Bunker Hill Mining and Metallurgical Complex Superfund Site OU1 2013 House Dust and Blood Lead Data and Risk Management Evaluation

Prepared for:

Idaho Department of Environmental Quality

1410 N Hilton

Boise, ID 83706

Contract 985

Prepared by:

TerraGraphics Environmental Engineering, Inc.

121 S. Jackson St.

Moscow, ID 83843

www.terragraphics.com

August 11, 2015

Contents

Appendices

Figures

Tables

Acronyms and Abbreviations

BHSS	Bunker Hill Mining and Metallurgical Complex Superfund Site
CDC	Centers for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
DOH	Division of Health (Idaho)
HHRA	Human Health Risk Assessment
HHRE	Human Health Remedial Evaluation
HUD	U.S. Department of Housing and Urban Development
ICP	Institutional Controls Program
IDEQ	Idaho Department of Environmental Quality
IDHW	Idaho Department of Health and Welfare
IEUBK	Integrated Exposure Uptake Biokinetic
LHIP	Lead Health Intervention Program
NAS	National Academy of Sciences
NPL	National Priorities List
NRC	National Research Council
OU1	Operable Unit 1-also known as “the Box”
O&M	Operation and Maintenance
PHD	Panhandle Health District
PRP	Potentially Responsible Party
QAPP	Quality Assurance Project Plan
RADER	Risk Assessment Data Evaluation Report
RAO	Remedial Action Objective
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
ROW	right-of-way
RSA	reasonable segregable area
SAP	Sampling and Analysis Plan
TerraGraphics	TerraGraphics Environmental Engineering, Inc.
UMG	Upstream Mining Group
URS	URS Greiner
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

Units

µg/dL	microgram per deciliter
mg/kg	milligrams per kilogram
$mg/m^2/day$	milligrams per square meter per day

Section 1.0 Introduction

1.1 Purpose

The purpose of this report is to provide an update on the status of the risk management strategy for Operable Unit 1 (OU1) of the Bunker Hill Mining and Metallurgical Complex Superfund Site (BHSS). The primary objectives of this report are to evaluate recent house dust and blood lead data relative to a) past data and trends, b) the risk assessment completed for OU1, and c) risk management strategies incorporated as part of the Selected Remedy.

This report is organized as follows:

Section 1 Introduction – provides an overview of the site history, background, and human health selected remedy.

Section 2 Data Evaluation – evaluates the most recent house dust and blood lead data collected in 2013 to provide an update on the current state of children's exposures in OU1. This is the first evaluation since the Remedial Action Objectives (RAOs) were achieved in 2002 with observed blood lead levels, and includes a brief summary of the Lead Health Intervention Program (LHIP), participation rates, and participant follow-ups by the Panhandle Health District (PHD). An Integrated Exposure Uptake Biokinetic (IEUBK) Model (USEPA 1994a) analysis of these recent community exposures and the predicted community mean blood lead levels is also included.

Section 3 Evaluation of Risk Management Strategy – presents RAO achievements, selected remedy accomplishments, and current environmental exposures. It includes a description of ongoing risk management programs through the Institutional Controls Program (ICP) and the PHD.

Section 4 Conclusions and Recommendations – presents summary and recommendations developed in coordination with federal and state agency representatives.

Section 5 References.

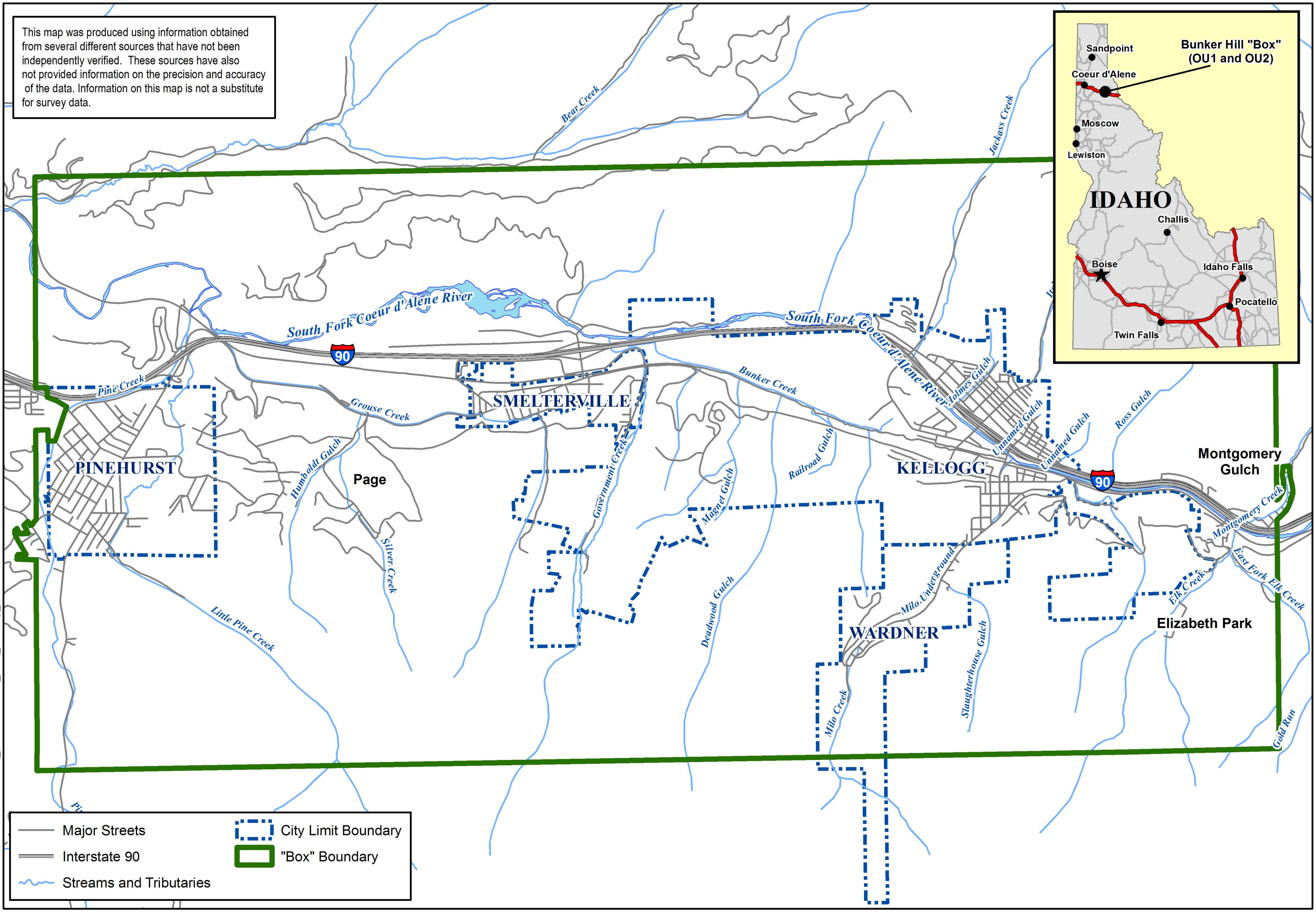
1.2 Site History, Contamination, and Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Activities

The Coeur d'Alene River Basin in northern Idaho has been affected by mining and smelting activities for more than 100 years. Significant deposits of gold, silver, and lead were first reported in the Coeur d'Alene Mining District in 1882. This discovery soon attracted miners who settled several towns in northern Idaho's Silver Valley, which became one of the largest and most productive lead, silver, and zinc areas in the U.S. A few mining companies are still active in the area today.

Heavy metals contamination in soil, sediment, surface water, and groundwater from the years of commercial mining, milling, smelting, and associated modes of transportation has affected both human health and environmental resources in many areas throughout the Site. In 1973, the Bunker Hill Smelter caused widespread particulate lead contamination by continuing to operate after a fire destroyed pollution control systems designed to minimize emission of airborne particulates. During this period, the smelter emitted up to hundreds of tons of particulates per month containing 50-70 percent lead, contaminating surrounding areas (TerraGraphics 1990). Blood lead results from children living closest to the smelter averaged nearly 70 micrograms of lead per deciliter of blood (µg/dL), almost double the Centers for Disease Control and Prevention (CDC) blood lead criterion at that time. Subsequent public health investigations identified particulate lead in soils and dusts as sources of lead exposure to children living near the smelter (Landrigan et al. 1976, Yankel et al. 1977). The primary route of children's exposure to lead was determined to be incidental ingestion of soils and dusts by ordinary hand-to-mouth and play activities (USEPA 2000a, von Lindern et al. 2003a).

The U.S. Environmental Protection Agency (USEPA) placed the 21-square-mile area surrounding the former Bunker Hill Company lead and zinc complex in Kellogg, Idaho on the National Priorities List (NPL, i.e., Superfund) in 1983 as the Bunker Hill Mining and Metallurgical Complex Superfund Site. This 21-square-mile area, which is referred to as "the Box," was divided into two OUs for manageable cleanup. Records of Decision (ROD) were issued in 1991 for OU1, the populated areas of the Box (USEPA 1991), and in 1992 for OU2, the non-populated areas of the Box (USEPA 1992). OU1 includes the cities of Kellogg, Wardner, Smelterville, and Pinehurst, and several smaller unincorporated areas (Figure 1). It is currently home to over 4,000 people (U.S. Census Bureau 2010). A ROD was issued in 2002 for a third OU (OU3), the greater Coeur d'Alene River Basin surrounding the Box (USEPA 2002).

More in-depth background and historical information on site history and sampling and cleanup activities can be found in the OU1, OU2, and OU3 RODs (USEPA 1991, 1992, 2002), the Risk Assessment Data Evaluation Report (RADER, TerraGraphics 1990), the Human Health Risk Assessment (HHRA, TerraGraphics and URS 2001), the Human Health Remedial Evaluation (HHRE) (TerraGraphics 2004b), the National Academy of Sciences (NAS) review of the Basin (National Research Council [NRC] 2005), and the 2010 Five-Year Review (USEPA 2010).



U:\Moscow\Clients\Idaho\Bunker_Hill\MXDs\OU1_OU2_sitemap_letter.mxd

TerraGraphics
Environmental Engineering, Inc.
www.terragraphics.com

Print Date: April 28, 2015	Project Manager: M. Thorhaug	Project Name: Technical Analysis of 2013 House Dust and Blood Lead data	Figure 1
Project Number: 14005-05-03	Requestor: M. Thorhaug		
	Cartographer: B. Bailey		

1:48,000
1 inch = 1 miles
0 0.5 1 Miles

OU1 and OU2 Site Map

1.3 Remedial Action Objectives and Selected Remedy

The primary aim of the BHSS cleanup has been to reduce childhood lead exposures and absorption to meet RAOs. The human health RAOs for the Populated Areas, defined in the OU1 ROD (USEPA 1991), are to reduce the incidence of elevated blood lead levels such that:

i. no more than 5 percent of children in the community would have a blood lead level of 10 μg/dL or greater, and
ii. less than 1 percent of children exceed 15 μg/dL lead.

The long-term strategy to achieve the blood lead RAOs is to remove lead-contaminated surface soils and replace them with clean material, maintain the soil barriers into perpetuity, and stabilize other areas throughout the site, all with the goal to substantially reduce house dust lead levels. House dust has been identified as the primary source of lead intake and subsequent absorption among young children in the Box (PHD 1986)—a finding supported by many subsequent studies of other populations (Lanphear and Roghmann 1997, Succop et al.1998, Manton et al. 2000, Lanphear et al. 2002, Lanphear et al. 2003, Laidlaw et al. 2005). Up to 60–80 percent of lead in interior house dust is estimated to originate from exterior soils (von Lindern et al. 2003a).

Soil and dust action levels and performance standards were developed for the BHSS based on observed site-specific relationships between children's blood lead levels and environmental media lead concentrations. The BHSS was the first site to use the initial version of what became the USEPA IEUBK Model (USEPA 1994a) to develop target cleanup criteria for lead in soil and dust. Based on the original dose-response relationships modeled in the RADER, community soil and dust geometric means of 400–500 milligrams per kilogram (mg/kg) (and threshold cleanup levels of 500–1,000 mg/kg) were estimated to yield a blood lead response of less than 10 μg/dL for 97–100 percent of the childhood population (TerraGraphics 1990).

The risk management strategy defined in both the OU1 and OU2 RODs (USEPA 1991, 1992) is to protect residents through the following:

i. remediate all yards, commercial properties, and rights-of-way (ROWs) that have lead concentrations ≥1,000 mg/kg.
ii. achieve a geometric mean yard soil lead concentration of less than 350 mg/kg for each community in the site.
iii. control fugitive dust and stabilize and cover contaminated soils (which influence house dust) throughout the site in both OU1 and OU2.
iv. achieve geometric mean interior house dust lead levels of 500 mg/kg or less for each community, with interior cleaning of individual homes that have house dust lead levels exceeding 1,000 mg/kg (after completion of remedial actions to address fugitive dust).
v. implement an LHIP to provide personal health and hygiene information to help reduce exposure to metals.
i. establish an ICP to ensure barriers are installed and maintained into perpetuity to prevent recontamination and consequent exposure, provide clean materials and appropriate disposal options for the local communities, and minimize the impact of residual subsurface contamination from community development and the conduct of commerce.

In combination, these efforts were expected to reduce children's lead intake from soils and dusts to sufficiently low levels to meet the blood lead objectives. As of 2002, the RAOs, as measured with observed blood lead data, were met in all OU1 communities (USEPA 2005). Many of the actions outlined as part of the Selected Remedy have been completed and are discussed further in Section 3.0.

Section 2.0 Data Evaluation

This section summarizes and evaluates recent house dust and blood lead data through 2013 and predicted blood lead concentrations under current environmental conditions using USEPA's IEUBK Model.

