Public Health Assessment for

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

PECK IRON AND METAL
PORTSMOUTH, VIRGINIA
EPA FACILITY ID: VAN000306115
DECEMBER 12, 2011

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment 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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PUBLIC HEALTH ASSESSMENT

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EPA FACILITY ID: VAN000306115

Prepared by:

U.S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry
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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 cleanup of the sites.

Since 1986, ATSDR has been required by law to conduct public health assessment activities 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 state, tribal, and territorial programs 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. Whatever the form of the public health assessment, the 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, rather than collecting its own environmental sampling data, ATSDR 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 are needed.

The route of a contaminant's movement is called the exposure pathway, which has five elements: (1) a source of contamination, (2) an environmental media (such as, soil, water, or air), (3) a point of exposure, (4) a route of human exposure, and (5) a receptor population. The source is the place where the chemical or radioactive material was released. The environmental media transport the contaminants. The point of exposure is the place where persons come in contact with the contaminated media. The route of exposure (for example, ingestion, inhalation, or dermal contact) is the way the contaminant enters the body. The people actually or potentially exposed are called the receptor population.

Health Effects

If there are potential or completed exposure pathways where people have or could come into contact with hazardous substances, ATSDR scientists then evaluate whether 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 likely to be more sensitive and vulnerable to hazardous substances than adults. 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. ATSDR identifies those types of information gaps and documents public health actions needed in public health assessment documents.

Conclusions and Recommendations

If appropriate, this report presents conclusions about the public health threat, if any, posed by a site. Any health threats that have been determined for high-risk groups (such as children, the elderly, chronically ill people, and people engaging in high-risk practices) are summarized in the Conclusions section of the report. Recommendations are presented on how to stop or reduce exposure. The public health action plan describes how those recommendations will be implemented.

ATSDR is primarily an advisory agency, so its reports usually 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 recommend health education or pilot studies of health effects, full-scale epidemiology studies, exposure 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. Comments received from the public are addressed 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:

Manager
ATSDR Records Center (MS F-09)
4770 Buford Highway, NE
Building 106, Room 2108
Atlanta, GA 30341

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List of Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
CREG	cancer risk evaluation guide
CV	comparison valueDAA Draper Aden Associates
EMEG	environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
KM	Kaplan Meier (statistical procedure)
MCL	maximum contaminant level
mg/kg	milligram per kilogram
MPI	Malcolm Pirnie, Incorporated
MRL	minimal risk level
PCB	polychlorinated biphenyl
PHA	public health assessment
PHAP	Public Health Action Plan
PIM	Peck Iron and Metal
ppb	parts per billion
ppm	parts per million
RfD	reference dose
ROS	Regression on Ordered Statistics (statistical procedure)
UCL	upper confidence limit

Summary

INTRODUCTION

The purpose of this public health assessment (PHA) is to determine if exposure to chemicals from the Peck Iron and Metal (PIM) site is a public health hazard for people who live or work in the area. The public health determination is based on an evaluation of the concentrations of toxic substances present at or released from the site and the pathways by which people living or working around the site may be exposed to those substances.

Background

The site is a 33 acre, U-shaped parcel that is bounded by Paradise Creek to the south and southwest; Navy recreational and commissary facilities (ball fields, stores, etc.) and a commercial building (Sherwin Williams Co.) to the west; a commercial freight yard (containerized trucking) to the north; a Navy residential apartment building to the east; and a municipal incinerator to the southeast. A residential neighborhood (Cradock Community) and a school are located on the opposite side of Paradise Creek. The PIM site is mostly vegetated with weeds and shrubs with unpaved roadways and drives, rubble piles, scrap and debris, with derelict buildings occupying the remainder of the property.

From 1945 to 1997 the PIM site was used for scrap metal storage, processing, and recycling operations. Scrap metal handled at the facility included damaged and obsolete equipment, attachments, parts, and other miscellaneous materials, including scrapped naval vessels. Some of these scrap materials contained cadmium (automobile parts), polychlorinated biphenyls (PCB) (insulated wire, gaskets, fluorescent lights and transformer oils) and lead (scrapped bridge sections and automobile batteries).

There is limited access to the PIM site because of boundary fences around the PIM site and the adjoining commercial/industrial properties, and because of the muddy/marshy Paradise Creek shoreline. Consequently the potential for exposure to on-site contaminants is limited to intermittent soil exposures to site workers (including a site watchman), site visitors and trespassers, and occasional exposures to sediments in Paradise Creek by children or fishermen. As groundwater flow is away from residential areas (and the surrounding communities use public water supplies) and there is limited potential for airborne migration of soil contaminants, off-site exposures to contaminated airborne dust and groundwater are unlikely.

CONCLUSIONS

ATSDR has evaluated the current and potential for future chemical exposures at the Peck Iron and Metal site. On the basis of the likely exposure pathways and the available environmental data, ATSDR concludes the following:

Soil Exposure ATSDR concludes that the available surface soil data are not adequate for assessing surface soil exposures. The geometric mean of the vertically composited soil samples averaged across the entire site and the northwest area of the site do not exceed health-based comparison values. However, the available data were collected using 0 to 18 inch depth composited soil samples. Generally, people are only exposed to the top few inches of soil; therefore, ATSDR recommends that future surface soil samples be collected from a depth of 0 to 3 inches with appropriate spatial increments from specifically defined exposure areas. This conclusion also assumes that future site remedial activities will use appropriate procedures to minimize exposures to on-site soil and dust and that the site will continue to be used for industrial/commercial activities.

Sediment Exposure ATSDR concludes that contaminated sediment in Paradise Creek is not expected to harm people's health, because average contaminant concentrations (geometric means) are below applicable health-based comparison values and potential exposures are likely to occur on an intermittent or occasional basis. The sediment sampling data appear adequate for making a public health determination.

Future site remedial activities should maintain appropriate erosion control procedures to ensure that contaminated site soils do not migrate to Paradise Creek. Additional sediment data from Paradise Creek are not required for public health determinations.

Paradise Creek Fish/Shellfish Eating crab meat from Paradise Creek and/or downstream waters of the Southern Branch of the Elizabeth River is safe for most people. Whole (soft-shell) crabs and crab mustard (hepatopancreas) from these areas should not be consumed. People consuming fish and shellfish caught from these areas should adhere to fishing advisories established by the Virginia Department of Health for the Elizabeth River system. This area is closed for oyster harvesting and oysters from this area should not be consumed.

None of the measured contaminant concentrations are specifically linked to the PIM site but are generally applicable to Paradise Creek and downstream waters.

Groundwater/Air Exposure Based upon current conditions, people are not exposed to contaminated groundwater or airborne dust migrating from the PIM site. There are no wells or points of groundwater exposure on-site, adjacent to, or down-gradient of the PIM site. Entrainment of airborne dust from site soils is prevented by vegetation and debris covering most of the PIM site. Future site remedial activities may remove soil cover and enable dust entrainment. Appropriate dust control procedures should be implemented to control those potential exposures.

For More Information

If you have concerns about your health, you should contact your health care provider. For questions or comments related to this Public Health Assessment please call ATSDR at 1-800-CDC-INFO: Peck Iron and Metal Site, Portsmouth, VA.

Purpose and Health Issues

Scope of the PHA

The purpose of this public health assessment (PHA) is to determine if the Peck Iron and Metal (PIM) site is a public health hazard for people who live or work in the area. The public health determination is based on an evaluation of the concentrations of toxic substances present at or released from the site and the pathways by which people living or working around the site may have been exposed to those substances (a glossary of terms used in this PHA is included as Appendix A). If site-related toxic substances are present at areas of potential exposures at concentrations of health concern, this PHA will determine if such exposures may have occurred (or are occurring) at levels likely to cause sickness or other adverse health effects. The process used by this PHA to evaluate the PIM site is described in the preceding "Foreword."

Following this introductory section of the PHA, is a "**Background**" section that describes the PIM site and surrounding community as it relates to the releases and migration of toxic substances. It includes information on the physical conditions of the site, surrounding land uses, and information about people living adjacent to the site.

The next section, "**Pathways of Exposure and Site Contaminants**" outlines the pathways by which people may be exposed to site contaminants and the concentrations and distributions of site-related toxic substances. This section describes the exposure scenarios that define the amount and times of exposure for those pathways that are considered "complete or potentially complete". In conjunction with contaminant concentrations, these scenarios allow the calculation of exposure doses which are standardized estimates of contaminant uptake and absorption.

The section on "**Public Health Implications**" includes a description of the public health concerns of the community surrounding the PIM site, an evaluation of the physical hazards presented by the site, how the special public health concerns for children are addressed, and an assessment of the adequacy of the available data for the public health determinations in this PHA. The overall findings of the PHA are presented in the section on "**Conclusions, Recommendations, and Public Health Action Plan.**" This section summarizes ATSDR's public health findings regarding the PIM site and describes appropriate recommended actions.

Several appendices are also included in this PHA. Appendix A presents the definitions of scientific terms used in the document. Appendix B describes the derivation and use of.health comparison values (CVs) that underlie the contaminant screening process. Appendix C includes a summary of a Public Health Consultation on seafood consumption from Paradise Creek and downstream waters (ATSDR, 2008a). Finally, Appendix D presents the statistical procedures used in evaluating the sampling data for this site.

This PHA will not address past exposures to PIM site workers that occurred from metal salvage/scrapping activities while the facility was operational (circa 1940's to 1990's; MPI, 2007). There is no information available regarding the historic work site operations or practices that would allow evaluation of former worker exposures. Considering the residual concentrations of lead, PCBs, arsenic, and other contaminants present in site soils, past worker exposures may have been significant, but cannot be quantitatively evaluated in this PHA.

This PHA was released for public comment on January 6, 2011 (through March 2, 2011). No public comments were received. The Virginia Department of Health did submit several editorial comments suggesting clarification on the issue of seafood consumption from Paradise Creek and downstream areas. Appropriate editorial changes have been made to this document.

Background

Site Description, Land Use, and Demographics

From 1945 to 1997, the PIM site was used for scrap metal storage, processing, and recycling operations. Figure 1 shows the approximate boundary for the PIM site and the adjoining properties. The site is a 33 acre, U-shaped parcel that is bounded by Paradise Creek to the south and southwest, Navy recreational and commissary facilities (ball fields, stores, etc.) and a commercial building (Sherwin Williams Co.) to the west; a commercial freight yard (containerized trucking) to the north; a Navy residential apartment building to the east; and a municipal incinerator to the southeast (Figure 1). A residential neighborhood (Cradock community) and school are located on the opposite (southwest) side of Paradise Creek. Naval shipyard facilities surround the entire area to the north, east, and south.

The following description of site conditions and activities are based on direct observations by ATSDR and EPA representatives on August 11, 2009. The Peck Iron property is mostly flat-lying with elevations ranging from approximately mean sea level (MSL) to about 10 feet above MSL, with several rubble piles and mounds (~25 feet above MSL). The property is mostly vegetated with weeds and shrubs. Unpaved roadways and drives, rubble piles, scrap and debris, and derelict buildings cover the remainder of the property. The primary points of access (public roads and along adjoining properties) are fenced and gated. Remote property boundaries are not fenced, but direct access to those areas is limited by natural barriers, such as Paradise Creek[1].

As stated above, most of the site is vacant, weedy, and debris-strewn, however, portions of the site, including the derelict building in the northwest corner of the property are apparently being used for vehicle repair, storage, and construction equipment staging. A site watchman is also living on-site in a travel trailer located adjacent to the building and vehicle storage/staging area. The frequency and duration of these on-site activities could not be determined from the August 11, 2009 site visit.

As of the 2000 census, almost 11,000 people lived within one mile of the PIM site boundary (Figure 2). Of that total population, there were 1,146 children under 6 years of age, 1,444 adults 65 years of age or older, and 2,414 females of child-bearing age (15-44 years). A large proportion of the total population residing within one mile of the PIM site are Naval personnel and dependents living in one of several Naval housing facilities. The Naval personnel reside in this area for one or two years.

