compare those doses with *health guidelines*[2], or comparison values that are based on levels shown to cause specific diseases or adverse health effects. The potential health effects of those contaminants with doses that exceed their respective health guidelines are discussed relative to the types of exposures that have occurred at Swann Park.

Until its recent closure, Swann Park was a highly used recreational facility. Activities at the Park included baseball, softball, football, soccer, and lacrosse, as well as general recreation and visitation by community members. In addition to park visitors, the Park workers were constantly engaged in field maintenance activities. All of these park activities may result in exposures to Park soil.

The following *Community Health Concerns* section of this document presents the specific concerns or questions that people have raised to ATSDR and the City of Baltimore Health

[1] *Environmental Guideline*: Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The comparison value (CV) is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

[2] *Health guideline*: Substance-specific doses derived using toxicologic and epidemiologic data with safety factors to ensure that they are protective of human health. When adequate dose-response data are available, guidelines are developed for ingestion and inhalation exposures. Various guidelines are developed by ATSDR and other Federal and State agencies. Specific guidelines used in this assessment are referenced and defined.

Department about their exposures to Park soil. In part, we used these specific concerns to define how people may have been exposed to park soils and subsequent sections of this report will provide our evaluation of the potential for those exposures to cause sickness or disease.

The Background Section provides brief descriptions and histories of the Race Street chemical plant and Swann Park and the surrounding neighborhood. The *Results* section presents our evaluation of the specific contaminants present in Swann Park soil and the contaminant doses from specific park activities. The section on *Public Health Implications* presents an evaluation of the effects and/or types of diseases caused by exposure to these contaminants and whether the estimated doses are at levels likely to cause those effects and/or diseases. This section also includes specific responses to the community concerns and comments ATSDR received. Finally, the *Conclusions, Recommendations and Public Health Action Plan* section summarizes our findings on Swann Park and our recommendations and proposed actions for addressing public health issues related to contaminated soil in the park.

Swann Park Community Concerns

ATSDR and the Baltimore City Health Department collected community concerns during public meetings held at Digital Harbor High School on April 26, 2007 and June 14, 2007, as well as in follow up communications with a neighbor to the site, current and former coaches from local high schools that regularly fielded teams at Swann Park, and City employees who maintained the park.

Community concerns include:

- Nearby residents are concerned about their unique exposures to contamination at the park, including inhalation of dust that would blow from the park towards their homes. One family is concerned in particular about any relationship between exposure to arsenic-contaminated soils and skin conditions, seizures in a toddler, nervous system/mental health conditions, sleep apnea, diabetes, and a fatal blood clot/aneurysm.
- Many community members raised concerns and questions about medical testing options for individuals who were exposed to the contamination at the park. One concern was raised that there is a need for public health authorities to provide some guidance to parents who have already pursued getting hair and nail testing for their children.
- Some community members were interested in long term follow up for people who were exposed to contamination at the park.
- Many concerns were raised about the exposures to student athletes and their coaches. For example, several times a year, students and their coaches would engage in heavy field maintenance activities (raking, moving dirt/muck around, etc.), and this would represent a high level of contact with the soils at the site. Many current and former student athletes would be a member of a sports team that would use the field for their entire four-year high school career; a minority of these student athletes would be members of multiple sports teams and therefore would frequent the fields for more than one playing season. Many student athletes would not only use the fields for their team activities, but also during their off hours for general recreation. Athletic team representatives and community members emphasized that there are no facilities for washing hands at the fields, and many users would eat and drink with dirty hands in the midst of activities at

the site. One particular concern is exposure to baseball catchers, who spend a significant amount of their playing time at ground level and in the dirt.
- Community members were interested in how ingestion of arsenic-contaminated soils affects the human body.
- Community members asked how much soil at the highest levels of arsenic contamination found in surface soils at the park would need to be ingested to produce a toxic effect.

ATSDR also received three letters and two emails from members of the Swann Park community in response to the June 13, 2007 Public Comment Release of this health consultation. The concerns identified in those letters are summarized below.

- One community member indicates that he has played sports and fished and crabbed at Swann Park for his entire life and believes that he has suffered nervous and mental problems from exposures at the Park.
- One community member questions whether arsenic testing should have been included in 1976 when kepone testing was conducted for certain people using the Park.
- One community member believes that contamination is widespread in Baltimore urban soils and that these areas should all be remediated.
- One community member was concerned about eating tomatoes grown in a residential vegetable garden near Swann Park.
- A researcher asked if there would be difference in use of hair samples for agents that bind to sulfhydryl bonds.

Although the concerns identified in these letters and emails are similar to those voiced at the public meetings and other communications, specific responses to the concerns identified in the letters are included in Table 7.

Background

Site Description and History

Race Street Site

A chronology of historic and recent actions at the Allied Signal Race Street Site is available at the Maryland Department of the Environment (MDE) web site (MDE, 2007). Various insecticides, herbicides, and other arsenic products were produced or processed at the Race Street site from 1897 until 1976 (Matanoski, et al. 1981). The original facility was torn down and replaced in 1952. The rebuilt plant produced arsenic acid, calcium and lead arsenic, cupric acetoarsenite (Paris green), and sodium arsenite. These products were dried and packaged as solid materials except for Paris green, which was shipped as a liquid (not produced after early 1950s). Other pesticides, such as chlorinated hydrocarbons and organophosphates, were not produced at the Plant, but were processed and packaged at the facility.

Allied Chemical (later Allied-Signal) purchased and operated the Plant in 1955 until it was shut down in 1976. Allied-Signal, was in turn, purchased by Honeywell International in 1999. The City of Baltimore purchased the Race Street Property in 1977 and demolition of the factory buildings occurred throughout 1977. Interstate 95 was built on a portion of the property. MDE has overseen several remedial actions, such as placement and maintenance of a clay cap, to limit exposure and migration of site contaminants. An Administrative Consent Order between MDE, the City of Baltimore, and Honeywell International to complete assessment and cleanup of the Race Street Site was signed on May 23, 2007.

Swann Park

Swann Park is an approximately 11-acre, rectangular park owned by the City of Baltimore, south of the Federal Hill neighborhood (Figure 1). It borders the Middle Branch of the Patapsco River, and has been park land since at least 1914 (Honeywell, 2007a). Until the park was closed on April 19, 2007, the field was used for recreational activities for team sports (e.g., softball, football). For decades, Swann Park was used by Southern High School (now Digital Harbor High School) football and baseball teams, as well as local sports leagues. The park was temporarily closed in 1976, when a pesticide called kepone was found in the soil of the ball fields. Following completion of remediation (including removal of contaminated soil, plowing, raking, and re-sodding) a panel of federal, state and local officials allowed the park to be reopened that year (Swann Park Task Force, 2007).

The Swann Park Community: Figure 1 shows the location of Swann Park and the surrounding community. This figure also shows how many people live within one half mile of the site. Swann Park is located in an industrial area of south Baltimore and is bounded by the Interstate 95 and the Patapsco River. Based on the 2000 census, approximately 3,650 people live within one half mile of the park, with most of those homes located north of Interstate 95. Although relatively few people live directly adjacent to the park, it is highly used as a recreational area.

Swann Park Soil Data: Swann Park soils were sampled for arsenic and kepone in 1976. Forty-five surface samples (1-2" depth) were collected by Allied Chemical Corporation (1976a). Twelve additional surface (0-3") and six subsurface (3-9") cores were collected and analyzed (Allied Chemical, 1976b), and four composite samples of the baseball and softball fields were also collected and analyzed (Allied Chemical, 1976c). The geometric mean of the initial 45 surface arsenic samples was 313 mg/kg with a maximum value of 6,600 mg/kg (located in the northwest corner of the Park). The spatially composited (averaged) arsenic samples of the four ball fields had much lower concentrations (24 to 144 mg/kg) with the northwest field having the highest arsenic value. ATSDR incorporated arsenic soil data from the pre-1976 data obtained by the Swann Park Task Force (2007) which reported a maximum arsenic concentration of 10,000 mg/kg. Inclusion of this value in the lognormal distribution changes the arsenic geometric mean from 313 mg/kg to 339 mg/kg and the 95th upper confidence limit of the mean (UCL) from 1107 mg/kg to 1417 mg/kg.[1]

The high concentrations of arsenic and kepone along the northern boundary of the Park led the 'State Kepone Task Force" to recommend that the 100 foot strip of park paralleling the Allied Chemical Corporation boundary be plowed, raked, top-soiled, and sodded (Allied Chemical,

[1] In addition to new data provided in this version, the EPA released an updated data evaluation tool for calculating distributions and UCLs of environmental data (Singh, et.al., 2007). Our use of this tool provides better assurance that the UCL calculated for each contaminant is statistically representative of the sampling data.

1976d). The "State Kepone Task Force" reviewed the soil sampling data as well as air sampling data and biological analyses of blood kepone concentrations and determined that "there are no significant health hazards existing in Swann Park…" Although comments from Park personnel indicate that these recommendations were completed, these were no confirmatory data collected to verify the effectiveness of the remedial actions.

Following a 2007 inquiry by the MDE to Honeywell concerning the results of the 1976 "State Kepone Task Force," Honeywell collected 25 surface and subsurface soil samples from Swann Park, and analyzed these samples for arsenic, hexavalent chromium, and kepone. A subset of those samples were further analyzed for a broad array of metals, pesticides, and semi-volatile organic compounds (SVOCs; Honeywell, 2007a/b). These are some of the soil data evaluated in the June 2007 version of this health consultation. Following receipt of these results, Swann Park was closed pending clean up.

Honeywell, with oversight from MDE and the City of Baltimore, has recently completed an extensive re-sampling program of soil and groundwater at Swann Park (Honeywell, 2007c). Analytical results from this latest sampling effort are used to update this health consultation. This latest sampling effort includes several notable features. First, surface soil samples from each of the eight individual playing fields (Figure 2) were sampled using a compositing method that allows for determination of spatially representative average concentrations for each field.[1] Second, specific analyses were conducted to assess the specific geochemical and size composition of arsenic particles in selected samples.[2] These analyses included an attempt to determine the arsenic bioavailability, or how much of the arsenic present in each sample is likely to be absorbed into the bloodstream after it has been ingested. These analyses specifically measure "bioaccessiblity" using a chemical digestion procedure that is supposed to mimic the human gastrointestinal system.