House dust lead concentrations in home vacuum cleaner bags were monitored in the Box beginning in the 1970s and were used in the risk assessment and dose-response analyses relating children's blood lead levels with environmental lead concentrations. Between 1988 and 2002, the contents of a home's vacuum cleaner were collected as part of the annual door-to-door blood lead screening through the LHIP. Between 1997 and 2002, vacuum bag samples were also collected from Box communities in surveys conducted by the Idaho Department of Environmental Quality (IDEQ) because data from LHIP participant homes may not have been representative of the community at large (i.e., homes with older children or no children, or families that did not participate in the LHIP). Beginning in 1996, door mats (hereinafter referred to as dust mats) were also placed inside homes to assess dust and lead loading rates, in addition to lead concentrations (IDHW 2000). Vacuum and dust mat samples continued to be collected during annual house dust sampling surveys through 2005, and again in 2008 and 2013, because the success of the remedy is based on sustaining house dust lead levels at post-remedial soil levels. The 2013 house dust samples, collected from 279 homes, are the most current dust data available.

In 2013, PHD also conducted the first door-to-door effort since 2002 to increase participation in the annual blood lead screening and obtain data to evaluate the observed blood lead levels 11 years after the RAOs were met. A total of 276 children, or 50 percent of the estimated eligible population, participated in the 2013 blood lead screening program.

2.1 House Dust Lead Levels

This section discusses house dust trends using data through 2013, summarizes the sampling methodologies employed at the BHSS, and evaluates risk co-factors in homes that have elevated house dust lead concentrations equal to or exceeding 1,000 mg/kg. For the remainder of this report, the term "elevated" is used to refer to house dust lead levels greater than or equal to 1,000 mg/kg. The data collected since 2002 have been reported in a number of data summary reports (TerraGraphics 2003, 2004b, 2005a, 2006, 2009, 2014), and the 2005 and 2010 Five-Year Reviews contain additional detail on past trends observed in house dust data from 1988 through 2008 (USEPA 2005, 2010).

A total of 279 homes were sampled for house dust in 2013. In order to assess participation rates in the 2013 house dust sampling survey, an estimate of the number of homes in the Box was derived from the door-to-door blood lead survey conducted by PHD. PHD identified approximately 2,900 residential homes in the Box (Appendix A, Table A-1). Based on this estimate, house dust samples (either a vacuum sample or mat sample, or both) were collected from approximately 10 percent of Box homes in 2013. Between 9 percent and 16 percent of homes were sampled within each Box community.

Dust data summarized in this report include the vacuum and dust mat samples collected from the annual house dust surveys and the LHIP, as well as samples collected for two other studies that utilized the same sampling protocols. “Pre-cleaning” and “12-months post-cleaning” vacuum and dust mat samples from the 2000–2001 House Dust Pilot Project were included. In addition, vacuum and dust mat samples collected from a 2004 U.S. Department of Housing and Urban Development (HUD) study were included (PHD and TerraGraphics 2005). Unless otherwise stated, the higher of a split or duplicate sample pair was used in data summaries.

2.1.1 Sampling Methods

Although lead in house dust is recognized as one of the most significant contributors to children’s lead intake, no dust sampling technique has been accepted as a universal standard. Two interior dust sampling methodologies employed in the Box are i) personal household vacuum cleaners, and ii) dust mats. Vacuum dust samples are useful in determining a general lead concentration inside homes. A vacuum sample is obtained by collecting the disposable bag or the entire contents of permanent bags or bagless vacuums, provided the resident has not used the vacuum in a car, outdoors, or at another house since the bag was last changed. Vacuum samples are logistically easy and inexpensive to collect, although this methodology is largely uncontrolled, subject to the individual’s recall, and biased due to variations in cleaning habits and differences in vacuum cleaner efficiencies.

Dust mat data have been used to evaluate achievement of the OU1 house dust performance standards and assess remedy performance in reducing soil contributions to house dust lead. Dust and lead loading rates provide information on the amount of dust and lead from soils that are tracked into the home during a specified time period. Carpeted mats for dust collection are placed just inside the main entry of participating houses for a prescribed number of weeks, with instructions that the mats not be disturbed or cleaned. The mats are collected and vacuumed in a controlled laboratory to quantify lead concentration and lead and dust loading rates.

The *Final Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP) for the 2013 Property Sampling in the Bunker Hill Mining and Metallurgical Complex Superfund Site* provides additional details on both of these sampling methodologies (IDEQ 2013).

2.1.2 Vacuum Bag Lead Levels (1988 to 2013)

Since 1988, vacuum dust lead concentrations have decreased substantially as exterior soil remediation reached completion (USEPA 2010). In the early 1990s, geometric mean vacuum dust lead concentrations were above 1,000 mg/kg in all communities except Pinehurst (Figure 2). As of 2002, all communities had geometric means below 500 mg/kg lead. Community geometric means continue to remain well below 500 mg/kg in 2013, ranging from 160 mg/kg in Page to 288 mg/kg in Kellogg (Figure 2 and Appendix A, Table A-2). Tables and figures in Appendix A show vacuum lead concentrations over the years.

Through the years, the percentage of vacuum bag samples that exceed 1,000 mg/kg lead has steadily decreased, as did vacuum dust lead concentrations. In 1988, nearly 70 percent of vacuum bag samples collected from Box homes had lead concentrations that exceeded 1,000 mg/kg (Appendix A, Table A-2). Approximately 10 percent of all vacuum bag samples collected each year from 2001 to 2005 were above 1,000 mg/kg lead, decreasing to 5 percent in 2008 and 3 percent in 2013.

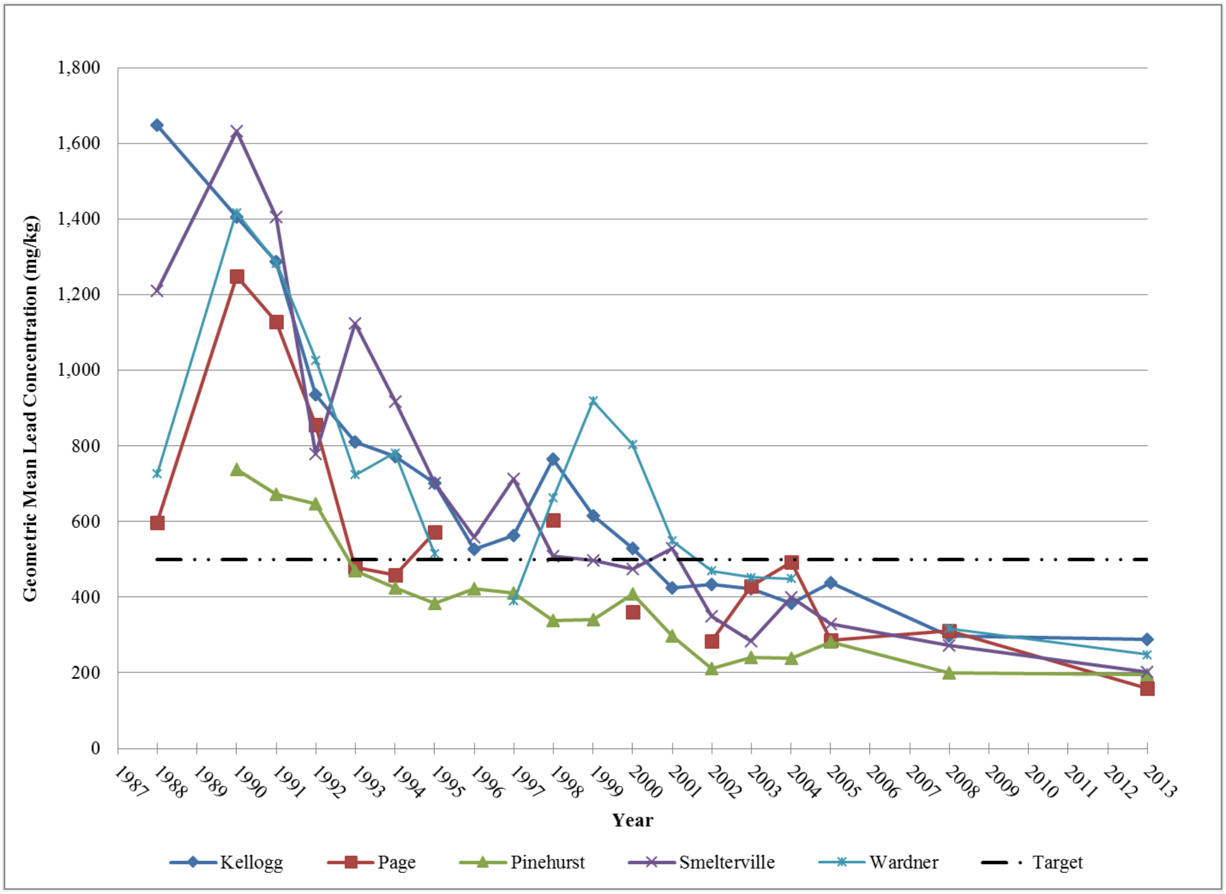


Figure 2. Mean Vacuum Dust Lead Concentrations by Community and Year, 1988–2013

2.1.3 Dust Mat Lead Levels (1996 to 2013)

Dust mat samples provide lead concentrations as well as dust and lead loading rates. Tables and figures in Appendix A show dust mat data over the years.

2.1.3.1 Dust Mat Lead Concentrations

Since dust mat data collection began in 1996, geometric mean dust mat lead concentrations have decreased substantially in each community (Figure 3). Similar to vacuum bag concentrations, a consistent decrease in lead levels has been observed as the soil remedy progressed. From 2002 to 2013, geometric mean dust lead concentrations have been less than 500 mg/kg in all Box communities. In 2013, geometric mean dust lead concentrations ranged from 151 mg/kg in Pinehurst to 322 mg/kg in Kellogg (Appendix A, Table A-3).

As geometric mean dust mat lead concentrations in the Box have decreased, so has the percentage of dust mat samples equal to or greater than 1,000 mg/kg lead. Almost 50 percent of samples in the Box were above 1,000 mg/kg lead in 1996 through 1998 (Appendix A, Table A-3). This percentage dropped to between 20 and 35 percent in 1999 through 2001 and has fluctuated between 3 and 8 percent from 2002 through 2013.

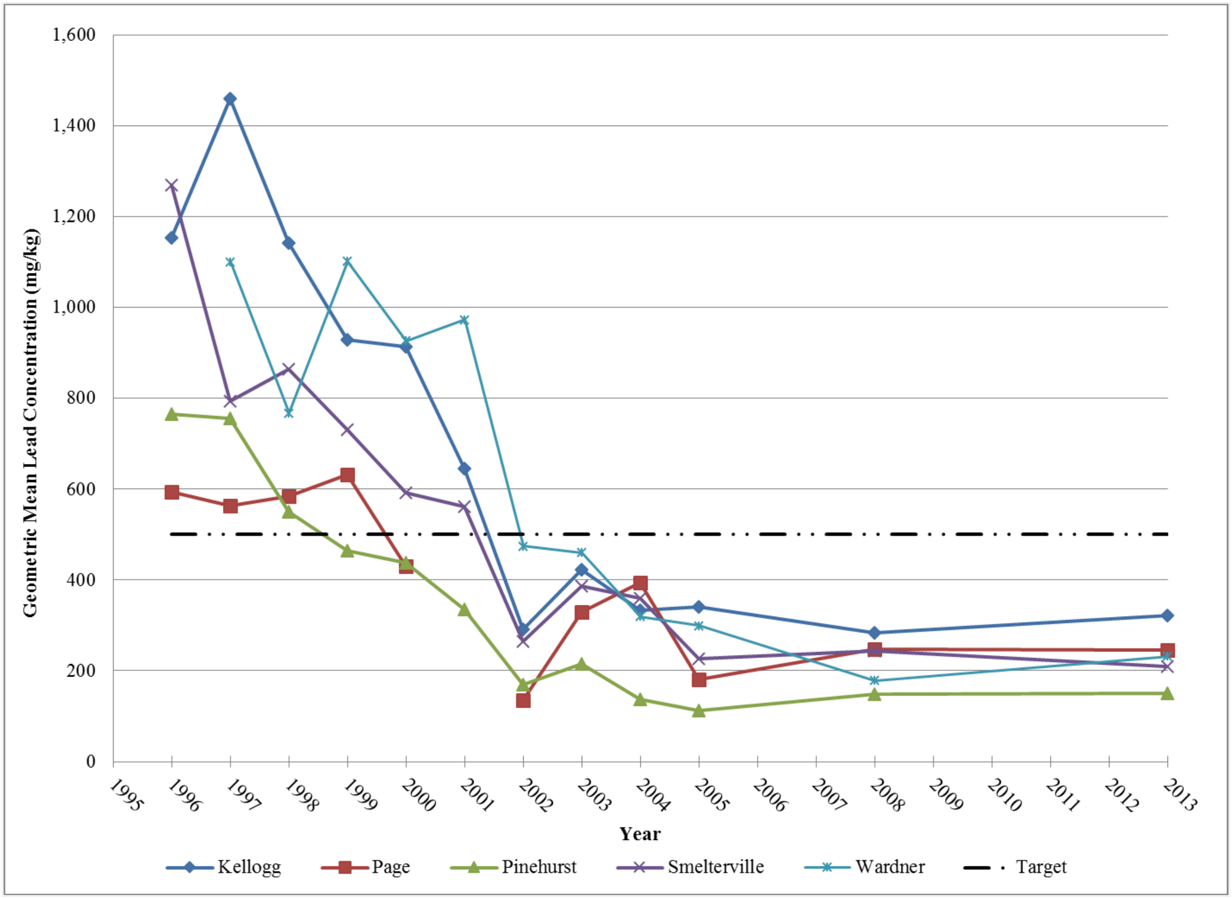


Figure 3. Mean Dust Mat Lead Concentrations by Community and Year, 1996–2013

2.1.3.2 Dust and Lead Loading Rates

In general, geometric mean dust loading rates have remained similar over time (Figure 4), but the amount of lead being tracked into homes has decreased (Figure 5) due to the reduced lead concentrations in remediated outdoor soils. By 2002, geometric mean lead loading rates were at an all-time low for the larger communities, near 0.1 milligrams per square meter per day (mg/m^2/day) (Appendix A, Table A-4). Since then, geometric mean lead loading rates have remained similar and in 2013 were 0.16, 0.12, and 0.07 mg/m^2/day in Kellogg, Smelterville, and Pinehurst, respectively. Page and Wardner have too few samples to assess trends. The 2013 Page results are influenced by one extremely dusty mat.