The U.S. Environmental Protection Agency (EPA) added Peck Iron and Metal to the National Priorities List (NPL) on November 4, 2009 (http://www.epa.gov/reg3hwmd/npl/VAN000306115.htm#reuse). The EPA Region 3 Superfund Program and the PIM site owner are currently in negotiation concerning proposed site assessment and remediation activities.

1 The Paradise Creek shoreline of the PIM site, including a one-acre tidal wetland, three acres of riparian buffer, and a six acre permanent conservation zone has undergone habitat restoration in conjunction with the Elizabeth River Keeper and associated conservation groups.

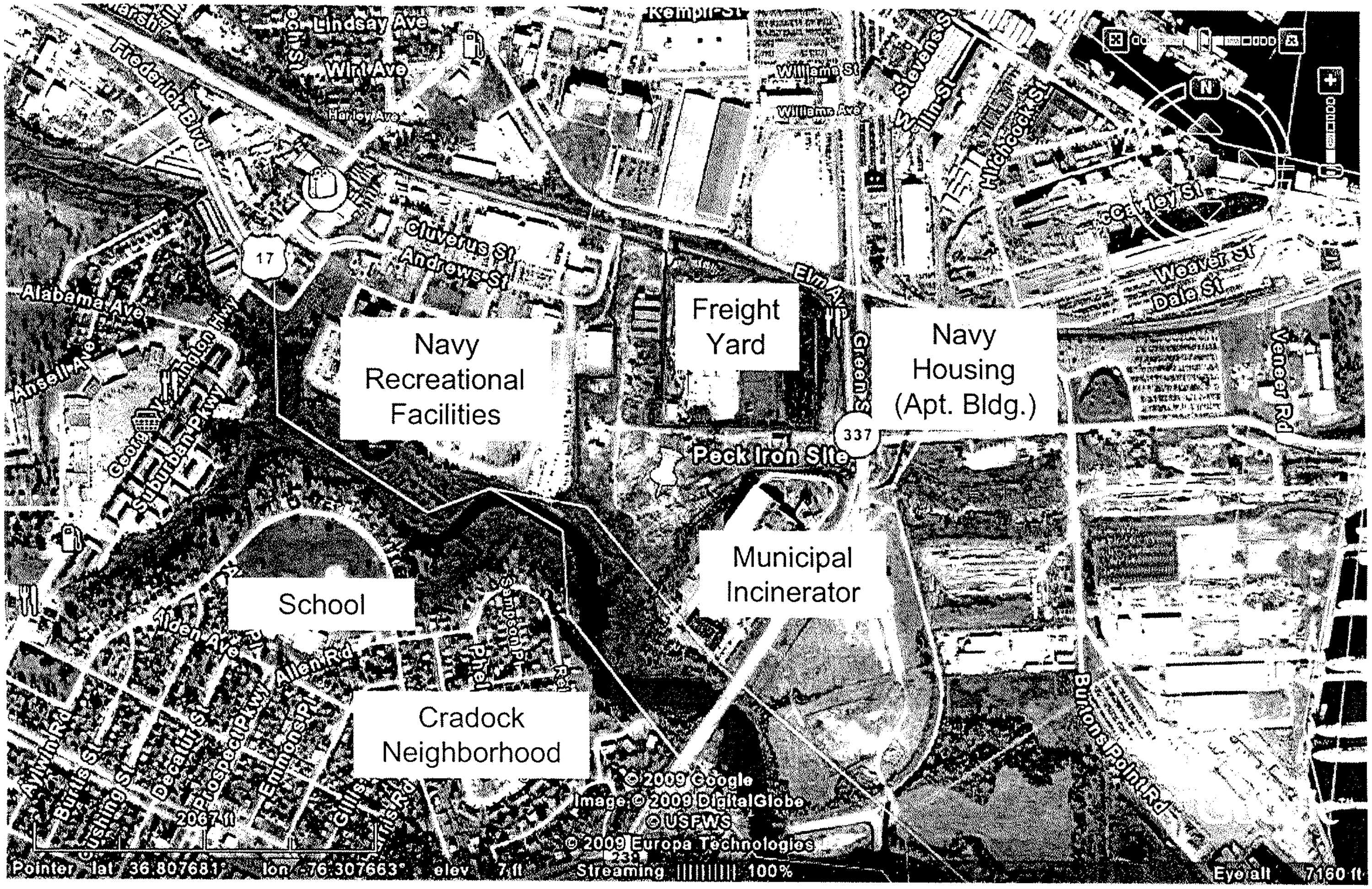
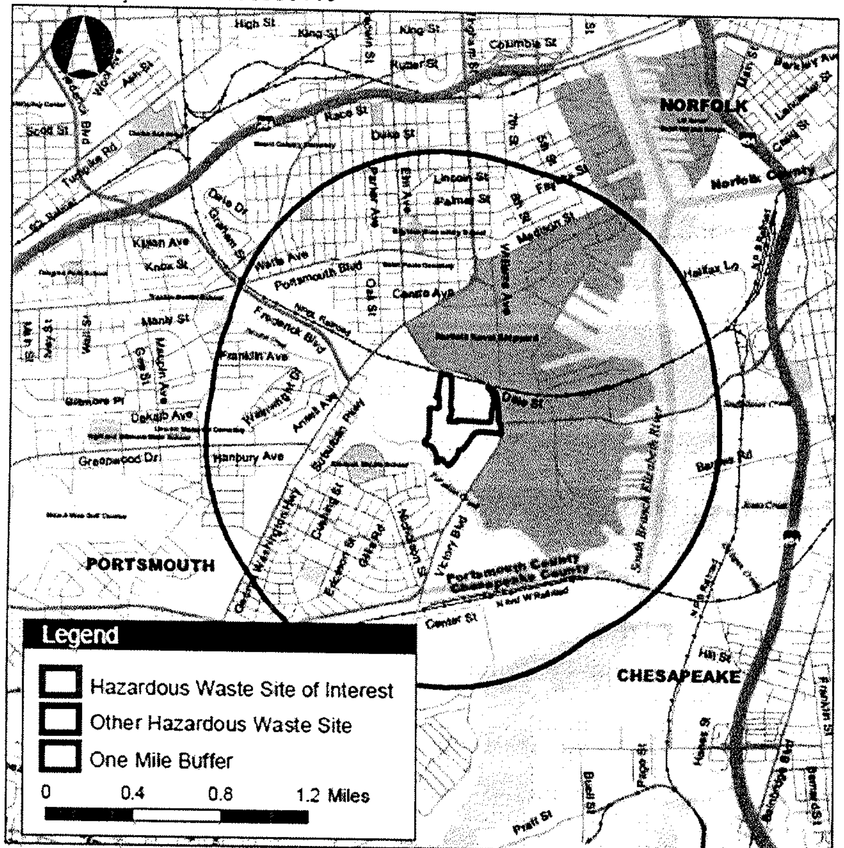


Figure 1. Peck Iron and Metal site location and adjacent land uses.

Peck Iron and Metal
Portsmouth, VA

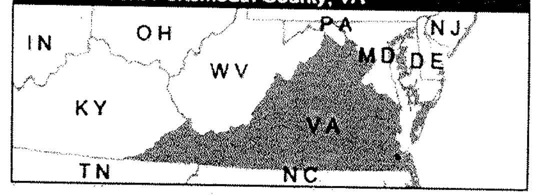
ATSDR

EPA Facility ID: VAN000306115



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 Virginia South FIPS 4502 Feet

Site Location: Portsmouth County, VA



Demographic Statistics
Within One Mile of Site*

Total Population	10,684
White Alone	4,003
Black Alone	6,300
Am. Indian & Alaska Native Alone	62
Asian Alone	59
Native Hawaiian & Other Pacific Islander Alone	1
Some Other Race Alone	73
Two or More Races	186
Hispanic or Latino**	171
Children Aged 6 and Younger	1,146
Adults Aged 65 and Older	1,444
Females Aged 15 to 44	2,414
Total Housing Units	4,774

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.

Figure 2. Population characteristics of the area within a one mile radius of the Peck Iron and Metal site.

Pathways of Exposure and Site Contaminants

Pathways of Contaminant Exposure at the PIM Site

A pathway of exposure describes the process and timeframe by which a person is (or may be) exposed to contaminants from a site. Pathways may be "**complete**" if all parts of the pathway are present, "**potentially completed**" if one or more parts are unknown, or "**eliminated**", if no exposure pathways are present. Exposure pathways also have a time component, such that they may have been completed in the **past**, the **present**, or potentially complete in the **future**.

As previously described in the site background section, recycling activities are no longer ongoing at the PIM site. The site is mostly vacant with a few abandoned buildings, covered with debris and/or weedy vegetation. At the time of the EPA/ATSDR site visit (August 2009), the northwest portion of the site was apparently being used for construction vehicle parking/staging and one building was being used for automotive repairs and vehicle maintenance. A travel trailer was also parked on site and apparently occupied by a site watchman.

Table 1 describes the pathways of exposure and status of each pathway for the PIM site. Exposure to "On-site soils" is the only completed exposure pathway for this site. People working on the site, visitors, and trespassers may be exposed to contaminated soils via incidental ingestion, inhalation of dust, and direct skin contact. Although direct contact with on-site soils to workers, visitors, and trespassers is likely, an estimate of how often such exposure occurs is quite uncertain. The contaminant dose that any person receives from contaminated soils depends on the contaminant concentrations (presented in the following sections) as well as how often such exposure occurs.
Based on the present and historic industrial land use of this site and adjoining properties, this PHA assumes that the PIM site will not be used for residential land use in the foreseeable future. Exposures to soil under residential land use scenarios are different than those for industrial land uses such that different CVs are used. In the unlikely event that future use of the PIM site changes to residential land use, the following assessment of soil contamination will need to be revised.

In addition to the ongoing intermittent exposures to on-site soils by current workers, site visitors, and possibly trespassers, future site remediation workers are likely to have daily exposure to both surface and subsurface soils. Although these direct soil contact activities present the potential for significant short term exposures (over the duration of remedial activities), this PHA assumes that these remedial activities will be conducted using appropriate protective clothing, equipment, and operational procedures to minimize worker exposures.

Table 1 also lists several potentially completed pathways of exposure, including incidental exposure to contaminated sediments in Paradise Creek and ingestion of fish and crabs from Paradise Creek and other downstream waters. Incidental and likely infrequent exposures to potentially contaminated sediments in Paradise Creek are possible for people fishing or playing in this area. The Paradise Creek shoreline of the PIM site is accessible by crossing the creek from the Cradock Community on the opposite shore. Although possible, such exposure is unlikely to occur with any regular frequency. As with on-site soil, it is difficult to determine how often such exposures to Paradise Creek sediments may occur. Sediment contaminant concentrations are presented in the following section to determine whether such potential exposures are likely to present a public health hazard.

If Paradise Creek sediments are contaminated by materials from the PIM site, these contaminants may be taken up by fish and crabs which may then be eaten by people. ATSDR has previously completed a Public Health Consultation which specifically evaluated this exposure pathway for the Atlantic Wood site, which is just downstream of the PIM site on the Southern Branch of the Elizabeth River (ATSDR, 2008a). This health consultation evaluated how much seafood people eat and contaminant concentrations from fish, crabs, and oysters collected from waters directly adjacent to Paradise Creek. As the contaminant concentrations in those samples were relatively uniform over the different locations and the species are mobile (except oysters), the results are representative of those same species from Paradise Creek. Consequently, the results of that health consultation are directly applicable to fish and crab consumption from Paradise Creek and are included by reference as part of this public health assessment.

The "Summary and Statement of Issues" and "Conclusions and Recommendations" of this consultation are included as Appendix C of this health assessment. The referenced health consultation has more information concerning species and areas sampled (ATSDR, 2008a; http://www.atsdr.cdc.gov/HAC/pha//AtlanticWoodIndustries/Atlantic_Wood_Industries_Site%20HC%206-6-2008.pdf) and the following web site has more information concerning Virginia Department of Health seafood consumption advisories for this area (http://www.vdh.virginia.gov/epidemiology/DEE/PublicHealthToxicology/Advisories/index.htm).

