Health Consultation

Soil Data Review for Properties near the

Former John T. Lewis and Brothers Site

Philadelphia, Philadelphia County, Pennsylvania

EPA Facility ID: PAN000306638

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

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

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

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Prepared By:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry (ATSDR)
Division of Community Health Investigations
Eastern Branch

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Acronyms

ALM – Adult Lead Methodology

ATSDR –Agency for Toxic Substances and Disease Registry

BLL –Blood Lead Level

BLPP –Blood Lead Poisoning Prevention Program

CDC – Centers for Disease Control and Prevention

CTE – Central Tendency Exposure

DHHS – the U.S. Department of Health and Human Services

HC– Health Consultation

ICP – Inductively Coupled Plasma

IEUBK – Integrated Exposure Uptake and Biokinetic Model

IQ – Intelligence Quotient

IVBA – In Vitro Bioaccesibility Assay

LBP – Lead-Based Paint

LOAEL – Lowest Observed Adverse Effect Level

MRL – Minimal Risk Level

NOAEL – No Observed Adverse Effect Level

PADEP – Pennsylvania Department of Environmental Protection

PADOH – Pennsylvania Department of Health

PDPH- Philadelphia Department of Public Health

PIR – Poverty Income Ratio

RFP – Request for Proposal

RME –Reasonable Maximum Exposure

RfD – Reference Dose

US EPA – U.S. Environmental Protection Agency

XRF– X-ray Fluorescence

Summary

Introduction

To support ongoing community education activities and address community concerns, the Agency for Toxic Substances and Disease Registry (ATSDR) prepared this health consultation (HC) document evaluating recent U.S. Environmental Protection Agency (U.S. EPA) soil sampling data for a few residential properties near the former John T. Lewis and Brothers site (the site), Philadelphia, PA. ATSDR evaluated exposure to lead and arsenic in residential soils for this densely populated area, located in the Kensington area of the City of Philadelphia.

From 1849 to 1996, lead and lead paint production operations were conducted at the John T. Lewis facility and contaminated the onsite and nearby offsite soils with lead and other metals. Currently, the area consists of residential homes with scattered industrial, commercial, and educational/service facilities. The community has expressed concerns about lead in the soils of residential areas, eating home-grown vegetables grown in potentially contaminated soils, and the cancer effects of lead exposure. The City of Philadelphia, the Pennsylvania Department of Environmental Protection (PADEP), U.S. EPA, the Pennsylvania Department of Health (PADOH), and ATSDR have conducted numerous environmental and public health investigations in the vicinity of the former John T. Lewis facility since the 1970s.

Although there has been a great deal of environmental sampling data collected for this area, much of it is more than 10 years old. The data used for this evaluation were soil samples collected from six residential properties as a part of the 2009 U.S. EPA site assessment and 2011 U.S. EPA removal assessment in the site area. U.S. EPA is planning to collect additional soil samples in the neighborhood in 2014. ATSDR could provide a review of that additional residential soil information when it is available.

Conclusion 1

Blood Lead:

- *Children 6 months to 7 years:* The blood lead exposure model (IEUBK) predicts that more than 75% of the children (age 6 months to 7 years) who regularly play in the yards that were sampled in the area could be exposed to lead in soil at levels high enough to raise their average blood lead levels (BLLs) above the U.S. Centers for Disease Control and Prevention (CDC)'s current childhood blood lead reference level of 5 µg/dL. There is also reason to believe that the soil levels are high throughout the area near the former John T. Lewis plant and could affect other children.
- *Pregnant Women:* The Adult Methodology Method (ALM) model also predicts that 37% of pregnant women living on those properties could be exposed to lead in soil at levels high enough to raise their developing fetuses' blood lead levels above 5 µg/dL.

- The current predicted average blood lead levels using the 2009 and 2011 U.S. EPA residential soil data from a few residential properties in the site area may be high enough to harm the health of children and the unborn children of pregnant women. Chronic exposure to lead resulting in blood lead levels below 10 µg/dL has shown sufficient evidence of neurological, behavioral, and developmental effects in young children.
- Review of blood lead exposure risk factors for census tract 160 show that population is at increased risk for lead exposure.
- Blood lead screenings, studies, and surveillance conducted in the site area between 1987 and 2010 have been inconclusive as to whether children in the area had higher blood lead levels than those in surrounding areas. Average blood lead levels for children in some of the studies were higher than 5 µg/dL.
- Because this area is subject to seasonal variations in lead exposure conditions, ATSDR predicts higher seasonal variations in blood lead levels in the warmer/dryer months, particularly in the school age group.

Basis for Conclusion

ATSDR used U.S. EPA's Integrated Exposure Uptake and Biokinetic (IEUBK) model to predict blood lead levels for children age 6 months to 7 years and the U.S. EPA Adult Lead Methodology (ALM) to estimate the blood lead level in pregnant women and their fetuses. Using soil data (the 2009 and 2011 site data) from yards in the neighborhood and default values in U.S. EPA's IEUBK model and ALM, the predicted average blood lead levels exceeded CDC's current reference level of 5 µg/dL for children and the unborn children of pregnant women.

There is the potential that soil lead levels are high throughout the area near the former John T. Lewis facility. There is not enough information currently available to discern if soil lead levels in the site area are significantly different from soil lead levels throughout the City of Philadelphia generally.

In addition, ATSDR evaluated lead exposure risk factors for this community. In Census Tract 160, ATSDR determined that 90% of the population lives in housing built before 1950 when paint had the highest levels of lead. Also, this housing area is in the urban area of the northeastern U.S. where 34% rent their homes and 20% have a Poverty Income Ratio (PIR) less than 1.24. Those factors put this population at an increased risk for lead exposure.

Although past operations at the former John T. Lewis plant may have resulted in high levels of lead in the soils in the area, there are other important sources of lead exposure in this community, such as deteriorating lead paint in older housing and deposition from historic leaded gasoline emissions.

Conclusion 2

Eating Home-Grown Vegetables: A limited number of home-grown vegetables were sampled; the lead levels were low and thought to be mainly associated with loose garden soil and not uptake into the plant. ATSDR concludes that levels of lead found in the tested vegetables are not expected to harm people's health if home grown vegetables are properly cleaned before consumption. It is not known if these limited vegetable data are representative of lead levels in home-grown vegetables throughout the neighborhood.

Basis for Conclusion

Six vegetables samples of lettuce and mustard greens were collected from one yard. These vegetables had lead concentrations ranging from 1.67 to 4.49 parts per million (ppm). In general, most of the lead found on leafy vegetables is from surface deposition of dust and soil. Washing and peeling fruits and vegetables, especially root crops, can reduce lead exposure.

Conclusion 3

Cancer and Soil Lead Exposure: Because of the limits of science from human epidemiologic studies, it is not possible to estimate the cancer risk in humans from soil lead exposure.

Basis for Conclusion

There are no definitive studies showing that lead causes cancer in humans. Occupational epidemiology studies of lead exposure and health effects were limited by poor exposure assessment methods and did not control for other exposures that might cause cancer.

Conclusion 4

Arsenic and Soil Exposure: It is unlikely that adults or children at any of the tested properties would experience cancer or non-cancerous harmful effects from exposure to arsenic in soil. It is not known if these data are representative of arsenic levels throughout the neighborhood.

Basis for Conclusion

ATSDR used the average surface soil arsenic concentration of 29.1 ppm to estimate site-specific exposure. The estimated doses for adults and children at any of the tested properties were less than 0.0003 mg/kg/day and well below doses found in studies showing harmful effects in humans. For cancer effects, the estimate indicated that for every 1,000,000 persons exposed to arsenic in soil on a daily basis for 78 years, 3 additional cases of cancers might be expected. This is a very low estimated increased risk of cancer predicted for residents who were exposed arsenic in soil in this area.

Next Steps

Reduce exposure. Since there is no proven safe level of lead in the blood, ATSDR and CDC recommend reducing lead exposure wherever possible. Practical ways to reduce exposure are summarized below and further detailed in the recommendation section.

ATSDR recommends that EPA and/or the state and local government take measures to reduce the potential for future human exposures and continue efforts to characterize the extent of the contamination at the site with additional sampling and other investigation activities.

ATSDR understands that U.S. EPA plans to sample/screen soil from the community and similar residential/industrial neighborhoods to estimate the relative bioavailability of lead in soil. This would help gain further insight on the relative absorption risk the soil poses and extent as well as on urban background lead levels in the City of Philadelphia.

ATSDR recommends that parents or guardians in the site area reduce their own and their children's exposure to lead in soil and from other sources such as deteriorating lead paint. Practical ways to reduce exposure are further detailed in this health consultation.

Test blood for lead. The City of Philadelphia recommends that all children in Philadelphia be screened for lead at ages 12 and 24 months; or if there is no proof of prior screening, then at 36-72 months. U.S. EPA is considering plans for offering additional blood lead screening options for children and pregnant women residing within two census tracts surrounding the former John T. Lewis facility. ATSDR is considering offering target screening to residents as well.

Reduce lead absorption. To help prevent lead absorption from the stomach, eat a nutritious diet including several small meals per day (appropriate for age and growth) rich in iron, calcium, vitamins C and D and zinc such as dairy products and green vegetables. This is particularly important for children and pregnant women.

Provide health education to community and health care provides. U.S. EPA and ATSDR staff will work with the community and health providers near the former John T. Lewis facility to recruit residents for yard soil lead screening/sampling, provide health education and outreach, advertise and promote blood lead screening events, issue fact sheets and generally be accessible to community residents. See more details in the recommendation and public health action plan sections of this health consultation.

Perform periodic review of clean up effectiveness. If soil remediation takes place, ATSDR recommends that U.S. EPA or the appropriate agency periodically evaluate the cleanup effectiveness as appropriate (e.g., Does the soil cover remain intact, is the erosion control working, are the amendments functioning).

Review additional data. ATSDR will review additional data as needed.

For More Information

For further information about this public health assessment, please call ATSDR at 1-800-CDC-INFO and ask for information about the "John T. Lewis Site." If you have concerns about your health, you should contact your health care provider.

Purpose and Statement of Issues

To support the community education activities and address community concerns, ATSDR evaluated exposure to lead and arsenic in residential soils for this densely populated Kensington area of Philadelphia. This area was the site of a former lead powder and leaded paint production facility that released lead-containing wastes into the surrounding community.

ATSDR conducted a number of visits to this site and the nearby community since 2011, reviewed information provided by U.S. EPA, developed exposure scenarios, and is conducting ongoing health education and community outreach in the site area. ATSDR applied the site-specific parameters in predictive blood lead models for children and pregnant women, and evaluated exposure to arsenic in soil. Although the data used for the soil lead evaluation were limited to soil samples from six residential properties, it is unknown if but possible that these soil levels are representative of soil in the area near the former John T. Lewis facility and/or the City of Philadelphia generally. U.S. EPA plans to collect more samples in neighborhood yards in the site area, and ATSDR could provide a review of that additional sampling information when it is available.

Site Description

The former John T. Lewis facility occupied several land parcels on what is now the 2500 block of Aramingo Avenue in the Kensington section of Philadelphia, Pennsylvania (zip code 19125). The Kensington area of Philadelphia was one of the most heavily industrialized areas of the City of Philadelphia for more than 150 years. Row homes co-existed directly adjacent to the industrial factories throughout this time period. Previous industries in the area included leather tanneries, knitting mills and secondary lead smelters.

The original facility occupied approximately 8.5 acres and was demolished and redeveloped during the late 1990s through the mid-2000s. Currently, the area consists of residential homes with scattered industrial, commercial, and service facilities (see Figures 1-4). The former facility is now a commercial shopping center. The site is listed in the U.S. EPA Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database with a CERCLIS ID number of PAN000306638 [Tetra Tech 2009].

The former facility used numerous kilns, oxidizing furnaces, and corroding beds to make products containing lead. Over the years, plant emissions, equipment malfunctions, and fires at the facility released lead-containing wastes into the surrounding community. The former John T. Lewis facility and other nearby industrial facilities were the subject of various environmental and public health investigations in the 1990s. In the City of Philadelphia, the prevailing wind direction is from the south/southwest in the spring, summer and fall and from the northwest in winter. Given the changing wind patterns and the length of time the plant was in operation, plant emissions could have deposited in any direction in the neighborhood near the facility. U.S. EPA is currently assessing the dimensions of the site area; current estimates approximate the site area to include the former John T. Lewis facility and the area denoted by higher historic air emissions in Figure 3.

Demographics

According to the 2010 U.S. Census data, the total population living in census tract 160 is about 7,000 people. The majority of the population is White (90%) with small percentages of other origins such as Hispanic or Latino origin (6%), black (2.8%), and Asian and other Pacific Island (2.6 %). The 2010 U.S. Census demographics statistics also show that the population living in the census tract includes the following potentially sensitive groups: approximately 7.8 % children aged 6 and younger, 25% women of childbearing age, and 9.6% adults aged 65 and older. The total housing units in the census tract is about 3,200 [US 2010 census].

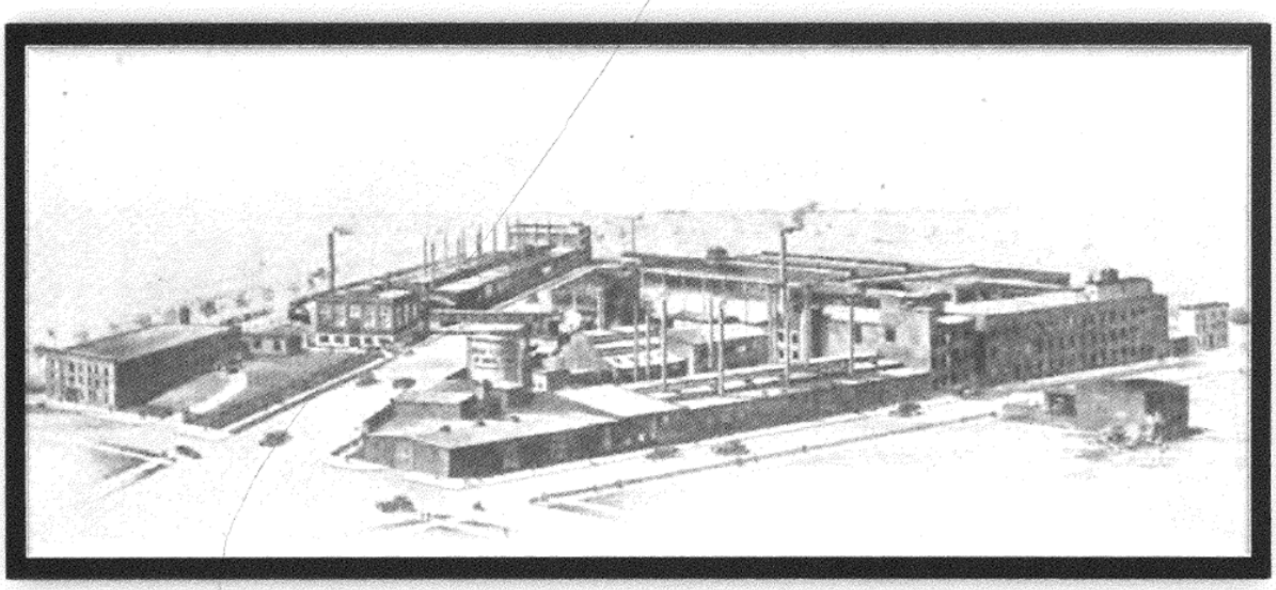
Background

The former John T. Lewis plant was a business operating from 1849 to 1996 under different names including Mordecai Lewis & Company, John T. Lewis Brothers Company, N.L. Industries, National Lead Company, Associated Lead Inc. and Anzon Inc.