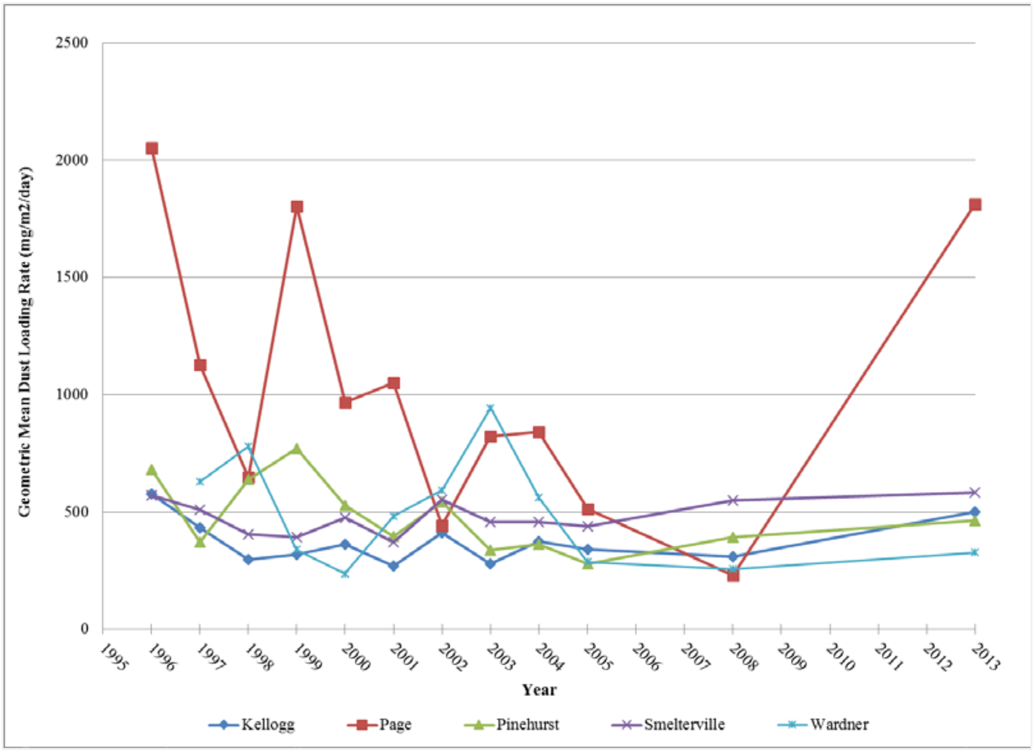


Figure 4. Mean Dust Loading Rates, 1996–2013

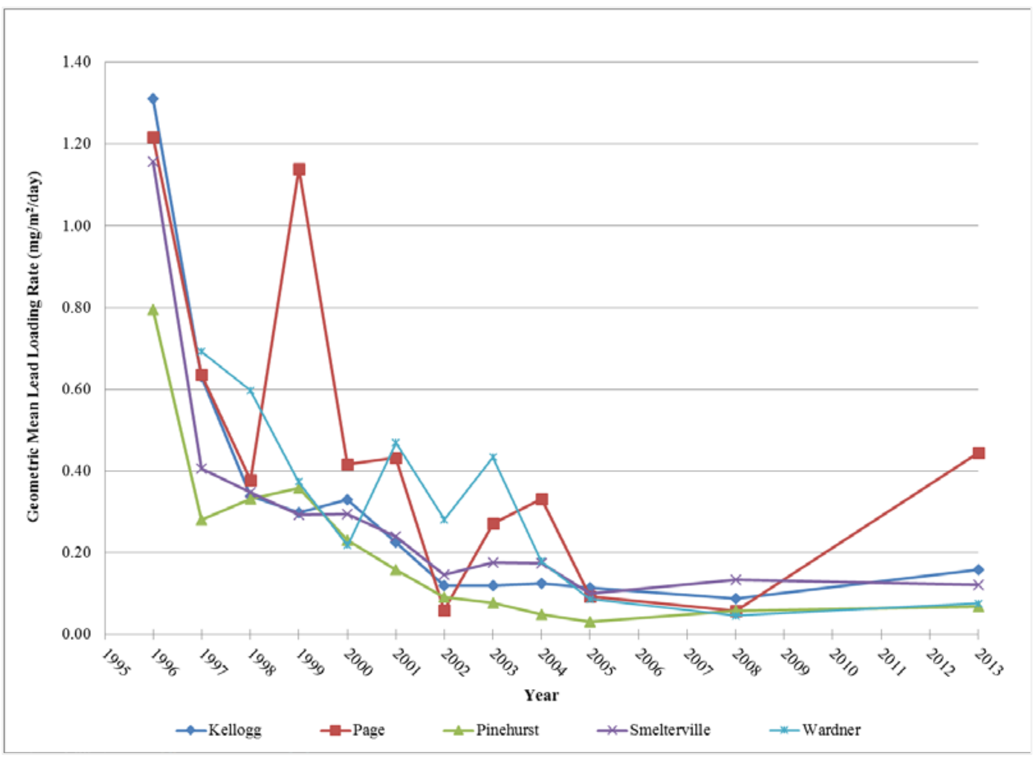


Figure 5. Mean Lead Loading Rates, 1996–2013

2.1.4 Dust Sampling Methodology Relationships

Past analyses using paired vacuum and dust mat lead concentrations obtained from the same home indicated that, in general, the two sampling techniques' results have a linear relationship and are well correlated, although they provide different information about dust inside a home (TerraGraphics 2005b). The trend observed from paired data between 1996 and 2005 showed dust mat lead levels were generally higher than the vacuum bag lead levels from 1996 until 2002. Yard remediation throughout the communities was still underway in the Box during these years, and therefore, higher dust mat concentrations were expected due to contaminated exterior soils. In 2002, mean vacuum bag concentrations were higher than mat concentrations and statistically different (p value was less than 0.05, paired t-test, TerraGraphics 2008). A new dust mat model was first used in 2002 because the previous model had been discontinued. A portion of the observed decrease in mat lead concentrations in 2002 may be an artifact of the change in mat type. A comparison of the mat models' performance indicated that the new mat retained more lead mass than the previous mat (TerraGraphics 2005b).

From 2003 through 2005, mat and vacuum bag results in the Box converged to similar levels, and paired data were no longer significantly different (p values were greater than 0.05, paired t-test, TerraGraphics 2008). This was expected, since yard remediation was winding down. By 2005, most yard soils had been remediated, and in 2008, USEPA certified remediation was complete. Additionally, two studies on background house dust levels in communities unaffected by mining (outside the Box) revealed that mat and vacuum bag lead concentrations showed no significant difference (Spalinger et al. 2007, PHD and TerraGraphics 2005).

The 2008 and 2013 paired dust data were evaluated for this report, and similarly, Boxwide lead concentrations were not significantly different between the two sampling methodologies, (Appendix A, Table A-5). This indicates that the exterior soils and interior dusts are still in equilibrium and the remedy is functioning as intended. Although lead concentrations are highly correlated and show no significant difference between the two sampling methods, they do not always provide the same results in identifying individual homes that have elevated dust lead levels.

Homes that had both a vacuum and a dust mat sample collected in the same year (from 2002 through 2013) and at least one sample result above 1,000 mg/kg lead were reviewed to determine whether a home with an elevated vacuum result would also have an elevated mat result and vice versa. Between 2002 and 2013, a total of 71 homes had both a vacuum and a mat sample collected during the same year and had at least one elevated dust lead result (Figure 6). Of these homes, only 17 percent (12 homes) had both a vacuum and mat result greater than or equal to 1,000 mg/kg lead in the same year (ranging from 0 to 40 percent, depending on the year). In general, homes that were identified as having elevated dust lead concentrations had only a high vacuum sample (49 percent), as opposed to only a high mat result (34 percent). It is difficult to conclude if one sampling method is better than the other to identify homes with elevated dust lead levels.

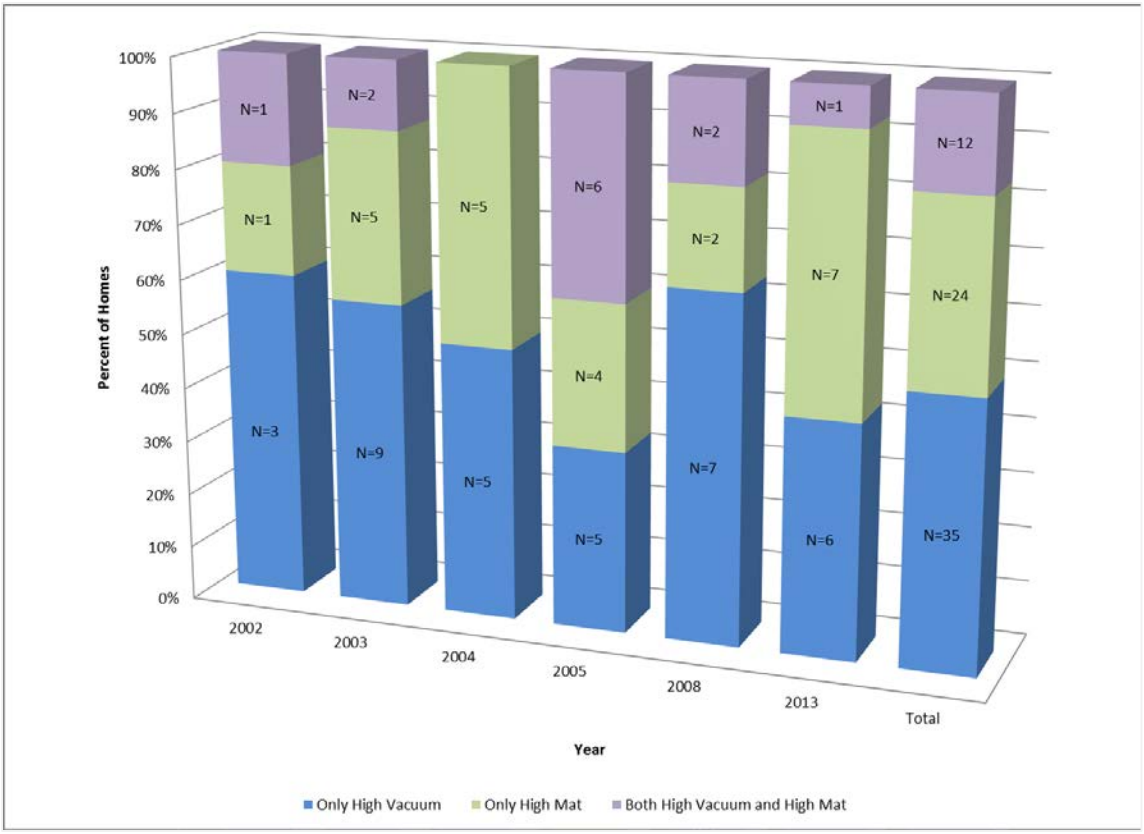


Figure 6. Homes Identified to Have Elevated Dust Lead Levels by Sampling Methodology

2.1.5 Homes with Elevated Dust Lead Concentrations

Although the community-wide house dust target of 500 mg/kg was achieved in all communities by 2002, some individual homes continue to show lead levels equal to or greater than 1,000 mg/kg lead (by either sampling method). As remediation continued and was completed throughout the site, the number and percentage of homes with elevated dust lead levels decreased (Table 1). From 1988 through 2000, 25 to 75 percent of Box homes had elevated dust lead concentrations. Since 2001, less than 20 percent of all sampled homes had an elevated dust lead result, decreasing to 5 and 6 percent, respectively, in 2008 and 2013 (Table 1). By extrapolation, approximately 175 (6 percent) of the estimated 2,940 homes in the Box may have elevated house dust lead concentrations.

The following subsections summarize the analyses that were completed to try to understand why some homes continue to exhibit elevated dust lead levels, even though residential remediation in the Box has been certified complete for more than five years.

Table 1. Number of Homes with Elevated House Dust Lead Concentrations

Year[a]	Number of Homes Sampled[b]	Homes with Dust Lead Concentrations ≥ 1,000 mg/kg[c]	
		Number	Percent
1988	74	52	70%
1990	132	76	58%
1991	132	74	56%
1992	158	65	41%
1993	138	43	31%
1994	136	44	32%
1995	113	28	25%
1996	122	42	34%
1997	296	155	52%
1998	473	242	51%
1999	370	142	38%
2000	392	130	33%
2001	321	57	18%
2002	362	29	8%
2003	367	42	11%
2004	343	30	9%
2005	199	23	12%
2008	277	15	5%
2013	279	17	6%

[a] Six homes sampled in 2006 are not displayed due to small sample size.
[b] Total number of homes where a vacuum or mat sample was collected and a result is available (this excludes rejected or insufficient samples).
[c] Number of homes where either the vacuum or mat sample, or both is elevated.

2.1.5.1 Remediation and Elevated Dust Lead Concentrations

The influence of remediation on house dust lead concentrations has been evaluated and discussed in previous reports (von Lindern et al. 2003b, TerraGraphics 2008, USEPA 2010). In general, interior dust lead concentrations are influenced by both community soils and an individual home’s yard soil. As expected, a higher proportion of homes requiring remediation had elevated dust lead levels in multiple years (40 percent) and every single year a dust sample was collected (14 percent) in comparison to homes that did not require yard remediation (24 percent and 4 percent, respectively, TerraGraphics 2008). However, after remediation occurred, more than half the homes still had elevated house dust lead concentrations, indicating the influence of community soils and/or other factors.