Ingestion of groundwater from the PIM site and off-site inhalation of airborne dust from site soil are listed as eliminated or incomplete pathways. No drinking water wells are present on or near the PIM site (the resident site watchman uses a municipal water supply source). Also the site related contaminants at the PIM site (metals and PCBs) are not particularly mobile in groundwater. Consequently, based on current site conditions, groundwater exposures are an incomplete pathway and no further assessment is necessary at this site.[1]

In the absence of soil cover, soil contaminants from the PIM site may become airborne as fugitive dust. This dust may then be blown off-site and inhaled by people living or working adjacent to the PIM site. However, most of the site is covered with vegetation, buildings, and/or debris (see Figure 1) which will prevent or reduce windblown erosion and entrainment of dust. Additionally, there are a number of sources of airborne contaminants directly adjacent to the PIM site (including a municipal waste incinerator, an unpaved freight yard, Navy Shipyard facilities, and roadways, etc.) such that airborne dust from PIM site soils is unlikely to be a measurable component of background air pollution in the surrounding community.[2]

Current and recent past air exposures are an incomplete pathway and further assessment is not necessary at this site. When site soil remediation occurs and site vegetation and cover are removed, it will be necessary to follow appropriate dust suppression procedures to minimize future dust entrainment. Appropriate dust management procedures should be enforced to ensure that the air pathway will continue to be incomplete for future airborne exposures. Note that this

1 Even though there are no drinking water wells on or down-gradient of the PIM site, groundwater contaminants have been measured in multiple on-site monitor wells (MPI, 2008). Contaminant concentrations in these wells are below health-based comparison values.

2 Air emissions from the waste incinerator are regulated by the Virginia Department of Environmental Quality and the U.S. EPA (http://iaspub.epa.gov/enviro/multisys2_v2.get_list?facility_uin=110005228645). Air concentrations contaminants in site soil were evaluated using an EPA air screening analysis model (Peck Iron Metal Air Screening Analysis.xls) assuming the site cover is 50% vegetated and using site-wide soil concentrations. Calculated on/off-site air concentrations are below health-based comparison values.

determination of the air pathway does not include historic conditions (pre-1997) when the recycling facility was operational. There is insufficient information available to assess past facility operational air releases.

Table 1. Exposure Pathway Elements and Status at the PIM site

Pathway Name and Source of Contamination	Fate and Transport	Point of Exposure	Route of Exposure	Potentially Exposed Population	Time Frame for Exposure
Completed Pathways On-site soils: PCBs and metals from past recycling activities	Limited potential for migration due to widespread vegetation on-site and debris covering much of soil.	Soils on the facility	Ingestion Skin contact Inhalation	Site workers and resident watchman have limited contact with contaminated soil. Appropriate protective procedures are assumed for future remedial workers who may have exposure to soils.	Past Current Future
Potential Pathways Off-site sediments and surface water in Paradise Creek: PCBs and metals that have eroded or leached into Paradise Creek	Sediment in Paradise Creek and downstream waters are contaminated by a number of sources. The contribution from the PIM site is unknown. Migration of contaminants from sediment to water is possible.	Off-site sediments and water in Paradise Creek and downstream waters	Ingestion Skin contact	Limited contact by recreational users of Paradise Creek	Past Current Future
Eating fish and crabs from Paradise Creek (and downstream waters)	Sediment in Paradise Creek and downstream waters are contaminated by a number of sources. The contribution from the PIM site is unknown	Fish and crabs from Paradise Creek (and downstream waters)	Ingestion	People consuming seafood taken from Paradise Creek (and downstream waters)	Past Current Future
*Eliminated Pathways*Groundwater: Contaminated on-site soils or liquids released/spilled during site operations	Groundwater flow is towards Paradise Creek. Limited potential for contaminated groundwater to flow under or past Paradise Creek.	None. No groundwater use at site or down-gradient area.	None	None	None
Fugitive dust (and airborne particulates): Dust from contaminated soil and past recycling activities	Limited potential for migration due to widespread vegetation and debris covering most of site. The surrounding industrial areas include a number of air contaminant sources.	None. The dust contribution from the PIM site is minor compared with background.	None	None	Past None Current None Future None(assuming dust control during remediation)

Site Contaminants

Limited information is available concerning the specific scrap metal recycling activities conducted at the site during its ~50 year operational history. The following information is from the U.S. EPA NPL Site Narrative (http://www.epa.gov/superfund/sites/npl/nar1795.htm).

> "From 1945 to 1999, Peck Iron purchased, processed, stored, and shipped metal scrap from various military bases; other Federal, state, and local government agencies; and local businesses. Scrap metal handled at the facility included damaged and obsolete equipment, attachments, parts, and other miscellaneous materials, including scrapped naval vessels. Some of these scrap materials contained cadmium (automobile parts), polychlorinated biphenyls (PCB) (insulated wire, gaskets, fluorescent lights and transformer oils) and lead (scrapped bridge sections and automobile batteries). PCB-containing transformers were disassembled at the facility and the wires were burned to remove insulation."

While documentation of specific past site activities is limited, there have been several investigations of site environmental contamination. These field sampling studies (summarized in (Malcolm Pirnie 2007 and 2008) confirm the above statements that various metals (including arsenic, cadmium, chromium, lead, and others) and PCBs are the primary contaminants at the PIM site. The following discussion summarizes the results of those field studies with respect to contaminant concentrations and distributions in soil and sediment. Potential contamination of groundwater is not evaluated because there is no current or anticipated future human exposure to groundwater from this site. Similarly, the air pathway is not evaluated because vegetation and debris cover most of the site preventing significant entrainment of airborne dust from site soil (this assessment assumes that future site remediation will use appropriate dust control measures).

Soil Contaminants

Surface and subsurface soils from the PIM site have been sampled for various contaminants several times by several different investigators. These investigations are summarized in a report by Malcolm Pirnie, Inc. (2007). Hatcher-Sayre, Inc. conducted an investigation of soil contaminants in 1999 (Hatcher-Sayre, Inc., 1999) which collected 39 grid-based soil samples (0 to 12 inch depth; 250 foot grid spacing) and used a portable X-Ray Diffraction (XRF) instrument for field screening (metals). Based on screening results, fifteen surface soil samples were selected for laboratory analysis of metals (eight for PCBs) and ten subsurface soil samples were analyzed for both metals and PCBs. Results of the soil analyses found soil contamination above the Virginia DEQ Voluntary Remediation Program Tier III screening levels for copper, arsenic, chromium, lead, mercury, PCB Arochlors[4] 1254 and 1260, and subsurface soil contamination for arsenic, lead, and PCB 1260.

Draper Aden Associates conducted additional soil sampling in 2003 with a total of 26 soil samples (0 to 18 inch depth) analyzed for lead and PCBs. The results of that investigation, while consistent with the Hatcher-Sayre study, were used to develop an extensive PCB soil investigation that collected 524 soil samples (0 to 18 inch depth; 50x50 foot grid spacing)

[4] PCBs are polychlorinated biphenyls; Arochlor (1254 and 1260 and others) is a trade name for specific PCB congenors.

(DAA, 2005). No written report was prepared, but the resulting data were transferred to Malcolm Pirnie, Inc.

Malcolm Pirnie, Inc. summarized all of the previously collected soil data in the 2007 Final Response Action Plan (MPI, 2007). This plan described additional field sampling to be conducted that would provide complete PCB and metals analyses for the 50x50 foot sampling grid initially developed by DAA (shown in Figure 3). The results of this integrated sampling study are presented in the 2008 Draft Extent of Contamination Study Report (MPI, 2008).

EXCEL spreadsheets of the DAA (2005) and MPI (2008) data sets were provided to ATSDR by MPI. The data from these spreadsheets, which represent a consistent sampling procedure and include appropriate supporting data quality assurance information, are the basis for this public health assessment. Table 2 summarizes the metal and PCB soil concentrations from the PIM site.

There is nearly comprehensive coverage of the 569 (50x50 foot) grid cells over the 33 acre site. However, there are different numbers of samples for the various analytes depending on whether partial cells along property boundaries were sampled and/or differing numbers of duplicate samples for PCBs or metals. All field samples listed in the spreadsheets including non-detects (but excluding matrix spikes and blanks) are summarized in Table 2. The procedures for handling non-detects and derivation of geometric means (or medians) and upper confidence limits (UCLs) are presented in Appendix D. A description of the limitations and uncertainty associated with the integrated data set is presented in the following Public Health Implications section (Adequacy of Available Data).

Table 2 (and Table 4) includes several different types of CVs for screening of the soil and sediment contaminants. The soil CVs for screening of on-site soils are based on adult exposures because children are unlikely to regularly visit this site. The CVs for sediment exposure in Paradise Creek are based on children's exposures because children may incidentally ingest sediment while playing in the creek. Arsenic and PCBs are considered human carcinogens or probable human carcinogens (respectively) so CVs for those contaminants include cancer risk evaluation guides (CREGs). See Appendix B for a derivation of the CREGs and the procedures used to adjust the continual lifetime exposure assumptions underlying the calculation of CREGs for intermittent exposures prevalent at this site.

None of the contaminant geometric means[5] (or medians) or geometric mean 95th % upper confidence level (UCL) values listed in Table 2 are greater than their respective non-cancer health comparison or screening values. CVs based on cancer endpoints for arsenic and PCBs, when modified for site specific exposure factors, are greater than the non-cancer CVs; see

5 Note that geometric means and medians are approximately equal for most environmental data. Appendix D presents specific statistical analyses of this data describing why medians may be more appropriate and the specific analytes for which they are used.

Appendix B. The lead geomean UCL is equal to the listed CV of 1,200 ppm.[6] However, the lead soil screening value of 1,200 ppm is based on continuous adult exposure at a residential location and is protective for intermittent adult exposures in an industrial setting such as the PIM site. The adult residential lead screening value is also protective for the resident site watchman. The residential lead screening value for a child's play area is 400 ppm, however, due to the industrial nature of this site and current access restrictions, children are unlikely to visit this site.

Current site activities appear to be occurring predominately in the northwest portion of the site (Figures 3 and 4). Lead concentrations in this portion of the site range from 8.9 to 4,200 ppm and the geometric mean concentration is 276 ppm with a 95th UCL of 341 ppm. Total PCB concentrations in the same NW portion of the site range from non-detects to 59.0 ppm and the geometric mean concentration is 0.75 ppm with a 95th UCL of 1.0 ppm. Lead and PCB concentrations in the portion of the site where most soil exposures are likely to occur are below their respective CVs (Table 2 and Figures 3 and 4) and also significantly lower than site-wide average values (Table 2).

None of the measured soil contaminant concentrations (metals and PCBs in soils 0 to 18 inches) exceed their respective CVs on the basis of the site-wide or northwest area geometric means (and UCLs; see Appendix B for definitions and derivations of CVs). This does not mean that soils at the PIM site are not contaminated. The "Frequency Above CV" column in Table 1 lists the number of samples from individual 50x50 foot grid cells that exceed their respective CVs. About 47 % of the discrete lead samples are greater than 1,200 ppm. The grid cells with high contaminant values are grouped in the central and southern portions of the site where historic recycling activities occurred (Figures 3 and 4; MPI, 2008). This portion of the site is covered with vegetation and debris piles and does not appear to have any ongoing occupation or use by site workers.

In addition to spatial segregation of contaminant concentrations, there are many different ways to calculate "average concentrations" and upper confidence limits of those averages. The geomeans and geomean UCLs listed in Table 1 are only one way to represent the distribution of sample values across the site. For example, the arithmetic means are much larger than the geometric means. The rationale for use of the geometric means is presented in Appendix D. Although Table 1 indicates that there are no specific surface soil contaminants of concern related to site-wide exposures, the potential for more localized exposures and data adequacy are discussed in the following Public Health Implications section.