In response to requests from the Maryland Department of Environment and the City of Baltimore, Honeywell Inc. also sampled the soil from the yards of three residences adjacent to Swann Park (West McComas St.; results conveyed via e-mail from L. Werner to M. Evans, ATSDR, September 18, 2007). Concentrations from these analyses ranged from 49—177 mg/kg for arsenic and 554—820 mg/kg for lead. These contaminant concentrations are within the ranges measured in Swann Park. Although the small amount of soil within the largely paved courtyards of these residences presents limited potential for exposure, the MDE has required Honeywell to remediate the these yards (and four other adjacent yards).

In addition to new sampling conducted by Honeywell (2007c), the Swann Park Task Force has obtained and published additional historic sampling data that had previously been collected by Allied Chemical (Swann Park Task Force, 2007). All of the newly available data are discussed and referenced as appropriate in the following sections.

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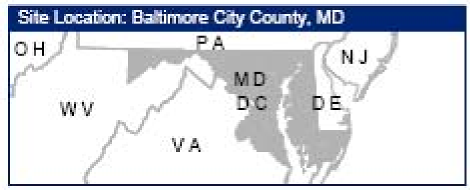
[1] The spatially-composited samples consist of thirty randomly selected sub-samples from a specific field or area that is combined into one sample for analysis. Discrete samples are taken from one location.

[2] The EPA has recently released a report addressing the use of bioavailability tests for metals in soil (EPA, 2007). Although arsenic bioaccessibility is not a preferred method, we use the Swann Park bioaccessibility results because they are more health protective than the previous assumption of 50% bioavailability.

Figure 1. Location of Swann Park and surrounding community

Baltimore, MD

EPA Facility ID: UNAVAILABLE

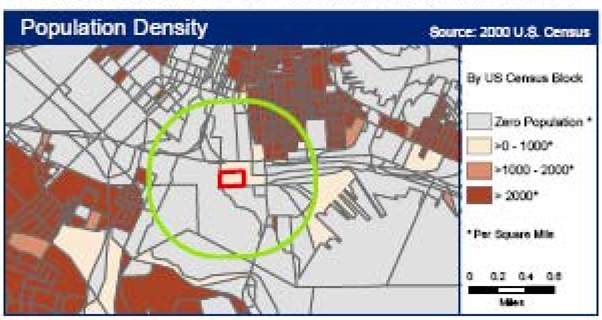


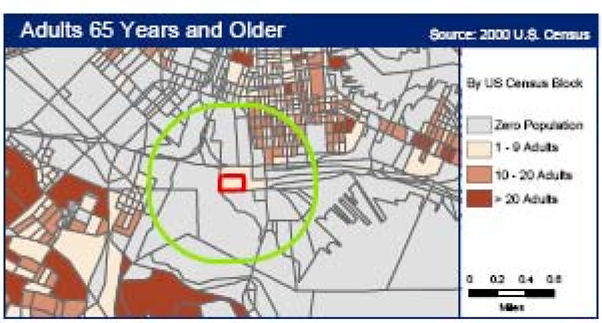
Demographic Statistics
Within Area of Concern*

Total Population	3,650
White Alone	3,285
Black Alone	236
Am. Indian & Alaska Native Alone	17
Asian Alone	42
Native Hawaiian & Other Pacific Islander Alone	0
Some Other Race Alone	23
Two or More Races	47
Hispanic or Latino**	69
Children Aged 6 and Younger	328
Adults Aged 65 and Older	401
Females Aged 15 to 44	826
Total Housing Units	1,622

Base Map Source: Geographic Data Technology, May 2005.
Site Boundary Data Source: ATSDR Geospatial Research, Analysis, and Services Program, Current as of Generate Date (bottom left-hand corner).
Coordinate System (All Panels): NAD 1983 StatePlane Maryland FIPS 1900 Feet

Demographics Statistics Source: 2000 U.S. Census
* Calculated using an area-proportion spatial analysis technique
** People who identify their origin as Hispanic or Latino may be of any race.





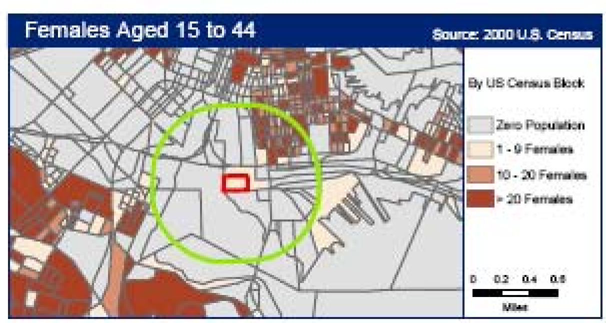


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Figure 2. Locations of individual playing fields at Swann Park sampled for the July 2007 Soil and Groundwater Data Report (from Honeywell, 2007c). Each numbered field (1 to 8) was sampled using a compositing method to determine average contaminant concentrations for each field.

Results

Contaminants of Concern

ATSDR screened all of the contaminants detected in the April and July 2007 Swann Park soil samples against environmental guidelines. Of the many contaminants analyzed and detected in Swann Park soils (24 metals, 38 pesticides, and 65 SVOCs), only arsenic and lead were consistently detected above their environmental guidelines (i.e., the environmental guidelines ATSDR used in this report are arsenic—20 mg/kg; lead—400 mg/kg; Table 1 and Attachment 1). Table 1 presents summaries of the discrete or single point arsenic, kepone, and lead soil sample results. Table 2 presents summaries of the composite, or spatially averaged surface soil samples for each of the 8 playing fields shown in Figure 2.

The results of the most recent (July 2007; Honeywell 2007c) analyses, although generally similar to the April 2007 results (Honeywell 2007a/b), include higher maximum arsenic and lead concentrations, and accordingly higher average and 95^{th} UCL concentrations (Table 1). Also the spatially-composited average concentration of arsenic from field 5 is 810 mg/kg (Table 2; Figure 2). The arsenic concentration in field 5 is higher than the average arsenic concentrations calculated from the April 2007 data. Spatially-composited arsenic concentrations of all other fields are similar to values from the April 2007 samples (Tables 1 and 2). The other notable difference between the April and July data sets is the spatially-composited lead concentrations (Table 2). The lead concentrations from 5 of the 8 fields are above the 400 mg/kg environmental guideline as are the overall Park average and 95^{th} UCL values (Table 2; 446 mg/kg and 609 mg/kg, respectively). Discrete sample results for the April and July analyses are similar for all contaminants.

The environmental guideline for lead is based on the average concentration in a residential yard or child's play area (400 mg/kg; EPA, 1998). The upper 95^{th} percentile confidence limit of the mean for lead is 608 mg/kg in Swann Park.[1] The potential for adverse health effects from exposure to lead in Swann Park soil are discussed in the following "Public Health Implications" section.

Arsenic was detected in all of the spatially-composited Swann Park samples (Honeywell, 2007c; Table 2). Concentrations in surface samples (0 to 3" depth) for the different fields ranged from 77 to 810 mg/kg. The geometric mean of the 8 arsenic surface samples was 212 mg/kg with a 95^{th} UCL of the mean of 506 mg/kg (Table 2).

Kepone (chlordecone) was detected in most of the recent soil samples from Swann Park. Kepone concentrations from the April and July 2007 data sets were similar. Although kepone concentrations in soil were well below the environmental guideline (30 mg/kg; Attachment 1), potential doses were estimated because it was processed at the Race Street facility and has

[1] Note that the 400 mg/kg environmental guidance level for lead in residential soils refers to an average concentration. The referenced average and UCL values are based on the eight spatially composited field concentrations (Table 2). Average soil concentrations are used for screening and dose assessment because exposure to soil occurs over a large area and duration of time. The exception is for pica children who may be exposed during a single event to a localized area of soil.

widespread distribution in Swann Park soils. The spatially-composited Kepone concentrations ranged from 0.06 mg/kg to 1.2 mg/kg and had an average value of 0.46 mg/kg (Table 2).
There are no available screening values for several other analytes listed in attachment 1. However, as these analytes were not specifically manufactured or processed at the Race Street facility, they are not present in significant concentrations (based on the data reviewed) in Swann Park soils and are not further evaluated in this health consultation. Results for the April and July 2007 analyses (Honeywell b and c; respectively) are similar for all analytes except arsenic and lead.[1]

Several poly aromatic hydrocarbons (PAHs); e.g. antharacene, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene were also detected in soil within the range of levels typically found in urban soils. However, most detections were below 0.1 mg/kg and the maximum concentrations were between 2-5 mg/kg. Because the average concentrations of these PAHs are below their respective screening values and they were not specifically manufactured or processed at the Race Street facility they will not be further evaluated in this health consultation.

Table 1. Summary of arsenic, kepone, and lead in discrete surface soil samples.

Contaminant	Concentration Range (mg/kg)		Geometric Mean (mg/kg)		95^{th} UCL (based on gamma distribution)	
	1976	2007**	1976	2007**	1976	2007**
Arsenic	12—6,600 10,000*	37—1,930	313 339*	139	1107 1417*	352
Kepone	1.5—25	0.05—1.6	8.1	0.2	10.2	0.74
Lead	NA	47—1250	NA	208	NA	411

--The 1976 data are based on the Allied Chemical (1976a) report.

*1976 and pre-1976 data obtained by the Swann Park Task Force (2007) indicate a maximum arsenic concentration of 10,000 mg/kg. Inclusion of this value in the lognormal distribution changes the arsenic geometric mean from 313 mg/kg to 339 mg/kg and the 95^{th} UCL from 1107 mg/kg to 1417 mg/kg.

** The 2007 discrete samples include results from both the April 2007 and July 2007 reports. Inclusion of the July 2007 data caused significant changes in the summary results.

[1] It is also important to point out that many of the analytes listed in Attachment 1 were not detected above their respective minimum detection limit. Although numerical results are produced, they include a laboratory qualifier (U) such that the numerical results should be used with caution.

Table 2. Summary of spatially-composited (average) arsenic, lead, and kepone concentrations and estimated bioaccessiblity for each of the Swann Park playing fields (as shown in Figure 2). Data are from the July 2007 report (Honeywell, 2007c).