Community mean house dust lead concentrations largely paralleled the community mean soil concentrations as the soil cleanup progressed. Geometric mean vacuum bag and dust mat lead concentrations generally decreased between 1988 and 2005 (for vacuums) and 1996 and 2005 (for mats), regardless of a home’s remediation status. However, there was an apparent lag time for dust lead levels equilibrating with outdoor soil lead content (TerraGraphics 2004a).

An analysis for this report was completed to further examine the potential impact of soil remediation on house dust lead concentrations. House dust data from 1988 through 2013 were merged with the year of yard remediation, the source of which is the Upstream Mining Group's (UMG) soil remediation database. Each dust result was assigned a number based on the years elapsed since yard remediation was complete relative to collection of the sample. For example, a dust sample was assigned a "5" if a home was remediated in 1999 and the dust sample was collected in 2004. Dust samples that were collected prior to remediation or during the same year as remediation were assigned a "0."

Dust samples were excluded if they were collected from homes that refused soil remediation, did not require yard remediation (i.e., yard soils were below the soil removal action level), or were built recently and developed under the guidance of the ICP. Remediation information was not available for all homes where a dust sample had been collected; three reported addresses could not be located and verified, so remediation years could not be assigned, and these records were excluded.

The percentage of homes with elevated vacuum sample lead concentrations dropped dramatically over the first five years after individual yard remediation (Figure 7). Nearly 50 percent of homes had elevated lead results prior to or during the same year as yard remediation. This percentage decreased to approximately 20 percent five years after remediation and continued to decline. After 18 years post-remediation, no homes exhibit elevated vacuum sample lead concentrations, although the number of homes that have been sampled 18 years or more after remediation is relatively low.

The percentage of homes with elevated mat lead sample concentrations follows a trend similar to vacuum samples, decreasing as the length of time post-remediation increases (Figure 7), although the decline is not as consistent as with vacuum samples. This may be because mat samples are more indicative of exterior soil/dust that enters the home and may be more impacted by personal habits and activities as well as other events affecting clean barriers.

These findings support the observation that soil remediation lowers house dust lead levels, but the effect is gradual, most likely due to the influence of community and neighborhood soils (TerraGraphics 2004a). Additional factors likely complicate these findings due to the various activities occurring throughout the cleanup such as increased homeowner awareness and education. In order to account for the potential lingering effects of contaminated yard, community, and neighborhood soils and potential confounding factors on interior dust lead concentrations, vacuum and dust mat results that were collected within five years of yard remediation were excluded in the analyses described in sections 2.1.5.2 and 2.1.5.3.3.

It is important to note that the remediation year was assigned based solely on soil remediation of the yard at a home. All areas of a property were remediated if the yard soil sample exceeded 1,000 mg/kg. If a yard soil sample result was below the cleanup action level, then discrete areas of the property, such as a gravel driveway or play area, were sampled and remediated if necessary. Consequently, some of the homes classified as "did not qualify for remediation" may actually have had one or more discrete areas that required remediation. This may possibly explain some of the elevated dust lead concentrations seen in certain homes described in this section. However, due to the nature of the database, discrete soil sample results were not systematically evaluated for this report.

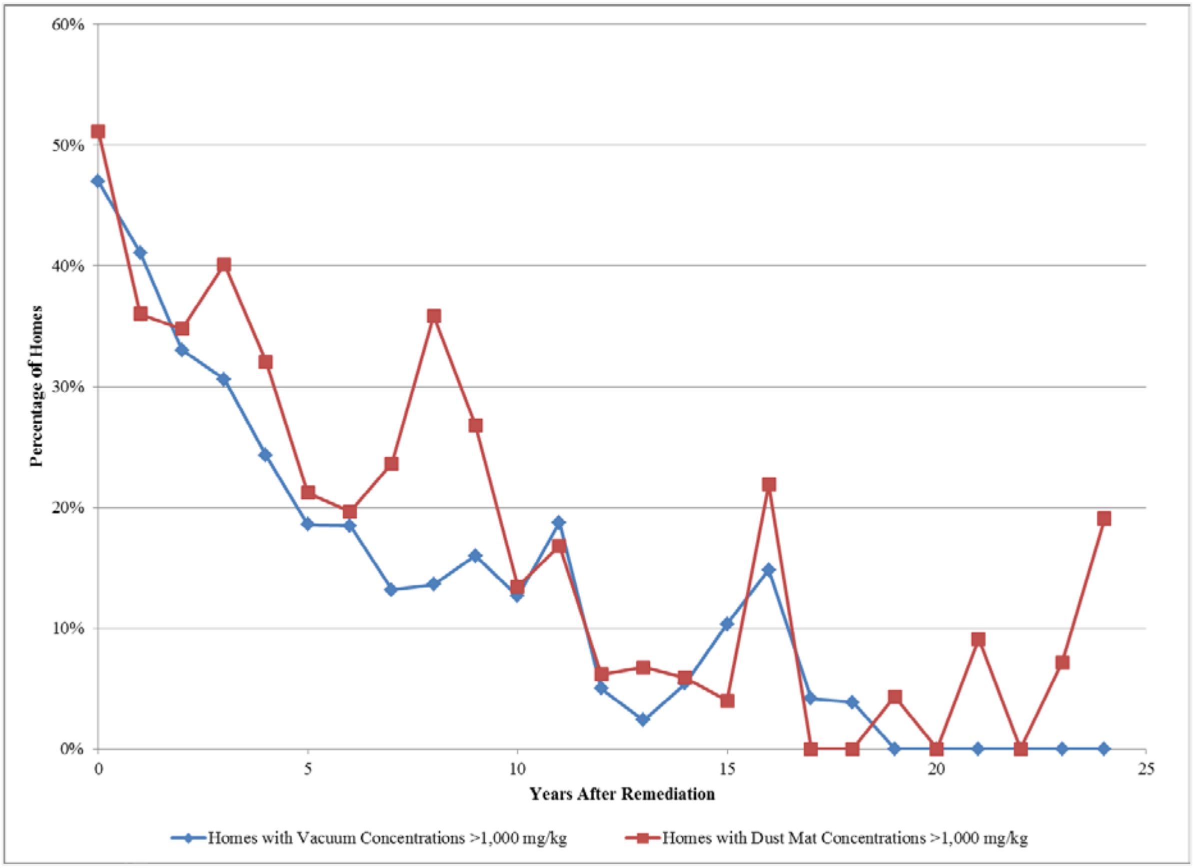


Figure 7. Percent of Homes with Dust Lead Concentrations ≥ 1,000 by Number of Years After Remediation

2.1.5.2 Elevated Dust Lead Concentrations at Homes Sampled Multiple Times

A review of data from homes sampled in multiple years indicates that elevated dust lead concentrations within a home are not consistent over time (TerraGraphics 2005b, 2008). An analysis conducted using dust results from 1988 through 2005 showed that approximately half of the homes sampled multiple times since yard remediation (48 percent) had two or more years of elevated results (six or more years after the yard was remediated), and approximately half (52 percent) of the homes had a high sample in only one of the years (TerraGraphics 2008). Approximately 17 percent of homes that were sampled multiple years after remediation had a high result every year a sample was collected.

A similar analysis was conducted for this report using available dust data from 1988 through 2013. Dust results from homes that did not require yard remediation or that underwent yard remediation at least six years before the dust sample(s) were collected (as per Section 2.1.5.1) were included in this analysis. A total of 255 homes met these criteria, were sampled in at least two different years, and had at least one high vacuum and/or mat sample result (or both).

Of these homes, 66 percent (169 homes) had a high sample in only one year and had at least one low dust result in a previous or later year (and may also have had a low result the same year as the high result if both a vacuum and mat sample were collected). Thirty-three percent (86 homes) had a high dust sample in multiple years (and may have had one or more low results in previous, the same, or later years). Of the 86 homes with multiple high results, 26 homes had a high result every year they were sampled; however, this is only 10 percent of the 255 homes evaluated. These 26 homes are further reviewed in Section 2.1.5.3.3 in order to evaluate the factors that might cause consistent elevated house dust concentrations in these homes.

2.1.5.3 Risk Co-factors and Elevated Dust Lead Concentrations

During each house dust survey, questionnaires are administered to participants when the dust mat is retrieved. Several of the questions represent potential risk co-factors that could influence lead concentrations and dust and lead loading rates in the home. The questionnaires include multiple-choice questions to be answered by participants and a section completed by the interviewer upon inspection of the home. The questions cover information about house age; house occupation time; general conditions of the home, yard, play areas, and other surrounding areas; the number of residents; residents' habits, activities, and occupations; the number and habits of pets; and detailed information about the treatment of the dust mat while inside the home.

Recall and self-selection bias, both inherent in a questionnaire for a voluntary survey, limit interpretations. Recall bias occurs when the respondent's memory affects their ability to accurately answer a question. Self-selection bias may occur with voluntary studies when participation rates are low. A participant's decision to participate could be related to traits that affect the survey. For example, individuals that are concerned about lead levels in their home may be more likely to participate in the house dust sampling program and may also be more likely to have above average hygiene, which might reduce lead concentrations. Despite these potential biases, several analyses have been conducted using these questionnaires to evaluate potential risk co-factors.

2.1.5.3.1 Summary of Previous Questionnaire Analyses

Several Box reports have evaluated questionnaire factors to assess their influence on dust and lead loading rates and lead concentrations. Combined questionnaire and environmental data from 1998 indicated that house age was identified as a probable factor influencing interior house dust lead content (von Lindern et al. 2003b). Several socio-economic and demographic factors (e.g., owner/renter status, number of people living in the house) were related to house dust and lead loading rates. Socio-economic status seems to play a complex role in dust loading rate relationships. In the presence of active sources of lead (e.g., contaminated soils or paint), socio-economic factors contributed to higher lead loadings in house dust. People's habits and activities (e.g., number of hours spent outside by children, recreational activities, entry precautions, number of pets), yard grass cover, and general household hygiene were also significant factors affecting dust loading rates. As expected, paint condition was related to dust and lead loading rates inside the house, although this was confounded by home condition, hygiene, and socio-economic status. Analysis of occupational effects on dust and lead loading rates lacked sufficient responses to determine statistical significance.

The 1999–2004 questionnaire data were evaluated to determine why individual homes continued to show elevated dust lead concentrations (TerraGraphics 2005b). Results from questionnaires for homes with elevated house dust lead concentrations indicated that personal habits, hobbies and/or lead-based paint may be influencing the elevated concentrations. However, in most cases, the cause of elevated lead concentrations could not be definitively determined.

The dust mat questionnaire was revised prior to the 2005 house dust sampling program in response to recommendations and a literature review of risk factors influencing house dust lead concentrations (TerraGraphics 2005b). Using the 2005 questionnaire results, qualitative comparisons were made between homes with elevated house dust lead concentrations (either in vacuum bag or dust mat or both) and those with house dust concentrations <1,000 mg/kg. Overall, homes with elevated dust lead concentrations were older than homes with dust lead concentrations <1,000 mg/kg. A larger percentage of homes with elevated dust lead levels were occupied by renters (rather than owners), had been flooded (mostly prior to 1999), had been recently remodeled, or had residents that participated in dirt biking/four wheeling, mountain biking, camping, fishing, and other activities, compared to homes that were below 1,000 mg/kg lead.

2.1.5.3.2 2005 to 2013 Dust Mat Questionnaire Summary

Two analyses were conducted for this report using questionnaire data from 2005, 2008, and 2013 to attempt to identify the sources and co-factors influencing house dust lead levels: 1) a comparative analysis evaluating the frequencies of responses between homes that have elevated dust lead concentrations and those that do not, and 2) exploratory regression analysis. The questionnaire is included in Appendix B.

Comparative analysis: Questionnaire responses from 52 homes with elevated house dust concentrations were compared to those from 641 homes where house dust concentrations were less than 1,000 mg/kg lead. Based on this review of response frequencies, few factors appear to be associated with a higher likelihood of elevated dust lead levels (Appendix B, Table B-1). A few questionnaire factors that previously indicated a relationship with lead concentration or loading rates continue to show higher responses for elevated homes, such as the condition of exterior paint and the age of the house (Appendix B, Figure B-1). A few additional factors appear to be associated with elevated dust lead levels, including remodeling activities (when remodeling occurred and whether it included exterior sanding) and the presence of lead-based paint within the home based on participant response (Figure B-1). However, these same co-factors were also common responses among homes with lead levels less than 1,000 mg/kg and do not necessarily indicate that a home will have a high lead concentration.

Exploratory regression analysis: Linear regression techniques were applied as an exploratory analysis to identify questionnaire factors that have the most influence on dust lead levels. A forward stepwise regression (SAS software V8® PROC REG) selected a subset of factors that may be best suited for multiple regression models for mat and vacuum lead concentrations (Appendix B, Tables B-2 and B-3). The selected variables for each dust sampling method were then applied to the respective multiple regression model. As an exploratory tool, the multiple regression analysis is not intended to produce a predictive model. A detailed description of this analysis is included in Appendix B.

Both regression models (mat concentration and vacuum concentration) were significant, but the models do not explain much of the variability in lead concentrations (Appendix B, Tables B-4 and B-5). The use of categorical variables from observational data is not expected to fully explain the variability in lead concentrations. The following variables were significant (p-values < 0.05) in the models:

- Mat lead concentration:

  - Total number of people living in the home
  - Total number of recreational activities in which any members of the household partake
  - Interior paint condition
  - Forced air heating or cooling
  - Whether the home was built prior to 1960
  - Whether the ground immediately surrounding the residence had been flooded
- Vacuum lead concentration:
  - Whether the home was built prior to 1960
  - Total number of recreational activities in which any members of the household partake
  - Exterior paint condition

These questionnaire variables significantly explain some variability in lead concentration, albeit to a small extent (less than 15% of the variation is explained by these models).