Subsurface soils have also been collected and analyzed for metals and PCB concentrations as part of the above referenced studies (DAA, 2005; MPI, 2008). Site-wide average metals concentrations (geomeans and geomean UCLs) for soils are listed in Table 3 and subsurface PCB concentrations shown in Figure 5. Note that subsurface soil samples are vertically composited

6 The EPA has recently promulgated a soil screening value of 800 ppm for commercial and industrial sites. This value is based on continuous (219 days/year) exposures to the fetus of a pregnant female worker (http://www.epa.gov/superfund/lead/almfaq.htm#freq). As PIM site workers are on-site only intermittently, this continuous worker value can be doubled (EPA, 2003; 800 ppm x 2= 1,600ppm) if exposures occur with ½ the frequency of workers using a site on a continual basis. Consequently, the soil lead screening value for continuous adult residential exposures of 1,200 ppm is a health protective soil CV.

from a depth of 18 inches to the water table (WT; depth to WT varied from less than a foot along Paradise Creek to approximately 6 feet in central portion of site; MPI, 2008).

For all contaminants, subsurface soil concentrations (below 18 inch depths) are lower than 0 to 18 inch depth concentrations and below CVs (Tables 2 and 3). Subsurface concentrations of metals and PCBs are lower than surface soil concentrations because these contaminants are strongly adsorbed onto soil particles and are thus relatively immobile in the soil column rather than leaching downward with percolating groundwater. The site-wide subsurface metals concentrations listed in Table 3 are based on approximately 380 subsurface samples (the specific number of analyses were different for each analyte). Although additional samples of subsurface contaminant concentrations may be required for site remediation purposes, the existing subsurface soil data set is adequate for assessing potential exposures. Note that soil sample data (composited from 0 to 18 inch depth) present an important source of uncertainty for evaluating surface soil exposures as discussed in the following Public Health Implication section.

Table 2. Metal and PCB (Arochlor) concentrations in on-site soil (0 to 18 inch depth) at Peck Iron and Metal site

Chemical	Range of Detections (ppm)	% NDs	Median or Geomean (ppm)	95th% UCL GM or Med (ppm)	Frequency Above CV-- %	CV (ppm)
Metals						
Arsenic	1.30—380	2.3%	17	18	14 of 484—2.9% 138 of 484—28.5%	200 EMEG-c (adult) 25 CREG (adjusted)
Cadmium	0.16—370	3.3%	8.6	11	40 of 484—8.3%	70 EMEG-c (adult)
Chromium	6.3—22,000	1.7%	160	190	56 of 484—11.6%	700 EMEG-c (adult)
Lead	7.9—76,000	1.0%	970	1,200	225 of 484—46.5%	1,200 SSL
Mercury	0.055—270	1.9%	1.5	1.8	1 of 484—<0.1%	200 RMEG (adult) mercuric chloride
Nickel	2.9—28,000	1.7%	235	290	2 of 484—<0.1%	10,000 RMEG (adult)
PCBs[1]						
Arochlor -1016	0.002—1.5	95.2%	0.044	0.051	No Comparison Values available for these arochlors	
Arochlor -1248	0.001 —99	59.0%	0.21	0.33		
Arochlor -1254	0.002 —3,499	8.9%	3.45	4.25	156 of 586—26.6%	10 EMEG-c (adult)
Arochlor -1260	0.001 —2,799	8.2%	1.60	2.34	No CVs available for these arochlors	
Arochlor-1268	0.001 —5.90	94.6%	0.026	0.040		
Sum of Arochlor geomeans & UCLs		>95%	5.33	7.01	208 of 447—46.5%	10 EMEG-c (adult) 15 CREG (adjusted)

CREG—Cancer risk evaluation guide, adjusted for intermittent exposure (see Appendix B for derivation).
ND--nondetects
Geomean – (GM) the geomean is the average value of the logarithms (converted back to original units) and is approximately equal to the median (the 50th percentile value of all measured concentrations) in lognormal distributions.
95th UCL GM/Median—is the 95th percentile upper confidence limit of the larger of the geomean or median.
Metal and PCB concentrations are from Draper Aden Associates (2005) and Malcolm Pirnie, Inc. (2008).
Comparison values (CVs) are based on adult exposures as on-site exposures to children are unlikely, see Appendix B for derivation and definitions of CVs.
EMEG-c – chronic environmental media evaluation guide
EMEG-i – intermediate environmental media evaluation guide
ppm – parts per million (same as mg/kg)
RMEG – reference dose media evaluation guide
SSL – EPA soil screening level is for average concentration of a residential area excluding direct play areas of children.
PCBs[1]—Other PCB congeners were also evaluated but had few if any analytical detections.

Table 3. Site-wide Average Metals Concentrations in Soil (0 to 18") and Subsurface Soil (18" to Water Table)							
	Arsenic ppm	*Cadmium ppm*	*Chromium ppm*	*Mercury ppm*	*Nickel ppm*	*Silver ppm*	*Lead ppm*
Subsurface (18" to WT) Geomean	10.1	3.0	64.5	0.3	55.0	1.2	176.8
95th% UCL Geomean	12.97	4.76	87.10	0.53	79.60	1.78	275.89
Soil (0 to 18") Geomean	16.7	8.9	164.2	1.4	199.2	2.4	830.1
95th% UCL Geomean	18.20	10.30	186.90	1.58	227.01	2.71	963.04
See Appendix D for derivation and distinction between geomeans and medians. UCL—upper confidence limit							

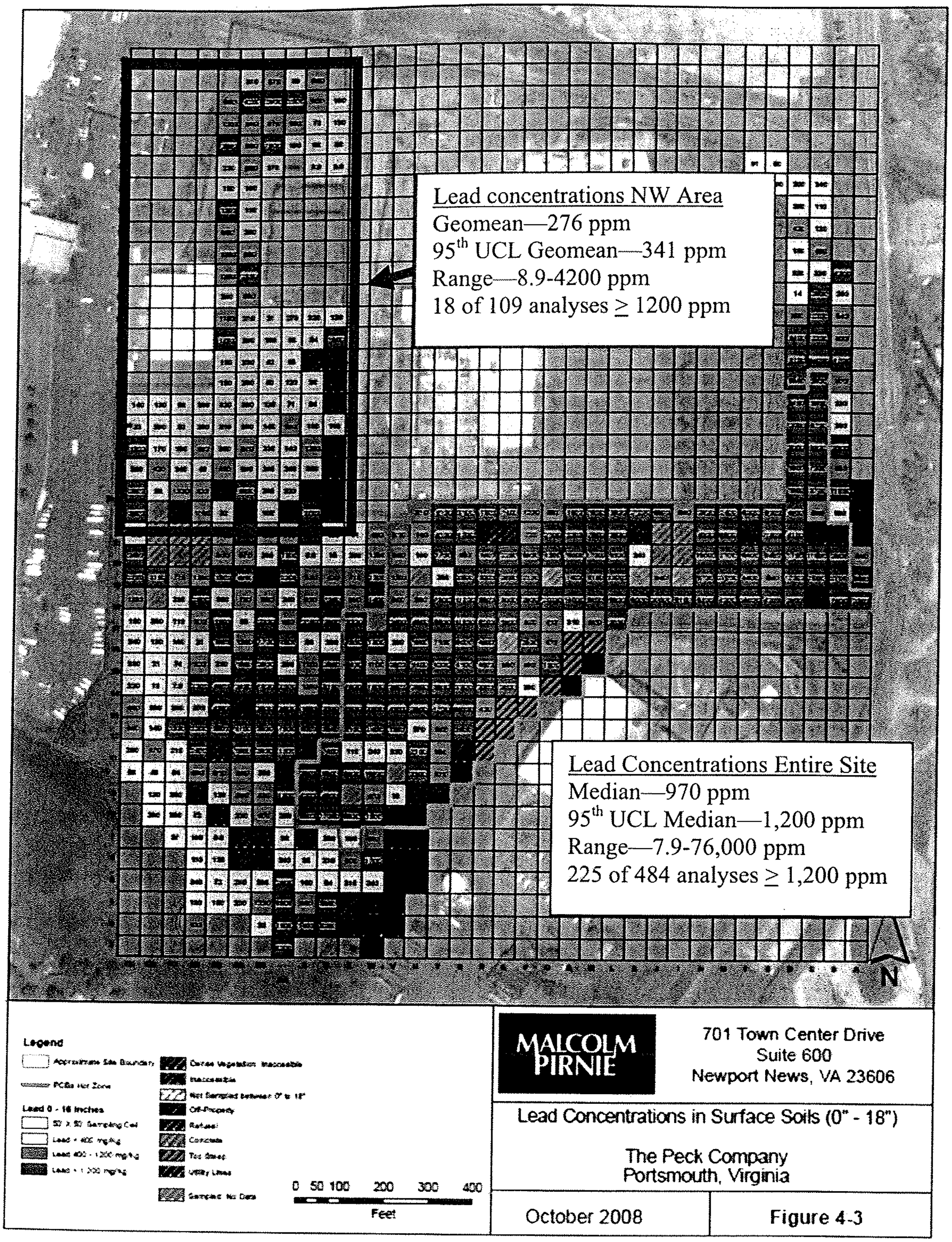


Figure 3. Zero to 18 inch soil grid sampling layout and measured lead concentrations (Figure 4-3 from MPI, 2008). Current site activities appear to predominately occur in the northwest portion of site. Lead concentrations in this portion of site are lower than overall site averages.

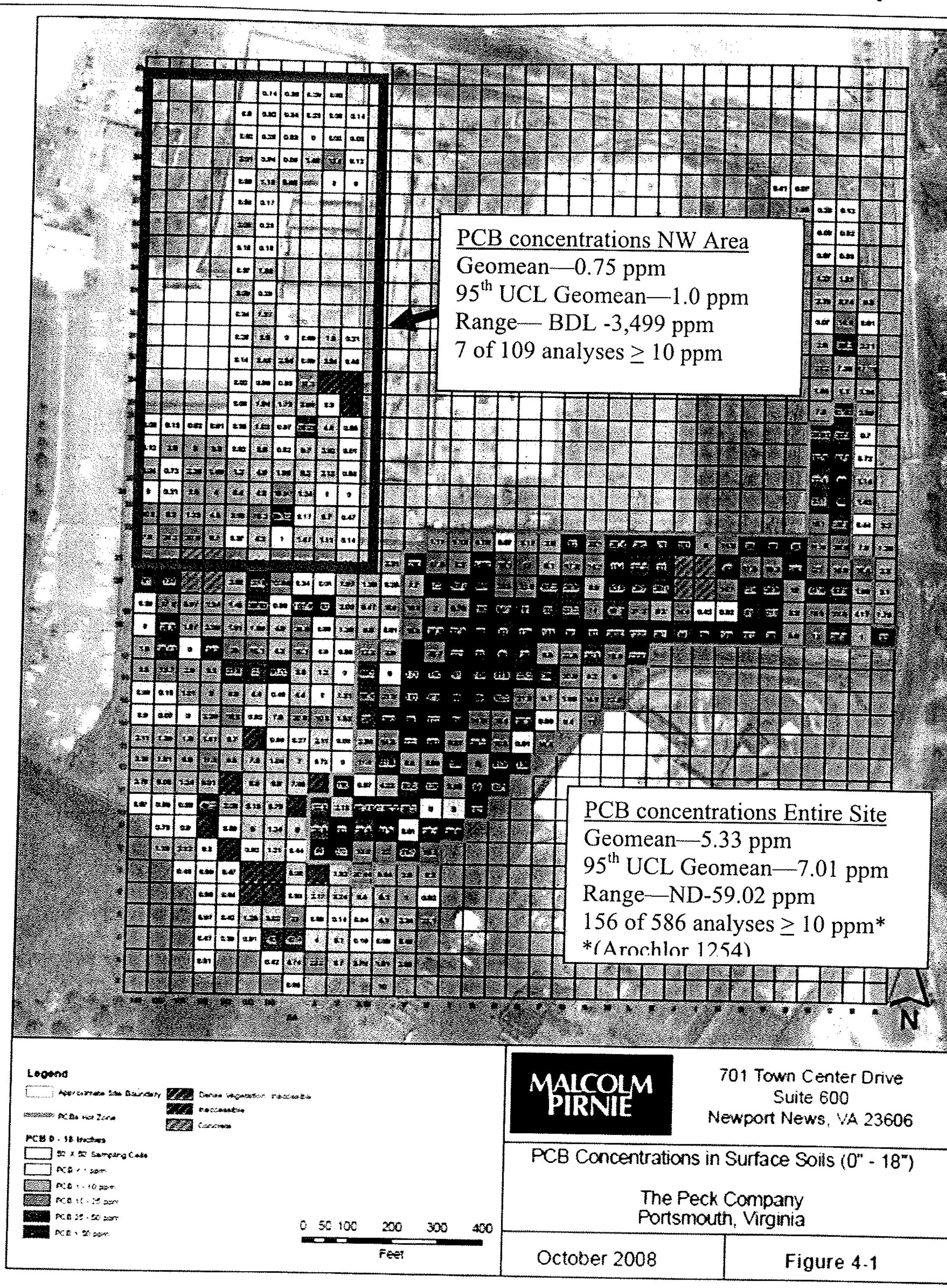


Figure 4. Zero to 18 inch soil grid sampling layout and measured PCB concentrations (Figure 4-1 from MPI, 2008). Current site activities appear to predominately occur in the northwest portion of site. PCB concentrations in this portion of site are lower than overall site averages.