	Bioaccessibility %	Arsenic mg/kg	Lead mg/kg	kepone mg/kg
field 1	61	337	429	0.28
field 2	43	77	163	0.06
field 3	56	102	275	0.16
field 4	44	111	218	0.27
field 5	74	810	930	1.20
field 6	68	336	535	0.42
field 7	57	184	495	0.38
field 8	47	275	523	0.95
Mean*	56	212	446	0.46
95^{th} UCL*	64	506	609	0.74

- Bioaccessibility, lead, and kepone results appear to be normally distributed. The listed means are the normal averages and the 95^{th} UCLs are calculated assuming normal distributions.
- Arsenic results appear to be a gamma or lognormal distribution. The listed mean is a geometric mean and the 95^{th} UCL is calculated using the "approximate gamma UCL" (Singh, et.al., 2007).

Exposure Scenarios

Calculation of exposure doses requires a specific estimate of the activities and time for each type of exposure. This evaluation will rely on the types of park activities described in the above *Community Health Concerns* to identify the types of exposures that occurred at Swann Park. Specifically, we evaluated exposures related to the following.

- Youth (teen) athletic activities (such as baseball, football, and other sports)
- Park workers
- Adult athletic coaches
- Adult park visitors and spectators (including nearby residents who may have visited the park on a regular basis)
- Children playing at the Park (including nearby residents who may have visited the park on a regular basis)
- Pica children (geophagy, including pica behavior, refers to the intentional ingestion of soil items. The sensitive population associated with pica behavior is children aged 1–3 years old.)

Each of the above activities or exposure scenarios involves different behaviors and timeframes of exposure to soil. Table 3 lists the exposure scenarios and the assumed durations, soil intake rates, body weights, and time frame for each type of exposure. The primary exposure route of concern for surface soil is ingestion (oral exposure). This ingestion could occur by the inadvertent consumption of soil on hands or food items, inhalation and subsequent ingestion of soil particles in air, mouthing objects with soil particles, or intentional ingestion (pica behavior).

The assumed exposure durations (Table 3) are based on discussions with community members, coaches, and park workers. Soil intake rates and body weights are based on recommendations from the EPA Exposure Factor Handbook (EPA, 1999) and the ATSDR Public Health Assessment Guidance Manual (ATSDR, 2005a). Soil intake rates for teen athletes and park worker are based on intake rates for adult agricultural workers (EPA, 1999). This soil intake rate provides a health protective estimate for Swann Park users as agricultural workers are exposed to soil over an entire work day (especially to bare soil between rows of crops or on root crops).

Table 3. Exposure scenarios and assumptions for people using Swann Park.

Exposure Scenario	Duration of Exposure	Soil Intake Rate	Body Weight	Time Frame for Cancer Evaluation*
Toddler (pica child)	A few hours to a day	5, 000 mg/day 0.7 tsp/event	10 kg (22 lbs.)	NA; Single event; Acute Exposure
Child (non-pica)	250 days/yr	100 mg/day 0.02 tsp/day	14 kg (22 lbs.)	6 years
Adult Visitor or Spectator (including nearby residents)	250 days/yr	50 mg/day 0.01 tsp/day	70 kg (154 lbs.) Adult men/women body wt.	4 years
Teen Athlete	182 days/yr	100 mg/day 0.02 tsp/day	50 kg (110 lbs.) Average 13 yr old child	4 years
Adult Coach	182 days/yr	100 mg/day 0.02 tsp/day	70 kg (154 lbs.) Adult body wt.	20 years
Adult Park Worker	250 days/yr	100 mg/day 0.02 tsp/day	80 kg (176 lbs.) Adult male body wt.	30 years

•Soil intake rates: Teen athlete, coach, and adult park worker soil ingestion rates are based on the adult agricultural worker soil intake rate (EPA, 1999), others are ATSDR or EPA recommended rates (central tendency) for children and adults (ATSDR, 2005a; EPA, 1999).
•The soil intake rates, as converted to teaspoons, are based on a soil bulk density of 1.5 g/cm^3 and a volumetric conversion of 1 tsp = 4.93 cm^3.
•Estimates of excess lifetime cancer risk can be summed across scenarios if a person had exposures across multiple exposure scenarios (e.g., a person who played at the park as a young child, then played sports on the fields as a student athlete, and then visited the park later as an adult).

Estimated Exposure Doses

Estimating an exposure dose requires identifying how much, how often, and how long a person may come in contact with some concentration of the chemical in a specific medium (air, water, soil). The equation and assumptions used to estimate exposure doses from ingesting arsenic in surface soil follow (ATSDR, 2005a).

Equation 1: Exposure Dose Equation for Ingestion

$$\textbf{Dose} = \frac{\mathbf{C \times IR \times EF \times CF \times BF}}{\mathbf{BW}}$$

Where:

D	=	exposure dose in milligrams per kilogram per day (mg/kg/day)
C	=	chemical concentration in milligrams per kilogram (mg/kg)
IR	=	intake rate in milligrams per day (mg/day)
EF	=	exposure factor (unitless)
CF	=	conversion factor, 1×10^{-6} kilograms/milligram (kg/mg)
BF	=	bioavailability factor (unitless)
BW	=	body weight in kilograms (kg)

For arsenic in soil, the primary exposure route of concern is ingestion (oral exposure). Ingestion of soil could occur by the inadvertent consumption of soil on hands or food items, inhalation and subsequent ingestion of soil particles in air, mouthing objects with soil particles, or intentional ingestion (pica behavior). For kepone exposures, the rate of absorption through skin (dermal absorption) must also be considered. The dermal dose equation is similar to the ingestion dose equation (1) except that soil adhered to skin is substituted for the intake rate (Table 4). Estimates of soil adhered are based on activity-specific soil adherence rates from the EPA Exposure Factors Handbook (EPA, 1999, Table 6-12). Note that these soil adherence rates are very similar to the soil ingestion rates (Table 3). Dermal doses are not important for arsenic and lead because these metals are not readily absorbed through the skin.

Table 4. Soil adherence rates for kepone dermal dose estimation.

Scenario	Soil Adhered mg/day
Adult Park Worker	427.5
Teen Athlete	461.7
Toddler (Pica Child)	356.3
Child (non pica)	356.3
Adult Visitor	100
Adult Coach	200

These soil adherence rates are derived by multiplying activity-specific rates of soil adherence (mg/cm^2) with the recommended surface area (cm^2) for outdoor soil contact (EPA Exposure Factors Handbook Table 6-12 and 6-14, respectively; EPA, 1999).

ATSDR estimated surface soil exposure doses using Equation 1. In the absence of complete exposure-specific information, ATSDR applied several health protective exposure assumptions to estimate exposures as accurately as possible. Specifically, ATSDR estimated arsenic exposure doses using the following assumptions and default intake rates for exposure via ingestion:

- The contaminant concentrations used in estimating the dose for the child exhibiting pica behavior are the maximum detected values for a single location (arsenic—1,930 mg/kg, kepone—1.6 mg/kg; pre-1976 arsenic—10,000 mg/kg).
- Because the teen athletes exposures could have occurred from a single playing field, the contaminant concentrations used in estimating the dose for the teen athletes are the highest spatially averaged values (field 5; arsenic—810 mg/kg, kepone—1.2 mg/kg, and lead—930 mg/kg).
- All other exposures are calculated based on contaminant concentrations from the entire park using the upper 95th percentile confidence limits of the composite sample means (arsenic—446 mg/kg, kepone—0.74 mg/kg).[1] These 95% UCL values are health protective estimates of the average soil concentrations.
- Soil intake rates, exposure factors, and body weights for all exposure scenarios are as listed in Tables 3 and 4.
- The bioavailability (BF) of arsenic was assumed to be 74% for the teen athlete exposure scenario (based on field 5 bioaccessibility; Table 2), 100% for pica behavior due to direct effects on the gastrointestinal system, and 64% for all other exposure scenarios (95th UCL of bioaccessibility for all fields; Table 2).[2]
- The bioavailability of kepone is assumed to be 100%—that is, all of the contaminant ingested or adhered to skin was assumed to enter the bloodstream.
- Arsenic is excreted rapidly from the body such that for non-cancer effects there is no carryover from one sport season to the next. For cancer effects, the doses from multiple season and multiple year exposures are summed to assess long term exposures.

ATSDR derived exposure doses are based on these health protective assumptions. The estimated doses for arsenic and kepone exposures (based on 2007 soil data) are listed in Table 5. Estimated kepone doses for all exposure scenarios are at least 10 times lower than the respective

[1] The geometric mean is the mean or average of the logarithms of the concentrations. Log transformation of contaminant concentrations is applied because these geological parameters are log-normally distributed. This type of skewed distribution means that there are typically many low values with a few high values. The log-transformed concentrations are approximately normally distributed. The upper 95th percentile confidence limit means that there is a 95% chance that the average concentration is less than the upper confidence limit value.

[2] Most studies indicate that arsenic bioavailability is in the range of 15-40% such that the bioaccessibility used in these dose calculations is a health protective assumption.

health guidelines (Table 5). On the basis of these results, exposures to kepone at Swann Park are unlikely to result in any adverse health effects and will not be discussed in the following section on *Public Health Implications*.

Arsenic exposures for pica children are greater than the short term (acute) minimal risk level (MRL) and exposures for children and teen athletes are greater than the long term (chronic) minimal risk level. It is important to emphasize that a calculated dose greater than the MRL does not necessarily mean that a child consuming 5 grams (~1 teaspoon) of Swann Park soil or a child visiting the park every day will become sick.

Arsenic is a known human carcinogen and has been linked with skin, bladder, lung, and other cancers following years of exposure to high levels of inorganic arsenic in drinking water (ATSDR, 2005b). Consequently, ATSDR also evaluated the potential for Swann Park arsenic exposures to cause cancer by estimating a theoretical excess lifetime cancer risk level (ATSDR, 2005a. The Department of Health and Human Services (DHHS) has determined that chlordecone (kepone) may reasonably be anticipated to be a carcinogen. There are no studies available on whether kepone is carcinogenic in people. However, studies in mice and rats have shown that ingesting kepone (trade name Mirex)can cause liver, adrenal gland, and kidney tumors (ATSDR, 2005).

Equation 2. Excess Lifetime Cancer Risk

$$\textbf{Cancer risk=dose (mg/kg/day) x cancer slope factor (mg/kg/day)}^{-1}$$

These cancer risks are usually compared to a 10^{-6} risk (one in a million) level or risk range (10^{-4} to 10^{-6}) as defined by other governmental agencies. As with the non-cancer evaluation approach, exposures below a screening value (by convention for cancer risk evaluations, less than a 10^{-6} risk) require no further evaluation, while estimated dose levels that exceed the 10^{-6} value are evaluated further. The interpretation of risk would be as follows: if risk = 2×10^{-6}, 2 excess cancer cases (upper bound estimate) are expected to develop per 1,000,000 people. The potential for observing adverse effects is made on the basis of dose evaluation (a margin of exposure or MOE approach), rather than on the basis of theoretical risk calculations. Potential excess lifetime cancer risks for non-pica children and adult park workers exposed to soil arsenic for years are in the range of 2 in ten thousand (2.0E-04; Table 5).