The house dust questionnaires have been useful tools in evaluating risk co-factors and have provided helpful information to PHD during follow-ups, but fewer homes now have elevated dust lead concentrations. The questionnaires contain numerous questions that are time-consuming for participants to answer. Additionally, PHD attempts to follow up with residents of homes with high dust lead concentrations and administers another questionnaire containing similar questions. From a practical and logistical viewpoint, the utility of the questionnaires collected at the time of dust mat sampling may be decreasing. The analyses completed for this report also indicate that only a few variables are risk co-factors, and questionnaire responses alone rarely identify a home with elevated dust lead concentrations.

It is recommended that the house dust questionnaire be modified in coordination with PHD before the next sampling effort, and the number of questions be reduced to save time and effort at the time of dust mat sampling. Questions pertaining to mat placement and condition, questions that may cause bias due to participant recall, and the significant factors identified in the regression analyses should be retained in the dust mat questionnaire. Questions ultimately removed from the dust mat questionnaire should be reviewed and added to PHD's follow-up questionnaire if they are more pertinent to follow up due to elevated lead results.

2.1.5.3.3 Questionnaires from Homes with Consistently Elevated Dust Lead Concentrations

In general, a home sampled over multiple years may not consistently have elevated dust lead concentrations, as discussed in Section 2.1.5.2. However, some homes consistently exhibit elevated interior dust lead concentrations, even though the yard soils have either been remediated or did not require remediation (i.e., they were below the action levels). A total of 26 homes with vacuum and/or mat dust samples collected in more than one year (at least six years after yard remediation occurred, if remediation was required) had elevated results every year the home was sampled for dust. An anecdotal review of the questionnaires from these homes was conducted to assess if the answers might help explain why dust concentrations in these homes are consistently above 1,000 mg/kg lead.

Twenty-two of the 26 homes had remediated yards. At the four remaining homes, remediation occurred in one or more discrete areas (but did not occur in the yards). These four homes were excluded from further analyses because it is unknown for how long these soils might potentially cause elevated dust lead results after discrete remediation occurred (whereas it appears that most of the lingering effects at homes where yard remediation occurred dissipated by six years post-remediation). The remaining 22 homes were spatially examined, including their locations compared to other homes that do not exhibit consistently high dust results, their distance from the historical smelter, whether they are along a stream, and their proximity to hillsides. There were no obvious spatial trends except for their proximity to hillsides (where contaminated material may slough off or become fugitive dusts). Nineteen of the 22 homes are located within 0.2 miles of hillsides, and 68 percent are located within 0.1 mile of hillsides. However, a large number of homes in the Box are located near hillsides and many do not show consistently high interior dust lead concentrations.

Questionnaires were not available for every year each home was sampled (for example, one home had five years of high results but only one available questionnaire). One home had no available questionnaires from the years with high dust results and was excluded from further analysis. Of the 21 homes with at least one available questionnaire, one home had high results all five years it was sampled, two had high results all four years sampled, three had high results all three years sampled, and the majority (15) had high results both of the two years they were sampled. A majority of the homes (15) had at least one dust sample (either mat or vacuum sample) with a low result. This is not surprising because when both a vacuum and a dust mat sample are collected in the same year from the same home, it is rare for both results to be above 1,000 mg/kg lead (described in section 2.1.4), which adds complexity when reviewing the factors that might cause high results. In addition, none of the 21 homes had the same residents in every year.

When reviewed in aggregate, the 21 homes have some factors in common. The majority of them (85 percent) were built before 1960 (although many homes in the Box were built prior to 1960). More than 60 percent of them had participants who responded in at least one year that they owned more than two pets, did not remove shoes inside the homes, recreated in the BHSS, and participated in activities that may be related to dust and/or lead loading. About 50 percent of the homes had remodeling occur in recent years. Less than a third of the homes were observed to have poor interior or exterior paint, mostly dirt yards, dusty surrounding areas, or poor hygiene in one or more years. Few of the homes had participants respond in at least one questionnaire that flooding occurred in recent years or that a resident was employed in one of the occupations listed on the questionnaire.

There are no obvious trends in the sample types or sample years for the homes that have repeated elevated house dust concentrations (Appendix A, Table A-6). Three homes had elevated results for every mat sample analyzed, with low paired vacuum results, suggesting exterior sources of lead. Similarly, three homes had elevated results for every vacuum sample analyzed, with low paired mat results, which may indicate interior as opposed to exterior sources. Questionnaire responses from all six of these homes indicate several potential exterior and interior sources.

This data review did not identify obvious causal factors for consistent elevated house dust lead concentrations in the 21 homes assessed. Multiple lead sources that potentially contribute to interior dust lead levels still exist in the Box: lead-based paint; contamination remaining under barriers in the community; contamination at recreational areas such as hillsides, mine sites, and the river; and/or reservoirs of mining-impacted dust in attics, basements, crawlspaces, and/or carpets.

2.2 Blood Lead Levels

This section summarizes trends in blood lead data, focusing on the data collected in 2013, and includes a brief history of how and why the data were collected, a description of the LHIP, and a review of participation in the 2013 LHIP blood screening. The HHRE provides additional details on the history of blood lead levels and health responses conducted in the Box as well as documented RAO achievement (TerraGraphics 2004a). This report documents the status of observed blood lead levels since the HHRE, 11 years later.

2.2.1 Lead Health Intervention Program

Biological monitoring and health response activities have been ongoing in the Box for over thirty years (IDHW 1976, Yankel et al. 1977, PHD 1986, JEG et al. 1989, TerraGraphics 1997, TerraGraphics 2001, von Lindern et al. 2003a). Health intervention activities were initiated among families identified in the 1983 Lead Health Study (PHD 1986). Those efforts were formalized as the LHIP in 1985. Since 1985, the LHIP has served as an interim risk management strategy to minimize lead exposure through non-engineering means as the investigation and remedial action phases of the Superfund project continued.

Lead health intervention activities have been designed to intervene in lead absorption pathways through biological monitoring follow-up, parental awareness and counseling, education, and behavior modification. The LHIP has been conducted by the local PHD.

Annual voluntary blood lead screening of children between six months and nine years old and follow-up with those exhibiting high lead levels have been conducted each year from 1985 to the present. An aggressive door-to-door solicitation approach was conducted from 1985 to 2002 in order to maximize the identification and monitoring of eligible children. Beginning in 1988, a monetary incentive was offered to each participating child, paid at the time of the blood draw to encourage participation.

Annual door-to-door solicitation occurred in July or August. The PHD trained and hired local residents to contact each home in the site. Participating families completed a questionnaire, and appointments for blood drawing were scheduled at the local hospital. At residences where no one was at home, a minimum of two additional contact attempts were made during the survey period. If residents were still not contacted, a written notice was left informing residents of the survey. More than 40 percent of the estimated child population was tested each year (discussed further in Section 2.2.1.1). Venous blood lead screening was used from 1988 until 2002, when capillary blood lead testing was adopted. From 2002 through 2011, confirmatory venous samples were collected if a capillary result was greater than or equal to 8 µg/dL; in 2012 this threshold was lowered to 5 µg/dL in response to CDC recommendations (CDC 2012).

PHD discontinued door-to-door LHIP blood lead surveys in 2003, after the OU1 blood lead RAOs were achieved in 2002 (TerraGraphics 2004a). Instead of active solicitation and financial incentives, residents were notified of the annual screening via mailings and advertisements, and blood lead testing was done at a fixed site. Participation rates dropped significantly and less than twenty children were tested each year. In 2013, USEPA, PHD, and IDEQ reinstituted the door-to-door survey and incentive program for one year to increase participation and help inform the regulatory agencies about the status of current exposures, 11 years after observed blood lead levels had dropped to below the RAOs.

2.2.1.1 Annual Blood Lead Survey Participation Rates

Participation rates for the annual blood lead surveys from 1988 through 2002 were assessed in the HHRE (TerraGraphics 2004a). During that period, blood samples were obtained from approximately 50 percent of the total estimated eligible population. Repeat participation was high, with approximately 50 percent of children having participated in the preceding year. From 2003 to 2012, annual participation decreased from approximately 200 to400 children to 20 or fewer children each year.

The 2013 LHIP door-to-door survey identified an estimated total of 502 children residing in the Box (based on consenting participants, refusals, and information from neighbors or site observations to determine if children lived at homes where no contact was made), which is within 10 percent of the estimated number of children between 6 months and 9 years (555) based on school enrollment data, described in Appendix C.

Blood lead samples were obtained from 276 children, or 50 percent of the estimated eligible population (Figure 8). This is similar to participation rates from 1990 through 1998, which averaged 50 percent or more. Although the participation rate is similar to previous years, the number of children residing in the Box has continued to decline since 1990. Between 1989 and 1998, child population estimates ranged from 729 to 871, dropping to 685 between 1999 and 2002 (TerraGraphics 2004a). In 2013, there were approximately 130 fewer eligible children than in 2002 and 300 fewer than at the peak of population estimates in 1990.

In 2013, a substantial number of families reported that they had lived at their current address for less than a year, which confounds participation rates and any exposure analysis. Nearly half of participating children in Kellogg and Smelterville resided at their current address for less than one year, with approximately 27 percent of participating children residing at their current address for less than six months in both cities (Table 2).

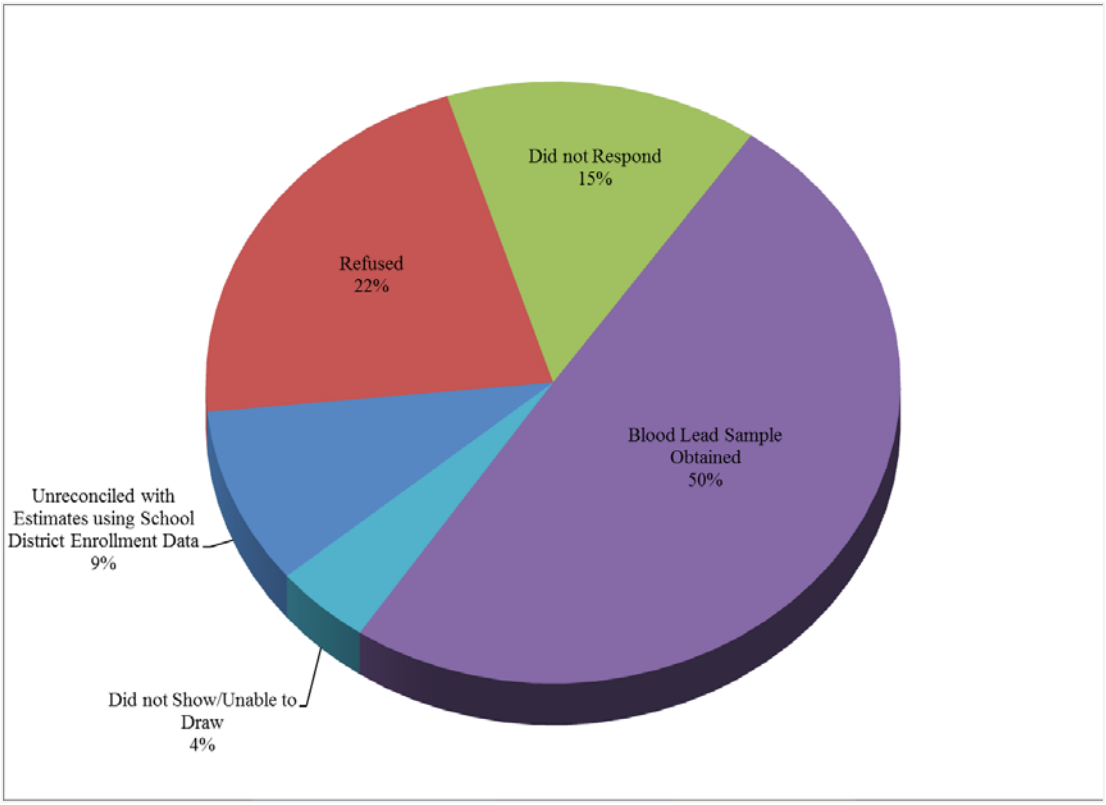


Figure 8. Participation in the 2013 LHIP Blood Lead Survey

Table 2. Length of Time at Residence for Blood Lead Survey Participants

City	Number of Participants	Percent Living at Residence for less than 6 months	Percent Living at Residence for 6 months to 1 year	Percent Living at Residence for more than 1 year
Kellogg	147	27%	17%	56%
Page	6	17%	0%	83%
Pinehurst	68	4%	10%	84%
Smelterville	45	27%	20%	53%
Wardner	10	0%	40%	60%

2.2.1.2 Participation Refusal

The LHIP is a public health service and a voluntary program. When incentive payments are used, 50 percent or more of the estimated eligible child population participates and less than half does not for various reasons. The 50 percent participation rate substantially reduces the potential for selection bias.

Prior to 2003, approximately 20 percent of children refused to participate, and 4 percent failed to respond to repeated solicitations (TerraGraphics 2004a). In 2013, the percentage of refusals is similar (22 percent), but a higher estimated percentage of children were from homes who failed to respond to repeated solicitations (15 percent). A review of the surveyors' notes indicated the most common reasons for parents' refusal in 2013 were that they had already been tested or they were not interested.

2.2.2 Blood Lead Levels (1988 to 2013)

The HHRE (TerraGraphics 2004a) provides a thorough discussion of blood lead levels and the prevalence of high blood lead levels through 2002. This section provides a brief summary of blood lead levels and prevalence of high blood lead levels, focusing on recent data. Appendix C includes tables and figures showing blood lead levels through the years.