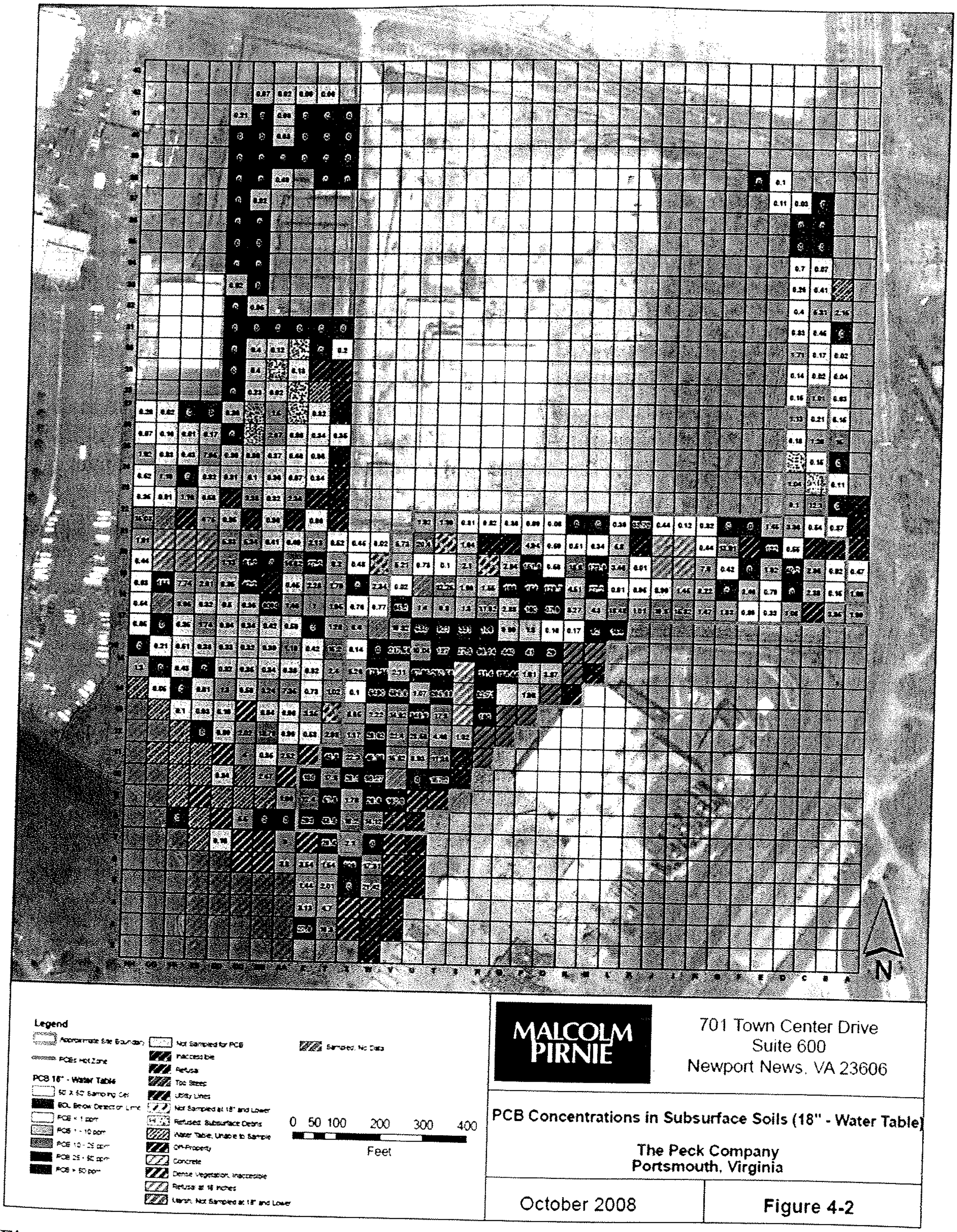


Figure 5. Subsurface soil (18"to water table) PCB concentrations (Figure 4-2 from MPI, 2008). Subsurface PCB concentrations are lower than surface soil concentrations (see Table 3).

Sediment Contaminants

Sediments from Paradise Creek (abutting the PIM site boundary) have been analyzed for metals, PCBs, and polycyclic aromatic hydrocarbons (PAHs) in several different studies. DAA collected and analyzed six sediment samples (0 to 6 inch depths) from Paradise Creek in 2003 and concluded that the sediments had lead concentrations less than 1,000 ppm and PCB (Arochlor 1254 and 1260) concentrations of less than 10 ppm (as summarized in MPI, 2007). The MPI Final Response Action Plan (2007) also references a sediment study conducted by Unger et.al. that collected 19 Paradise Creek sediment samples and analyzed eight of them for PCBs and PAHs. Although the Unger samples reportedly contained PCB concentrations of 0.001 to 1.5 ppm and PAH concentrations of 11 to 52 ppm (MPI, 2007), the cited reference does not provide any supporting identification or documentation for evaluation of this dataset.

The most comprehensive study of Paradise Creek sediments at the PIM site was conducted by MPI (2008). This 2008 study divided the entire creek area adjacent to the PIM property boundary into 37 50x50 foot grids and collected and analyzed surface sediments (0 to 6 inch depth) from each grid cell. The data from this study were provided to ATSDR as an EXCEL spreadsheet by MPI and are the basis for the following evaluation of sediment contaminant concentrations.

Table 4 provides a summary of the metals and PCB concentrations of the 37 sediment samples. The geometric means and geomean UCLs for all metals and all PCB congeners are below their respective CVs. Total chromium concentrations are below the intermediate duration (14 to 365 days) child CVs for both the hexavalent chromium (Cr-VI), and the trivalent chromium (Cr-III) CVs. Although the reported chromium analyses are not speciated, chromium occurs predominately as the trivalent species in soil and sediment (ATSDR, 2008b). The listed chromium concentrations (geomean--206 ppm, geomean UCL—279 ppm) are much lower than the chromium-III intermediate CV for children of 80,000 ppm (there is no chronic duration CV for trivalent chromium).

As with the soil contaminants, average sediment concentrations (geomean and geomean UCLs) of metals and PCBs are not present in Paradise Creek above health CVs.

Table 4. Metal and PCB concentrations measured in Paradise Creek sediment adjacent to Peck Iron Metal site

Chemical	Range of Detections (ppm)	Geomean (ppm)	UCL Geomean (ppm)	Frequency Above CV	CV (ppm)
Arsenic	8.8—21	14.1	14.7	1 of 41	20 EMEG-c (child) 25 CREG (adjusted)
Cadmium	1—3.3	2.2	2.4	0 of 41	30 EMEG-i (child)
Chromium	88—1,400	206	279	0 of 41	Cr(III): 80,000 RMEG
Lead	110—450	194	210	1 of 41	400 SSL (child play area)
Mercury	0.08—2.2	0.9	1	0 of 41	20 RMEG (child) mercuric chloride
Nickel	45—1,100	117	172	1 of 41	1,000 RMEG (child)
PCBs **	0.04—0.14	1 or 2 detections insufficient to calculate GMs, UCLs.		0 of 41	2 EMEG-i (child) Arochlor -1254 15 CREG (adjusted)

Metal and PCB concentrations are from Malcolm Pirnie, Inc. (2008).
Comparison values are based on intermediate duration (exposures occurring over a period of 14 to 365 days) child exposures.
The derivations of the following CVs are described in Appendix B.
CREG—Cancer risk evaluation guide, adjusted for intermittent exposure (see Appendix B for derivation).EMEG-c – chronic environmental media evaluation guide
EMEG-i – intermediate environmental media evaluation guide
ppm – parts per million (same as mg/kg)
RMEG – reference dose media evaluation guide
SSL – soil screening level is for average concentration of a play area of children (residential setting).
Chromium is most likely present as Cr(III) but analytical results were not speciated. The chronic child EMEG for hexavalent chromium is 50 ppm and is based on a continuous residential exposure scenario. Correcting the CV for occasional exposure (one day per month) to Paradise Creek sediments produces an adjusted hexavalent Cr CV of ~1,500 ppm (50 ppm x 1/30= 1,515ppm).
** Measured as hexachlorobiphenyl and heptachlorobiphenyl; Only 4 of 451 PCB analyses in sediments were detections.

Public Health Implications

The preceding section on Pathways of Exposure and Site Contaminants identified and described exposures to soil, sediment, and consumption of seafood from Paradise Creek (Appendix C) as the primary completed and potentially completed pathways of exposure at the PIM site. Off-site exposures to wind-blown dust and groundwater are currently incomplete pathways of exposure. An evaluation of soil and sediment contaminants across the PIM site and the adjoining Paradise Creek[1] determined that site-wide and northwest area average concentrations (based on geometric means and geomean UCLs) of metals and PCBs do not exceed applicable health CVs.[2]

Based on the above assessment of current property use, exposure pathways and the calculated estimates of site-wide contaminant concentrations (Tables 2 and 3), PIM site soils and sediments do not represent a public health hazard. This finding is subject to several areas of considerable uncertainty and may be revised as additional data become available. The 0 to 18 inches depth soil samples are not adequate for assessing the surface soil exposures (usually considered to be a depth of 0 to 3 inches) It must also be noted that this finding is based on current uses of the site. As a listed NPL (Superfund) site, this PHA assumes that there will be no significant changes to the use of this site without appropriate remediation. Discussions of the physical health hazards presented by the PIM site, how children's health issues are addressed, and the adequacy of available data comprise the remainder of this section.

Community Health Concerns

As part of the public health assessment process ATSDR representatives regularly contact community members, local interest groups, and representatives of local government agencies to determine if people living around a site have expressed any specific health or environmental concerns that may be related to that site. For the PIM site, ATSDR representatives conducted interviews during the period May 3 through May 5, 2010. Interviews were conducted with community members, faith-based and non-profit organizations, businesses, state and local governmental agency representatives, and health care providers. These interviews did not identify any community health concerns directly related to the Peck Iron site. Several community members did express concerns about the quality of the local environment because of a number of nearby hazardous waste sites and industrial facilities.

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[1] Contaminant concentrations, exposure assumptions, and dose calculations for consumption of crabs and oysters from nearby areas of the Southern Branch of the Elizabeth River (including Paradise Creek) are presented and discussed in an ATSDR Health Consultation (Evaluation of Contaminant Exposures from Human Consumption of Crabs and Oysters Near the Atlantic Wood Industries Site, Portsmouth, VA; ATSDR 2008). The "Summary and Statement of Issues" and "Conclusions and Recommendations" of this consultation are included as Appendix C of this health assessment. It should be noted that even though the results of the referenced health consultation are applicable to consumption of crabs and oysters from Paradise Creek, those contaminant concentrations cannot be directly related to soil and sediment contaminants from the PIM site.