Arsenic and kepone doses estimated from the pre-1976 arsenic and 1976 soil data would be higher than exposure doses estimated from the 2007 data since the reported soil concentrations were higher. Also, during the time the Race Street plant was operating, there may have been an additional inhalation dose from airborne emissions from the plant. Consequently, although we have not calculated the combined ingestion and inhalation arsenic and kepone doses at Swann Park when the Race Street Plant was operating (prior to 1976), they were likely higher than present.

These estimated arsenic doses and cancer risks are based on very health protective exposure assumptions. The potential health effects of a community member’s exposure to arsenic and lead are detailed in the following section.

Table 5. Calculated doses for arsenic and kepone at Swann Park; 2007 soil data.

Exposure Scenario	Contaminant	Estimated Dose (mg/kg/day)	Health Guideline (mg/kg/day) Source	Theoretical Excess Life-time Cancer Risk
Toddler – pica child	Arsenic	9.7E-01	5.0E-03 Acute MRL	Not Applicable
	Kepone	8.6E-04	1.0E-02 Acute MRL	
Child (non-pica)	Arsenic	1.6E-03	3.0E-04 Chronic MRL	2.0E-04
	Kepone	1.9E-05	5.0E-04 Chronic MRL	1.2E-05
Teen Athlete	Arsenic	6.0E-04	3.0E-04 Chronic MRL	5.1E-05
	Kepone	3.4E-06	5.0E-04 Chronic MRL	1.9E-06
Adult Coach	Arsenic	1.2E-04	3.0E-04 Chronic MRL	5.0E-05
	Kepone	1.3E-06	5.0E-04 Chronic MRL	3.6E-06
Adult Visitor	Arsenic	1.2E-04	3.0E-04 Chronic MRL	9.9E-06
	Kepone	6.4E-07	5.0E-04 Chronic MRL	2.4E-07
Adult Park Worker	Arsenic	2.8E-04	3.0E-04 Chronic MRL	1.8E-04
	Kepone	2.7E-06	5.0E-04 Chronic MRL	1.1E-05

- Doses are calculated using the contaminant concentrations and the exposure scenarios from Tables 2 and 3 (pica uses maximum discrete concentrations; Table 1).
- Because kepone may be absorbed through skin contact, kepone doses include an ingestion component plus a dermal absorption component.
- Excess lifetime cancer risk is not applicable to short term pica behavior.
- Excess lifetime cancer risks for multiple exposure scenarios can be summed if a person used the park for multiple activities. For example, if someone visited the park as a child and a teen athlete, the arsenic cancer risk would be 1.5E-04 + 5.1E-05= 2.0E-04.
- MRL—Minimal risk level; An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose an appreciable risk of harmful (adverse), non-cancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic).
- These MRLs are all for oral or ingestion exposure; also the chronic and intermediate MRLs for kepone have the same value.

Public Health Implications

Arsenic and Kepone

Arsenic occurs naturally in soil and minerals. People normally take in small amounts of arsenic in air, water, soil, and food. Of these, food is usually the most common source of arsenic for people (ATSDR 2005). In order to determine whether the potential exposures to arsenic-contaminated soil presents a public health hazard at this site, ATSDR compared the estimated doses with benchmarks or screening doses that are derived from dose levels known to produce adverse health effects. For arsenic, ATSDR has developed minimal risk levels (MRLs) that cover brief exposures (acute, or less than 14 days) and longer term exposures (chronic, or more than a year).

An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. The MRL is derived from exposure levels observed to produce adverse effects, with uncertainties (or safety factors) incorporated into the value. Thus, MRLs are intended only to serve as a screening tool to help public health professionals decide which exposure situations require more extensive evaluation. Estimated exposure dose levels below an MRL are not likely to produce non-cancer adverse effects. Exposure estimates above an MRL do not mean that adverse effects will occur, but rather that further evaluation of the exposure is warranted. ATSDR then evaluates the potential for adverse health effects in an exposed community by comparing levels known to produce adverse effects to the estimated site-related doses. This margin of exposure (MOE) approach, along with an evaluation of available epidemiologic, toxicologic, and medical data, is used by health assessors as part of the public health determination to reach qualitative (rather than quantitative) decisions about hazards posed by site-specific conditions of exposure.

At low-level exposures, arsenic compounds are detoxified—that is, changed into less harmful forms—and excreted in the urine (ATSDR, 2005) . At higher-level exposures, however, the body may not have the ability to detoxify the increased amount of arsenic. When this overload happens, blood levels of arsenic increase and adverse health effects may occur. Arsenic, like some other chemicals, does not seem to cause adverse health effects until a certain amount, or threshold, of the chemical has entered the body. Once the threshold, also known as the minimal effective dose, is reached adverse health effects may result (ATSDR 2005b).

ATSDR reviewed the scientific literature regarding arsenic toxicity to evaluate whether non-cancer adverse health effects would be expected to occur at the estimated exposure doses. The acute oral MRL for arsenic (0.005 mg/kg/day) is based on several temporary effects that could occur from acute exposures (≤14 days). Acute exposure to arsenic can be toxic to the stomach and intestines, with symptoms such as pain, nausea, vomiting, and diarrhea. When an estimated acute exposure dose for pica behavior is below 0.005 mg arsenic/kg/day, non-cancerous effects are unlikely. It should be noted that the acute MRL is 10 times below the levels reported to cause these effects in humans (acute Lowest Observed Adverse Effect Level (LOAEL) = 0.05 mg/kg/day).

The estimated exposure dose for children exhibiting pica behavior at Swann Park exceeds the ATSDR acute MRL, and is also above the LOAEL. Sensitive populations, such as children who eat non-food items like soil, could receive doses that might cause temporary effects (e.g., nausea, diarrhea, vomiting and stomach cramps). Groups that are at an increased risk for pica behavior are children aged 1–3 years old. ATSDR suggests that concerned parents monitor their children's behavior while they are playing outdoors to ensure that their children (of any age) are not exhibiting pica behavior and eating excessive amounts of soil and discuss their concerns and/or observed behaviors with their doctor.

In addition to the acute MRL, ATSDR developed a chronic oral MRL for arsenic of 0.0003 mg/kg/day. The estimated exposure doses for children (non-pica) and teen athletes are above the chronic oral MRL (see Table 4). The estimated exposure doses for adult visitor, adult coach, and adult worker do not exceed the chronic oral MRL. The ATSDR chronic oral MRL is based on common and characteristic effects of arsenic ingestion that produce a pattern of skin changes known as hyperpigmentation and hyperkeratosis. These dermal effects have been noted in some human studies that involved daily, long-term ingestion (more than 45 years) of elevated arsenic levels in drinking water. Collectively, these studies indicate that the lowest dose producing the hyperpigmentation and hyperkeratosis is 0.014 mg As/kg/day (Lowest Observed Adverse Effect Level, LOAEL; ATSDR 2005b). These skin affects have not been observed at arsenic doses (estimated) of 0.0008 mg/kg/day (No adverse observed health effect; NOAEL).

The estimated chronic (long term) dose for a 14 kg (31 lb) child is above the arsenic NOAEL dose of 0.0008 mg/kg/day (assuming ingestion of 100 mg of Swann Park soil for 250 days/year). Figure 3 shows the estimated doses for a child ingesting Swann Park soil for different periods of time. This figure shows that estimated doses are below the NOAEL for exposures less than 150 days per year. Similarly, if a child is heavier than 31 pounds, the doses decrease such that a 62 pound child would have one half the dose of a 31 pound child. Also, a child is unlikely to ingest 100 mg of park soil by visiting or walking through the park.

Studies have shown that 45 to 85 percent of an ingested dose of arsenic is eliminated within 1 to 3 days; however, some remains for several months or longer (Buchet et al. 1981; Crecelius 1977; Mappes 1977; Tam et al. 1979). Although we do not expect that a child's chronic exposure to arsenic in Swann Park soil would result in a dose level or body burden high enough to cause chronic health effects, because potential doses are above the NOAEL of 0.0008 mg As/kg/day, ATSDR determined that it was important to state in this updated version that the revised exposure estimates for this exposure category exceed a relevant no observed adverse effect level.

Estimated arsenic doses for teen athletes are also above the MRL and NOAEL for exposure durations of 182 days per year for a 110 pound athlete ingesting 100 mg of soil from field 5 (average arsenic concentration of 810 mg/kg). For exposure durations of less than 240 days per year, estimated arsenic doses are less than the NOAEL of 0.0008 mg Arsenic/kg/day. Considering that the coaches and several of the athletes have indicated that they played at the park for 120 days per year or less, these exposures are unlikely to result in a dose level or body burden high enough to cause health effects.

Historic Exposure Evaluation using pre-1976 and 1976 data

Regarding historical chronic exposure to arsenic and kepone in Swann Park soil, we used the upper 95th percentile confidence limits of the means (arsenic—1,417 mg/kg; kepone—10.2 mg/kg) from the 1976 reported soil concentrations (see Table 1) under the same exposure scenarios and default assumptions used above. The estimated chronic doses from kepone exposure in soil for all scenarios were well below the health guideline value (Table 4). Therefore, chronic non-cancer health effects are not expected to occur for any kepone exposure scenario based on the 1976 soil sampling results.

The estimated acute and chronic doses for arsenic exposures based on the pre-1976 and 1976 sampling results (10,000 mg/kg for acute and 1,417 mg/kg for chronic) are all above their respective non-cancer MRLs (Table 6). For long term (chronic) exposures, only the non-pica child is above the chronic NOAEL of 0.0008 mg/kg/day.

Table 6. Arsenic doses for Swann Park community members based on 1976 data (1,417 mg/kg 95th UCL of the means and 10,000 mg/kg maximum concentration; Table 1). All other exposure parameters are as before (Table 3).