The facility produced white lead, red lead, litharge, sugar of lead, zinc white, linseed oil and "paints and colors of all kinds" as indicated in its 1867 marketing advertisement. Over the years, the facility also manufactured lead oxides, linseed oil, acetic acid, lead stabilizers for use in cable wire and plastics, zinc stearate, lead stearate, lead phthalate, lead phosphate, lead pipe, lead powders and sheet lead. For many years, the "Dutch Boy" brand of paints was a principal product [TerraGraphics 1993].

Air Emissions

Survey plates prepared in the late 1800s showed numerous kilns, oxidizing furnaces, and corroding beds. Although the specific type of emissions from each stack are unknown, a 1922 depiction of the facility shows what appears to be more than twenty emissions stacks rising above the plant.



There appears to be no sampling data for the neighborhood near the facility before 1970. Sampling data from monitors on the facility are unavailable prior to the 1960s. In 1971, the total lead emissions released was reported to be 70,220 pounds. From 1981 to 1987, the facility reportedly emitted annual lead amounts ranging from 23,600 to 29,000 pounds except for 1982 when the lead emission amount was 14,600 pounds. By 1987, the annual emission release was down to 521 pounds/year.

Historic and recent air modeling runs of facility lead emissions predict the immediate area to the northeast and east of the former facility may have been impacted the most. This is partly due to the prevailing wind direction which is from the southwest in spring, summer and fall [USEPA 2013, TerraGraphics 1993; see Figure 3].

Relatively Recent Air Releases and Cleanup

In August 1988, a fire occurred at the facility emitting an estimated 50 pounds of lead-containing material into the air. U.S. EPA immediately responded and concluded that dust had settled on streets, residential properties, cars and buildings along several blocks north of the facility. Residents living within the affected street blocks were evacuated and a three-day cleanup of the area took place including vacuuming the affected streets, cleaning the exterior and interior of evacuated homes, removing fire debris from the affected sidewalk and street, cutting grass on a nearby abandoned lot, washing automobiles along the affected block, and cleaning affected swimming pools and replacing affected pool filters.

In March 1991, an accidental release of approximately 50 pounds of lead monoxide occurred from a storage hopper at the facility and was carried by air and deposited on cars, streets and buildings in the area. The facility hired a cleanup contractor to vacuum the affected streets and sidewalks, wash cars, clean window sills, vacuum affected homes, clean a nearby playground and take clothing from residents who believed they were exposed.

Previous Sampling

Since the early 1970s, numerous soil sampling events took place in the vicinity of the former John T. Lewis facility to evaluate the effects of facility emissions. Average lead levels from those sampling events ranged from 800 to 2,800 parts per million (ppm). A summary of those events is provided in Appendix A.

Information from some of the sampling events mentioned above were not used for this evaluation for one or more of the following reasons: (1) the data is not representative of current site conditions/exposures; (2) the sampling/modeling descriptions were incomplete; and /or (3) the Quality Assurance (QA)/Quality Control (QC) procedures were unknown. ATSDR focused this evaluation on soil samples collected from six residential properties that were part of the 2009 U.S. EPA Site Assessment and the 2011 U.S. EPA Removal Assessment in the site area.

Methods - Lead

Data Used in Lead Exposure Model

In June 2009, the U.S. EPA contractor, Tetra Tech Inc, collected 17 discrete soil samples from 5 properties on the upwind side of the former J. T Lewis facility. Soil samples were collected from 0 to 6 inches below the ground surface. Soil samples were analyzed for lead and other metals using a portable x-ray fluorescence (XRF) instrument [Tetra Tech 2009, USEPA 1994a]. Table 1 is a summary of the 2009 U.S. EPA Site Assessment results.

Table 1. 2009 U.S. EPA Site Assessment Sampling Results Summary for Lead

Location	*Results (ppm)*
Yard 1	1,910 – 2,345
Yard 2	345 – 2,364
Yard 3	1,777 – 2,939
Yard 4	1,599 – 2,774

Location	Results (ppm)
Yard 6	345 - 1,552

Note: ppm: parts per million

In May 2011, U.S. EPA conducted a site assessment and collected over 40 soil samples from three properties including two properties that were screened in 2009. Details of the sampling are listed in Appendix B and sampling information is summarized below:

Table 2. 2011 U.S. EPA Site Assessment Sampling Results Summary for Lead

Location	Results (ppm)
Yard 1	1,618 – 2,117
Yard 4	988 – 2,387
Yard 5	507 - 1,157

Note: ppm: parts per million

The average soil lead level for the 6 yards ranged from 743 to 2,509 ppm.

Although the data for soil near the former John T. Lewis facility show high levels of lead, data from the many previous sampling events shows that there are high levels of lead even in areas thought to be unaffected by emissions from the former John T. Lewis plant.

Evaluation Approach

Neither ATSDR nor U.S. EPA has developed a minimal risk level (MRL) or reference dose (RfD) for human exposure to lead. Therefore, the usual approach of estimating a human exposure dose to an environmental contaminant and then comparing this dose to a health based comparison value (such as an MRL or RfD) cannot be used [ATSDR 2005]. Instead, human exposure to lead is evaluated by using a biological model that predicts a blood lead concentration resulting from exposure to environmental lead contamination. There are different biological models to estimate lead exposure of children and adults.

Children 6 months to 7 years

The most widely used model to estimate lead exposure of children is the U.S. EPA's Integrated Exposure Uptake and Biokinetic (IEUBK) model. The IEUBK model is designed to integrate lead exposure from soil with lead exposures from other sources, such as air, water, dust, diet, and paint with pharmacokinetic modeling to predict blood lead concentrations in children 6 months to 7 years of age. The model estimates a distribution of blood lead concentrations centered on the geometric mean blood lead concentration [USEPA 2002]

Pregnant Women

The Adult Lead Methodology (ALM) can be used to estimate blood lead levels (BLLs) in the developing fetus. The method is often used for women of child-bearing age to estimate blood lead levels in the developing fetus because the developing fetus is likely to be more sensitive to lead than adult women.

More information about U.S. EPA's adult lead methodology can be found at this U.S. EPA web address: http://www.epa.gov/superfund/lead/products.htm [USEPA 2009].

Model Assumptions

Estimating BLLs from Exposure to Soil, Indoor Dust, Drinking Water, and Foods

We assessed the possible public health implications of lead exposure for this community by:

1. Determining probable exposure situations.
2. Using U.S. EPA's IEUBK Model for Lead in Children. We considered the following scenarios for children to be exposed to lead in the community:
    - Young children can be exposed to lead in soil by hand-to-mouth activities especially when playing in areas with bare soil.
3. Using the EPA ALM to estimate BLLs in pregnant women. We considered the following scenarios where pregnant women could be exposed to lead:
    - Pregnant women in the community can be exposed to lead in soil by incidental ingestion of contaminated soil by conducting daily activities such as gardening.

U.S. EPA's IEUBK Model

The IEUBK model is designed to integrate exposure from lead in air, water, soil, dust, diet, paint, and other sources with pharmacokinetic modeling to predict blood lead concentrations in children 6 months to 7 years of age. The model estimates a distribution of blood lead concentrations centered on the geometric mean blood lead concentration [USEPA 2002].

A detailed description of the model and supporting documentation is available on the U.S. EPA's web site (http://www.epa.gov/superfund/lead/products.htm#guid)

Model Results

The estimated blood lead concentrations are influenced by numerous input parameters in the model. Site-specific estimates of these parameters can strongly influence the blood lead predictions. The average soil lead level for the 6 yards ranged from 743 to 2,509 ppm. To be conservative, ATSDR used the lowest average soil lead concentration as site-specific input parameter.

Children 6 months to 7 years

Using the lowest average soil lead concentration of 743 ppm detected at the samples area, the IEUBK model predicts that more than75% of the children under 7 who regularly play in the yards that were sampled in the area could be exposed to lead in soil at levels high enough to raise their BLLs above CDC's reference value of 5 µg/dL.

Pregnant women

Using the lowest average soil lead concentration of 743 ppm detected at the samples area, the ALM predicts that of the pregnant women who are exposed to contaminated soil daily in their yards, 37 % would have fetal BLLs greater than or equal to 5 µg/dL with a 95th percentile fetal BLL of 10.8 µg/dL.

Discussion–Lead

The blood lead exposure models predict that a very high percentage of young children and fetuses of pregnant women exposed to contaminated soil could have blood lead levels above the current CDC reference level of 5 µg/dL. Many factors can influence lead exposure and uptake, and therefore the estimates of blood lead levels. Those include the lead bioavailability and individual nutritional status, model limitations, lead exposure risk factors, seasonality, exposure age, and multiple sources of lead exposure.

Bioavailability

There are absolute or relative (comparative) bioavailabilities. Absolute bioavailability, for example, is the amount of substance entering the blood via a particular biological pathway relative to the absolute amount that has been ingested. Relative bioavailability of lead is indexed by comparing the bioavailability of one chemical species or form of lead with that of another form of lead [USEPA 1994].

Certain areas of the country have naturally occurring lead soil sources that are more bioavailable than others. Table 3 shows the relative bioavailability of some of lead's mineral phases.

Table 3. Ranking of Relative Bioavailability of Lead Mineral Phases in Soil[a]

Low bioavailability	Medium bioavailability	High bioavailability
(RBA<0.25)	(RBA=0.25–0.75)	(RBA>0.75)
Angelsite	Lead oxide	Cerussite
Fe(M) oxide	Lead phosphate	Mn(M) oxide
Fe(M) sulfate		
Galena		
Pb(M) oxide		

a- Estimates are based on studies of immature swine. M = metal;

RBA = relative bioavailability (compared to lead acetate) (ATSDR 2007)

(Note: Bioavailability input parameter in the IEUBK model is an absolute value, but it may be experimentally determined by relative means, provided that the absolute bioavailability of the "standardized reference material" is known.)

The default for bioavailability of soil/dust in the IEUBK model is 30%. For the IEUBK model, soluble lead in water and food is estimated to have 50% absolute bioavailability. The model presumes that the relative bioavailability of lead in soil is 60%, thus producing an absolute bioavailability for soil lead of 30% (*i.e.,* 60% x 50% = 30%) [USEPA 1999]. However lead absorption from soil decreases with time and increasing pH [ATSDR 1992]. In fact, less than 10% of lead was bioavailable in soil with a pH >4 [ATSDR 1992].

Bioavailability for this Evaluation: For the exposures in this evaluation, we assumed a bioavailability of 30% because it was not measured at this site. This assumption can have a large impact – over- or underestimating – the predicted blood lead levels.

Nutritional Status and Other Considerations

Lead uptake, especially from the gastrointestinal (GI) tract, is influenced by nutrients such as calcium, iron, phosphate, vitamin D, fats, etc., as they occur in meals or with intermittent eating. Lead uptake generally increases as dietary levels of these nutrients decrease. In addition, uptake is a function of developmental stage (age), ingested/inhaled dose, the chemical species and the particle size of the lead-containing media.

Review of Blood Lead Data

In April 1987, in response to community concerns about air emissions and operating practices at the John T. Lewis plant, the Philadelphia Department of Public Health (PDPH) conducted a one day capillary blood screening. Participation was voluntary. It is not known what geographical boundaries were used for participation. Blood specimens were obtained from 119 children age 5 and younger and 27 had blood lead levels greater than 25 µg/dL[1].

In September 1988, the PDPH conducted a venous blood lead screening of 116 children ages 0 -5 years; 72 were identified as living in an area PDPH determined to be potentially affected by lead emissions. The affected area appears to have included all of census tracts 159 and 160 (see Figure 5). Sixteen (22%) of the 72 children and 24 (21%) of the 116 children reportedly had blood lead levels of 15 µg/dL or higher. ATSDR reviewed the data and did not identify a trend between blood lead levels and distance from the facility. The results were similar to national childhood blood lead values at that time. However, the low participation rate (22%) raised bias concerns leading to questions about the reliability of the screening conclusions.

In September 1989, the City of Philadelphia and the University of Pennsylvania with funding support by ATSDR conducted a follow-up blood lead study. Of 2,658 people selected from the Lower Port Richmond neighborhood, 736 (27.7%) participated despite extensive outreach and recruitment. The study was designed to compare children's BLLs with two similar Philadelphia neighborhoods: Manayunk and Upper Port Richmond. The report entitled *Philadelphia Neighborhood Lead Study,* did not identify a significant difference in average blood lead levels of children 0–71 months living in Lower Port Richmond (9.7 µg/dL) and those living in the comparison neighborhoods (9.5 µg/dL). In contrast, 10.6% of the Lower Port Richmond children had blood lead levels above 15 µg/dL while only 5.2% of the comparison children did. Again, primarily because of a low turnout in participation, the study authors concluded that although the Lower Port Richmond and comparison neighborhoods showed much similarity, comparisons between them could not be made with certainty.

The City of Philadelphia's Childhood Blood Lead Poisoning Prevention Program recently provided summary blood lead data to U.S. EPA for children residing in the 19125 area zip code area for the period of January 2005 to June 2010. That zip code contains all or parts of seven census tracts. A total of 426 blood lead values were provided for children of unspecified age in census tracts 159 and 160; several results were from the same child on different dates. The results showed 33 values above 10 µg/dL and 69 values greater than or equal to 5 µg/dL. No trend was identified between elevated values and distance from the facility.