[2] Note that the site-wide median 95th UCL of lead is equal to the 1200mg/kg CV. However, the CV is based on continuous residential adult exposure and is over protective relative to the intermittent exposures likely at this site.

There is also significant community interest in a planned park and recreational facility on Paradise Creek (to be located just downstream of the PIM site). Current park plans do not identify any direct contact with Paradise Creek water or sediment via swimming beaches, etc. (http://paradisecreekpark.org/). Indirect and/or intermittent contact with water or sediment may occur via boating or other activity but does not represent a potential public health hazard as evaluated in the previous sections.

Physical Hazards

The PIM site presents a number of physical hazards including piles of scrap metal and other construction debris, abandoned buildings, standing water (in one of the buildings), broken bottles and other sharp objects. Collectively, the site represents an attractive nuisance with places to explore and numerous objects to scavenge or reclaim. However, there is limited access to the site with fences and a gate at the front entrance and along adjoining property boundaries. The only adjacent residential area is on the opposite side of Paradise Creek (Cradock Community) and the marshy/muddy shoreline would tend to reduce access from that area. Other adjoining properties consist of industrial or commercial facilities that are likewise fenced with restricted access. A watchman is also apparently residing on the PIM site further reducing the potential for site trespassers. Although the site does present potential physical hazards, current restrictions appear adequate to prevent unauthorized site access.

Child Health Considerations

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 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 more dust 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.

In this PHA, current potential children's chemical exposures are only relevant for the pathways related to Paradise Creek. Children may be exposed to contaminated sediment while playing in the creek or by consuming seafood caught in the creek. Those exposures to children have been evaluated using child-specific CVs and exposure factors. As the estimated child-specific exposures and/or doses are somewhat greater than adult doses, the resulting public health determinations include the potential adverse health effects specific to children.

Future soil exposures to children could be a public health hazard if this site changes from its current industrial to a residential land use without appropriate remediation. This PHA assumes that such a land use change is unlikely.

Adequacy of Data for Public Health Determination

The 33 acre PIM site has been divided into approximately 469 grid cells (50x50 foot) for soil sampling. The number of grid cells is approximate because certain of the cells (about 22) are deemed inaccessible for sampling because of concrete or dense vegetation and some partial cells along property boundaries may have been sampled by one investigator but not another leaving a total of about 447 accessible grid cells (MPI, 2008). Metals analyses (including duplicates) consisted of 484 sample results while PCB analyses included 586 analyses for the Arochlor 1248, 1254, and 1260 congenors, 649 samples for the Arochlor 1016 congenor, and only 261 analyses for the Arochlor 1268 congenor. The difference in the number of PCB analyses is due to inclusion of differing numbers of duplicate analyses and because the 1268 congenor was not analyzed in the 2005 DAA study.

In spite of the differing numbers of analyses of the metals and PCB soil data, there is near universal coverage of the accessible grid cells for soil samples collected from the 0 to 18 inch depth. All of these analyses have undergone consistent analytical data quality assurance procedures and are appropriately included for data evaluation. However, because the samples were vertically composited over the upper 18 inches the resulting data are of limited utility for assessing exposures to surface soil.

ATSDR recommends that surface soil samples be restricted to a depth of 3 inches (ATSDR, 1994). Because the PIM site soil contaminants (metals and PCBs) have limited mobility in soils and are unlikely to migrate below the upper few inches of soil, compositing across an 18 inch depth is likely to result in reduced soil contaminant concentrations (relative to 0 to 3 inch sampling depth). Note that the 0 to 18 inch soil samples were collected for the purpose of assessing soil remediation activities and may be appropriate for that use[1].

Additionally, using site-wide average concentrations minimizes the effect that localized areas of elevated contaminant concentrations (or hot spots) may have on estimating exposure doses. Figures 3 and 4 show that high lead and PCB concentrations in surface soils are predominately located in the central and southern portions of the site. Although this pattern of contaminant distribution is likely to be reproduced in future sampling, it should be noted that a single discrete sample from a 50x50 foot grid cell may not be representative of average contaminant concentrations over the entire grid cell area.

The soil concentrations evaluated in this public health assessment are based on site-wide averages using geometric means (or medians; see Appendix D) and the 95th UCL of the geometric mean concentrations. Average site-wide concentrations are used for one primary reason. That is because chronic exposures to soil occur over a time period of at least a year and typically over many years. Thus exposure will not take place at one location or one event on the site. Using this rationale, exposure at any single grid location is equally likely which requires the use of site-wide average concentrations to assess exposure. The CVs used to evaluate contaminant concentrations are similarly based on average values. Consequently, it would be inappropriate to compare a spatially-averaged CV or soil screening level to a discrete, non-spatially averaged sample concentration.

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[1] Subsurface soil samples were vertically composited from 18 inches down to the water table. In contrast to surface soil samples, the vertical compositing of subsurface soils is appropriate for evaluating exposures to subsurface soil. Also sediment samples were collected from a 0 to 6 inch depth and are adequate for assessing potential sediment exposures.

It should be noted that soil samples have not been collected in any off-site areas, such as the Cradock community or Naval housing areas. However, the available on-site data indicate that lead and PCB concentrations in on-site grid areas along the site boundary are below residential screening levels (Figures 3 and 4; the NW area 95th UCL median lead of 341 ppm is less than the 400 ppm screening value for a child's play area). As areas of potential off-site soil exposure are more distant than these intervening on-site areas and the site presents limited potential for air-borne contaminant migration there appears to be little public health basis for off-site soil sampling.

If a future exposure scenario is defined that determines that exposure activities were restricted to a specific portion of the site, it may be necessary to estimate spatially restricted average concentrations for sub-areas within the overall site. As an example, current exposures to site soils may occur predominately in the northwest portion of the site in the vicinity of a large building and the travel trailer occupied by the site watchman (see Figures 3 and 4). In this case, lead and PCB (summed congener-specific values) concentrations for this sub-area are lower than overall site averages. If future soil sampling for evaluating exposure is conducted, it should focus on specific exposure areas using a multi-increment sampling procedure. This sampling procedure will ensure that spatially representative average contaminant concentrations are measured. These exposure areas may be large or small depending on the type of exposure evaluated, but should consist of a single analysis of 30 or more increments collected from a depth of 0 to 3 inches across each exposure area.

Conclusions, Recommendations, and Public Health Action Plan

Conclusions

The purpose of this public health assessment (PHA) is to determine if the Peck Iron and Metal (PIM) site is a public health hazard for people who live or work in the area. The public health determination is based on an evaluation of the concentrations of toxic substances present at or released from the site and the pathways by which people living or working around the site may be exposed to those substances. From 1945 to 1997 the PIM site was used for scrap metal storage, processing, and recycling operations. The site is a 33 acre, U-shaped parcel that is bounded by Paradise Creek to the south and southwest; Navy recreational and commissary facilities (ball fields, stores, etc.) and a commercial building (Sherwin Williams Co.) to the west; a commercial freight yard (containerized trucking) to the north; a Navy residential apartment building to the east; and a municipal incinerator to the southeast.

Currently, there is limited access to the PIM site because of boundary fences around the PIM site and the adjoining commercial/industrial properties, and because of the muddy/marshy Paradise Creek shoreline. Consequently the potential for exposure to site contaminants is limited to intermittent soil exposures to site workers, site visitors and trespassers, and a site watchman and occasional exposures to sediments in Paradise Creek by children or fishermen. Off-site exposures to airborne dust and groundwater are currently unlikely.

On the basis of the likely exposure pathways (current and/or future) and the available environmental data, ATSDR concludes the following:

1) The public health hazard presented by exposure to contaminated soil at the PIM site is uncertain because available surface soil samples were vertically composited from 0 to 18 inch depth. However, using this data, such exposures are not expected to harm peoples' health because site-wide and northwest area average concentrations of soil contaminants (geomeans and geomean UCLs) do not exceed CVs and contact with the soils will only occur on an intermittent basis. The lead geomean UCL is equal to the listed comparison value of 1,200 ppm. However, the lead soil screening value of 1,200 ppm is based on continuous adult exposure at a residential location and is protective for intermittent adult exposures in an industrial setting such as the PIM site.
2) Exposure to contaminated sediment in Paradise Creek is not expected to harm people's health, because average contaminant concentrations (geomean and geomean UCLs) are below applicable health comparison values and potential exposures are likely to occur on an intermittent or occasional basis.
3) Consumption of two crab meat meals per month from Paradise Creek or downstream waters of the Southern Branch of the Elizabeth River is safe for most people. Whole crabs, crab mustard (hepatopancreas), and oysters from these areas should not be consumed. People consuming fish and crabs caught from these areas should adhere to fishing advisories established by the Virginia Department of Health.
4) People are not exposed to contaminated groundwater or airborne dust migrating from the PIM site under current site conditions. Future site remediation may increase dust exposures for remediation workers and offsite residents.

Recommendations

On the basis of the above conclusions, ATSDR makes the following recommendations:

1) The available surface soil data were collected using 0 to 18 inch depth integrated samples. The available data are not adequate for assessing surface soil exposures. Future surface soil samples should be collected using 0 to 3 inch depth spatially incremented samples from a well-defined exposure area.
2) Current site access restrictions (including a locked gate, fencing, and security guard) should be continued until site remediation is completed.
3) Future site remedial activities should maintain appropriate erosion control procedures to ensure that site soils do not migrate to Paradise Creek. Additional sediment data from Paradise Creek are not required for public health determinations.
4) Future site remedial activities may remove the soil's vegetative cover and enable dust entrainment. Appropriate dust control procedures should be implemented during remedial activities to reduce potential exposures to windblown dust.

Public Health Action Plan

The PIM site is an active CERCLA (Superfund) site and it is anticipated that additional site characterization studies and site remediation will occur. ATSDR will evaluate any additional site-specific data as it becomes available and revise the conclusions and recommendations of this PHA as appropriate. ATSDR will also distribute this PHA document to the Cradock community and other interested parties and, if desired, present this information at an appropriate community meeting.

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APPENDICES

Appendix A: ATSDR Glossary of Terms

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Aerobic
Requiring oxygen [compare with anaerobic].

Ambient
Surrounding (for example, ambient air).

Anaerobic
Requiring the absence of oxygen [compare with aerobic].

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The 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.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose-response relationship
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].

In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Mutagen
A substance that causes mutations (genetic damage).

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP)
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action
A list of steps to protect public health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Receptor population
People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or an environment.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)]

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance [see public health surveillance]

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].

Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)
National Library of Medicine (NIH)
(http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

For more information on the work of ATSDR, please contact:
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Appendix B: Derivation and Use of Health Comparison Values

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

ATSDR considers these physical and biological characteristics when developing health guidelines. Health guidelines provide a basis for evaluating exposures estimated from concentrations of contaminants in different environmental media (soil, air, water, and food) depending on the characteristics of the people who may be exposed and the length of exposure. Health guideline values are in units of dose such as milligrams (of contaminant) per kilogram of body weight per day (mg/kg/day).

ATSDR reviews health and chemical information in documents called toxicological profiles. Each toxicological profile covers a particular substance; it summarizes toxicological and adverse health effects information about that substance and includes health guidelines such as ATSDR's minimal risk level (MRL), EPA's reference dose (RfD) and reference concentration (RfC), and EPA's cancer slope factor (CSF). ATSDR public health professionals use these guidelines to determine a person's potential for developing adverse non-cancer health effects and/or cancer from exposure to a hazardous substance.

An MRL is an estimate of daily human exposure to a contaminant that is likely to be without an appreciable risk of adverse non-cancer health effects over a specified duration of exposure (acute, less than 15 days; intermediate, 15 to 364 days; chronic, 365 days or more). Oral MRLs are expressed in units of milligrams per kilogram per day (mg/kg/day); inhalation MRLs are expressed in micrograms per cubic meter ($\mu g/m^3$). MRLs are not derived for dermal exposure.