Arsenic	Dose mg/kg/day	MRL	cancer risk
City Worker	7.8E-04	3.0E-04	5.0E-04
Teen Athlete	1.0E-03	3.0E-04	9.0E-05
Pica Child	5.0E+00	5.0E-03 (acute)	Not Applicable
Child	4.4E-03	3.0E-04	5.7E-04
Adult Spectator	3.2E-04	3.0E-04	2.8E-05
Adult Coach	3.2E-04	3.0E-04	1.4E-04

Cancer risk is "Theoretical Excess Lifetime Cancer Risk."

The estimated exposure doses to arsenic in soil (Table 1: 1976 data) for children (both pica and non-pica) at Swann Park exceed the ATSDR acute and chronic arsenic and acute kepone MRLs. The pica child kepone dose is based on a maximum kepone concentration (1976 data) of 26 (25 in Table 1) mg/kg. While the estimated exposure dose (1.3E-02 mg/kg/day) is above the acute oral MRL (1.0E-02 mg/kg/day), it is not expected to result in adverse effects due to conservative calculation of both the exposure dose and screening value. For both historic and recent exposures to Swann Park soil, sensitive populations, such as children who eat non-food items like soil, could receive arsenic doses that might cause temporary effects (e.g., nausea, diarrhea, vomiting and stomach cramps) and potentially chronic skin effects (discoloration and lesions).

Current Exposure Evaluation using 2007 data

For current exposures, non-pica children who ingested 100 mg of Swann Park soil per day for more than 150 days per year (Figure 3) are also susceptible to skin conditions such as hyperkeratosis (lesions) or hyperpigmentation (skin discoloration). Teen athletes who ingested 100 mg of Swann Park soil per day from field 5 for more than 250 days per year could also be susceptible to the same health effects (Figure 4). However, as stated earlier, this is a conservative conclusion because these skin effects from exposure to arsenic in soil have never actually been reported in children or adults living in the United States.

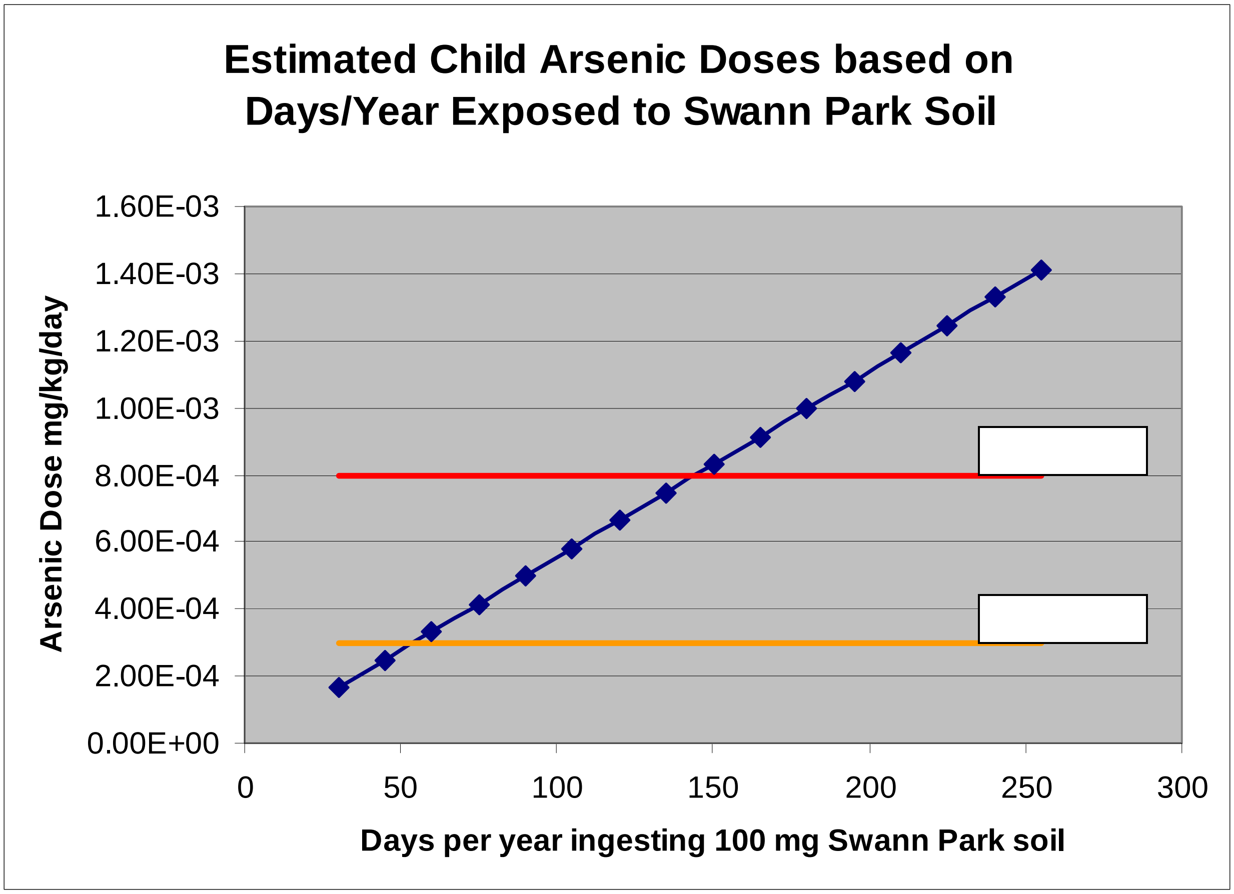

Figure 3. Estimated child arsenic doses from surface soils in Swann Park. These estimated doses are based on a 31 pound child ingesting 100 mg of soil with an arsenic concentration of 506 mg/kg. NOAEL is the "No observed adverse effect level" of 0.0008 mg Arsenic/kg/day and the MRL is the "minimal risk level" of 0.0003 mg Arsenic/kg/day for skin discoloration and lesions. Ingestion of 100 mg of soil for 150 or more days per year result in doses above the NOAEL

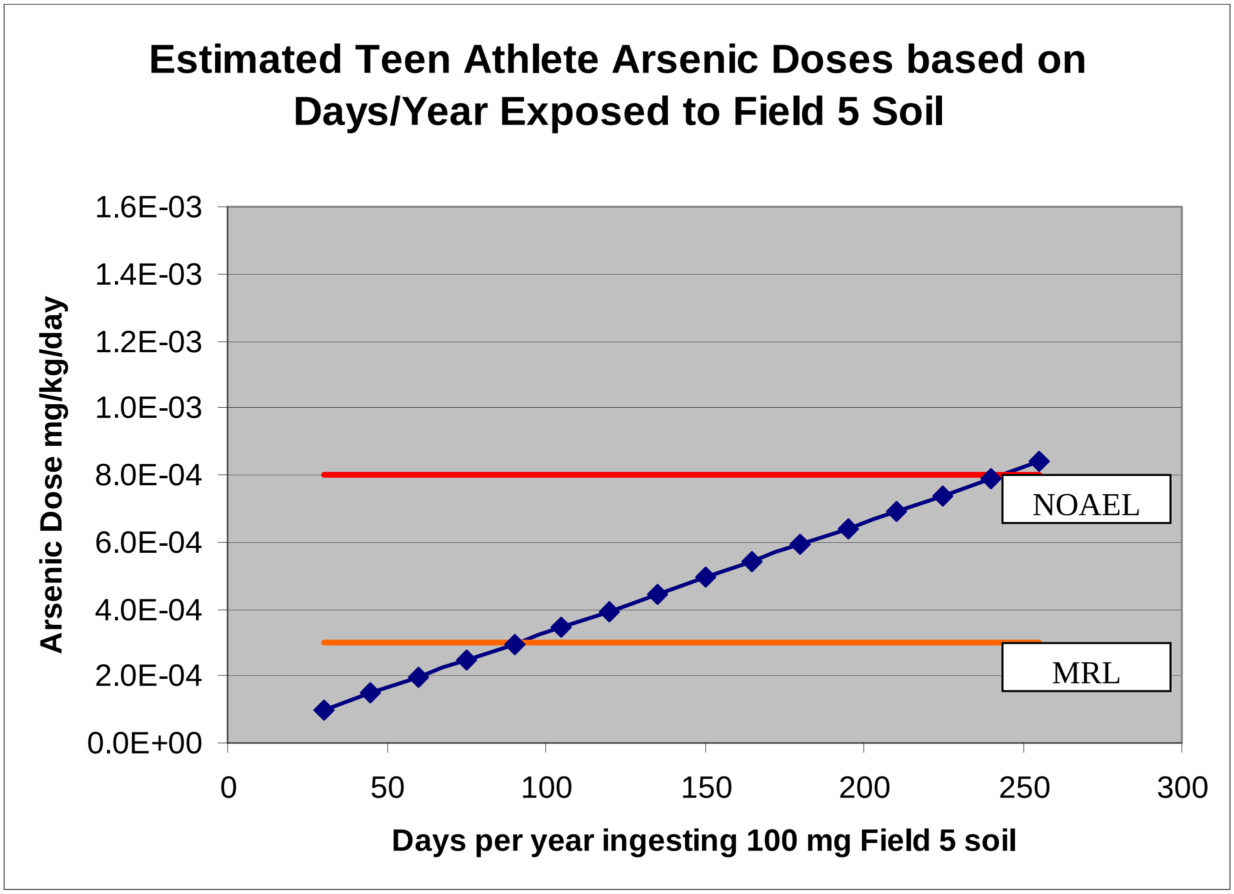

Figure 4. Estimated teen athlete arsenic doses from field 5 soils in Swann Park. These estimated doses are based on a 110 pound teen ingesting 100 mg of soil with an arsenic concentration of 810 mg/kg. NOAEL is the "No observed adverse effect level" of 0.0008 mg Arsenic/kg/day and the MRL is the "minimal risk level" of 0.0003 mg Arsenic/kg/day for skin discoloration and lesions. Ingestion of 100 mg of field 5 soil for 250 or more days per year result in doses above the NOAEL.

ATSDR discussed concerns about this site with Dr. Genevieve Matanoski, a researcher from Johns Hopkins University. Dr. Matanoski conducted an investigation of environmental data and cancer information for the site area (Matanoski et al., 1981). She found the distribution of arsenic in soil near the old Allied plant and along the railroad line was higher than in control areas in the city, and based on a review of death certificates concluded that men living in close proximity to the old Allied facility had a higher risk of lung cancer in the 1960s and early 1970s compared to individuals in other areas of the city. Dr. Matanoski emphasized to ATSDR that the key issue regarding current exposures at Swann Park is the bioavailability of the arsenic in the soil to users of the playing fields. Consistent with the conclusions in this document, Dr. Matanoski stated that it would be very difficult for users of the park to swallow enough dirt from activities at the park to achieve a dose with toxic health effects. She stated that she believes that her original findings about elevated cancer risk were related to ongoing air exposures from the Allied Chemical facility, and not from incidental soil exposures.