[1] At the time, the CDC recommended that children with blood lead levels above 15µg/dL should see a physician for follow-up. In 1991, the value was lowered to 10 ug/dl and referred to as a "level of concern" warranting education and intervention. In May 2012, CDC officially lowered the level to 5µg/dL and identified this concentration as a "reference value."

Lead Exposure Risk Factors

Multiple factors (demographic and socioeconomic status, living in older houses, and contact with contaminated air or soil) are associated with lead exposure. Specifically, those factors include the following:

- Children less than 6 years of age [Rowden et al. 2011]
- Women of child bearing age (Between 15 and 44) [Shannon et al. 2005]
- Blacks and Hispanics [Bernard et al. 2003, CDC 2013, Jones et al. 2009]
- People who live in homes built before 1978 [Bernard et al. 2003; CDC 2013]
- People who rent [Schleifstein 2011]
- People born in Mexico [Dixon et al. 2009; USEPA 2013]
- Those with a Poverty Income Ratio (PIR) less than 1.24 [CDC 2013, Jones et al. 2009]
- Living in an area with a population density that is urban [Mielke et al. 2010]
- Living in specific regions of the U.S. (i.e., Northeast >* Midwest> South> West) [Lee et al. 2005]

*> = greater than

We evaluated those factors for this area (2010 census data from Census Tract 160[2]) and determined that 90% of the population lives in houses built before 1950 when paint had the highest levels of lead. Also, this housing area is in the urban area of the northeastern U.S. where 34% rent their home and 20% have a PIR less than 1.24. Therefore, this population has an increased risk for lead exposure.

Seasonal Variations in Exposure and Blood Lead Levels

The correlation between lead-contaminated soil and blood lead can be influenced by seasonal variations in exposure conditions [Laidlaw et al, 2005]. For example, the ground may be covered with snow part of the year, or seasonally wet making the lead more inaccessible and less mobile. Because this area is subject to seasonal variations in lead exposure conditions, ATSDR predicts higher seasonal variations in blood lead levels in the dryer months, particularly in the school age group.

Others Sources of Lead

[2] We did not evaluate Census Tract 159 because in the 2010 Census, Tract 159 combined with 181 and 182 to become a large tract with Census Tract number 378.

Lead can be found in many products and locations. Lead-based paint and contaminated dust are the most widespread and dangerous high-dose source of lead exposure for young children [CDC 2009].

Lead exposure can occur from one or more of the following:

Indoor

Paint – Ingesting paint chips primarily found in homes built prior to 1978 and on older toys and furniture

Dust – Ingesting dust (from hand-to-mouth activity) found in older homes (built prior to 1978) or tracked in from contaminated soil

Water – Drinking water containing lead that comes from corrosion of older fixtures, from the solder that connects pipes, or from wells where lead contamination has affected the groundwater

Tableware – Eating foods from imported, old, handmade, or poorly glazed ceramic dishes and pottery that contains lead. Lead may also be found in leaded crystal, pewter, and brass dishware

Candy – Eating consumer candies imported from Mexico. Certain candy ingredients such as chili powder and tamarind may be a source of lead exposure. Candy wrappers have also been shown to contain some lead

Toy Jewelry – Swallowing or putting in the mouth toy jewelry that contains lead. This inexpensive children's jewelry is generally sold in vending machines and large volume discount stores across the country

Traditional (folk) Medicines –Ingesting some traditional (folk) medicines used by India, Middle Eastern, West Asian, and Hispanic cultures. Lead and other heavy metals are put into certain folk medicines on purpose because these metals are thought to be useful in treating some ailments. Sometimes lead accidentally gets into the folk medicine during grinding, coloring, or other methods of preparation

Outdoor

Outdoor Air – Breathing lead particles in outdoor air that comes from the residues of leaded gasoline or industrial operations

Soil – Ingesting dirt contaminated with lead that comes from the residues of leaded gasoline, industrial operations, or lead-based paint

Other

Hobbies – Ingesting lead from hobbies using lead such as welding, auto or boat repair, the making of ceramics, stained glass, bullets, and fishing weights. Other hobbies that might involve lead include furniture refinishing, home remodeling, painting and target shooting at firing ranges

Workplace – Ingesting lead found at the workplace. Jobs with the potential for lead exposure include building demolition, painting, remodeling/renovation, construction, battery recycling, radiator repair, and bridge construction. People who work in a lead environment may bring lead dust into their car or home on their clothes and bodies exposing family members

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Public Health Implications – Lead

Lead

Lead is a naturally occurring bluish-gray metal found in the earth's crust and it has many different uses. It is used in the production of batteries, ammunition, metal products (solder and pipes), and devices to shield X-rays. Because of health concerns, lead from paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years. The use of lead as an additive to gasoline was banned in 1996 in the United States. Today, lead can be found in all parts of our environment because of human activities including burning fossil fuels, mining, manufacturing, and past uses [ATSDR 2007a].

Lead can affect almost every organ and system in the body, although the main target for lead toxicity is the nervous system. In general, the level of lead in a person's blood gives a good indication of recent exposure to lead and also correlates well with adverse health effects [ATSDR 2007a]

Blood Lead Levels and Health Effects

- *Shift of Focus from Exposure to Prevention* -In May 2012, CDC updated its recommendations on children's blood lead levels. By shifting the focus to primary prevention of lead exposure, CDC wants to reduce or eliminate dangerous lead sources in children's environments <u>before</u> they are exposed.

- *Blood Lead Reference Level now 5 µg/dL* - Until recently, children were identified as having a blood lead level of concern if the test result was 10 µg/dL or more of lead in blood. CDC recommends a reference level of 5 µg/dL to identify children as having lead exposures. This new level is based on the U.S. population of children ages 1 to 5 years who are in the highest 2.5% of children when tested for lead in their blood [CDC 2012].

- *No Change in Blood Lead Levels Requiring Medical Treatment* - What has not changed is the recommendation for when to use medical treatment for children. Experts recommend chelation therapy when a child is found with a test result of greater than or equal to 45 µg/dL [CDC 2012]. (See Appendix D for more information on medical treatment guidance)

- *Health Effects in Children With Blood Lead Levels less than 10 µg/dL* - Chronic exposure to lead resulting in blood lead levels below 10 µg/dL has shown sufficient evidence of neurological, behavioral, and developmental effects in young children. Specifically, lead causes or is associated with the following [CDC 2012a; CDC 2012b; CDC 2012c]:
    - decreases in intelligence quotient (IQ);
    - attention-related behaviors problems;
    - deficits in reaction time;
    - problems with visual-motor integration and fine motor skills;
    - withdrawn behavior;
    - lack of concentration; issues with sociability;
    - decreased height; and
    - delays in puberty, such as breast and pubic hair development and delays in the first menstrual cycle.
- *Health Effects in Children With Blood Lead Levels less than 5 µg/dL* - In children, there is *sufficient* evidence that blood lead levels less than 5 µg/dL are associated with increased diagnosis of

attention-related behavioral problems, greater incidence of problem behaviors, and decreased cognitive performance as indicated by (1) lower academic achievement, (2) decreased intelligence quotient (IQ), and (3) reductions in specific cognitive measures [NTP 2012].

- *Health Effects of Lead on Unborn Babies*: Lead crosses the placenta; consequently it can pass from a mother to her unborn baby. Follow-up testing, increased patient education, and environmental, nutritional and behavioral interventions are indicated for all pregnant women with blood lead levels (BLL) greater than or equal to 5 µg/dL to prevent undue exposure to the fetus and newborn [CDC 2010] Too much lead in a pregnant women's body can:

    - Put her at risk for miscarriage;
    - Cause the baby to be born too early or too small;
    - Hurt the baby's brain, kidneys, and nervous system; and
    - Cause the child to have learning or behavior problems [CDC 2010].

- *Blood Test* - Children can be given a blood test to measure the level of lead in their blood.

    Since there is no proven safe level of lead in the blood, ATSDR and CDC recommend reducing lead exposure wherever possible. Practical ways on how to reduce lead exposure are provided in Appendix D.

Methods – Arsenic

At the 2009 and 2011U.S. EPA evaluations at this site, arsenic was the other metal that was detected above its comparison values at the tested properties. We don't know whether detected arsenic was naturally occurring or site related. ATSDR cannot determine if the sampling results from the 3 yards were representative for the area. Therefore, the following discussion only applies to the tested properties.

Data Used

Three properties were tested for arsenic with XRF and ICP methods. When high concentrations of lead were present in the samples, the accuracy of arsenic measurement was interfered by lead using XRF method [Olympus Corporation 2013]. Therefore ATSDR used laboratory results for this evaluation because the XRF results were not in close agreement with the laboratory results. Currently, no children live on any of the properties sampled. Table 2 is a summary of the arsenic analytical results.

Table 4. Summary of Arsenic Soil Samples (ICP method results)

Property	***Concentration Range (ppm)***	***Number of samples***	***Concentration Average***
Yard 1	26.7 - 35.7	6	29.1
Yard 4	6.9	1	NA*
Yard 5	10.7 - 41.3	6	21.9

Notes:

ICP: inductive coupled plasma

ppm: parts per million

* Not Applicable (only one ICP sample for this yard. However, there were 6 XRF samples with an average concentration of 32 ppm.)

Results

ATSDR used the average surface soil arsenic concentration of 29.1 mg/kg to estimate site-specific exposure. ATSDR derived exposure doses for residents exposed daily to arsenic in soil. See Appendix C for dose calculation. Table 5 presents the dose calculation results.

Table 5. Summary of Arsenic Chronic Exposure Dose Calculations

Age Groups	*RME Doses mg/kg/day*	*CTE Doses mg/kg/day*	*MRL mg/kg/day*	*Exceeding the MRLs(Yes/No)*
Child 0.5 to < 1 year	0.000269	0.000162	0.0003	No
Child 1 to < 2 year	0.000435	0.000217	0.0003	Yes*
Child 2 to < 6 year	0.000285	0.000142	0.0003	No
Child 6 to < 11 year	0.000156	0.000078	0.0003	No
Child 11 to <16 year	0.000087	0.000044	0.0003	No
Child 16 to <21 year	0.000069	0.000035	0.0003	No
Adults ≥ 21 year	0.000031	0.000015	0.0003	No
Special Groups				No
Child (pica) 1 < 2 year (EF = 3 days/week	NA	0.004658	0.005	No
Child (pica) 2 < 6 year (EF = 3 days/week)	NA	0.003052	0.005	No
Gardeners ≥ 21 year	NA	0.000031	0.005	No

Note:

CTE: central tendency exposure. Refers to persons who have average or typical exposures.

RME: reasonable maximum exposure. Refers to people who are at the high end of the exposure distribution (approximately the 95th percentile). The RME scenario is intended to assess exposures that are higher than average, but are still within a realistic range of exposures.

Pica: the recurrent ingestion of unusually high amounts of soil (i.e., on the order of 1,000-5,000 mg per day). Groups at risk of soil-pica include children aged 6 years and younger and developmentally delayed individuals.

EF: exposure factor

kg: kilogram

mg: milligram

MRL: Minimal Risk Level

NA: not applicable

Currently, no children live on any of the properties sampled.

* : the RME group dose is slightly higher than the MRL but well below the effect level. Therefore, no risk of harmful effects is expected.

Discussion - Arsenic

Public Health Implications – Arsenic

Arsenic is a naturally occurring element widely distributed in the earth's crust in forms of inorganic and organic arsenic compounds. The mean of arsenic in soil and other surficial materials in the U.S. is 7.2 ppm. Inorganic arsenic compounds are mainly used to preserve wood. In the past, arsenic was also used for pigment in paint. Organic arsenic compounds are primarily used as pesticides. Ingesting low levels (e.g., 0.3-30 parts per million in water) of inorganic arsenic for a long time can cause discoloration of the skin and the appearance of small corns or warts [ATSDR 2007b].

Arsenic Non-Cancer Health Effects

ATSDR has a provisional acute oral MRL of 0.005 mg/kg/day and a chronic oral MRL of 0.0003 mg/kg/day for arsenic. The MRL is an exposure level below which non-cancerous harmful effects are unlikely. The acute MRL is based on several transient (i.e., temporary) effects including nausea, vomiting, and diarrhea. When an estimated acute dose of arsenic is below 0.005 mg/kg/day, non-cancerous harmful effects are unlikely. It should be noted that:

1) The acute MRL is 10 times below the levels that are known to cause harmful effects in humans;
2) The acute MRL is based on people being exposed to arsenic dissolved in water instead of arsenic in soil – a fact that might influence how much arsenic can be absorbed once ingested; and
3) The MRL applies to non-cancerous effects only and is not used to determine whether people could develop cancer [ATSDR 2007b].

The chronic oral MRL (0.0003 mg/kg/day) is based on a study in which a large number of farmers in Taiwan were exposed to high levels of arsenic in well water. A clear dose-response relationship was observed for characteristic skin lesions. A group consisting of 17,000 farmers was exposed to 0.0008 mg/kg/day and did not experience adverse health effects. This is considered to be a no observed adverse effect level (NOAEL). Hyperpigmentation and keratosis of the skin were reported in farmers exposed to 0.014 mg/kg/day (less serious lowest observed adverse effect level - LOAEL). Those exposed to 0.038–0.065 mg/kg/day also experienced an increased incidence of dermal lesions. The MRL is supported by a number of well conducted epidemiological studies that identified reliable NOAELs and LOAELs for dermal effects. Collectively, these studies indicate that the threshold dose for non-cancerous dermal effects (e.g., hyperpigmentation and hyperkeratosis) is approximately 0.002 mg/kg/day [ATSDR 2007b].

Based on this conservative exposure dose estimate, ATSDR considers it unlikely that adults and children at any of the tested properties would experience non-cancerous harmful effects from exposure to arsenic in soil.

Arsenic Cancer Health Effects

For cancer effects, the U.S. Department of Health and Human Services (DHHS), the International Agency for Research on Cancer, and U.S. EPA have all determined that arsenic is carcinogenic to humans. This is based on evidence from many studies of people who were exposed to arsenic-contaminated drinking water, arsenical medications, or arsenic-contaminated air in the workplace for exposure durations ranging from a few years to an entire lifetime [ATSDR 2007b]. U.S. EPA established an oral cancer slope factor of 1.5 $(mg/kg/day)^{-1}$ for arsenic. Using this value, and assuming children and adults are exposed to soil containing 29.1 ppm arsenic daily, we calculated an estimated cancer risk of:

3 in 100,000 for children who live at a property for less than 21 years, and

3 in 1,000,000 for adults who live at a property for 58 years.