RfDs and RfCs are estimates of daily human exposure, including exposure to sensitive subpopulations that are likely to be without appreciable risk of adverse non-cancer health effects during a lifetime (70 years). These guidelines are derived from experimental data and lowest-observed-adverse-effect levels (or no-observed-adverse-effect levels), adjusted downward using uncertainty factors. The uncertainty factors are used to make the guidelines adequately protective for all people, including susceptible individuals. RfDs and RfCs should not be viewed as strict scientific boundaries between what is toxic and what is nontoxic.

For cancer-causing substances, EPA established the cancer slope factor (CSF; EPA 2004). A CSF is used to determine the number of excess cancers expected from maximal exposure for a lifetime (estimated as 70 years).

Health comparison values (CVs) are estimated contaminant concentrations that are unlikely to cause detectable adverse health outcomes when these concentrations occur in specific media. CVs are used to select site contaminants for further evaluation. CVs are calculated from health guidelines and are presented in media specific units of concentration, such as micrograms/liter (µg/l) or ppm. CVs are calculated using conservative assumptions about daily intake rates by an individual of standard body weight. Because of the conservatism of the assumptions and safety factors, contaminant concentrations that exceed CVs for an environmental medium do not necessarily indicate a health hazard.

For nonradioactive chemicals, ATSDR uses CVs like environmental media evaluation guides (EMEGs), cancer risk evaluation guides (CREGs), reference dose (or concentration) media evaluation guides (RMEGs), and others. EMEGs, since they are derived from MRLs, apply only to specific durations of exposure. Also, they depend on the amount of a contaminant ingested or inhaled. Thus, EMEGs are determined separately for children and adults, and also separately for various durations of exposure. A CREG is an 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 CSFs. Reference dose (or concentration) media evaluation guides (RMEGs) are media guides based on EPA's RfDs and RfCs.

EPA's maximum contaminant levels (MCLs) are maximum contaminant concentrations of chemicals allowed in public drinking water systems. MCLs are regulatory standards set as close to health goals as feasible and are based on treatment technologies, costs, and other factors.

CVs, such as EMEGs and MCLs, are derived using standard intake rates for inhalation of air and ingestion of water, soil, and biota. These intake rates are derived from the ATSDR Public Health Assessment Guidance Manual (ATSDR 1992a) or from the EPA Exposure Factors Handbook (EPA 1999). Doses calculated using health protective exposure factors and environmental concentrations are considered "health protective doses" because it is unlikely that any real community exposures are greater than the calculated doses and are most likely to be less than the health protective doses.

Cancer risk guides (CREGs) are contaminant concentrations that are estimated to produce a theoretical, excess cancer risk of 0.000001 assuming continuous exposure (seven days/week), and 100% contaminant bioavailability for a 70 year lifetime. ATSDR CREGs are calculated from EPA cancer slope factors and assumptions about hypothetical cancer risks at low levels of exposure (ATSDR, 2005a). For cases of intermittent exposure, such as occurs at this site, the EPA has established a process to adjust contaminant concentrations (or screening values) by the conditions of exposure at a site (EPA, 2003).

The default CREGs for arsenic and PCBs are 0.5 ppm and 0.4 ppm (respectively). Assuming that exposures to PIM site soils occur one day per week over a period of 20 years and that the bioavailability of arsenic (ATSDR, 2005b; EPA, 2011)[10] and PCBs (ATSDR, 2004/Appendix D) are 50% -As and 65%- PCBs, the adjusted CREGS would be:

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[10] From http://www.epa.gov/region8/r8risk/hh_rba.html: "In 26 test materials, the relative bioavailability of arsenic ranged from 8 - 61% with a mean of 34%. Of the 26 test materials investigated, only 5 exceeded 50%, and 1 exceeded 60%. Similarly, bioavailability studies conducted by Roberts et al.

For arsenic	0.5 / (1/7) / (20/70) / 0.5 = 25 ppm
For PCBs	0.4 / (1/7) / (20/70) / 0.65 = 15 ppm.

After estimating the potential exposure at a site, ATSDR identifies the site's "contaminants of concern" by comparing the exposures of interest with health guidelines, or contaminant concentrations with CVs. As a general rule, if the guideline or value is exceeded, ATSDR evaluates exposure to determine whether it is of potential health concern. Sometimes additional medical and toxicological information may indicate that these exposures are not of health concern. In other instances, exposures below the guidelines or values could be of health concern because of interactive effects with other chemicals or because of the increased sensitivity of certain individuals. Thus additional analysis is necessary to determine whether health effects are likely to occur.

Exposure doses via ingestion are calculated on the basis of the following equation:

Dose (Ingestion) = (Chemical Conc. x IR x EF x ED) / (BW x AT)

Where:

Chemical Conc.	= concentration of each contaminant (in mg/g, µg/g, mg/L, or µg/L)
IR	= ingestion rate (in grams/day or liters/day)
EF	= exposure frequency in days per year
ED	= exposure duration in years
BW	= body weight in kilograms
AT	= averaging time in days

For soil and sediment doses, we take an additional step to determine exposure via dermal absorption, with the total dose being the sum of the ingestion dose and the dermal dose.

Dose (Dermal) = (Chemical Conc. x ABS x TSA x EF x ED) / (BW x AT)

Where all factors are as above except:

ABS	= a chemical-specific absorption or bioavailability factor (unitless)
TSA	= total soil adhered in milligrams (skin surface area x soil adherence value)

(2006) in Cynomolgus monkeys measured the bioavailability of arsenic in 14 soil samples from 12 different sites, including mining and smelting sites, pesticide facilities, cattle dip vat soil, and chemical plant soil. The relative bioavailabilties ranged from 5% to 31%. Based on this, Region 8 has concluded that a relative bioavailability of 50% can be considered a generally conservative default value for arsenic in soil."

Appendix C: Summary of:

HEALTH CONSULTATION

Evaluation of Contaminant Exposures from Human Consumption of Crabs and Oysters Near the ATLANTIC WOOD INDUSTRIES SITE PORTSMOUTH, VIRGINIA EPA FACILITY ID: VAD990710410

June 6, 2008

Summary and Statement of Issues

The Environmental Protection Agency Region 3 has requested that the Agency for Toxic Substances and Disease Registry (ATSDR) evaluate the public health risk associated with consumption of crabs and oysters from the Southern Branch of the Elizabeth River (Portsmouth, Virginia) near the Atlantic Wood Industries (AWI) Superfund site. In addition to the AWI site, there are two other Superfund sites, other sources of contamination, and a number of active port and industrial facilities near this portion of the Southern Branch of the Elizabeth River.

The Atlantic Wood NPL site is located in the waterfront area of the Southern Branch of the Elizabeth River in Portsmouth, VA. Historic industrial operations, including wood-treating operations, at the facility have resulted in soil, groundwater, and sediment contamination. The predominant contaminants at the site are polynuclear aromatic hydrocarbons (PAHs) from creosote, pentachlorophenol and associated dioxins, and metals such as arsenic, cadmium, lead, copper and chromium. There is a ban on collecting oysters due to bacteria and metals, but oyster beds are being restored which will increase opportunities for harvesting. Also, there is a fin fish advisory for poly-chlorinated biphenyls (PCBs, and kepone) which recommends limiting fish consumption to two fish meals per month from this area for many species and recommends that some species not be eaten at all.

A Public Health Assessment (PHA) for this site was published in 1994, and considered the consumption of the area shellfish and fin fish as a potential exposure pathway (ATSDR, 1994). The 1994 PHA makes several recommendations concerning additional or continued site monitoring and characterization, worker safety, and public access restriction. The PHA also makes a specific recommendation to "Determine if the ban on collecting shellfish is effective and determine if the ban should include fin fish."

Conclusions and Recommendations

1) Based on measured concentrations of PCBs in crab meat and whole crabs and angler surveys of blue crab consumption rates, consumption of two crab meat meals per month is safe for most people.

2) The VDH should consider adding blue crab to the current PCB fishing advisory recommending limiting of crab meals to two times per month and no consumption for "high risk individuals." This would also cover exposures to "dioxins" in crabs.

3) Arsenic and dioxin doses from consumption of crab meat taken from the AWI area are below levels of public health concern for expected rates of consumption. Subsistence and recreational fishermen who eat more than two fish and crab meals per month should not take all of their catch from the AWI area.

4) Whole crabs and crab hepatopancreas (mustard) should not be consumed from the Southern Branch of the Elizabeth River. As such, it is recommended that proper signs be posted—especially in high access areas such as the fishing piers and boat ramps.

Based on the above conclusions, consumption of up to 2 crab meat meals per month taken adjacent to the AWI site is "no apparent public health hazard" for most people. This conclusion means that eating crab meat from this area will result in an increased intake of PCBs and dioxins but the doses are unlikely to produce any adverse health effects. More frequent consumption of crab meat, or any crab hepatopancreas (whole crab), or oysters from this area represents a public health hazard due to an increased risk of cancer and other potential health effects from PCBs, dioxins, and arsenic. Sensitive individuals such as pregnant or nursing women and young children should not consume fish, crabs, or other seafood from this area

Appendix D: Statistical Procedures Used for Evaluating Sampling Data at the PIM site.

Rationale for Use of Contaminant Medians and Median UCLs to Evaluate Exposure

Soil and sediment sampling at the PIM site is based on defining the entire site as a series of 50x50 foot grid cells (569 soil cells; 37 sediment cells) and then collecting and analyzing one discrete sample for each grid cell (see figures 4 and 5; sediment grid cells from Paradise Creek are similar and shown in MPI, 2008). The resulting data sets have at least one set of measured concentrations for each contaminant for each grid cell (for surface soil and sediment samples; there is a smaller number of subsurface soil samples). Duplicate field samples were collected and analyzed for a limited number of cells (~one per 20 samples) with additional quality assurance sampling for field blanks, matrix spikes, etc.

The definition and sampling procedure for surfical soils (based on a vertical composite of the upper 18 inches of soil) presents an important source of uncertainty relative to overall contaminant concentrations. Regardless of the uncertainty presented by the depth of surface soil sampling, the resulting data sets contain thousands of analyte-specific measurements indicating that many of the grid cells have very high concentrations of metals and PCBs and a larger number of low or moderate concentrations. The range of contaminant concentration data contained in these data sets presents an important question....What are the appropriate values to use for comparing contaminant-specific concentrations with CVs (Appendix B) or what is the appropriate exposure point concentration?

This overarching question about the exposure point (or area) concentration resolves into three basic questions:

1) Should we base exposure assessment on measured contaminant concentrations from a single grid cell (50x50foot) or some average value of multiple grid cells?
2) If yes, then how well does single discrete sample from grid cell represent average concentrations throughout entire cell area?
3) If no, and we use an averaged multi-cell concentration, what kind of average value is most representative of concentrations throughout exposure area?

The answer to question 1) is no. Exposures concentrations should not be based on concentrations from a single 50x50 foot area for several reasons. First, under most exposure scenarios, it is very difficult to imagine that there are ongoing (multiple days per year) exposures to a single grid cell. If a worker activity has been identified whereby a worker spends multiple days per year in the same small area, a small area concentration may be justified. No such worker/visitor activities are likely at the PIM site.

A second reason for using a spatially averaged concentration for assessing exposure is that the CVs used to screen or evaluate such exposures are also spatially averaged concentrations. Consequently, it is inappropriate to compare spatially discrete concentrations with spatially averaged CVs.

Another related reason for not using discrete cell concentrations for estimating exposure point concentrations is related to the answer for question 2). The available grid-based soil sampling data for the PIM site provide no assurance that the measured discrete point concentrations are representative of average concentrations across the entire cell area. Although duplicates were analyzed for about 5% of the grid cells, these duplicates are based on split analyses of the original grid sample and do not represent a spatially independent sample. Consequently the available data do not permit any evaluation of the within-cell variance of contaminant concentrations.