2.2.2.1 Blood Lead Concentrations

Blood lead levels have decreased substantially due to the emergency response actions, health response actions, and the remediation efforts that have occurred through the years (Figure 9). In 1974, children's average blood lead levels ranged from 35 µg/dL to 68 µg/dL (TerraGraphics 2004a). From 2000 through 2013, average blood lead concentrations generally remained less than 5 µg/dL in all communities (Figure 10 and Appendix C, Table C-1). In 2013, average blood lead levels ranged from 2.1 µg/dL in Pinehurst to 2.6 µg/dL in Page and Kellogg (Appendix C, Table C-1). Overall, average blood lead levels decreased between 71 and 83 percent from 1988 to 2013.

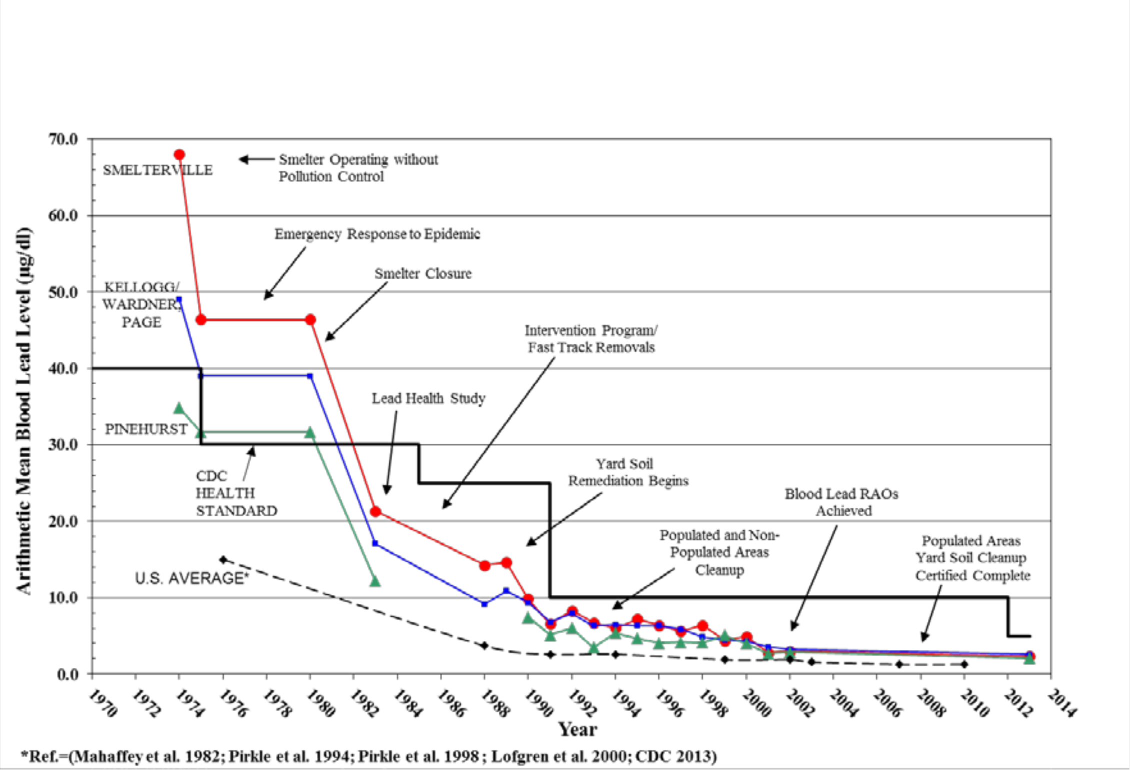


Figure 9. Children's Blood Lead Levels Relative to Major Site Events, 1974–2013

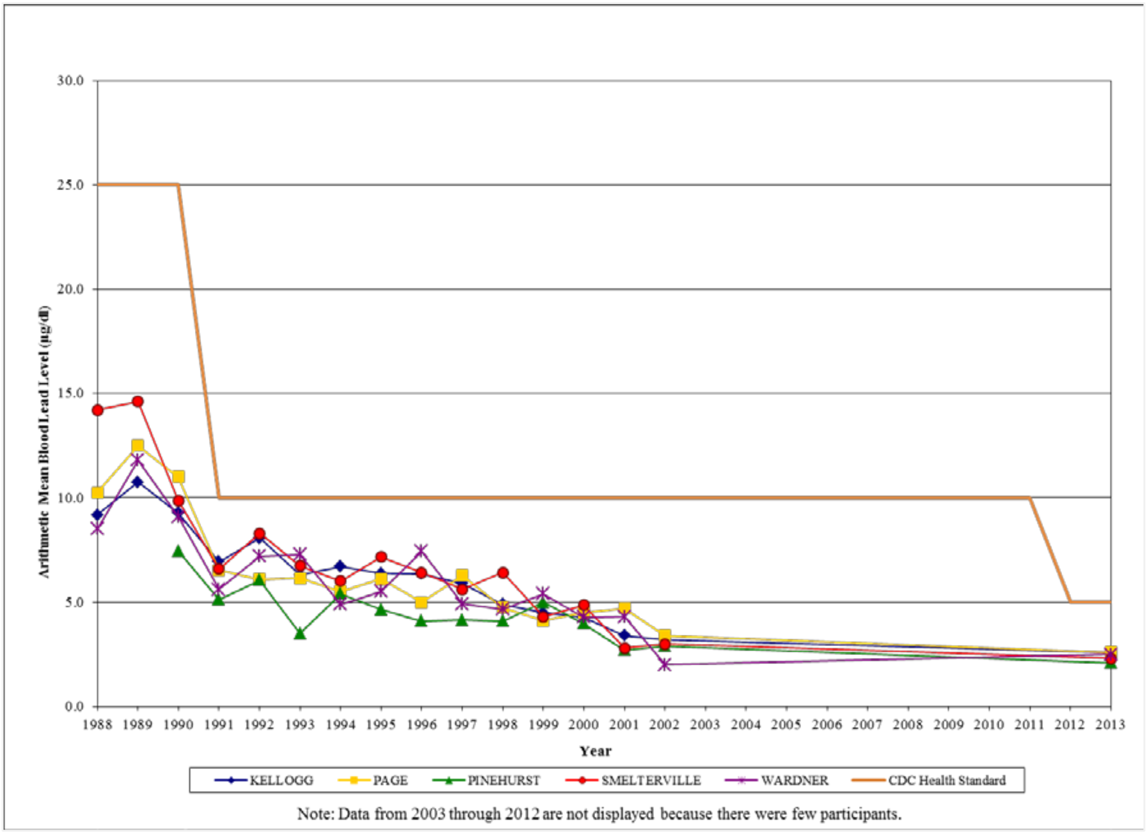


Figure 10. Children's Blood Lead Levels by City and Year, 1988–2013

2.2.2.2 Prevalence of High Blood Lead Levels

The incidence of children exceeding 10 µg/dL and 15 µg/dL largely parallels the pattern observed in mean blood lead levels (Appendix C, Table C-1). In 1988 and 1989, between 46 and 56 percent of children tested Box-wide exhibited blood lead levels at or above 10 µg/dL, with more than 70 percent of children tested in Smelterville exhibiting high blood lead levels. Between 15 and 26 percent of children Box-wide had blood lead levels ≥15 µg/dL in the same years.

By 2002, only 2 to 3 percent of children tested had levels exceeding 10 µg/dL, and 0 to 1 percent exceeded 15 µg/dL (Appendix C, Table C-1 and Figures C-1a through e). These results suggested that the blood lead RAOs for OU1 had been achieved, and the agencies decided to discontinue incentive payments (USEPA 2005). Few families took advantage of the annual fixed-site screenings from 2003 through 2012, with a total of only 130 children tested in those 10 years. Five of those children had blood lead levels exceeding 10 µg/dL, and none exceeded 15 µg/dL. In 2013, two children (1 percent) had blood lead levels ≥10 µg/dL, and one child (1 percent) had a blood lead level ≥15 µg/dL (Table 3).

In 2012, CDC urged primary prevention of lead exposure and replaced "blood lead level of concern" with a "reference blood lead level" based on the 97.5th percentile of national blood lead levels from the NHANES survey because adverse health effects appear to be present at any blood lead level (CDC 2012). CDC recommends the use of a reference value (currently 5 µg/dL) to identify children with elevated blood lead levels (CDC 2012). In 2002, 40 children (11 percent) had blood lead levels greater than or equal to 5 µg/dL. In 2013, this number was reduced to 10 children (or 4 percent, Table 3), indicating that although the number of children with blood lead levels greater than 5 µg/dL has declined, there are children at risk from lead exposure when using a reference value of 5 µg/dL.

Table 3. Children with Elevated Blood Lead Levels

Year	City	Number	Number ≥ 5 µg/dL	% ≥ 5 µg/dL	Number ≥ 10 µg/dL	% ≥ 10 µg/dL	Number ≥ 15 µg/dL	% ≥ 15 µg/dL
2002	Kellogg	195	22	11%	4	2%	2	1%
	Page	8	2	25%	0	0%	0	0%
	Pinehurst	115	10	9%	3	3%	1	1%
	Smelterville	45	6	13%	0	0%	0	0%
	Wardner	5	0	0%	0	0%	0	0%
	Box-Wide	368	40	11%	7	2%	3	1%
2013	Kellogg	147	8	5%	2	1%	1	1%
	Page	6	0	0%	0	0%	0	0%
	Pinehurst	68	1	1%	0	0%	0	0%
	Smelterville	45	1	2%	0	0%	0	0%
	Wardner	10	0	0%	0	0%	0	0%
	Box-Wide	276	10	4%	2	1%	1	0%

2.2.3 Elevated 2013 Blood and House Dust Levels and Home Follow-up

A review of paired 2013 blood and dust data revealed that the two children with blood lead levels ≥10 µg/dL were from the same home, for which both the vacuum and mat dust results were below 1,000 mg/kg, suggesting exposure from exterior sources. A total of 13 children lived in 9 homes with elevated dust levels, but all of those children had blood lead levels ranging from below detection (<1.4 µg/dL) to 4µg/dL.

In response to the CDC recommendations, PHD offered follow-up services to the parents of all children exhibiting a blood lead level of 5 µg/dL or greater. Follow-up consists of a home visit by a public health professional who provides parents with counseling and written information on how to identify sources of lead and reduce their child's exposure. A home survey and questionnaire are completed, and educational materials and nutritional counseling are provided to the parents. The follow-up routinely includes these activities:

- A records search of environmental data collected from the residence.
- Sampling of soil, dust, paint, water, etc., as appropriate.
- Counseling regarding the avoidance of locally grown produce.
- Education regarding play activities, including those not associated with the primary residence.

- Evaluation of sources of exposure associated with parental occupations, hobbies, and other household activities.
- Evaluation of past or planned home remodeling activities.
- Recommendation for those without vacuum cleaners to use one of the high efficiency vacuums available for loan, free of charge, from PHD since 1991.

A follow-up blood screen is offered 3 to4 months later, and the health professional recommends that the child's blood lead information be shared with the family physician and that the child participates in the next year's Screening Program. Since 2010, three families accepted follow-up services. One family accepted follow-up services in 2010 for a child with an elevated blood lead level, but to maintain confidentiality the home visit is not summarized. In 2013, two families (with a total of three children) accepted follow-up services. The general finding was that exposures were occurring from recreation in the Lower Basin.

A follow-up consultation was also offered to all residents with elevated home vacuum and/or dust mat results from the 2013 house dust survey. Phone consultations were conducted with nine individuals from houses with high results. All individuals declined an in-home consultation, and the sources of elevated dust lead levels in those homes could not be identified.

2.3 Lead Health Risk

PHD continues to offer blood lead sampling in the Box as a free public health service to all children in the community. Blood lead sampling provides useful information to target families and children in most need of intervention, but it is of limited use in developing remedial action criteria. The USEPA Office of Solid Waste and Emergency Response recommends that "... blood lead data not be used alone to assess risk from lead exposure" (USEPA 1998). USEPA recommends the use of its IEUBK Model, not actual blood lead levels, to evaluate lead health risk using environmental exposure data and develop consequent cleanup criteria. The model is used to predict the risk of elevated blood lead levels in children under the age of seven.

The BHSS was the first site that employed the IEUBK Model to develop site-specific cleanup levels (CH2MHill 1991; TerraGraphics 1990; TerraGraphics et al. 2001; USEPA 1991, 1992, 2002). The observed site-specific dose-response relationship between soil, dust, and blood lead levels was consistently lower than default IEUBK Model predictions (using the default bioavailability parameter of 30%, default soil/dust ingestion rates, and default soil/dust partition) (TerraGraphics 1990). This was attributed to lower soil and dust bioavailability (18%), although it was acknowledged that the reduced dose-response was likely a combination of lower bioavailability and ingestion rates (von Lindern et al. 2003a).

The IEUBK Model developed using site-specific data accounted for the lower dose-response relationship observed at the BHSS and became known as the "Box Model." It assumes a soil and dust bioavailability of 18 percent and a 40:30:30 house dust to yard soil to community soil partition (40 percent of children's soil/dust ingestion derives from house dust and 30 percent each from home yard and community-wide soils, TerraGraphics 2004a). Community-wide geometric mean soil lead concentrations are used to represent the community soil component and an assumed soil concentration of 100 mg/kg is used if a property has been remediated; otherwise, actual yard soil lead concentrations are used.

At the time the observed blood lead levels achieved the RAOs (see Section 1.3), the HHRE evaluated the 2002 environmental exposures by applying the Box Model. Results indicated the 10 µg/dL RAO was achieved, but the combined soil/dust concentrations caused exceedances of the 15 µg/dL RAO (TerraGraphics 2004a). In 2008, IEUBK modeling was again completed using exposure data from 2003 through 2006 to assess whether observed house dust lead concentrations would result in an exceedance of the blood lead RAOs (TerraGraphics 2008). That analysis indicated that the blood lead RAO (for community-wide risk not to exceed 10 µg/dL) was still achieved, but Smelterville's risk of a typical child's blood lead level exceeding 15 µg/dL was near 3 percent, which exceeds the second RAO. This result was due to a few unusually high dust lead levels (>27,000 mg/kg) that were attributed to conditions other than yard or community soils addressed in the cleanup (TerraGraphics 2008).