Stated another way, for every 1,000,000 persons exposed to arsenic in soil at 29.1 ppm on a daily basis for 78 years, one might expect 3 additional cases of cancers. This cancer risk calculation indicates that there would be a very low estimated increased risk of cancer predicted for residents who were exposed to 29.1 ppm arsenic in soil in this scenario. Table 4 is a summary of the cancer risk calculation. ATSDR suggests that residents consider taking measures to reduce their exposure to arsenic in soil, same as with lead exposure, such as practicing good personal hygiene (e.g., washing hands after playing/working in the yard, wiping shoes on a doormat or removing shoes before entering the house, etc.)

Table 6. Summary of cancer risk calculation

Age Groups	*Total Cancer Risk (CTE)*
Children Cancer Risk 0.5 to < 21 years	3.3E-05
Adult Cancer Risk 21 to 78 years	3.6E-06

Note:CTE: central tendency exposure

Community Health Concerns

ATSDR staff members have participated in numerous community events and public meetings, reviewed site documents, and held health education events to understand the community's concerns regarding the legacy of lead contamination in this community, and questions about further investigation and potential remediation of properties. The primary environmental health issues raised by community members to ATSDR are as follows:

- Lead exposures in residential areas,
- Lead exposure via consumption of home grown vegetables, and
- Cancer effects of lead exposure.

ATSDR addressed lead exposure at residential areas in previous sections of this document (See Public Health Implications – Lead section on pages 18-20).

Lead Exposure via Consumption of Home Grown Vegetables

To address community concerns regarding lead exposure via consumption of home grown vegetables, ATSDR reviewed available vegetable sample results. Six samples of vegetable (lettuce and mustard greens) from one yard had lead concentrations ranging from 1.67 to 4.49 ppm. In general, most lead on vegetables results from surface deposition from air. Under normal conditions, even when plants are grown in soil containing substantial amounts of lead, only a very small percentage of total soil lead is accumulated by the plant. This is assuming that all lead particulates are thoroughly washed from the plant surface before being analyzed. In general, soil contamination on the plant (e.g., small particles of soil that are on the surface of the plant) may be the most significant source of exposure for people [ERG 2001].

The soil-plant barrier is usually effective in limiting the amount of lead accumulated by plants. Small amounts of lead may be transferred from the soil into the roots of plants, but lead is not typically accumulated in high concentrations in the edible above ground portion of the plant. This is generally due to the low solubility (ability for a substance to dissolve in water) of lead in the soil, which influences the mobility of lead within the plant. However, cessation of growth in late summer and fall may be accompanied by increased mobilization of lead from roots into the plant tops. Some of the important variations in plant accumulation of lead are due to plant age and species, organic matter content, soil phosphorus level, pH, soil texture, climate, topography, pollution, and geological history of the soil. The amount of lead accumulated into the plant tissues decreases as pH, cation-exchange capacity (a measure of the soils ability to retain essential nutrients), and available phosphorus of the soil increases [ERG 2001].

After reviewing the limited vegetable data from the site area, ATSDR concludes that the levels of lead found in the tested vegetables are not of health concern if home grown vegetables were properly cleaned before consumption. In general, most of the lead found on leafy vegetables is from surface deposition of dust and soil. Washing and peeling fruits and vegetables, especially root crops, can reduce lead exposure and thus the health concern. It is not known if these limited vegetable data are representative of lead levels in home-grown vegetables throughout the neighborhood.

Cancer Effects of Lead Exposure

Another community health concern is the cancer effects of lead exposure. High doses of lead cause cancer in experimental animals. Although there are no definitive studies showing that lead causes cancer in humans, DHHS classifies lead and lead compounds as likely to be carcinogens. This classification is primarily based on occupational epidemiology studies; however these studies were limited by poor exposure assessment methods and did not control for other exposures that might cause cancer [NTP 2005]. Because of the limits of science from those studies, it is not possible to estimate the cancer risk from soil lead exposure.

Limitations

Lead Model Limitations

It should be noted that there are limitations of using the IEUBK model and ALM to estimate the distribution of BLLs. For example:

Reliable estimates of BLL depend on site-specific information: Reliable estimates of exposure and risk using the IEUBK and ALM models depend on site-specific information for a number of key parameters that include the following:

- Lead concentration in outdoor soil (fine fraction) and indoor dust,
- Soil ingestion rate,
- Lead concentration in deteriorating paint and indoor paint dust,
- Individual variability in child blood lead concentrations affecting the Geometric Standard Deviation (GSD), and
- Rate and extent of lead absorption from soil.

If no reliable site-specific inputs are available, the model will use default parameters. We used default variables for all of the inputs except lead concentration in outdoor soil. Because the model relies on so many different variables, lead risks may be over- or underestimated. Although the soil estimates were based on the most recent reliable sampling, they may not be representative of the affected areas. Additionally, soil bioavailability was not measured. Both of those parameters introduce more uncertainty into the model estimates.

Estimates are time-dependent: Because the IEUBK and ALM are dynamic (i.e., time-dependent) mathematical models, this introduces another chance for error that may result in an over-or underestimation of the risk of lead exposure.

Estimates are not person-specific: The IEUBK model is designed to predict an average BLL concentration for an entire population, or the probability that a child with a specific exposure scenario would have an elevated BLL [USEPA 2002].

Estimates are not for short-term or irregular exposures: The model should not be used to predict BLLs:

- for exposure periods that are less than three months,
- when higher exposure occurs less than once per week or varies irregularly, and
- for a specific child.

Although the model is not appropriate for short term exposures, intermittent exposures are likely due to seasonal variations. The model may under- predict blood lead levels during the dryer months and over-predict them during the colder, wetter months. However, because the usual approach of estimating human exposure to an environmental contaminant and then comparing this dose to a health based comparison value (such as an MRL or RfD) cannot be used, the IEUBK and ALM are used to make estimates for lead exposures.

Conclusions

Lead

1. *Percentage of children (predicted) with blood lead levels above 5 µg/dL:*

- The blood lead exposure model (IEUBK) predicts that more than 75% of the children (age 6 months to 7 years) who regularly play in the yards that were sampled in the area could be exposed to lead in soil at levels high enough to raise their blood lead levels (BLLs) above CDC's current reference level of 5 µg/dL. There is also reason to believe that the soil levels are high throughout the area near the former John T. Lewis plant and could affect other children.
- The Adult Lead Methodology (ALM) predicts that pregnant women regularly exposed to this soil could experience elevated BLLs in their developing fetus. Specifically, the ALM predicts that 37 % of the pregnant women would have fetal BLLs greater than or equal to 5 µg/dL.
- The predicted average blood lead levels may be high enough to result in harmful health effects for children and the unborn children of pregnant women. Chronic exposure to lead resulting in blood lead levels below 10 µg/dL has shown sufficient evidence of neurological, behavioral, immunological, and developmental effects in young children.
- Review of blood lead exposure risk factors for census tract 160 show that population is at increased risk for lead exposure.
- Blood lead screenings, studies, and surveillance conducted between 1987 and 2010 have been inconclusive as to whether children in the area had higher blood lead levels than those in surrounding areas.
- Because this area is subject to seasonal variations in lead exposure conditions, ATSDR predicts higher seasonal variations in blood lead levels in the warmer/dryer months, particularly in the school age group.

ATSDR used U.S. EPA's Integrated Exposure Uptake and Biokinetic (IEUBK) model to predict blood lead levels for children age 6 months to 7 years and the U.S. EPA Adult Lead Methodology (ALM) to estimate the blood lead level in pregnant women and their fetuses. Using soil data (the 2009 and 2011 site data) from yards in the neighborhood and default values in U.S. EPA's IEUBK model and ALM, the predicted blood lead levels exceeded CDC's current reference level of 5 µg/dL for children and the unborn children of pregnant women.

There is the potential that soil lead levels are high throughout the area near the former John T. Lewis facility. There is not enough information currently available to discern if soil lead levels in the site area are significantly different from soil lead levels throughout the City of Philadelphia generally.

In addition, ATSDR evaluated additional lead exposure risk factors for this community. In Census Tract 160, ATSDR determined that 90% of the population lives in housing built before 1950 when paint had the highest levels of lead. Also, this housing area is in the urban area of the northeastern U.S. where 34% rent their homes and 20% have a Poverty Income Ratio (PIR) less than 1.24. Those factors put this population at an increased risk for lead exposure. Although past operations at the former John T. Lewis plant may have resulted in high levels of lead in the soils in the area, there are other important sources of lead exposure in this community, such as deteriorating lead paint in older housing and deposition from historic leaded gasoline emissions.

2. *Eating home-grown garden vegetables:*

Levels of lead found in the tested vegetables are not expected to harm people's health if home grown vegetables are properly cleaned before consumption.

Six vegetables samples of lettuce and mustard greens were collected from one yard. These vegetables had lead concentrations ranging from 1.67 to 4.49 parts per million (ppm). In general, most of the lead found on leafy vegetables is from surface deposition of dust and soil. Washing and peeling fruits and vegetables, especially root crops, can reduce lead exposure. It is not known if these limited vegetable data are representative of lead levels in home-grown vegetables throughout the neighborhood.

3. *Cancer risk from lead exposure:*

Because of the limits of science from human epidemiologic studies, it is not possible to estimate the cancer risk from soil lead exposure.

There are no definitive studies showing that lead causes cancer in humans. Occupational epidemiology studies of lead exposure and health effects were limited by poor exposure assessment methods and did not control for other exposures that might cause cancer.

Arsenic

4. *Cancer and non-cancer risk from arsenic exposure:*

It is unlikely that adults or children at any of the tested properties would experience cancer or non-cancerous harmful effects from exposure to arsenic in soil. It is not known if these data are representative of arsenic levels throughout the neighborhood.

ATSDR used the average surface soil arsenic concentration of 29.1 ppm to estimate site-specific exposure. The estimated doses for adults and children at any of the tested properties were less than 0.0003 mg/kg/day and well below doses found in studies showing harmful effects in humans. For cancer effects, the estimate indicated that for every 1,000,000 persons exposed to arsenic in soil on a daily basis for 78 years, 3 additional cases of cancers might be expected. This is a very low estimated increased risk of cancer predicted for residents who were exposed arsenic in soil in this area.

Recommendations

Stop, Prevent, Reduce Exposure

1. **Reduce exposure:** Since there is no proven safe level of lead in the blood, ATSDR and CDC recommend reducing lead exposure wherever possible. Practical ways to reduce exposure are provided below.

   Reduce exposure to residential soil. To reduce exposure, ATSDR recommends:

   - U.S. EPA, state or local governments take measures to reduce the potential for future human exposures and continue efforts to characterize the extent of the soil lead contamination in the community near the former facility.
   - Lead bioavailability be measured in soil because it is important for understanding the true exposure risk. Testing for the bioavailability of lead in soil was not done at the site. ATSDR understands that U.S. EPA plans to sample/screen soil from the community and similar residential/industrial neighborhoods to estimate the relative bioavailability of lead in soil. This would help gain further insight on the relative absorption risk the soil poses and extent as well as on urban background lead levels in the City of Philadelphia.
   - Parents or guardians reduce their own and their children's exposure to lead in soil and can do so in the following ways:
     - Cover bare soil with vegetation (grass, mulch, etc.) or even add a layer of clean soil over existing soil to avoid contact,
     - Create safe play areas for children with appropriate and clean ground covers. Consider sand boxes for children who like to dig,
     - Watch children to identify any hand-to-mouth behavior or excessive intentional dirt eating – these behaviors should be modified or eliminated,
     - Create a raised bed and fill with clean soil for gardening to reduce exposures from gardening and digging. Rinse produce well to remove garden soil,
     - Wear gloves when working with contaminated soil and remove gloves after gardening,
     - Keep children's hands clean by washing periodically, before coming inside, and before eating. Do not eat food, chew gum or smoke when playing or working in the yard,
     - Change and launder any dirty clothes after playing outside,
     - Remove shoes before going in the house,
     - Frequently bathe your pets as they could also track contaminated soil into your home, and
     - Regularly conduct damp mopping and damp dusting of surfaces. Dry sweeping and dusting could increase the amount of lead-contaminated dust in the air.

Reduce exposure to lead from other possible sources.

- Lead can be found in various sources including soil, water, lead paint, imported tableware, jewelry, and toys. Lead-based paint and contaminated dust are the most widespread and dangerous high-dose source of lead exposure for young children. Homes built before 1978 may have lead-based paint, which can pose a problem if it starts to chip or peel, or if renovation work is done in the house. Lead sources and simple steps to making a home lead-safe are listed in the Appendix D and at the following link: http://www.cdc.gov/nceh/lead/ACCLPP/Lead_Levels_in_Children_Fact_Sheet.pdf

Residents may consider performing a Healthy Homes environmental assessment of their residences to identify potential hazards. Local or State health departments can help identify available resources. A Healthy Homes assessment includes a visual assessment of paint and housing conditions. More information about the principles of healthy housing and Pennsylvania's Healthy Homes Program can be found by calling PADOH at 717-772-2762 and through the following link:

http://www.portal.state.pa.us/portal/server.pt/community/lead_poisoning_prevention___control/14175/healthy_homes_foster_care_program_(hhfcp)/600352

2. **Test blood for lead.**
   - ATSDR recommends that women of child bearing age, pregnant women, and children less than six years of age have their blood tested for lead. By doing so, they can then make more informed decisions with their health care providers on whether to increase the frequency of blood lead testing and determine the need for other testing such as for nutritional deficiencies. If blood lead testing is not done by a personal health care provider, the test results need to be shared with their health care providers for follow-up recommendations. See Appendix D for the PADOH Childhood Lead Poisoning Prevention Program recommendations.

3. **Reducing lead absorption.**
   - To help prevent lead absorption from the stomach, eat a nutritious diet including several small meals per day (appropriate for age and growth) rich in iron, calcium, vitamins C and D and zinc such as dairy products and green vegetables. This is particularly important for children and pregnant women.

4. **Community and health care provider education.**

Provide education on reducing exposures. ATSDR recommends that U.S. EPA in conjunction with local and State health authorities implement a continuing education program for community members, including children, on methods to reduce exposures to lead in their environment. Appendix D provides links to prepared information for communities with lead exposure.

Provide education on blood lead testing. ATSDR recommends that U.S. EPA in conjunction with local and State health agencies encourage pregnant women, women of child bearing age, and parents of children less than six years of age to have their blood tested for lead and follow recommendations from their health care provider. More urgency is given to those living near the former facility who may be at an increased risk of lead exposures.