For all of the above reasons, it is appropriate to use a spatially averaged value as the exposure point (area) concentration. As formulated in question 3), what sort of average value is the most appropriate, spatially representative exposure area concentration? As explained in the Soil Screening Guidance: User's Guide (EPA, 1996), "an individual is assumed to move randomly across an exposure area (EA) over time, spending equivalent amounts of time in each location." http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg496.pdf

With respect to the PIM site the "average concentration contacted over time" is defined by the frequency with which any particular grid cell is visited or occupied. The median value of any contaminant concentration denotes the 50th percentile frequency of grid values. Fifty percent of the grid cells have lower values than the median, and 50% of the cells have higher values. The median thus defines the average frequency of sample values and is the most appropriate measure of exposure area concentration.

It should be noted that the sampled medians (as well as means and other statistics) are only estimates of the true population parameters. If different samples of the PIM site were collected and analyzed, the resulting values and the associated medians would be slightly different than the initial values. If the PIM site were re-sampled 100 times, the resulting medians would be less than 95th upper confidence limit (UCL) of the median 95 times out 100. Thus the 95th UCL of the median is a health protective estimate of the true median and an appropriate measure of central tendency for evaluation of exposure area concentrations.

The skewed character of PIM site soil contaminants is shown in Figure D-1. This figure shows the frequency (and cumulative percentages) of surface soil lead concentrations along a standard numeric scale (a) and a natural log scale (b). Figure D-1.a) shows that the concentrations are distinctly skewed with most (259 of 484) concentrations less than the 1,200 ppm CV with a smaller frequency of high lead concentrations (up to a maximum concentration of 76,000 ppm). Figure D-1.a) also shows that the numeric mean value of 2,651 ppm and the UCL of the mean (3,868 ppm) are also skewed and not representative of the central tendency of the lead distribution.

Figure D-1.b) shows the same lead concentrations transformed to a natural log scale (the labels on the log scale have been retransformed back to numeric concentrations). The geometric (geo) mean of 830 ppm is centered on the log transformed data distribution and is a useful indicator of the central tendency of the frequency of lead concentrations. Similarly, the 95th UCL of the median (1,200 ppm) is a health protective estimate of the central tendency of the distribution.

The distribution of log lead concentrations (D-1.b) also shows a strong bi-modal distribution with one mode centered on ~337 ppm and another mode centered on ~4,106 ppm. The bi-modal distribution of lead concentrations reinforces the spatial variation shown in Figure 3 and is consistent with the frequency and spatial distributions for all other metals and PCBs. It should be noted that the area with most likely and/or frequent exposures in located in the northwest portion of the site (Figures 3 and 4) which has lower concentrations of all site contaminants (relative to overall site averages).

An important aspect of the bi-modal distribution of contaminants is that the median concentrations are somewhat larger than the geomean concentrations. In a typical log-normal distribution of environmental data, the sample geomeans are equal to or slightly greater than the medians. For these log bi-modal distributions, the medians are slightly greater than the geomeans. Consequently, the exposure area concentrations are based on contaminant medians and the UCLs of the medians (Tables 2, 3, 4, and D-1).

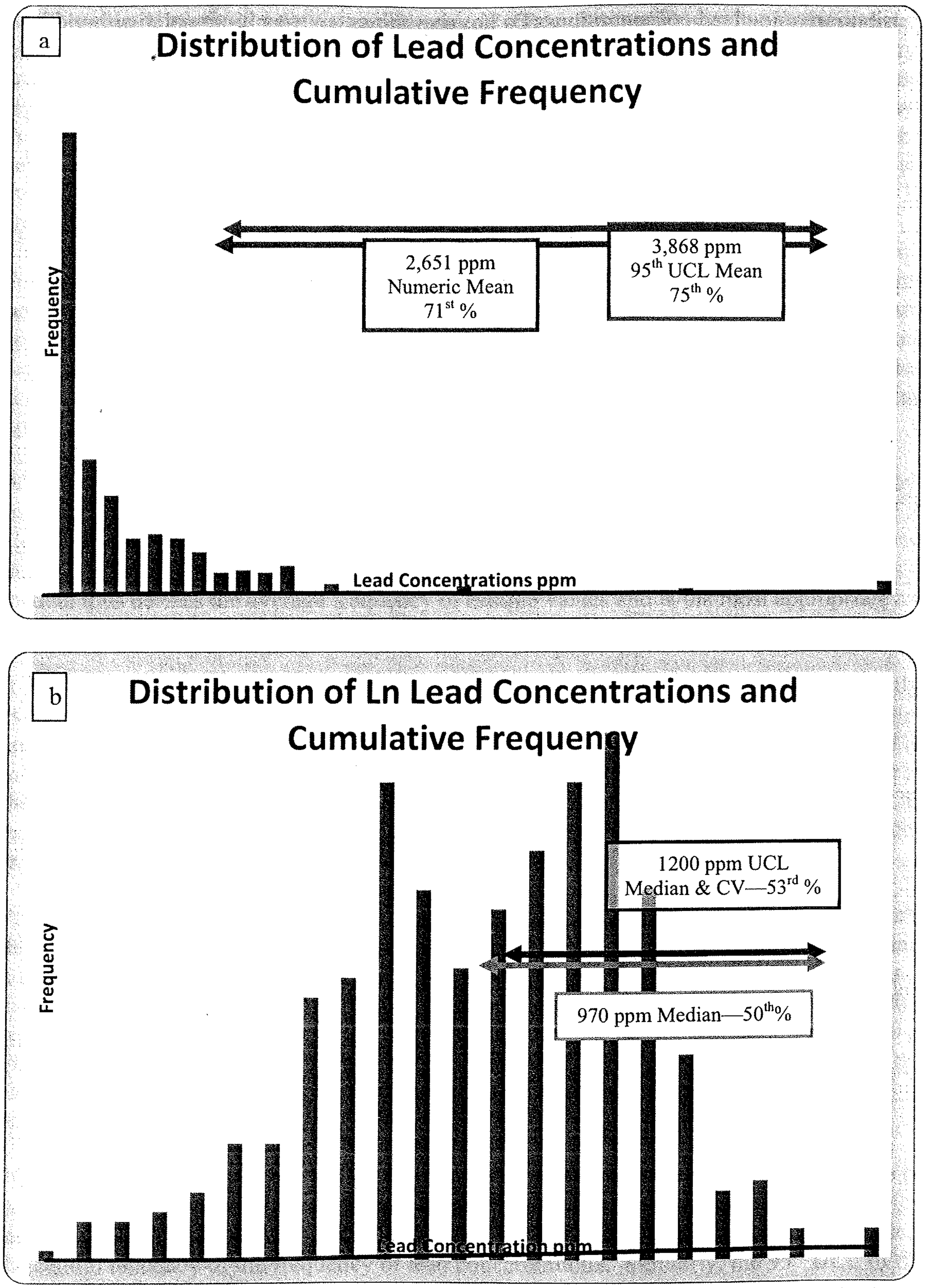

Figure D-1. Distribution and cumulative frequency of lead concentrations; a) standard numeric scale, and b) natural log (Ln) scale.

Procedures Used to Calculate Contaminant Medians and Median UCLs

Sample medians represent the 50^{th} percentile value of a distribution of data values.

1. Separate EXCEL datasets that included all grid-based data (from Draper Aden, Associates and Malcolm Pirnie, Inc. studies) for all analytes (metals, PCBs, etc.) were combined into spreadsheets for surface, subsurface and sediment samples with a separate spreadsheet for the Northwest subarea soils. All duplicate samples and non-detects were included, all matrix spikes and field blanks were excluded. Summary statistics including means, medians, and minimum/maximum values were calculated for each analyte for each sample type.
2. Sample values were graphically plotted as histograms to visually assess the distribution of concentrations for each analyte (i.e., Figure D-1a/b). These charts indicated that while the values are logarithmically distributed, due to the bi-modal distributions, they are not log-normal (the log values are bi-modal rather than normally distributed).
3. The data values were log-transformed and transferred to ProUCL4.0 worksheets. ProUCL has a specific data format for recognizing non-detect values and several procedures available for evaluating non-detections including the "Regression on Ordered Statistics (ROS)" and Kaplan Meier (KM) methods. Non-detections were common in PCB analyses and Table D-2 presents the results comparing the results of the KM and ROS methods on the contaminant geomeans and medians. Non-detections are rare in metals analyses and did not affect geomean or median estimates.
4. Non-parametric UCLs were calculated for the log-transformed data values using ProUCL. UCLs calculated from log-transformed data represent the upper confidence limits of the geomeans (or medians) rather than UCLs of the arithmetic means. ProUCL uses a variety of procedures to calculate UCLs and identifies a recommended method based on the data distribution. The UCLs listed in Tables 2, 3, 4, and D-1 are based on the ProUCL recommended method for analytes with nondetects and multiple detection limits (Kaplan Meier). UCLs for medians were calculated from ranked data values using the procedures of Bland (2000; Table D-1) and Helsel (2010).

Sample Point	*Arsenic Conc (mg/L)*	*Rank*	*Percent of....*			
349	380	1	100.00%			
41	305	2	99.70%			
436	292	3	99.50%	count	COUNT(B2:B485)	
91	290	4	99.30%	std dev	SQRT(F4*0.5*(1-0.5))	
197	274	5	99.10%		F4*0.5+(1.96*F5)	F4-ROUNDUP(F6,0)
277	255	6	98.90%		F4*0.5-(1.96*F5)	F4-ROUNDDOWN(F7,0)
146	238	7	98.70%			
241	229	8	98.50%		median	17
169	222	9	98.30%		UCL median	15

121	219	10	98.00%		UCL median	18

Table D-1. Non-parametric procedure to calculate UCLs for median (from Bland, 2000).

Soil 0 to 18"								
	Arsenic ppm	*Cadmium ppm*	*Chromium ppm*	*Mercury ppm*	*Nickel ppm*	*Silver ppm*	*Lead ppm*	*Lead NW Area ppm*
Geomean	16.7	8.9	164.2	1.4	199.2	2.4	830.1	276
95th% UCL Geomean	18.20	10.30	186.90	1.58	227.01	2.71	963.04	341
Median	17	9	160	2	235	3	970	270
95th% UCL Median	18	11	190	2	290	3	1200	481
Minimum	1.30	0.16	6.30	0.02	2.90	0.06	7.90	8.90
Maximum	380	370	22,000	64	28,000	270	76,000	4,200
Number detections	473	468	476	475	474	454	479	109
Number samples	484	484	484	484	484	484	484	109

Soil 0 to 18"					
	PCB-1016 ppm	PCB-1248 ppm	PCB-1254 ppm	PCB-1260 ppm	PCB-1268 ppm
Geomean (KM)	0.044	0.188	2.780	1.581	0.026
95th% UCL Geomean (KM)	0.051	0.333	4.188	2.333	0.040
Median (ROS)	0.032	0.209	2.858	1.603	0.015
95th% UCL Median (ROS)	0.037	0.332	4.246	2.339	0.022
Minimum	0.036	0.014	0.032	0.016	0.001
Maximum	1.542	99.083	3499.452	2798.981	5.902
Number detections	31	240	534	538	12
Number samples	649	586	586	586	221

See text for explanation of Kaplan Meier (KM) and Regression on Ordered Statistics (ROS) methods.

Subsurface soil 18" to Water Table							
	Arsenic ppm	*Cadmium ppm*	*Chromium ppm*	*Mercury ppm*	*Nickel ppm*	*Silver ppm*	*Lead ppm*
Geomean	10.1	3.0	64.5	0.3	55.0	1.2	176.8
95th% UCL Geomean	12.97	4.76	87.10	0.53	79.60	1.78	275.89
Median	7.80	3.10	46.70	0.29	49.50	1.10	180.00
95th% UCL Median	NA	NA	NA	NA	NA	NA	NA
Minimum	1.10	0.04	4.70	0.0043	2.10	0.05	5.80
Maximum	323	170	31,000	28	17,000	180	22,000
No. detections	375	248	378	374	378	184	380

No. samples	376	313	378	376	378	281	380

Table D-2. Comparison of geomeans, medians and UCLs for soils.