Estimated excess lifetime cancer risks for exposure to Swann Park soils are presented in Tables 5 and 6. These theoretical risks assume that a park worker has been exposed to Swann Park soils for 30 years, an adult coach has been exposed to Swann Park soils for 20 years, and community members were exposed to Swann Park soils as young children who played in the park for six years, a teen athlete played at the park for four years, or visited the park as an adult for four years. The resulting excess lifetime cancer risks from exposure to arsenic in Swann Park soils using the pre-1976 data are all less than 6 in 10,000 (5.7E-04; Table 6) and less than 2 in 10,000 for park workers, adult coaches, and children if they ingested 100 mg of Swann Park soil for more than 182 days per year using 2007 soil data (Table 5). Note that these excess lifetime cancer risks can be summed if a person used the park for multiple activities.

The estimated excess cancer risks (Tables 5 and 6) represent the theoretical increase in cancer risk due to exposure to arsenic in Swann Park soils.[1] All of the uncertainties and health-protective assumptions associated with the dose calculations are included in the risk estimations, as well as the uncertainty in deriving the cancer slope factor (EPA, 2003). These estimates of cancer risk can be considered suggestive of a *moderate to low increased risk*.

Note that the above estimates of excess lifetime cancer risk are based on dose estimates from the pre-1976, 1976 and 2007 soil sampling data. In the absence of air monitoring data from plant emissions, we cannot speculate on potential cumulative arsenic and kepone doses and cancer risks at Swann Park when the plant was operating (prior to 1976).

Lead

Based on the July 2007 report, lead concentrations in Swann Park soils are above the environmental guideline value of 400 mg/kg (Table 2; mean = 446 mg/kg; 95th UCL = 609 mg/kg). The potential adverse health effects of exposure to lead are based on predicted blood lead concentrations (blood lead levels).

The soil lead screening value of 400 mg/kg is based on daily residential exposure to lead from soil, dust, air, food, and water for children less than six years old (EPA, 2003a). For cases of intermittent exposure to soil such as occurs for children playing at Swann Park, the EPA has established a process for adjusting the soil concentration by the frequency of the exposure (EPA, 2003a). Assuming that a child plays at and ingests soil from Swann Park for four days per week (for 52 weeks per year) the adjusted Swann Park soil UCL lead concentration is 609 mg/kg x 4/7 (days per week) = 348 mg/kg and the adjusted average Swann Park soil lead is 446 mg/kg x 4/7 (days/week) = 255 mg/kg. As the time weighted Swann Park soil lead concentrations are below the soil screening value of 400 mg/kg, exposures to lead in Swann Park soil are not expected to significantly increase blood lead levels of children playing in Swann Park.

[1] These estimates of “theoretical excess lifetime cancer risk” represent the additional risk due to exposures to Swann Park soil. In order to estimate total cancer risk, these excess risks must be added to the baseline risk for each cancer type. Typically, the baseline cancer risk is much greater than the additional excess risk.

The relationship between environmental lead levels and blood lead levels is affected by factors such as the age of the population exposed to the contaminated media, the physical availability of the contaminated area(s), the bioavailability of the lead, and differences in individual behavioral patterns. As indicated on page 262 of the ATSDR Toxicological Profile for Lead (ATSDR 2005c), "The relationship depends on depth of the soil sampled, sampling methods, cleanliness of the home, age of the children, and mouthing activities, among other factors." In addition, the amount of soil contact that a child may have is likely to vary depending on season of the year.

In general, environmental lead can have the greatest impact on the blood lead levels of preschool-age children. These children are more likely to play nearer the ground (floors and yards) and to place their hands and other contaminated objects in their mouths. They are better at absorbing lead through the gastrointestinal tract than adults, and they are more likely to have types of nutritional deficiencies that facilitate the absorption of lead from the gut. Site-specific conditions, such as the amount of bare soil in children's play areas, the chemical form of the lead, how much lead crosses the gut, and particle size may also affect blood-lead levels and the possibility of harmful effects (ATSDR 2005c).

Based on observations of enzymatic abnormalities in the red blood cells at blood lead levels below 25 micrograms per deciliter (µg/dL) and observations of neurological and cognitive dysfunction in children with blood lead levels from 10-15 µg/dL, the CDC has determined that a blood lead level greater than 10 µg/dL in children indicates excessive lead absorption and constitutes a basis for intervention. The relationship between soil lead levels and blood lead levels is affected by factors such as the age of the population exposed to the contaminated soil, the physical availability of the contaminated soil, the bioavailability of the lead in the soil, and differences in individual behavioral patterns. While there is no clear relationship applicable to all sites, a number of models have been developed to estimate the potential impact that soil lead could have on the blood lead levels in different populations. In general, soil lead will have the greatest impact on the blood lead levels of preschool-age children. These children are more likely to play in dirt and to place their hands and other contaminated objects in their mouths. They are better at absorbing lead through the gastrointestinal tract than adults, and they are more likely to exhibit the types of nutritional deficiencies that facilitate the absorption of lead.

Exposures to lead in Swann Park soil are not expected to significantly increase blood lead levels of children playing in Swann Park.

Child Health Concerns

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification.

Thus adults need as much information as possible to make informed decisions regarding their children's health.

There is a significant amount of toxicological data available on arsenic and human health effects. However, the data needed to account for an accurate representation of any potential unique concerns related to early-life exposures to arsenic appears to be insufficient. The National Research Council concluded in 2001 that "There are no reliable data that indicate heightened susceptibility of children to arsenic" (NRC, 2001).

The special concerns related to a child's health have been addressed in this assessment by specifically using exposure scenarios based on a child's soil intake, body weight, and park activities. The previous discussion of potential health effects from arsenic exposure also explicitly includes health endpoints in children. Children that may have consumed teaspoon quantities of Swann Park soil may have experienced temporary symptoms such as nausea, diarrhea, vomiting and stomach cramps due to arsenic exposure. Also, children ingesting much lower quantities of soil for 150 days per year may also be susceptible to skin conditions. Long term exposures to Swann Park soil also creates a low, but increased risk of cancer for children, park workers, and coaches (based on arsenic data from 1976 and 2007).

Response to Community Concerns

This assessment of exposures to arsenic-contaminated soil at Swann Park has attempted to incorporate the communities health concerns into the specific health issues that have been addressed as well as the types of exposures that have been evaluated. In order to highlight how ATSDR has responded to those concerns, Table 7 lists the specific concerns collected during public meetings along with the ATSDR response to each concern. ATSDR welcomes additional comments or concerns and will further address any unresolved issues as appropriate.

Table 7. Community concerns related to Swann Park and ATSDR responses.

Community Concern	ATSDR Response
Inhalation of dust that would blow from the park towards their homes	Inhalation of dust is a potential route of exposure to contaminated soil. Particles deposited in the upper parts of the lung are usually coughed up and swallowed, while those deposited deep in the lungs can dissolve, allowing a chemical to enter the blood stream. However, even though the dust is initially inhaled, most soil particles larger than ~2.5 micron, which includes essentially all re-suspended soil particles, end up in the digestive tract and are evaluated as part of the ingested soil. Although a small fraction of the arsenic in inhaled dust may be absorbed in lungs, it would be a minor fraction compared to the ingested arsenic. Current arsenic concentrations in nearby homes/yards are expected to be much lower than levels in the park and are unlikely to present a public health hazard. In the absence of historic air monitoring data, ATSDR cannot speculate on airborne arsenic concentrations when the Race Street plant was operating (prior to 1976).
Relationship between exposure to arsenic-contaminated soils and skin conditions, seizures in a toddler, nervous system/mental health conditions, sleep apnea, diabetes, and a fatal blood clot/aneurysm	Arsenic exposure has been related to several skin conditions including hyperpigmentation, hyperkeratosis, and skin cancer. The doses at which those diseases occur are much higher than any of the doses likely experienced at Swann Park. Also acute, high-dose exposures (much higher than those estimated for Swann Park) often lead to encephalopathy, with signs and symptoms such as headache, lethargy, mental confusion, hallucination, seizures, and coma (ATSDR 2005). An association has been demonstrated between exposure to arsenic in drinking water and increased incidence of diabetes mellitus (ATSDR 2005), although dose response relationships are not available and the mechanism of action for this response has not been characterized. There is little evidence to suggest that arsenic functions as an endocrine disruptor. ATSDR is not aware of any studies or associations between arsenic-contaminated soils and any of the other health conditions mentioned (seizures, sleep apnea, or blood clots).
Medical testing options for individuals who were exposed to the contamination at the park and guidance to parents who have already pursued getting hair and nail medical testing for their children.	**At this time ATSDR is not recommending biological testing (e.g., urine, hair,) of individuals because biologic results from Swann Park soil exposures would not be elevated above reference ranges and/or differentiated between normal background exposures.** Community members are referred to Attachment 1, which includes information about the limitations of hair testing generally. Community members who have already pursued hair testing are welcome to consult directly with ATSDR or have their physicians consult with ATSDR regarding interpretation of their results.

Table 7. Community concerns related to Swann Park and ATSDR responses.

Community Concern	ATSDR Response
Long term follow up for people who were exposed to contamination at the park	Although adverse health effects from Swann Park arsenic exposures are unlikely, exposures of potential health concern are possible. Any community members who think they or their family may have ingested soil regularly from the most contaminated areas of the Park (field 5) may wish to consult their health care provider. After ingestion, arsenic is rapidly excreted from the body such that most short term or infrequent exposures to Swann Park soil will not lead to long term health effects.
Soil exposures to student athletes and their coaches (including field maintenance activities, lack of water, hand washing facilities, and baseball catchers, etc.)	This evaluation explicitly included exposure assumptions related to student athletes and coaches. These assumptions include high soil ingestion rates based on adult agricultural worker activities (and dermal contact rates for soccer players and groundskeepers for kepone dermal exposures). Arsenic is excreted rapidly from the body such that for non-cancer effects there is no carryover from one sport season to the next. For cancer effects, the doses from multiple season and multiple year exposures are assumed to occur 365 days per year for four years.
What are the health effects from ingestion of arsenic-contaminated soil? How much soil would produce toxic effects?	The potential health effects from exposure to arsenic are presented in the preceding section. Table 2 presents ingestion rates in terms of teaspoons of soil (assuming a soil density of 1.5 g/cm^3).
Could exposure to Swann Park contaminants lead to nerve and mental problems?	Both arsenic and lead exposures have been associated with neurological disorders in laboratory animals. However, the doses at which those affects occurred are at least 1,000 times greater than any of the estimated long term doses at Swann Park. It is unlikely that these medical conditions are related to use of Swann Park.
Should arsenic testing have been conducted for members of the Swann Park community in 1976?	Yes, such testing may have been useful if done with appropriate knowledge of the limitations of the methods and assuming that adequate analytical procedures were available in 1976.