To assess if the most current exposure data achieve the RAOs, IEUBK Model analysis was conducted for this report to predict childhood residential lead health risk. Two batch mode applications employing the "Box Model" were run using the 2008 and 2013 environmental exposure data. Observed house dust lead concentrations from vacuum samples were used to be consistent with past analyses. Two different model input datasets were developed to represent a range of house dust conditions: 1) the "most current exposure" condition, which used the most recent dust lead concentration when vacuum samples were collected from the same home in both 2008 and 2013, and 2) an "average exposure" condition, which used the average of the two year's results when a home was sampled in both years because it may be representative of an annual average concentration in the home.

2.3.1 Risk Evaluation Results

The predicted percentages of children exceeding blood lead levels of 10 µg/dL and 15 µg/dL were estimated for each community. The results, under both scenarios (most recent and average), indicate that all communities achieve both the community blood lead RAOs (Table 4). These results are similar to past outcomes; however, the most recent data showed a maximum dust concentration near 12,000 mg/kg lead, unlike prior years when multiple homes had dust levels >27,000 mg/kg. The predicted mean blood lead concentrations ranged from 2.1 µg/dL in Smelterville to 2.8 µg/dL in Pinehurst. These are in concordance with the observed 2013 geometric mean blood leads of 2.1 µg/dL to 2.3 µg/dL (Appendix C, Table C-1).

Achieving the blood lead RAOs (both predicted and observed levels) is a key milestone because it has been more than five years since yard remediation was certified complete. The success of the risk management strategy was to be measured with post-remedial dust lead levels, such that predicted blood lead levels would remain below the RAOs. It is encouraging that both current observed and predicted blood lead levels remain low, similar to the 2002 blood lead levels, considering the number of ICP permits issued (4,387) and projects completed in the Silver Valley over the past 10 years (indicating disturbance of barriers), and despite flood events, some hot spot recontamination in soil ROWs, and the existence of several homes with dust lead concentrations ≥1,000 mg/kg. This indicates that the remedial actions and ongoing risk management strategies outlined in the Selected Remedy (i.e., ICP and LHIP) have been successful in reducing children's exposures and subsequent lead absorption.

Table 4. IEUBK Results: Vacuum Sample Results from Homes Sampled in 2008 and/or 2013

	Kellogg	Page	Pinehurst	Smelterville	Wardner
Predicted Geometric Mean Blood Lead (µg/dL)	2.2	2.4	2.8	2.1	2.3
Predicted % to Exceed 10 µg/dL	0.6%	0.0%	0.1%	0.0%	0.0%
Predicted % to Exceed 15 µg/dL	0.6%	0.0%	0.0%	0.0%	0.0%
Number of Homes	165	12	99	59	8
Percentage of Homes ≥ 1,000 mg/kg	4.2%	0.0%	5.1%	3.4%	0.0%
Minimum Dust Concentration (mg/kg)	5.9	15.1	28.1	33.8	112
Maximum Dust Concentration (mg/kg)	11,800	861	2,200	2,270	454
Dust Geometric Mean - Most Recent Dust Result[a] (mg/kg)	295	184	198	235	248
Dust Geometric Mean - Average Dust Concentration[b] (mg/kg)	293	200	210	239	243
Soil Geometric Mean (mg/kg) (30% Yard, 30% Community Mean)	117	215	304	121	167

Notes:

a: Most recent dust result was used when home was sampled in both years
b: The average dust concentration was used when home was sampled in both years
Dust geometric means were the only values that differed in the “most recent” and “average” scenarios
IEUBK = Integrated Exposure Uptake Biokinetic (Model)
µg/dL = micrograms per deciliter
mg/kg = milligrams per kilogram

2.3.2 Incremental Exposures and Additional Lead Sources

The Box Model proved to be an effective predictor of mean blood lead levels throughout the cleanup process (TerraGraphics 2004b). However, certain exposure factors may not be accounted for in the model. Despite extensive cleanup efforts in the BHSS, a number of residual lead sources in and surrounding the Box remain unaddressed. These sources include non-remediated hillsides and recreational areas, interior dust reservoirs (i.e., attics, basements, and crawlspaces), and lead-based paint. In addition, some occupations, hobbies, or activities (e.g., lead soldering, lead casting, and reloading ammunition) have been identified as possible contributors to elevated house dust lead concentrations.

2.3.2.1 Incremental Exposures

The risk analysis completed for this report accounts for the residential scenario (i.e., chronic and sub-chronic residential exposure through the air, diet, drinking water, and soil/dust pathways). However, evaluation of children's risk of an elevated blood lead level needs to consider multiple pathways and exposure factors. The original risk assessments completed for the Box (TerraGraphics 1990, SAIC 1992) also evaluated other activities that were characterized as incremental exposures. The following incremental activities or scenarios were identified as causing excessive risk:

- Ingestion of local produce
- Extreme soil and dust consumption (pica-type behavior)
- Consumption of contaminated (site) groundwater
- Inhalation of air exhibiting extreme levels of contamination
- Occupational contact with soils and dusts
- Recreational contact with soils and dusts

As discussed in Section 3.0, remedies for soils within the communities and for fugitive dust are complete in the Box and have addressed the risk associated with ingestion of local produce and yard soil consumption via pica behavior. Garden areas were remediated to a depth of two feet, and in addition to source control efforts, ongoing LHIP outreach and education efforts on these topics continue today.

Closure of private groundwater wells used for drinking and institutional controls inhibiting drilling of private wells prevent consumption of contaminated site groundwater. Ambient air monitoring was discontinued in 2005 due to low detection levels for several years, and particulate lead levels are not expected to have increased.

Potential occupational exposures evaluated for the industrial areas indicated that soil lead concentrations >3,000 mg/kg resulted in excessive lead intake for women of child-bearing age (SAIC 1992). The industrial complex areas either have been capped or are no longer in use for occupational scenarios.

The most important incremental exposure scenario that has not yet been fully addressed by the Selected Remedy is recreational contact with soils and dust, and tracking of those soils back to the home environment. A number of the environmental health follow-ups conducted over the past 10 years have identified recreational exposures as a likely reason for elevated levels. The original risk assessment indicated that soil lead levels of about 1,200 to 3,500 mg/kg resulted in excessive intakes above and beyond the residential scenario (SAIC 1992). Contaminated recreational areas remain in the Silver Valley, such as the Coeur d'Alene River Basin and upland hunting/hiking/ATV use/berry picking areas where legacy contamination and abandoned mine sites exist (URS 1999, TerraGraphics and URS 2001).

2.3.2.2 Interior Dust Reservoirs

Several studies have shown that significant deposits of lead can build up in attic spaces and enter living spaces through cracks between the wall and ceiling; electric light fittings; wall vents; or exhaust, roof, and ceiling fans (e.g., Davis and Gulson 2005). Renovations, housing additions, ceiling collapses, and storm damage can also cause attic dust to enter a home's living space (Davis and Gulson 2005).

The 2000 House Dust Pilot project confirmed that attics, basements, air ducts, and crawl spaces remain as interior residual lead sources and potential contributors to lead in house dust (TerraGraphics 2002). During the pilot project, geometric mean lead concentrations measured in dust collected from attics, basements, and air ducts were 4,425 mg/kg, 1,299 mg/kg, and 1,207 mg/kg, respectively (TerraGraphics 2002). Interior lead reservoirs have not been cleaned up as part of the BHSS remedy to date. The ICP regulates and provides information and supplies for interior construction and renovation projects that involve ceiling and/or insulation removal, as well as dirt basements and crawl spaces; however, as discussed in Section 3.0, the tracking and permitting of interior projects is difficult for the ICP because the projects are generally not visible from the exterior.

2.3.2.3 Lead-based Paint

A site-specific quantitative analysis of the blood lead, soil/dust, and paint relationship was conducted for the HHRA (TerraGraphics and URS 2001) and extensively reviewed by the NAS in 2005 (NRC 2005). The NAS concurred with the HHRA findings, stating that:

> *"EPA (in the HHRA) also applied reasonable methods to apportion risk among exposure sources, including those unrelated to mining wastes. EPA concluded that although lead from old house paint probably contributed to the exposure of some children, lead-contaminated soil was the primary contributor to health risk from lead"* (NRC 2005).

Additional quantitative analyses of mat dust lead loading suggest that dust lead concentrations and consequent lead loadings are strongly related to outdoor soil concentrations, with some contribution from both exterior and interior paint (TerraGraphics 2005b), and confirmed similar findings from previous reports (IDHW 2000, TerraGraphics 2001, and NRC 2005).

These analyses and studies indicate that soils impacted by mining waste account for most, but not all of the lead contribution to indoor dust, with lead paint also adding to house dust lead concentrations. Lead paint may explain some observed elevated house dust concentrations long after yard remediation and completion of the Box remedy. The proportion of lead in house dust that is attributable to lead paint in the Box is not known, but likely accounts for some of the observed lead mass now that legacy contamination in exterior soils is largely contained.

Section 3.0 Evaluation of Risk Management Strategy

This section summarizes the current status of the human health Selected Remedy accomplishments and RAO achievements. The risk management strategy relies on a combination of actions to cause significant reductions in house dust lead levels and assure sustainability of the remedy into perpetuity (i.e., the ICP).

3.1 Status of Human Health Selected Remedies

3.1.1 Remediate All Yards, Commercial Properties, and ROWs That Have Lead Concentrations ≥1,000 mg/kg.

The cleanup of Box residential yards, commercial properties, and ROWs was largely completed by 2007, and the reasonable segregable areas (RSAs) defined in the 1994 Box Consent Decree (CD 1994) were certified complete by USEPA in 2008 (USEPA 2008). As of 2013, all properties in OU1 have been remediated, with the exception of 14 properties that refused remediation. These properties are located throughout the Box: six properties in Pinehurst, three in Kellogg, two each in Wardner and Elizabeth Park, and one in Page. Soil lead concentrations at these properties and ROWs average about 2,000 mg/kg. At any point, the current owners or a prospective purchaser of these properties can arrange for remediation of the property through the State of Idaho's "remediation refusals" trust fund. New property development and future modifications to existing properties will occur under the ICP (Section 3.1.7).

Beginning in 2013, two programs have been implemented to ensure contaminated materials ≥ 1,000 mg/kg lead remain under a barrier: the Paved Roads program and Remedy Protection projects. The Paved Roads program provides assistance to local roadway jurisdictions with road improvement projects and deferred maintenance activities using available cleanup funding. The Remedy Protection projects were authorized by the Upper Basin ROD Amendment (USEPA 2012) and are intended to enhance the protection of human health remedies that are vulnerable to erosion and recontamination from stormwater drainage and localized flooding.

3.1.2 Achieve a Geometric Mean Yard Soil Lead Concentration of Less Than 350 mg/kg for Each Community.

The community mean soil target of 350 mg/kg was achieved in all communities in 2008 (USEPA 2010), and PHD continues to manage soils through the ICP in a manner consistent with the Rules of the Panhandle Health District 1 (IDAPA 41.01.01) to maintain this goal. To further reduce lead levels in community soils and maintain the community mean target goal, the ICP directs soils (with lead concentrations greater than 350 mg/kg) that are disturbed or moved to one of the designated repositories or to be placed under a cap. Clean soil criteria have been established for backfill material and, for calculating community mean soil lead concentrations, all remediated properties are assumed to have a nominal soil lead level of 100 mg/kg to account for potential recontamination from community and neighborhood soils.

Since the RSAs were certified complete, systematic sampling of yard soils has not occurred. In recognition of the potential for recontamination, ROWs were systematically monitored for a number of years after remediation was complete. ROW sampling conducted for the 2010 Five-Year Review indicated that by 2008 up to 9 percent of ROW sample locations showed lead levels in excess of 1,000 mg/kg, although geometric mean ROW results from 1997 to 2008 were generally less than 350 mg/kg (USEPA 2010). While it is clear that some ROW recontamination has occurred, widespread recontamination of ROWs to levels of human health concern has not been observed, and the Paved Roads Program has addressed some of these ROWs. Subsurface and some surface contamination remains in the Box and poses a risk of recontamination and consequent increased community-mean soil and house lead concentrations.

A visual assessment of 21 residential Box properties was also conducted for the 2010 Five-Year Review to assess the condition of barriers (USEPA 2010). These 21 properties had been remediated 11 to 20 years prior, and most of the properties were remediated prior to the adoption of the ICP in 1995. Although obvious signs of barrier disturbance were not commonly observed, several activities that could potentially compromise barriers or the protectiveness of the remedy were noted, and 81 percent of the properties had one or multiple ICP permits on record. Visual assessments provide only a limited ability to evaluate whether remedies have been compromised, and samples were not collected to assess existing barrier lead concentrations.

Besides the ROW monitoring and the limited visual assessments, the ICP is monitoring and permitting projects throughout the Box, as intended. Consequently, soil lead concentrations in community areas as of 2014 are still assumed to be similar to the community soil means presented in the 2010 Five-Year Review.

3.1.3 Control Fugitive Dust and Stabilize and Cover Contaminated Soils

Massive demolition, soil removals, surface capping, waste repository construction, and re-vegetation efforts were undertaken in the Non-Populated Areas to reduce onsite soil and waste material exposures and to prevent migration of contaminants into the Populated Areas through fugitive dust, mechanical tracking, flood, fire, and other potentially catastrophic events. The cleanup strategy recognized that exposure to house dust could only be controlled by reducing the sources of lead in soil adjacent to the homes of children as well as in the larger, outlying areas of the community.