Educate health care providers. ATSDR recommends that local and State health agencies alert area health care providers about the specific hazards of the site. Specific recommendations for clinicians are available at http://www.phila.gov/health/pdfs/GuideforClinicians7_8_13.pdf and http://www.atsdr.cdc.gov/emes/health_professionals/grem.html.

ATSDR also recommends that local and State health agencies educate health care providers about the seasonal variations in blood lead levels, particularly those in the school-age group. Prescribing nutritional supplements during the warmer months may be a prudent practice for reducing lead absorption.

5. **Perform periodic review of clean up effectiveness.** If soil remediation takes place, ATSDR recommends that U.S. EPA or the appropriate agency periodically evaluate the cleanup effectiveness as appropriate (e.g., Does the soil cover remain intact, is the erosion control working, are the amendments functioning).

Public Health Action Plan

The public health action plan for the site contains a description of actions that have been or will be taken. The purpose of the public health action plan is to ensure that this health consultation both identifies public health hazards and provides a plan of action designed to mitigate and prevent harmful human health effects resulting from exposure to hazardous substances.

Public health actions that have been taken include:

U.S. EPA:

In September 2013, U.S. EPA's National Enforcement Investigation Center (NEIC) accepted a proposal from U.S. EPA Region III to conduct a pilot lead attribution study in the community. The project will be challenged by the many potential sources of lead in this former heavily industrialized area including that from past vehicular emissions and the use of lead based paint. The resulting data may help further our understanding of lead in the urban environment.

U.S. EPA issued a Request for Proposal (RFP) to provide additional options for blood lead screening of children and pregnant women residing within two census tracts surrounding the former John T. Lewis facility.

Public health actions that will be implemented include:

- Starting in early 2014, U.S. EPA staff intend to work from a rented location in the community near the former John T. Lewis facility to recruit residences for yard soil lead screening/sampling, provide health education and outreach, advertise and promote blood lead screening events, issue fact sheets and generally be accessible to community residents.
- U.S. EPA and ATSDR will continue attending community group meetings as requested. There are five active community groups in the neighborhood near the former John T. Lewis facility. Most meet on a monthly basis.
- U.S. EPA plans to collect soil samples to estimate the relative bioavailability of lead in soil using the In Vitro Bioaccesibility (IVBA) assay.
- U.S. EPA plans to screen/sample soil from similar residential/former industrial neighborhoods in Philadelphia to gain further insight on urban lead background levels in the city.

- U.S. EPA and ATSDR will coordinate with community organizations, the city of Philadelphia, urban gardening groups, researchers, and possibly corporations to identify low cost methods to address soil with significantly elevated soil lead values.
- As data is collected and evaluated, U.S. EPA will make decisions on any need for a removal action at individual properties.
- ATSDR/U.S. EPA/State and local health agencies will continue to provide health education to residents as needed at the site. ATSDR will meet with residents to provide lead exposure education and conduct primary care physician education in the affected area.
- ATSDR will review additional data as needed.

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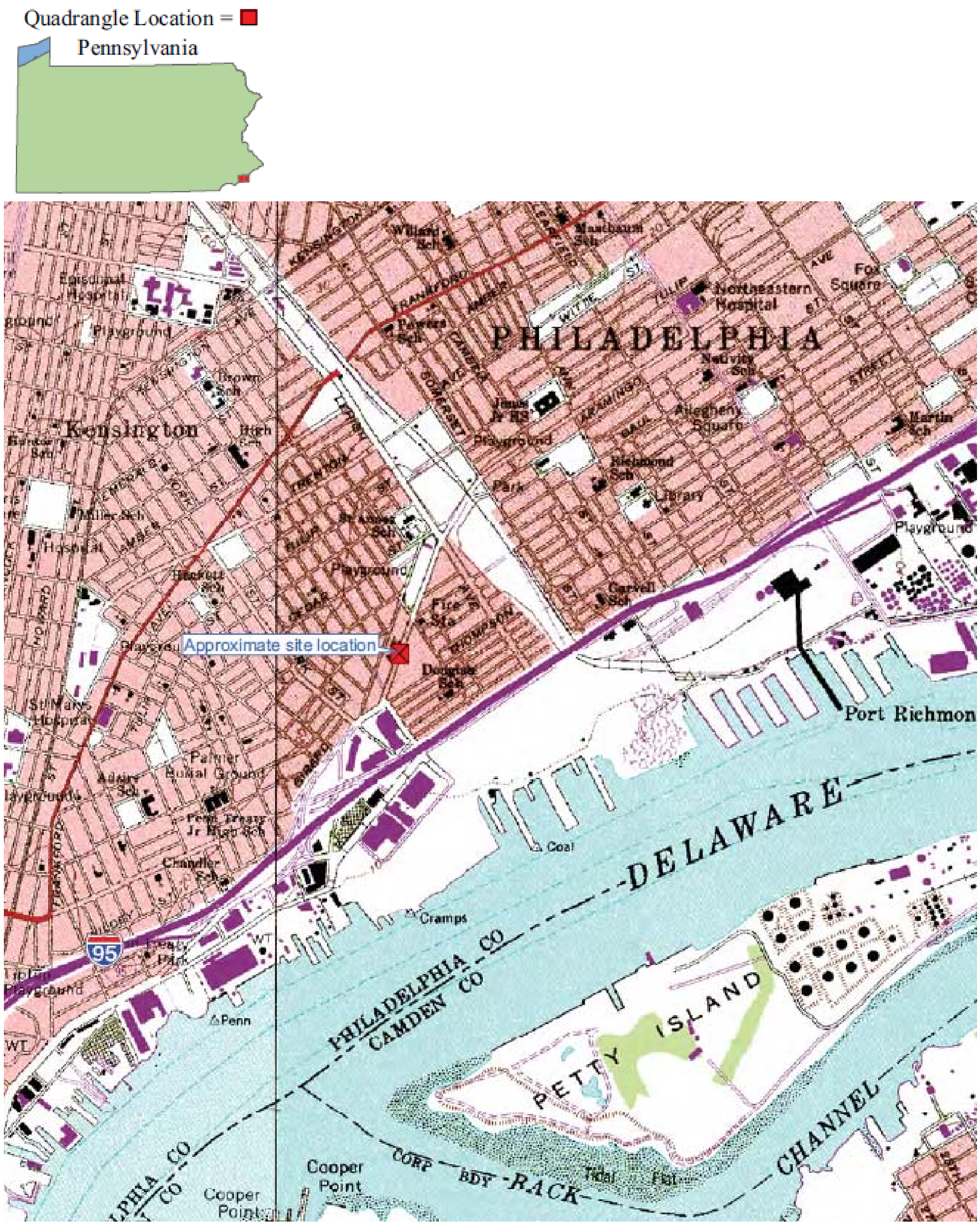
Figures

Figure 1: Site Location Map

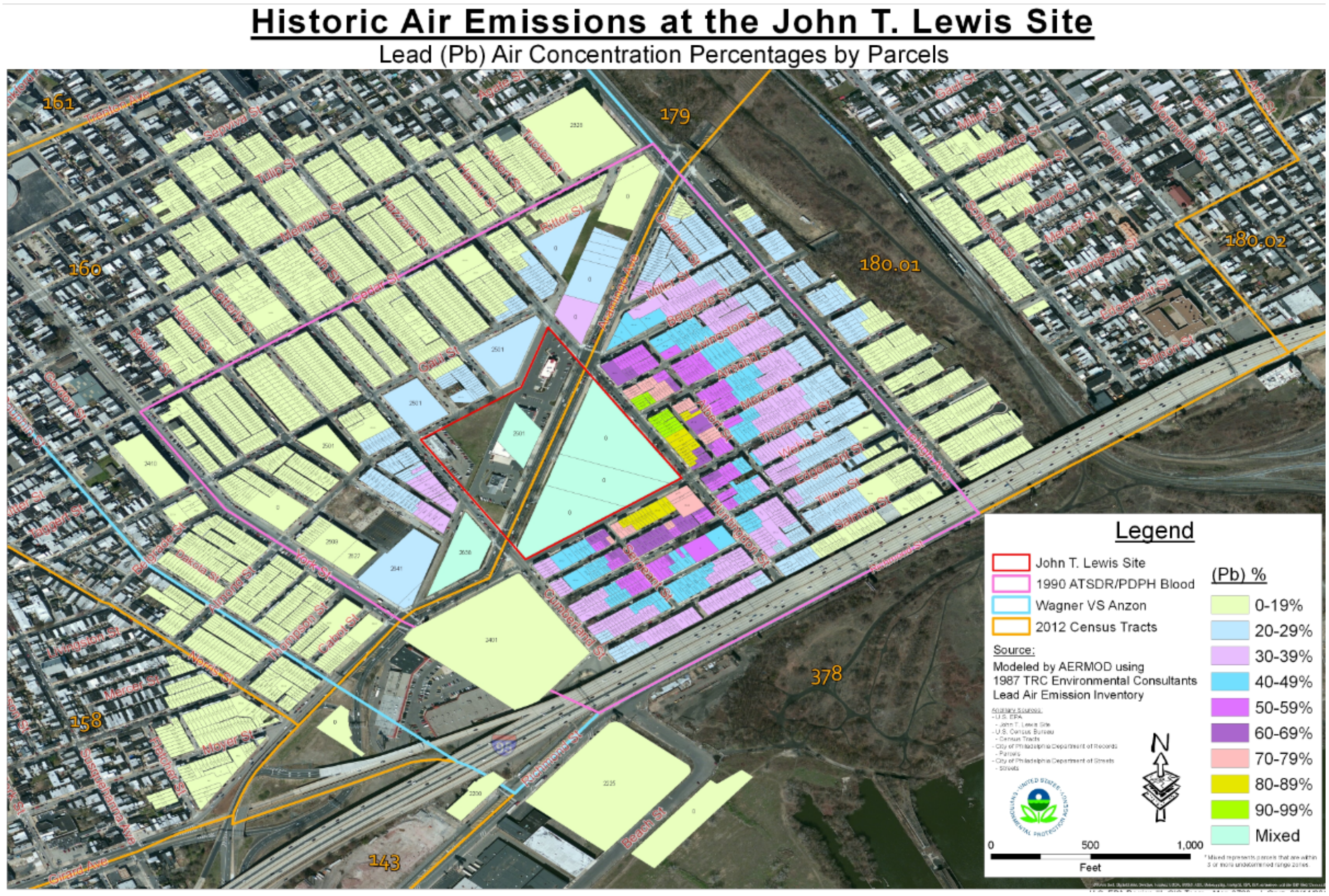


Source: [Tetra Tech 2009]

Figure 2: Aerial of Current Site Area

Source: [Tetra Tech 2009]

Figure 3: Historic Air Emissions at the John T. Lewis Site



Source: [U.S. EPA 2013]

Figure 4: Historic map John T. Lewis T Lewis facility, 1875

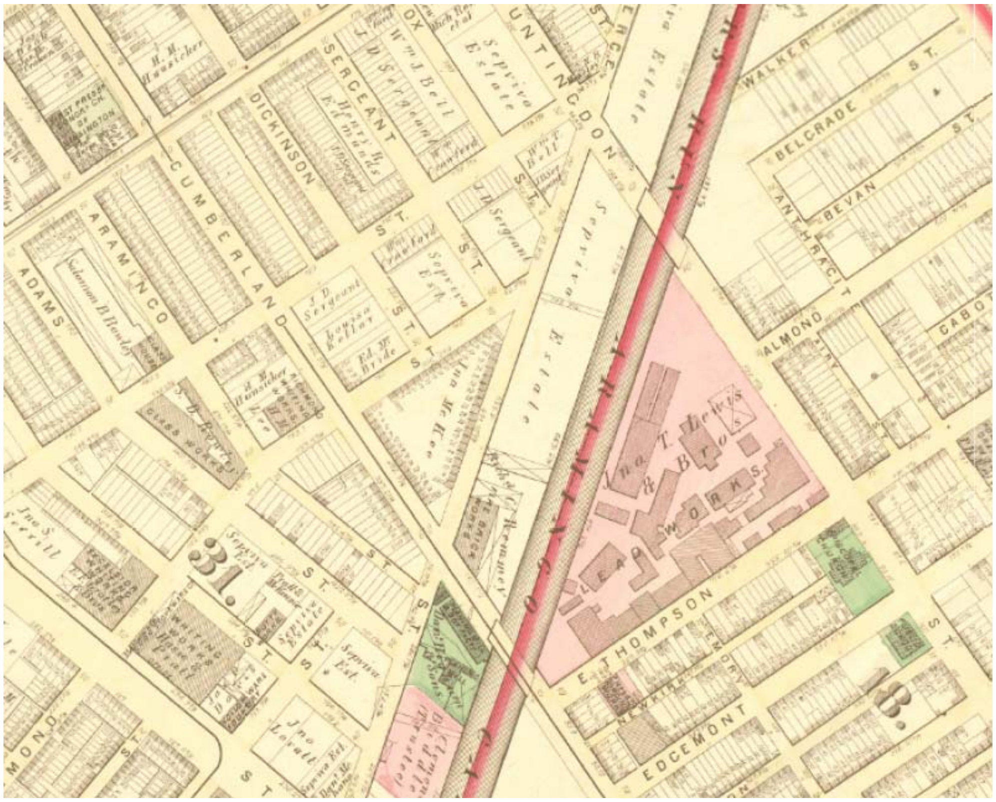
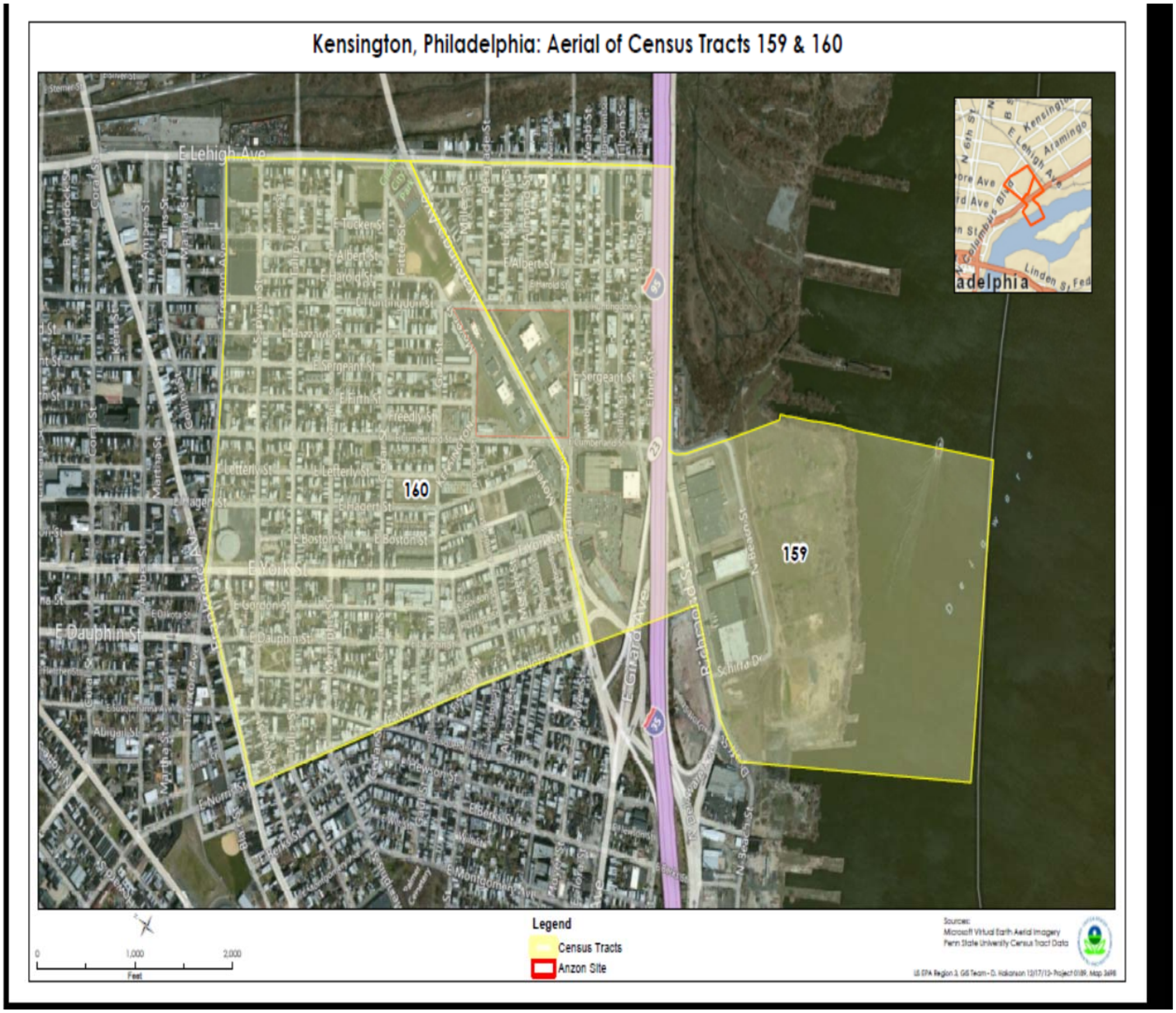