Table 7. Community concerns related to Swann Park and ATSDR responses.

Community Concern	ATSDR Response
Soils throughout the Baltimore urban area are contaminated and should be remediated.	We agree that contamination of urban soils is widespread in Baltimore as well as other urban areas. However, the relative public health hazard of these soils depends on how these land areas are used and the types of exposure people may have to the soil. Consequently, remediation of all urban soils would be prohibitively expensive and of limited public health benefit.
Should hair and/or finger nail testing be conducted?	ATSDR does not recommend any type of medical testing at this time. As stated above, adverse health effects from Swann Park arsenic exposures are unlikely and long term medical follow-up is unnecessary. Please see the "hair sample testing" fact sheet in the appendix.
Is there a concern about eating tomatoes grown in a residential vegetable garden near Swann Park?	No, even if arsenic was elevated in your garden soil we would not expect levels in tomatoes to ever be high enough to cause adverse effects in children or adults. This would be true even for the yards/gardens that were tested immediately near the park
Would there be a difference in ATSDR's recommendation regarding the utility of hair samples for agents that attach to sulfhydryl bonds?	No, there would not be a difference; arsenic binds to sulfhydryl groups (thiol groups) in the hair.

Conclusions, Recommendations, and Public Health Action Plan

Conclusions

Recent analyses of surface soil at Swann Park have shown concentrations of arsenic and lead that exceed various environmental guidelines. Other analytes, such as chromium, PAHs, and kepone were also detected but at levels that do not exceed such guidelines. However kepone, exposure doses were estimated because it was processed at the Race Street facility and has widespread distribution in Swann Park soils. Normal park activities, such as field sports (baseball, football, etc.), and park maintenance have resulted in exposures to the contaminated soil.

The average lead concentration in Swann Park soil exceeds the initial environmental guideline of 400 mg/kg. This guidance value is based on constant daily exposure for a child less than six years old. The time adjusted average soil concentration of lead in Swann Park soil is less than 400 mg/kg and is not expected to cause any adverse health effects for children or adults ingesting Swann Park soil.

Some of the arsenic exposure doses for specific park activities resulted in doses that may produce adverse health effects. A child consuming about a teaspoon of soil in one sitting may experience temporary nausea, diarrhea, vomiting or stomach cramps. These acute effects are transient (short-term and unlikely to continue) and usually stop shortly after the arsenic is eliminated from the body. Other long term health effects after years of repeated exposure, such as skin discoloration and lesions, may occur in young children ingesting 100 mg of soil for 150 or more days per year or teen athletes ingesting 100 mg of soil from field 5 for 250 or more days per year, using health protective assumptions. *However, it is important to note that these types of skin effects have never been reported in children or adults living in the United States after exposures to arsenic-contaminated soils; the skin effects have been observed in people exposed to drinking water with high levels of inorganic arsenic.* Biological testing (i.e., urine) of individuals who previously played on the park is not indicated because exposure stopped when the park closed, and arsenic is excreted from the body within a few days after exposure.

Using similar health protective exposure assumptions, park workers, adult coaches, and children also have a low to moderate increased risk of cancer if they ingested 100 mg of Swann Park soil for more than 182 days per year. Dose estimates based on historic soil sampling present the same conclusions as the recent soil data. That is, health protective estimates of arsenic doses based on the above park activities could produce similar adverse health effects. Additionally, there may have been an additional dose component from inhalation of airborne plant emissions when the plant was operating such that historical doses could be higher than predicted from soil contamination alone.

The predicted arsenic doses also result in low to moderately increased “theoretical excess lifetime cancer risk” for park workers, children, and adult coaches. Because the predicted arsenic doses and cancer risks are based on health protective assumptions, actual arsenic doses to the Swann Park community are expected to be lower than those predicted and adverse health effects, including cancer, are unlikely. However, the estimated exposure doses are possible, such that recent and historic exposure to Swann Park soil is considered a public health hazard.

Recommendations

1. Communicate the findings from this Health Consultation to the concerned community. This could include a presentation at a public meeting with the City of Baltimore Health Department, meetings with nearby residents, and outreach directly to Digital Harbor High School (e.g., to the school nursing staff and/or athletic department).
2. Concerned community members are encouraged to share these findings with their personal physicians. Community members who have already pursued hair testing are welcome to consult directly with ATSDR or have their physicians consult with ATSDR regarding interpretation of their results.
3. Swann Park soil should be remediated to reduce arsenic and lead concentrations before it is re-opened for public use. The remediation activities should include procedures to ensure that the site contaminants do not migrate to adjacent areas.

Public Health Action Plan

1. ATSDR will present the results of this health consultation to the Swann Park community and respond to ongoing public health concerns upon completion (initially completed in June 2007; additional public communications will be planned with the release of this updated report).
2. Honeywell, with guidance from MDE and the City of Baltimore, will develop and conduct an extensive re-sampling effort of Swann Park (completed, and information incorporated in to updated version of this report).
3. ATSDR will evaluate the June 2007 additional site characterization data and revise the conclusions of this consultation accordingly (completed via this updated report).
4. ATSDR will provide comments on the proposed remediation plan to the City of Baltimore Health Department.
5. ATSDR will discuss with the City of Baltimore Health Department possibilities for reviewing relevant health outcome data for this site, including cancer registry data, and will discuss options for providing health education to local health professionals on the findings of this updated report and on the topic of arsenic-related health effects.

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Attachment 1. Analytes and environmental guidelines for soil from Swann Park (from Honeywell, 2007b).

Contaminant	*Maximum mg/kg (ppm)*	*Geometric Mean mg/kg*	*Comparison Value mg/kg Source*
Metals			
Antimony	67	4.6	20 RMEG C
Arsenic	**1330 surface 2220 subsurface**	**156.1**	**20 EMEG CC**
Barium	167	84.7	30,000 EMEG CC
Beryllium	1.5	0.7	100 EMEG CC
Cadmium	1.3	0.3	10 EMEG CC
Chromium, Hexavalent	10.1	1.2	200 RMEG C
Cobalt	16.2	7.8	500 EMEG CI
Copper	116	46.4	500 EMEG CI
Lead	1080	196.7	400 EPA AL
Magnesium	8190	2322.5	NA (essential nutrient)
Manganese	537	214.1	3,000 RMEG C
Mercury	1.4	0.4	NA
Nickel	36.7	18.7	1,000 RMEG C
Potassium	2550	1253.9	NA (essential nutrient)
Selenium	2.2	1.3	300 EMEG CC
Silver	0.7	0.5	300 RMEG C
Thallium	2.1	1.7	5.5 EPA RBC
Vanadium	78.1	45.8	200 EMEG IC
Zinc	261	109.0	20,000 EMEG CC
SVOCs - Method 8270C			
1,1'-Biphenyl	0.05	0.04	3,000 RMEG C
2,2'-oxybis(1-Chloropropane)	0.05	0.04	NA
2,4,5-Trichlorophenol	0.10	0.08	5,000 RMEG C
2,4,6-Trichlorophenol	0.05	0.04	60 CREG
2,4-Dichlorophenol	0.05	0.04	NA
2,4-Dimethylphenol	0.10	0.08	1,000 RMEG C
2,4-Dinitrophenol	1.00	0.85	100 RMEG C
2,4-Dinitrotoluene	0.10	0.08	100
2,6-Dinitrotoluene	0.05	0.04	200 EMEG CI
2-Chloronaphthalene	0.05	0.04	4,000 RMEG C
2-Chlorophenol	0.05	0.04	300 RMEG C
2-Methylnaphthalene	0.14	0.05	200 RMEG C
2-Methylphenol	0.10	0.08	NA
2-Nitroaniline	0.05	0.04	NA
2-Nitrophenol	0.05	0.04	NA
3,3'-Dichlorobenzidine	0.15	0.13	NA
3-Nitroaniline	0.10	0.08	NA
4,6-Dinitro-2-methylphenol	0.26	0.21	NA
4-Bromophenyl-phenylether	0.05	0.04	NA

Contaminant	***Maximum mg/kg (ppm)***	***Geometric Mean mg/kg***	***Comparison Value mg/kg Source***
4-Chloro-3-methylphenol	0.10	0.08	NA
4-Chloroaniline	0.10	0.08	200 RMEG C
4-Chlorophenyl-phenylether	0.05	0.04	NA
4-Methylphenol	0.10	0.08	NA
4-Nitroaniline	0.10	0.08	NA
4-Nitrophenol	0.26	0.21	NA
Acenaphthene	0.51	0.05	3,000 RMEG C
Acenaphthylene	0.14	0.05	NA
Acetophenone	0.10	0.08	NA
Anthracene	1.20	0.07	20,000 RMEG C
Atrazine	0.05	0.04	200 EMEG CI
Benzaldehyde	0.10	0.08	5,000 RMEG C
Benzo(a)anthracene	2.90	0.29	NA
Benzo(a)pyrene	3.90	0.30	0.1 CREG
Benzo(b)fluoranthene	5.80	0.45	NA
Benzo(g,h,i)perylene	3.60	0.25	NA
Benzo(k)fluoranthene	1.70	0.16	NA
bis(2-Chloroethoxy)methane	0.05	0.04	NA
bis(2-Chloroethyl)ether	0.05	0.04	0.6 CREG
bis(2-Ethylhexyl)phthalate	0.36	0.14	NA
Butylbenzylphthalate	0.11	0.09	10,000 RMEG C
Caprolactam	0.05	0.04	30,000 RMEG C
Carbazole	0.56	0.05	NA
Chrysene	3.40	0.31	NA
Dibenz(a,h)anthracene	0.78	0.07	NA
Dibenzofuran	0.40	0.05	NA
Diethylphthalate	0.10	0.08	40,000 RMEG C
Dimethylphthalate	0.10	0.08	NA
Di-n-butylphthalate	0.10	0.08	5,000 RMEG C
Di-n-octylphthalate	0.10	0.09	20,000 EMEG CI
Fluoranthene	3.70	0.47	2,000 RMEG C
Fluorene	0.52	0.05	2,000 RMEG C
Hexachlorobenzene	0.05	0.04	5 EMEG CI
Hexachlorobutadiene	0.10	0.08	10 EMEG CI
Hexachlorocyclopentadiene	0.26	0.21	300 RMEG C
Hexachloroethane	0.05	0.04	50 RMEG C
Indeno(1,2,3-cd)pyrene	3.10	0.21	NA
Isophorone	0.05	0.04	10,000 RMEG C

Contaminant	*Maximum mg/kg (ppm)*	*Geometric Mean mg/kg*	*Comparison Value mg/kg Source*
Naphthalene	0.11	0.05	1,000 RMEG C
Nitrobenzene	0.05	0.04	30 RMEG C
N-Nitroso-di-n-propylamine	0.05	0.04	0.1 CREG
N-Nitrosodiphenylamine	0.05	0.04	0.01 CREG
Pentachlorophenol	0.26	0.21	50 EMEG CI
Phenanthrene	3.80	0.25	NA
Phenol	0.05	0.04	20,000 RMEG C
Pyrene	4.00	0.51	2,000 RMEG C
Pesticides - Method 8081A Kepone (chlordecone)	1.6	0.2	30 EMEG CC
Aldrin	0.01	0.001	2RMEG C
Alpha BHC	0.01	0.002	NA
Alpha Chlordane	0.01	0.002	30 RMEG C
Beta BHC	0.03	0.005	NA
Delta BHC	0.01	0.001	NA
Dieldrin	0.17	0.008	3 RMEG C
Endosulfan I	0.01	0.002	300 RMEG C
Endosulfan II	0.01	0.002	
Endosulfan Sulfate	0.01	0.002	
Endrin	0.01	0.002	20 RMEG C
Endrin Aldehyde	0.04	0.003	NA
Endrin Ketone	0.02	0.003	NA
Gamma BHC - Lindane	0.01	0.001	NA
Gamma Chlordane	0.03	0.007	30 RMEG C
Heptachlor	0.01	0.001	30 RMEG C
Heptachlor Epoxide	0.03	0.002	0.7 RMEG C
Methoxychlor	0.05	0.013	NA
p,p-DDD	0.37	0.025	3 CREG
p,p-DDE	8.40	0.447	2 CREG
p,p-DDT	2.90	0.218	30 RMEG C
Toxaphene	0.34	0.079	50 EMEG CI
Pesticides 8141A & Herbicides 8151A 2,4,5-T	0.03	0.001	500 RMEG C
2,4,5-TP	0.03	0.001	400 RMEG C
2,4-D	0.05	0.008	500 RMEG C
2,4-DB	0.01	0.007	NA
2,4-DP (Dichloroprop)	0.01	0.006	NA
Dalapon	0.07	0.023	NA
Diazinon	0.03	0.019	100 EMEG CI

Contaminant	***Maximum mg/kg (ppm)***	***Geometric Mean mg/kg***	***Comparison Value mg/kg Source***
Dicamba	0.03	0.003	2.000 RMEG C
Dinoseb	0.02	0.002	50 RMEG C
Ethion	1.00	0.042	30 RMEG C
Ethyl Parathion	2.70	0.048	NA
Guthion (Azinphos-methyl)	0.03	0.023	200 EMEG CC
Malathion	0.03	0.024	1,000 RMEG C
MCPA	4.90	1.555	NA
MCPP (Mecoprop)	1.20	0.630	NA
Methyl Parathion	0.03	0.028	10 RMEG C

Notes:

- Data from the June 2007 sample event (Honeywell, 2007c) were also reviewed but are similar to the earlier reports. Exceptions are discussed in the preceding text.
- Maximum and mean values for all analytes except arsenic and kepone include surface and subsurface samples.
- Contaminant maxima and geometric means include numeric values for contaminants with laboratory qualifiers of "U". These contaminant values are considered as non-detections.
- NA: Comparison values (environmental guidelines) are not available for many contaminants.
- CREG: *Cancer risk evaluation guide* is the estimated concentration of a contaminant that would likely cause, at most, one excess cancer in a million people exposed over a lifetime. CREGs are calculated from cancer slope factors and health protective exposure assumptions.
- EMEG: *Environmental media evaluation guides* are contaminant concentrations calculated from "minimal risk levels" that are likely to be without an appreciable risk of adverse, non-cancer health effects for a specified duration of exposure. EMEGs are determined separately for children and adults and for various exposure durations.
  - EMEG CI refers to *child* exposures for an *intermediate* duration (14 to 365 days).
  - EMEG CC refers to *child* exposures for an *chronic* duration (more than 1 year).
- EPA AL: Environmental Protection Agency: RBC = risk-based concentration; AL = Action Limit (EPA, 1998).
- RMEG: *Reference dose media evaluation guide* are contaminant concentrations calculated from EPA Reference Doses that are likely to be without appreciable risk of adverse non-cancer health effects during a lifetime of exposure.
  - RMEG C refers to RMEGs calculated based on exposure assumptions for a *child*.

Attachment 2. ATSDR Fact Sheet on Hair Sample Testing

http://www.atsdr.cdc.gov/HAC/hair_analysis/03-0330HairSampleTesting-Community.pdf

General Public

ATSDR AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Hair Sample Testing:

What can hair sampling results tell me about environmental exposures?

Sometimes health professionals can check whether people have been exposed to chemicals in the environment. For example, levels of chemicals can be measured in the soils, drinking water, and air where people live and work, and from these measures the amount of chemicals that people might routinely contact can be estimated. For some chemicals, urine and blood samples can be collected from people to look for evidence of actual exposure. In recent years, health professionals have debated what hair samples can tell us about environmental exposure. In this fact sheet, the Agency for Toxic Substances and Disease Registry (ATSDR), a public health agency of the U.S. Department of Health and Human Services, looks at how best to interpret results from human hair samples to evaluate environmental exposures.

Summary

ATSDR believes many scientific issues need to be resolved before hair analysis can become a useful tool to understand environmental exposures. Although hair analysis may answer some questions about environmental exposure to a few substances, hair analysis often raises more questions than it answers.

Currently, hair analysis is used for purposes other than assessing environmental exposures. For example, hair analysis has been used to test for illegal drug use and to conduct criminal investigations. This fact sheet does not address these other uses.

What are hair samples and hair analyses?

A *hair sample* is a collection of hair strands, which are most commonly cut from a person's head. Hair samples usually contain hair that has grown over the last 12 months. Although hair growth varies, 12 months of hair growth usually represents about 5 inches of hair. *Hair analysis* occurs when laboratories measure the amount of specific substances in the hair sample.

Unfortunately, no widely accepted standards specify how hair samples should be collected, stored, and analyzed, and different laboratories use different methods when conducting hair analysis. Therefore, it is possible that two laboratories will report different results for hair samples collected from the same person. The different approaches used to collect and analyze hair samples make it very difficult for health professionals to know what the results of any individual hair sample really means.

If a substance is detected in my hair, does that mean I have been exposed to environmental contamination?

Not necessarily. Generally, substances can end up in your hair in two ways. First, chemicals already in your body may get into your hair. These chemicals might have been in something you ate, the water you drank, or the air you breathed. Alternatively, the source of the chemicals could be from other exposures, or they could simply occur naturally in your body. Second, chemicals outside your body, like those in dust particles and hair care products, might stick to your hair after coming into contact with it.

Given how often most people cut their hair, hair analysis generally will not tell you anything about exposures that occurred more than one year ago. Furthermore, for most chemicals, hair analysis cannot tell you where a chemical in your hair came from. More specifically, when a chemical is detected in your hair, we often cannot tell if it is from a contaminated waste site, from your diet, or from other sources. This makes it very difficult to understand what a positive test result for a chemical in your hair truly means.

Do health professionals commonly use hair analysis to diagnose health problems?

No. For most environmental contaminants, we simply do not know enough right now to use someone's hair analysis results to predict if health problems will occur. In fact, for many chemicals, we do not even know the range of levels that are typically found in the hair of an unexposed person. Without this information, we cannot tell if one person's hair analysis result is unusually high or low. Because of these information gaps, doctors and other health professionals *rarely* use hair analysis to evaluate health problems. It is possible that future research will help us better understand what hair analysis results mean. Until this research is done, however, hair analysis results (with few exceptions) will not provide useful information about possible health problems.

With these limitations, why do health agencies and other groups collect hair samples?

Many public health agencies, including ATSDR, have collected and analyzed hair samples when addressing community concerns regarding environmental exposure. Before deciding to use hair analysis, ATSDR carefully considers if the results can be interpreted and will add to our understanding of potential community exposure. In most cases, we choose not to collect hair samples because the results would not help us address health concerns. Given the limitations of hair analysis, health agencies almost never base health conclusions entirely on hair analysis results. Rather, hair analysis results are viewed as just one small piece of evidence that are considered along with other information when evaluating a site.

What is the bottom line? What *can* hair analysis results tell me?

If an environmental chemical is detected in your hair, the only defensible conclusion you can draw, with few exceptions, is that you were exposed to the substance at some point over the last year or so. You will generally not know the source of the exposure or when it occurred. Most importantly, a detection will not tell you if your exposures might cause health problems.

Remember: For almost every environmental contaminant, hair analysis results alone will not tell you if you are likely to get sick or will have health problems.

Where can I get more information on how hair analysis relates to environmental exposure?

ATSDR recently gathered a group of experts to discuss what scientists currently know and do not know about hair analysis. You can get a copy of the report that summarizes this expert panel meeting by calling ATSDR's toll-free telephone number: 1-888-42-ATSDR (or 1-888-422-8737). If you have access to the Internet, the report is available on ATSDR's Web site at "www.atsdr.cdc.gov/HAC/hair_analysis." We can also send you a more detailed and technical fact sheet that summarizes our opinions on the current state of the science regarding hair analysis.

For more information, contact ATSDR's toll-free information line:

(888) 42-ATSDR. . .
that's (888) 422-8737

ATSDR's Internet address is http://www.atsdr.cdc.gov

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