Figure 5. Aerial Photograph of Cenust Tracts 159 and 160, Kensington, Philadelphia, PA.



Source: [U.S. EPA 2013]

Appendices

Appendix A: Summary of Previous Sampling Events

Appendix B: Details of 2011 Soil Lead Sampling

Appendix C: Arsenic Non-Cancer Health Effects Evaluation

Appendix D: Resources for Lead Education

1. Lead Exposure Sources
2. Information on Reducing Lead Exposure
3. Information for Clinicians on Blood Lead Testing, Exposure History, and Followup
4. Health Care Provider Education
5. Community Health Education Resources

Appendix A: Summary of Previous Sampling Events

Summary of the sampling events

Philadelphia Street Sweeping Samples (1974 -1987): Between 1974 and 1987, the city of Philadelphia Air Management Services (AMS) and PADER (now PADEP) collected street sweeping and soil samples. Most were collected within a block of the facility but occasionally, samples were collected up to three or four blocks away. Sample results within a block of the facility were generally more than 1,000 parts per million (ppm) with some sampling events averaging closer to 7,500 ppm. During the mid 1970s, the citywide average soil lead concentration was estimated to be 2,500 ppm.

- *EPA Residential Soil Samples (1987):* In 1987, U.S. EPA collected approximately 50 residential soil samples for lead analyses in response to community concerns regarding air emissions. EPA attempted to sample soil in undisturbed areas where soil had not been added to or turned over from digging. Sample results in the innermost circle – a radius of about one block from the facility – had a mean lead value of 3,036 ppm; the second concentric area, about 1½ additional blocks away, had a mean of 1,671 ppm; and the third concentric area, extending beyond the perimeter of the second area to three blocks depending on the direction, had a mean value of 862 ppm. Three background samples averaged 829 ppm.
- *Terra Graphics Inc. Street Sweeping Samples (1993):* In 1993, as a consultant to plaintiffs in a class action lawsuit, TerraGraphics Inc. collected street sweeping and soil samples to delineate lead contamination by using a linear regression model. Reported values of street dust adjacent to the facility were 3,000 to 5,000 ppm while levels approximately 1500 feet away (~0.3 miles; ~four blocks) were in the 850 to 1,000 ppm range.
- *EPA Site Assessment Samples (2009):* As part of its "Former Lead Smelter Initiative", EPA collected soil samples from four residential properties and a vacant lot located within a city block of the facility. Seventeen samples showed an average of 1,168 to 2,509 ppm.
- *EPA Removal Assessment (2011):* In May 2011, EPA did ex-situ X Ray Fluorescence (XRF) re-screening of soil at two of the four residential yards screened in the 2009 Site Assessment and at an additional nearby yard. The results showed average lead concentrations of 1,168 to 2,509 ppm.
- *USA Today Samples (2011):* In 2011, USA Today collected a total of thirty-three soil samples within four blocks of the site. The specific locations and location characteristics are not known and the results varied at individual locations. Two locations one to two blocks northeast of the facility in the prevailing wind direction, showed the most consistently elevated readings; 8 samples with lead levels ranging from 1,041 to 2,803 ppm. See story @ http://www.usatoday.com/story/news/nation/2012/12/19/lead-smelter-cleanup-liabilities/1766747/

Appendix B: Details of 2011 Soil Lead Sampling

In May 2011, EPA conducted a site assessment and collected over 40 soil samples from three properties including two properties that were screened in 2009. EPA contractor, Weston Solutions Inc., conducted the sampling and analyses following EPA Method 6200 for field x-ray spectrometry, which included confirmatory laboratory analyses and continuing calibration measurements. Sampling information is summarized below:

- At one property (Yard 1), U.S. EPA collected composite samples at 6 locations from depths 0-2, 2-4, and 4-6 inches separately. For each location, samples of different depth were composited again to form 6 additional samples marked as 0-6 inches. All samples were analyzed in the field (in-situ) and in an off-site facility (ex-situ) by XRF instrument for lead and other metals. Three of the composite samples were sent to the U.S. EPA-coordinated laboratory for confirmation using Inductively Coupled Plasma (ICP) analysis. The 6 additional samples marked as 0-6 inches depth were sent to a university laboratory for confirmation and independent analysis using both XRF and ICP methods. U.S. EPA also collected 6 vegetable samples grown in the yard for metal analysis. The lead levels ranged from 1,618 to 2,117 ppm.
- At another property (Yard 4), EPA collected 9 discrete soil samples at a depth of 0-6 inches and analyzed in-situ and ex-situ by XRF instrument for lead, arsenic and cadmium. One sample was sent to the EPA-coordinated laboratory for confirmation. The lead levels ranged from 988 to 2,387 ppm.
- At the third property (Yard 5), EPA collected 6 discrete soil samples at a depth of 0-6 inches and analyzed in-situ and ex-situ by XRF instrument for lead, and other metals. All 6 samples were sent to a university laboratory for confirmation and independent analysis using both XRF and ICP methods. U.S. EPA also collected 6 vegetable samples grown in the yard for metal analysis. The lead levels ranged from 507 to 1,157 ppm.

Appendix C: Arsenic Non-Cancer Health Effects Evaluation

ATSDR derived exposure doses for residents exposed to arsenic in soil based on the following equation:

$$D = \frac{C \times IR \times EF \times RBA \times CF}{BW}$$

where,

D	=	exposure dose in milligrams per kilogram per day (mg/kg/day)
C	=	chemical concentration in milligrams per kilogram (mg/kg)
IR	=	intake rate in milligrams per day (mg/day)
EF	=	exposure factor (unitless)
RBA	=	relative bioavailability factor (0.6 for arsenic)
CF	=	conversion factor, 1×10^{-6} kilograms/milligram (kg/mg)
BW	=	body weight in kilograms (kg)

ATSDR used the average surface soil arsenic concentration of 29.1 mg/kg to estimate site-specific exposure. ATSDR derived exposure doses for residents exposed daily to arsenic in soil. Table bellow presents the dose calculation results.

Summary of Arsenic Chronic Exposure Dose Calculations

Age Groups	*Body Weight*	*RME Doses mg/kg/day*	*CTE Doses mg/kg/day*	*MRL mg/kg/day*	*Exceeding the MRLs(Yes/No)*
Child 0.5 to < 1 year	9.5	0.000269	0.000162	0.0003	No
Child 1 to < 2 year	11.4	0.000435	0.000217	0.0003	Yes*
Child 2 to < 6 year	17.4	0.000285	0.000142	0.0003	No
Child 6 to < 11 year	31.8	0.000156	0.000078	0.0003	No
Child 11 to <16 year	56.8	0.000087	0.000044	0.0003	No
Child 16 to <21 year	71.6	0.000069	0.000035	0.0003	No
Adults ≥ 21 year	80	0.000031	0.000015	0.0003	No
Special Groups					
Child (pica) 1 < 2 year (EF = 3 days/week	11.4	NA	0.004658	0.005	No

Child (pica) 2 < 6 year (EF = 3 days/week)	17.4	NA	0.003052	0.005	No
Gardeners ≥ 21 year	80	NA	0.000031	0.005	No

Note:

CTE: central tendency exposure. Refers to persons who have average or typical exposures.

RME: resalable maximum exposure. Refers to people who are at the high end of the exposure distribution (approximately the 95th percentile). The RME scenario is intended to assess exposures that are higher than average, but are still within a realistic range of exposures.

Pica: the recurrent ingestion of unusually high amounts of soil (i.e., on the order of 1,000-5,000 mg per day). Groups at risk of soil-pica include children aged 6 years and younger and developmentally delayed individuals.

EF: exposure factor

kg: kilogram

mg: milligram

MRL: Minimal Risk Level

NA: not applicable

Currently, no children live on any of the properties sampled.

Appendix D: Resources for Lead Education

1. Lead Exposure Sources
2. Information on Reducing Lead Exposure- PADOH Childhood Lead Poisoning Prevention Program
3. Recommendation for Clinicians
4. Health Care Provider Education
5. Community Health Education Resources

1. Lead Exposure Sources

Lead is found in many products and locations. Lead-based paint (LBP) and contaminated dust are the most well-known and dangerous high-dose source of lead exposure for young children. Here are ways that you can be exposed to lead.

Indoor

Paint – Swallowing small pieces of peeling leaded paint found in homes built before 1978 and, on older toys and furniture.

Dust – Swallowing dust (from hand-to-mouth behavior in children) found in older homes (built prior to 1978) or tracked inside the home from contaminated soil.

Water – Drinking water having lead from wearing away of older fixtures, from the solder that connects pipes, or from wells where lead contamination has affected the groundwater

Tableware – Eating foods from old Mexican-made clay dishes that contain lead and drinking from leaded crystal, pewter, and brass cups.

Candy – Eating candies brought in from Mexico. Certain candy ingredients such as chili powder and tamarind may be a source of lead exposure. Candy wrappers have also been shown to contain lead.

Toy Jewelry – Swallowing or putting in the mouth toy jewelry that contains lead. This inexpensive children's jewelry is generally sold in vending machines and large volume discount stores across the country.

Traditional Medicines –Swallowing some traditional home medicines from India, the Middle East, Asia, and Mexico. Lead and other heavy metals are mixed with some home medicines. It is thought that they will help in treating illness. Sometimes lead accidentally gets into the home medicine during grinding, coloring, or other methods of preparation.

Outdoor

Outdoor Air – Breathing lead dust in outdoor air that comes from the residues of leaded gasoline or industrial operations.

Soil – Ingesting dirt contaminated with lead from old smelters and other industries.

Other

Hobbies – Ingesting lead from hobbies that include welding, auto or boat repair, the making of clay pottery, stained glass, bullets, and fishing weights. Other pastimes that might involve lead include furniture refinishing, home remodeling, painting and target shooting at firing ranges.

Workplace – Swallowing lead found at the workplace. Jobs with the potential for lead exposure include building demolition, painting, remodeling/renovation, construction, battery recycling, radiator repair, and bridge construction. People who work in a lead environment may bring lead dust into their car or home on their clothes, shoes, and bodies exposing family members.[i]

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2. Information on Reducing Lead Exposure

PADOH Childhood Lead Poisoning Prevention Program

Lead Poisoning and Smelting:

What You Can Do If You Live Near a Former Smelting Site

Lead Poisoning and Former Smelting Sites

People who live near a former smelting site can be at higher risk for lead poisoning.

Former smelting sites are places that used to make, heat or melt metals—including lead. Smoke from the smelting process can cause lead to get into the soil (dirt) around nearby homes. This can raise the risk of lead poisoning for the children who live there.

Who Is Most at Risk for Lead Poisoning?

Young children are more sensitive to contaminants in the environment than adults. Children's bodies are still developing and lack defenses that adults have. Also, their behavior puts them most at risk for lead poisoning. Young children put things in their mouth and play on the ground, often around soil.

Even small levels of lead in a child's blood can affect how they grow, how they behave, and how they learn. Most children with lead poisoning do not show any signs of being poisoned.

Get Your Child Tested for Lead

Ask your doctor to test your child for lead. Only a blood test can tell you if there is a high level of lead in your child's body.

The Philadelphia Department of Public Health suggests that all children under 7 years old be tested for lead at least once a year. Children between 9 months and 2 years are at highest risk.

If your child has been poisoned by lead, your doctor can talk to you about treatment.

Reduce Your Child's Contact with Lead in Soil

- Wash your child's hands each time they come inside and before eating.
- Avoid having bare soil areas in your yard. Keep a healthy level of grass on play areas. You can add clean soil, sod, or wood chips each year, or provide your child with a covered sand box.
- Don't track soil/dust indoors. Ask family members to take off their shoes and dirty/work clothes at the door, out of the reach of children. Wash dirty clothing and other items before reusing them.

http://www.cdc.gov/nceh/lead/ACCLPP/Lead_Levels_in_Children_Fact_Sheet.pdf

Parents can take simple steps to make their homes more lead-safe.

Lead can be found in a variety of sources.

These include:

- paint in homes built before 1978
- water pumped through leaded pipes
- imported items including clay pots.
- certain consumer products such as candies, make -up and jewelry
- certain imported home remedies

- Talk to your local health department about testing paint and dust in your home for lead if you live in a home built before 1978.
- Common home renovation activities like sanding, cutting, and demolition can create hazardous lead dust and chips by disturbing lead-based paint. These can be harmful to adults and children.
- Renovation activities should be performed by certified renovators who are trained by EPA-approved training providers to follow lead-safe work practices.
- Learn more at EPA's Renovation, Repair, and Painting rule Web page: http://www.epa.gov/lead/pubs/renovation.htm.
- If you see paint chips or dust in windowsills or on floors because of peeling paint, clean these areas regularly with a wet mop.
- Wipe your feet on mats before entering the home, especially if you work in occupations where lead is used. Removing your shoes when you are entering the home is a good practice to control lead.
- Remove recalled toys and toy jewelry from children. Stay up-to-date on current recalls by visiting the Consumer Product Safety Commission's Web site: http://www.cpsc.gov/.

Protect your Children from Lead Exposure

It is important to determine the construction year of the house or the dwelling where your child may spend a large amount of time (e.g., grandparents or daycare). In housing built before 1978, assume that the paint has lead unless tests show otherwise.

- ***Have your children tested for lead beginning at 9 months to one year of life.***
- ***Provide a healthy diet for your child that is rich in iron, calcium and vitamin C, and with appropriate levels of fat based on age.***
- ***Regularly wash children's hands, especially before eating.*** Always wash their pacifiers, drinking bottles and toys before they use them.
- ***Regularly wet-mop floors and wet-wipe window components.*** Because household dust is a major source of lead, parents should wet-mop floors and wet-wipe horizontal surfaces every 2-3 weeks. Windowsills and wells can contain high levels of leaded dust. They should be kept clean. If feasible, windows should be shut to prevent abrasion of painted surfaces or opened from the top sash.
- ***Make sure your child does not have access to peeling paint or chewable surfaces painted with lead-based paint.*** Do not try to remove peeling paint yourself! If there is peeling paint in your home, call the health department for help on how remedy this. If you rent, report peeling paint to your landlord. It is your landlord's responsibility to properly take care of this problem.
- ***Pregnant women and children should not be present in housing built before 1978 that is undergoing renovation.*** They should not participate in activities that disturb old paint or in cleaning up paint debris after work is completed.
- ***Create barriers between living/play areas and lead sources.*** Until environmental clean-up is completed, parents should clean and isolate all sources of lead. They should close and lock doors to keep children away from chipping or peeling paint on walls. You can also apply temporary barriers such as contact paper or duct tape, to cover holes in walls or to block children's access to other sources of lead.
- ***Remove shoes before entering your home and ask others to do the same.***
- ***Prevent children from playing in bare soil; if possible, provide them with sandboxes.*** Parents should plant grass on areas of bare soil or cover the soil with grass seed, mulch, or wood chips, if possible. Until the bare soil is covered, parents should move play areas away from bare soil and away from the sides of the house. If using a sandbox, parents should also cover the box when not in use to prevent cats from using it as a litter box. That will help protect children from exposure to animal waste.
- ***Let tap water run for one minute before you start using it.***

http://www.cdc.gov/nceh/lead/tips.htm

3. Information for Clinicians on Blood Lead Testing, Exposure History, and Followup

Philadelphia Department of Public Health

Guide for Clinicians: Preventing Lead Poisoning of Children **May 2013**

There is no "safe" level of lead in the human body. A growing body of evidence shows that even mildly elevated blood lead levels in young children are associated with learning and behavioral problems and adverse cardiovascular, immunological, and endocrine effects making prevention of lead poisoning of children of critical importance.

To help children avoid the harmful consequences of lead poisoning, clinicians should take a primary role in educating families to *prevent* lead exposures. Clinicians should ensure that parents and caregivers understand the long term, serious harm from lead poisoning, the most common sources of lead poisoning, especially in their homes, and strategies to preventing lead exposure to their children.

Tips for parents and caregivers of young children living in residences built before 1978:

- Keep children away from peeling paint and home repairs that disturb paint.
- Advise tenants to report peeling paint to their landlord for prompt repair in a lead safe manner. If a landlord does not make repairs, call 311 to request a home inspection by the Philadelphia Department of Licenses and Inspections.
- Homeowners should promptly repair all chipping and peeling paint in a lead safe manner.
- Frequently wash hands, toys, pacifiers, bottles, and other items a child puts in his or her mouth.
- Clean floors, windowsills, and dusty places often with wet mops and wet cloths.
- Serve foods rich in calcium, iron and vitamin C to help protect children from lead.

For all families

- Avoid using health remedies and cosmetics (such as kohl, kajal, surma) from other countries. Some of these products have been found to contain high levels of lead.
- Avoid using imported glazed clay pots and dishes to cook, serve, or store food, and do not use pottery that is chipped or cracked.
- Use caution when using candies, spices, foods, and children's toys and jewelry made in other countries. These items may contain lead.

Lead Screening Guidelines

- All children in Philadelphia should be screened for lead at ages 12 and 24 months or at 36-72 months if there is not proof of prior screening.
- Foreign-born children residing in Philadelphia (refugee and immigrant) should be tested within 60 days of arrival and again at 3 months after arrival, regardless of age, up to age 6 years.
- Discharge from tracking of venous BLL once patient has three consecutive BLLs <10 μg/dL.

For more information contact the Philadelphia Department of Public Health Childhood Lead Poisoning Prevention Program at 215 685-2788 or http://www.phila.gov/health/ChildhoodLead

PEHSU Pediatric Environmental Health Specialty Units

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

Recommendations on Medical Management of Childhood Lead Exposure and Poisoning

No level of lead in the blood is safe. In 2012, the CDC established a new "reference value" for blood lead levels (5 mcg/dL), thereby lowering the level at which evaluation and intervention are recommended (CDC).

Lead level	Recommendation
< 5 mcg/dL	1. Review lab results with family. For reference, the geometric mean blood lead level for children 1-5 years old is less than 2 mcg/dL . 2. Repeat the blood lead level in 6-12 months if the child is at high risk or risk changes during the timeframe. Ensure levels are done at 1 and 2 years of age. 3. For children screened at age < 12 months, consider retesting in 3-6 months as lead exposure may increase as mobility increases. 4. Perform routine health maintenance including assessment of nutrition, physical and mental development, as well as iron deficiency risk factors. 5. Provide anticipatory guidance on common sources of environmental lead exposure: paint in homes built prior to 1978, soil near roadways or other sources of lead, take-home exposures related to adult occupations, imported spices, cosmetics, folk remedies, and cookware.
5-14 mcg/dL	1. Perform steps as described above for levels < 5 mcg/dL. 2. Re-test venous blood lead level within 1-3 months to ensure the lead level is not rising. If it is stable or decreasing, retest the blood lead level in 3 months. Refer patient to local health authorities if such resources are available. Most states require elevated blood lead levels be reported to the state health department. Contact the CDC at 800-CDC-INFO (800-232-4636) or the National Lead Information Center at 800-424-LEAD (5323) for resources regarding lead poisoning prevention and local childhood lead poisoning prevention programs. 3. Take a careful environmental history to identify potential sources of exposures (see #5 above) and provide preliminary advice about reducing/eliminating exposures. Take care to consider other children who may be exposed. 4. Provide nutritional counseling related to calcium and iron. In addition, recommend having a fruit at every meal as iron absorption quadruples when taken with Vitamin C-containing foods. Encourage the consumption of iron-enriched foods (e.g., cereals, meats). Some children may be eligible for Special Supplemental Nutrition Program for Women, Infants and Child (WIC) or other nutritional counseling. 5. Ensure iron sufficiency with adequate laboratory testing (CBC, Ferritin, CRP) and treatment per AAP guidelines. Consider starting a multivitamin with iron. 6. Perform structured developmental screening evaluations at child health maintenance visits, as lead's effect on development may manifest over years.
15-44 mcg/dL	1. Perform steps as described above for levels 5-14 mcg/dL. 2. Confirm the blood lead level with repeat venous sample within 1 to 4 weeks. 3. Additional, specific evaluation of the child, such as abdominal x-ray should be considered based on the environmental investigation and history (e.g., pica for paint chips, mouthing behaviors). Gut decontamination may be considered if leaded foreign bodies are visualized on x-ray. Any treatment for blood lead levels in this range should be done in consultation with an expert. Contact local PEHSU or PCC for guidance; see resources on back for contact information.
>44 mcg/dL	1. Follow guidance for BLL 15-44 mcg/dL as listed above. 2. Confirm the blood lead level with repeat venous lead level within 48 hours. 3. Consider hospitalization and/or chelation therapy (managed with the assistance of an experienced provider). Safety of the home with respect to lead hazards, isolation of the lead source, family social situation, and chronicity of the exposure are factors that may influence management. Contact your regional PEHSU or PCC for assistance; see resources on back for contact information.

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PEHSU Pediatric Environmental Health Specialty Units

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

Recommendations on Medical Management of Childhood Lead Exposure and Poisoning

Principles of Lead Exposure in Children

- A child's blood lead concentration depends on their environment, habits, and nutritional status. Each of these can influence lead absorption. Children with differing habits or nutritional status but who live in the same environment can vary on blood lead concentration. Further, as children age or change residences, habits or environments change creating or reducing lead exposure potential.
- While clinically evident effects such as anemia, abdominal pain, nephropathy, and encephalopathy are seen at levels >40 µg/dL, even levels below 10 µg/dL are associated with subclinical effects such inattention and hyperactivity, and decreased cognitive function. Levels above 100 µg/dL may result in fatal cerebral edema.
- Lead exposure can be viewed as a lifelong exposure, even after blood lead levels decline. Bone acts as a reservoir for lead over an individual's lifetime. Childhood lead exposure has potential consequences for adult health and is linked to hypertension, renal insufficiency, and increased cardiovascular-related mortality.
- Since lead shares common absorptive mechanisms with iron, calcium, and zinc, nutritional deficiencies in these minerals promotes lead absorption. Acting synergistically with lead, deficiencies in these minerals can also worsen lead-related neurotoxicity.

Principles of Lead Screening

- Lead screening is typically performed with a capillary specimen obtained by a finger prick with blood blotted onto a testing paper. Testing in this manner requires that the skin surface be clean; false positives are common. Therefore, elevated capillary blood lead levels should be followed by venipuncture testing to confirm the blood lead level. In cases where the capillary specimen demonstrates an elevated lead level but the follow-up venipuncture does not, it is important to recognize that the child may live in a lead-contaminated environment that resulted in contamination of the finger tip. Efforts should be made to identify and eliminate the source of lead in these cases. Where feasible, lead screening should be performed by venipuncture.

Principles of Iron Deficiency Screening

- The iron deficiency state enhances absorption of ingested lead.
- Hemoglobin is a lagging indicator of iron deficiency and only 40% of children with anemia are iron deficient.
- Lead exposed children (≥ 5 mcg/dL) are at risk for iron deficiency and should be screened using CBC, Ferritin, and CRP. Alternatively, reticulocyte hemoglobin can be used, if available.
- Children with iron deficiency, with or without anemia, should be treated with iron supplementation.

Resources	
• Pediatric Environmental Health Specialty Unit (PEHSU)Network	• www.pehsu.net or 888-347-2632
• Poison Control Center (PCC)	• www.aapcc.org/ or 800-222-1222
• Centers for Disease Control and Prevention	• www.cdc.gov/nceh/lead/ or 800-232-4636
• U.S. Environmental Protection Agency	• www.epa.gov/lead/ or 800-424-5323

Suggested Reading and References:

Pediatric Environmental Health, 3rd edition. American Academy of Pediatrics, 2012.
Woolf A, Goldman R, Bellinger D. *Pediatric Clinics of North America* 2007;54(2):271-294.
Levin R, et al. *Environmental Health Perspectives* 2008; 116(10):1285-1293.
Baker RD, Greer FR. *Pediatrics* 2010;126(5):1040-50.
Guidelines for the Identification and Management of Lead Exposure in Pregnant and Lactating Women. CDC, 2010.
CDC Response to Advisory Committee on Childhood Lead Poisoning Prevention Recommendations in "Low Level Lead Exposure Harms Children: A Renewed Call of Primary Prevention" June 7, 2012

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(June 2013 update)

DEPARTMENT OF HEALTH

Edward G. Rendell, Governor
Calvin B. Johnson, M.D., M.P.H., Secretary of Health

Health Professional Fact Sheet and Maps

AUGUST 2004

Suspected Former Lead Smelter Sites: A Potential Risk Factor for Childhood Lead Poisoning

Background

The Pennsylvania Department of Health (DOH) and the federal Agency for Toxic Substances and Disease Registry (ATSDR) have mapped 53 suspected former lead smelter foundries that operated in the commonwealth of Pennsylvania primarily before 1964 and closed prior to today's strict environmental standards.* Air deposition from the former operations may have contaminated the soil or dust in surrounding neighborhoods and thereby present a potential current public health risk for childhood lead poisoning.

Former lead smelter sites nationwide were identified in an April 2001 article published in the American Journal of Public Health by Eckel, et al[1]. Soil samples taken from 9 of 10 of these sites in this study exceeded the residential standards for lead in soil. The extent of off-site contamination from these sites may vary greatly because of the type and extent of former facility operations, as well as atmospheric conditions that are unique to each location. In addition, changes in landscape over the years and current land use will have a significant effect on the risk of lead exposure from past contamination. The Pennsylvania Department of Environmental Protection and the U.S. Environmental Protection Agency (EPA) are investigating the sites in Pennsylvania to determine past and current use and will be completing a individual summary report on each site. Presently, the DOH and ATSDR feel it is a prudent public health action for you to consider blood lead screening for children under six who live near these sites.

Recommendations

- **The purpose of this fact sheet is to assist you in identifying children in your practice who may be at risk for elevated blood lead levels because they live near a former lead smelter site. Consider doing a blood lead test on children under six in your practice who live near these sites.**
- **Air deposition of lead from former smelter operations <u>may</u> be a health concern to nearby neighborhoods; either independently or more likely as an additive contributor to other common sources of lead in the home or environment. Since most facilities operated decades ago, residents living nearby may not be aware of a potential health risk.**
- **Elevated blood lead levels can damage the nervous system, kidneys, and reproductive system. Young children and pregnant women are especially vulnerable to adverse health effects. Recent research indicates that blood lead is harmful at low levels previously thought to be safe.**

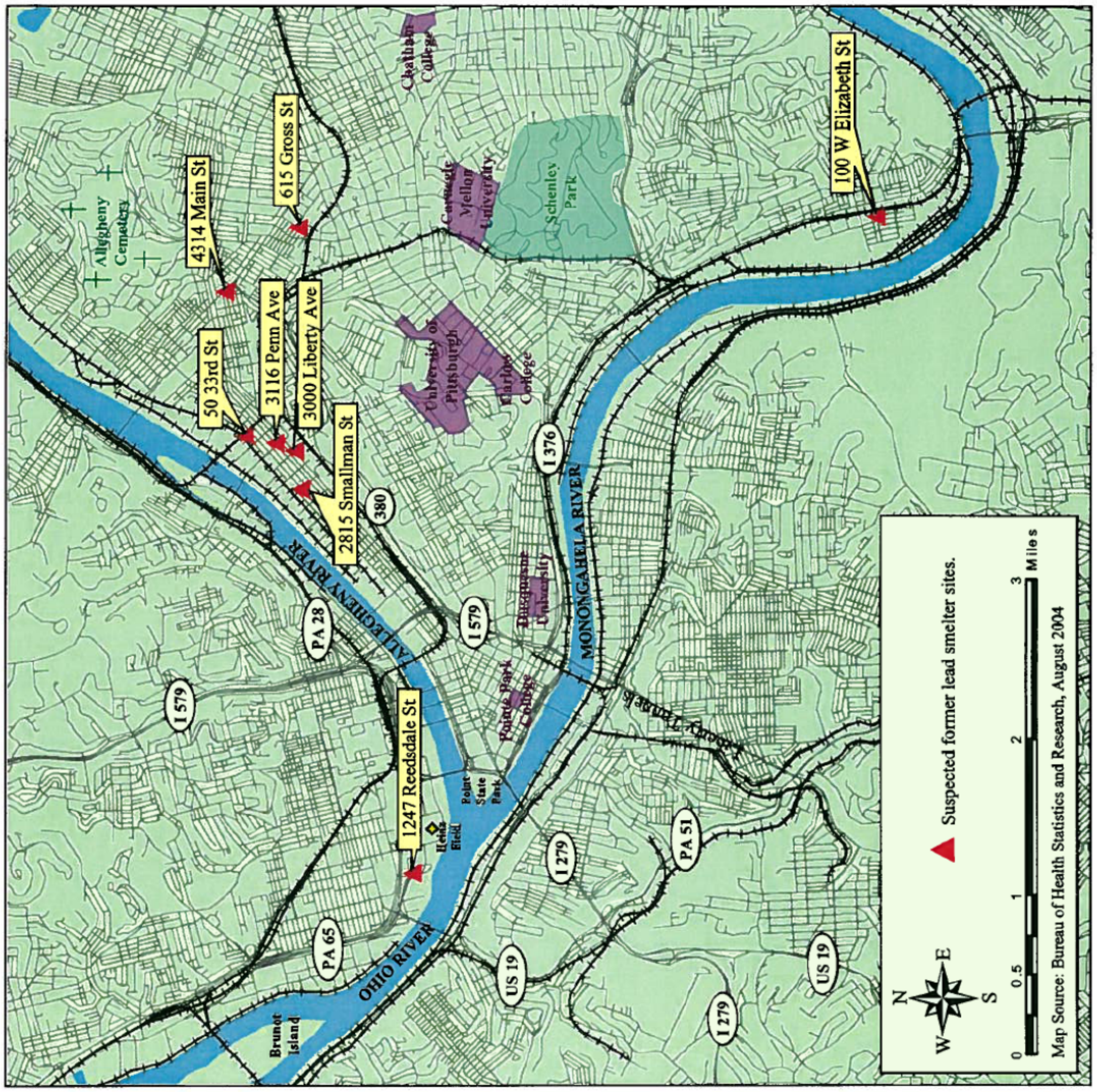
Resources and Reference

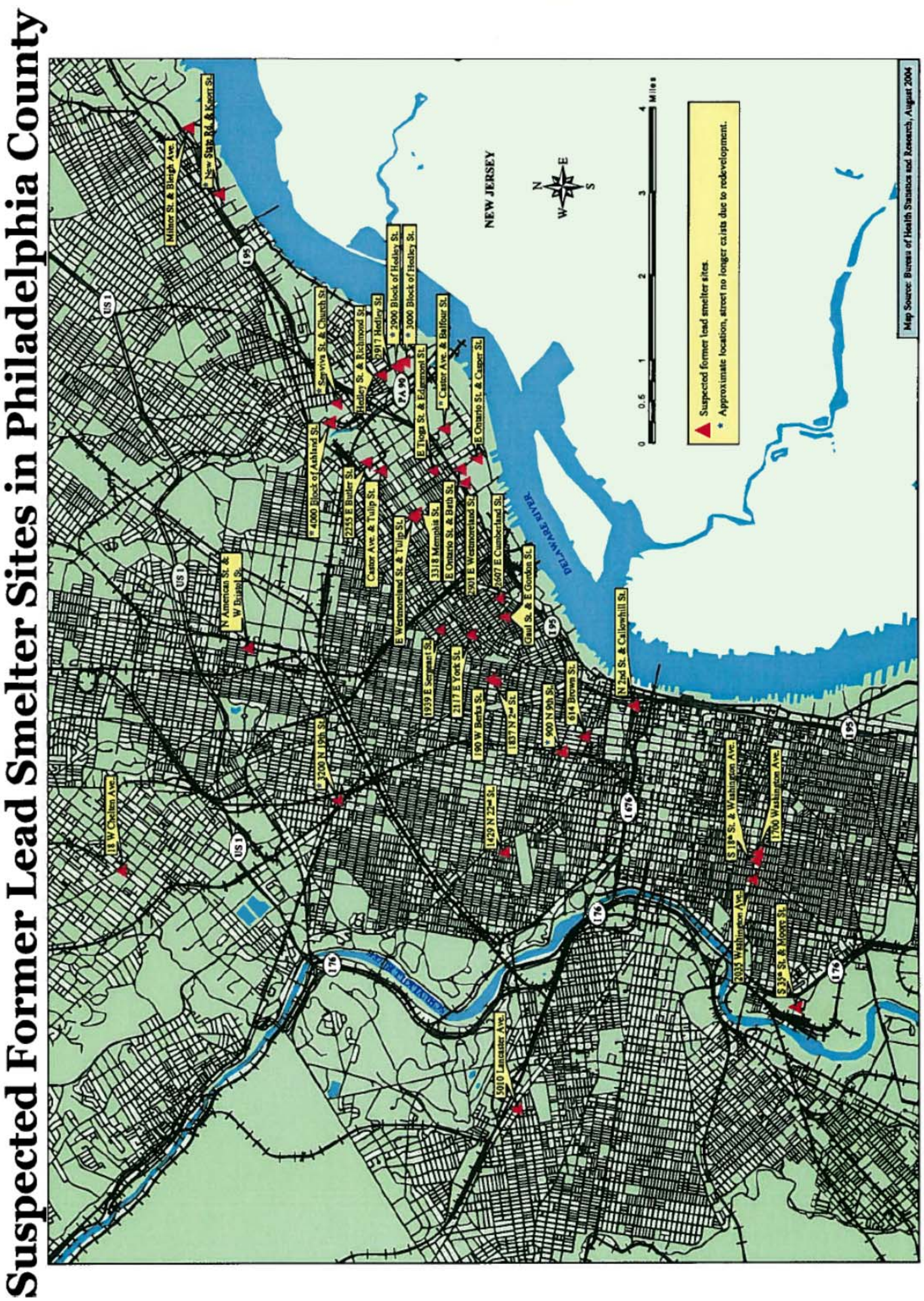
- **Agency for Toxic Substances and Disease Registry**
  ToxFAQs™ for Lead: http://www.atsdr.cdc.gov/tfacts13.html
  Lora Siegmann-Werner, MPH at (215) 814-3141 or lkw9@cdc.gov
- **Pennsylvania Department of Health**
  Lead Information Line 1-800-440-LEAD
  Barbara Allerton, MPH, RN at (717) 346-3283 or ballerton@state.pa.us
- **The Mid-Atlantic Center for Children's Health and the Environment**
  1-866-622-2431 or www.health-e-kids.org
- **The Environmental Protection Agency**
  www.epa.gov/opptintr/lead/nlic.htm or 1-800-424-LEAD
  John Rajkowski at (215) 814-3160 or Rajkowski.John@epa.gov
- **Centers for Disease Control and Prevention**
  www.cdc.gov/health/lead.htm

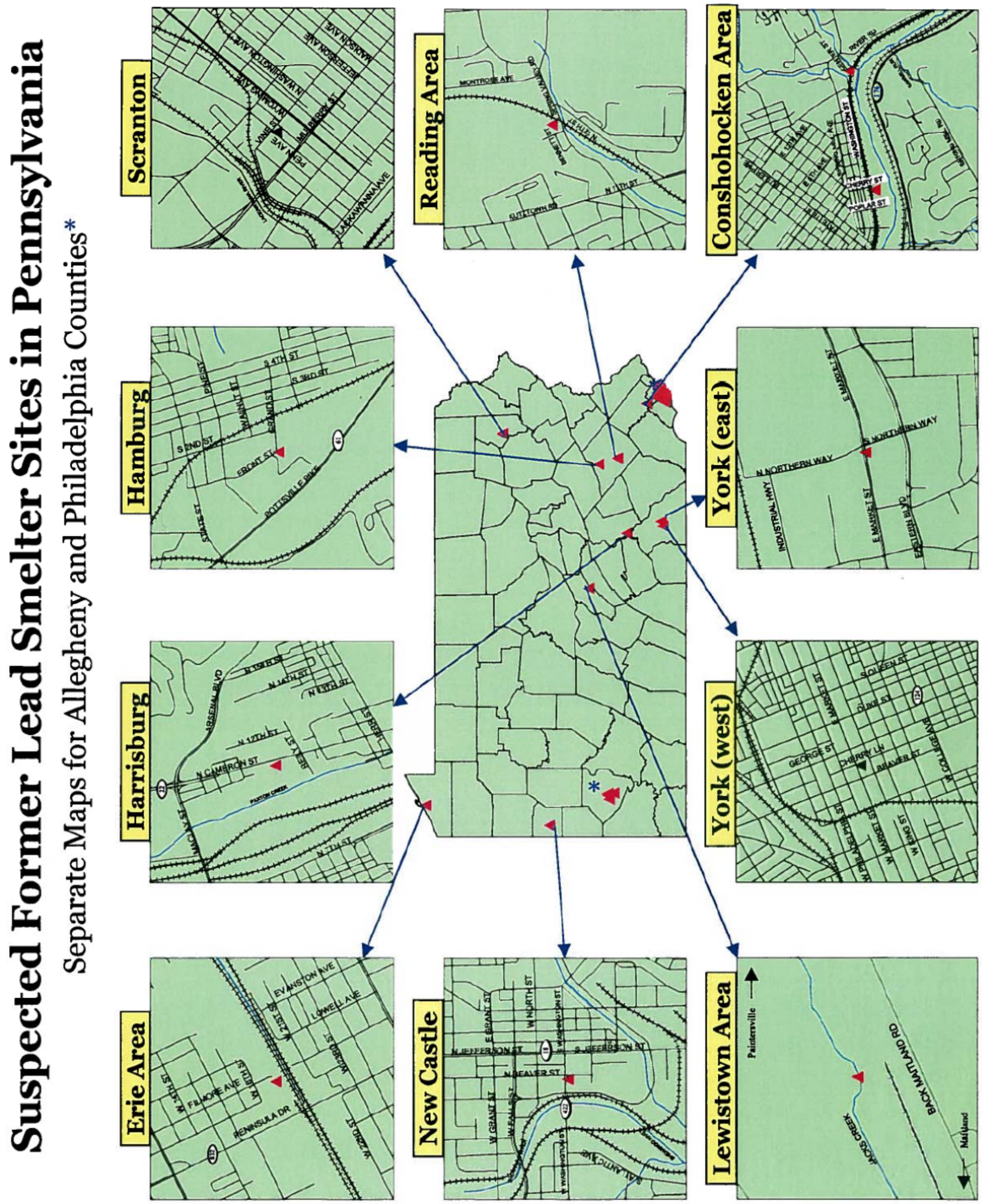
[1] Eckel, William P., M.S., Rabinowitz, Michael B. PhD, and Foster, Gregory D., PhD (April 2001). Discovering Unrecognized Lead-Smelting Sites by Historical Methods, American Journal of Public Health, 91, (4), 625-627.

* This list was designed to identify obscure smelters; smelters currently operating or under remediation may not be listed.

Suspected Former Lead Smelter Sites in Allegheny County




Suspected Former Lead Smelter Sites in Philadelphia County
NEW JERSEY
DELAWARE RIVER
Suspected former lead smelter sites.
* Approximate location, street no longer exists due to redevelopment.
Miles
Map Source: Bureau of Health Statistics and Research, August 2004


Suspected Former Lead Smelter Sites in Pennsylvania
Separate Maps for Allegheny and Philadelphia Counties*
Scranton
Reading Area
Conshohocken Area
Hamburg
York (east)
Harrisburg
York (west)
Erie Area
New Castle
Lewistown Area

4. Health Care Provider Education

Webcast –Grand Rounds in Environmental Medicine: Lead Toxicity

http://www.atsdr.cdc.gov/csem/lead/grand_rounds/

5. Community Health Education Resources

Webcast – Information for the community: Lead Toxicity

http://www.atsdr.cdc.gov/csem/lead/community/

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[i] References for Sources:

U.S. Centers for Disease Control and Prevention (CDC 2009). Lead (web page). Last Updated June 1, 2009. Available online@ http://www.cdc.gov/nceh/lead/tips/sources.htm

Oregon Department of Human Services (DHS) Undated. Available online at http://www.doh.state.fl.us/environment/medicine/lead/pdfs/OregonLeadSources.pdf

New York Department of Health (NYDOH 2010). Sources of Lead. Last updated April 2010. Available online at http://www.health.ny.gov/environmental/lead/sources.htm