Remedial actions for most OU2 areas that contributed to fugitive dusts (such as the former Industrial Complex and Mine Operations Area, Smelterville Flats, the Central Impoundment Area, hillsides, and various creeks and gulches) were largely implemented prior to 2002. Operation and Maintenance (O&M) activities continue to be conducted to maintain the remedies. However, barrier degradation or compromised remedies may cause surface recontamination, and effective O&M is crucial to prevention.

Fugitive dusts from hillsides could likely impact house dusts because so many homes are located nearby, although in the last 10 years, vegetation on the hillsides has stabilized most bare soil areas. The hillsides remedial action was fully implemented by 2002, involving planting over 88,500 seedlings (USEPA 2010). Since then, in compliance with the ICP, development of a golf course and associated residential community has covered additional areas that were not capped during the remedial action. The development activities are expected to further reduce erosion and runoff (USEPA 2010).

Revegetation of hillside areas and new development has increased hillside stability; however, several hundred remaining acres of developable hillside areas exceed the removal action level for commercial and residential properties. There are currently no plans to remove contaminated soils from these steep hillsides without private development. If these areas are developed in the future, ICP requirements include installation of appropriate human health barriers by the developer.

3.1.4 Achieve Geometric Mean Interior House Dust Lead Levels of 500 mg/kg or Less for Each Community

The community mean house dust target of 500 mg/kg was achieved in all communities in the Box in 2002 (USEPA 2010). House dust monitoring that has occurred since 2002 continues to show mean dust lead levels of less than 500 mg/kg. Remedial actions to address community soils, fugitive dusts, and ICP regulation of interior construction and renovation projects (that involve ceiling and/or insulation removal, as well as dirt basements and crawl spaces) were the risk management strategies expected to achieve and maintain the community house dust target.

3.1.5 One-time Interior Cleaning of Individual Homes That Have House Dust Lead Levels Exceeding 1,000 mg/kg (After Completion of Remedial Actions to Address Fugitive Dust)

Approximately 5 percent of homes have house dust lead concentrations above 1,000 mg/kg. The one-time interior cleaning remedy has not been implemented to date because reductions in lead concentration from cleaning did not persist in earlier studies (USEPA 2010). As remediation progressed and neared completion, one pilot study was conducted to evaluate the efficacy of interior cleaning (TerraGraphics 2002). That study and an earlier pilot project performed prior to exterior soil remedial actions (CH2M HILL 1991) demonstrated short-term reductions in interior lead concentrations; however, lead concentrations in the homes had returned to pre-cleaning levels within one year.

In the 2010 Five-Year Review, the USEPA made the following recommendations regarding the house dust remedy (USEPA 2010):

i) Determine whether additional work is needed to identify alternative lead sources that contribute to house dust levels. These additional sources include, but are not limited to, lead-based paint, soils/sediments from the Coeur d’Alene River Basin where many residents recreate, hillsides, occupational sources, and/or personal activities, occupations, or hobbies.

ii) Evaluate the need for a one-time cleaning prior to moving forward with the interior cleaning remedy and determine additional data/monitoring needs to support the evaluation.

The data collected since 2010 and analyses conducted for this report are part of the actions undertaken by the Agencies to address these recommendations.

The implementation of one-time residential interior cleaning depends on the ability to identify homes that have elevated dust lead levels. Review of house dust data and pilot cleaning studies at the BHSS indicates that measured house dust lead levels for an individual home vary from year to year and may differ depending on sampling methodology. Houses with high concentrations in one year may show lower levels in following years without intervention. Few homes consistently show elevated lead levels in consecutive years.

In recent years of dust monitoring (2008 and 2013), only about 5 percent of the houses in the community exceed the 1,000 mg/kg dust lead concentration criterion. No one source or reason for these elevated levels is evident for those homes. Data suggest that residents’ hobbies and activities (e.g., recreating in contaminated areas) and home characteristics (age, lead paint condition, etc.) likely impact house dust levels, indicating there are additional potential lead sources unrelated to the BHSS mining-related contamination.

A study conducted in 1999 to characterize background house dust concentrations (outside the BHSS) indicated that 12 percent of homes (6 of 50) had at least one dust lead concentration exceeding 1,000 mg/kg at one point during the year. Similar to the trends observed in the Box (discussed in this report), the background homes did not exhibit high lead levels every time they were sampled, and if both a vacuum and a mat sample were collected from the same house at the same time, they did not always both have results >1,000 mg/kg lead. Questionnaire responses indicated that lead based paint and ammunition reloading with lead bullets likely caused elevated lead levels in two homes. However, the reasons for elevated levels in the other homes could not be determined based on questionnaire responses (Petrosyan 2000).

In addition to the difficulties of identifying the sources of elevated house dust lead levels, the efficacy of a one-time cleaning is questionable. Onsite investigations, and a number of lead abatement studies at other locations, suggest that one-time interior cleaning benefits are transient and dust lead levels generally return to equilibrium with active interior and exterior sources (TerraGraphics 2008). Contamination sources that remain in the Box and the greater Silver Valley area include exterior soils; interior dust and soils found in attics, unimproved basements, and crawl spaces; non-remediated recreational areas and hillsides; and lead-based paint (TerraGraphics 2008).

3.1.6 Implement an LHIP

Since 1985, PHD continues to administer the LHIP, which includes educational programs, blood lead monitoring programs, yard soil and vacuum dust sample collection, and the offer of a follow-up home visit (if needed) conducted by a public health professional. Fixed-site blood lead screening continues to be offered annually, at no cost to Box residents. A total of 312 children participated in the program since 2010 (some children participated in multiple years). Follow-ups conducted with families of children who had elevated blood lead levels and participants who had elevated house dust concentrations were summarized in Section 2.2.3 of this report.

The HEPA vacuum loan program continues to be a valuable part of the ICP. From 2010 through 2014, there was an annual average of 125 vacuum checkouts for Box and Basin homes (there is no break-down of activity by OU). An average of 104 people checked out the vacuums annually from an average of 102 addresses, indicating this resource is used by the community.

3.1.7 Establish an ICP

The ICP was established in 1995 and continues today to: i) ensure that barriers are installed and maintained into perpetuity to prevent recontamination and consequent exposure, ii) provide clean materials and appropriate disposal options for the local communities, and iii) minimize the impact of residual subsurface contamination on community development and the conduct of commerce. Implementation and execution of the ICP follows the requirements and standards described in the Code (Idaho Administrative Procedures Act [IDAPA] 41.01.01.500 through 41.01.01.543 and 41.01.01.900 through 41.01.01.902) and is managed by PHD.

The success of the ICP has been demonstrated for almost 20 years in the Box. The ICP regulates construction and use changes on all properties within the ICP boundary. The program provides a number of free services to local residents, including education, sampling assistance, up to one cubic yard of clean soil for small projects, collection of soil removed in small projects, protective materials for residents conducting remodeling projects, and a permanent disposal site for contaminated soils generated in the Box. The ICP also regulates and provides information for interior construction and renovation projects that involve ceiling and/or insulation removal, as well as dirt basements and crawl spaces.

During the period between 2002 and 2013 (the years with low participation in the blood lead screening program), there were thousands of projects affecting soil barriers, and massive amounts of contaminated soils were managed and disposed appropriately. During those 11 years, the ICP issued 4,387 permits, including 166 for interior projects. As reported by PHD, approximately 225,000 cubic yards of contaminated material were directed by the ICP to a designated repository and 369 cubic yards of clean soil were supplied to homeowners.

Observations by field-based personnel and inspections of ICP-permitted projects by PHD indicate that maintenance of remediated properties by owners (or their representatives) generally appears effective in maintaining installed barriers (USEPA 2010). IDEQ and USEPA oversaw the installation of barriers during remedial actions, and the ICP provides an effective system through the permitting process to make sure barriers are installed and maintained correctly. The ICP does not directly guard against erosion or catastrophic events such as floods and fires, which may expose underlying contamination. Tracking and permitting of interior projects, which are often not permitted through the local building authorities, has proven to be difficult because interior work is not as visible as exterior projects (personal communication, Jerry Cobb, Sandi Lockhart, Mike Dancer, November 2009 through February 2010).

3.2 Blood Lead RAOs

Since the RODs were adopted in 1991 and 1992, USEPA guidance has changed. The Box RAOs are based on a community-wide approach. The current guidance advises that the risk of a typical child exceeding 10 µg/dL be less than 5 percent (USEPA 1994b, 1998), and uses the *individual* residence as the primary exposure unit of concern, as opposed to the community. As noted in previous Five-Year Reviews, the original OU 1 RAOs are considered to be protective of children living in the Box (USEPA 2000a, 2000b, 2005, 2010).

As discussed in Section 2.0, CDC has recognized that adverse health effects occur without an apparent blood lead level threshold and has lowered the reference value to 5 µg/dL (CDC 2012). USEPA is currently evaluating this lower blood lead level.

3.2.1 No More than 5 Percent of Children in the Community Have a Blood Lead Level of 10 µg/dL or Greater

IEUBK Model results (for children 6 months through 6 years old) indicate that under current residential exposures, all communities continue to achieve the OU1 RAO 10 µg/dL criterion.

Blood lead monitoring supports these results. In 2013, with approximately 50 percent of the estimated child population participating, 1 percent of children tested in Kellogg (2 children) had levels greater than or equal to 10 µg/dL. Blood lead levels of children in other Box communities were all below 10 µg/dL.

3.2.2 Less than 1 Percent of Children Exceed 15 µg/dL

The predicted percent of children (ages 6 months through 6 years) who exceed a blood lead level of 15 µg/dL is less than 1 percent in all communities. In addition, in 2013, 1 percent of children tested in Kellogg (1 child) exceeded the 15 µg/dL criterion, while blood lead levels of children in other Box communities were all below 15 µg/dL, indicating this RAO also continues to be achieved.

Compliance with this objective using observed blood lead levels is difficult to achieve because one or two children exceeding 15 µg/dL can equate to more than 1 percent of the population (e.g., 2 children ≥ 15 µg/dL divided by 90 children tested equals 2 percent, which is greater than 15 µg/dL).

The continued achievement of the blood lead RAOs over the course of a decade indicates that the risk management strategies outlined in the Selected Remedy have been successful in reducing children's exposures and subsequent lead absorption, despite the one component of the Selected Remedy that has not yet been implemented: one time cleaning of interiors when lead levels are ≥1,000 mg/kg.

Section 4.0 Conclusions and Recommendations

The purpose of this report was to provide an update on the status of the risk management strategy for OU1 of the BHSS. Section 2.0 evaluated recent house dust and blood lead data relative to past data and trends and the risk assessment completed for OU1. Section 3.0 discussed RAO achievements, selected remedy accomplishments, and current environmental exposures. A summary of RAO achievements is as follows:

- Observed mean blood lead levels have remained below 5 µg/dL, and the percentages of children with blood lead levels exceeding 10 µg/dL and 15 µg/dL are 1 percent or below in all communities in 2013.
- Predicted children's mean blood lead levels using current environmental exposures indicate the RAOs are achieved in all communities.
- The blood lead RAOs continue to be achieved, years after yard remediation was certified complete and despite continued development, flood events, and the existence of several homes with dust lead concentrations ≥1,000 mg/kg. This indicates that the risk management strategies outlined in the Selected Remedy have been successful in reducing children's exposures and subsequent lead absorption. If USEPA lowers the blood lead level of concern in response to CDC guidance, the appropriate response at the BHSS will be determined by USEPA at that time.

The human health Selected Remedy has been largely completed and continues (with ongoing programs), with the exceptions of a few residential soil remediation refusals and the one-time interior cleaning remedy that has not been implemented. Table 5 summarizes conclusions and recommendations for each Selected Remedy component.

Table 5. Summary of Conclusions and Recommendations

Risk Management Strategy Component	Conclusions	Recommendations
Remediate all yards, commercial properties, and rights-of-way (ROWs) that have lead concentrations ≥1,000 mg/kg (see Section 3.1.1).	Complete, with the exception of 14 properties that refused remediation and can be remediated in the future through use of a trust fund. New property development and future modifications to existing properties will occur under the guidance of the ICP.	Remediate remaining refusal properties as property owners allow.
Achieve a geometric mean yard soil lead concentration of less than 350 mg/kg for each community (see Section 3.1.2).	Complete. The community mean soil target of 350 mg/kg was achieved in all communities in 2008 (USEPA 2010). The Paved Roads program and Remedy Protection projects have been implemented to ensure contaminated materials ≥ 1,000 mg/kg remain under a barrier. PHD continues to manage soils through the ICP, including directing soils greater than 350 mg/kg lead to a repository.	Develop an approach or program that defines how barrier integrity would be monitored over time.
Control fugitive dust and stabilize and cover contaminated soils (see Section 3.1.3).	Complete. Remedial actions for OU2 areas that contributed to fugitive dusts were largely implemented prior to 2002 and are maintained through O&M activities that are critical to prevent barrier degradation.	Continue O&M activities.

Risk Management Strategy Component	Conclusions	Recommendations
Achieve geometric mean interior house dust lead levels of ≤500 mg/kg for each community (see Section 3.1.4).	Complete. Interior mean lead dust concentrations in Box communities have remained below community-wide risk-based goals since 2002.	Periodically evaluate the need for additional dust mat and vacuum sampling to assess achievement of this performance standard. Reduce the number of questions used in the dust mat questionnaire since fewer homes now have elevated dust lead concentrations and PHD attempts to follow up with residents of homes with high dust lead concentrations (see Section 2.1.5.3).
One-time interior cleaning of individual homes that have house dust lead levels exceeding 1,000 mg/kg (see Section 3.1.5).	Likely not necessary to meet blood lead RAOs. Approximately 5 percent of individual homes continue to have house dust lead concentrations above 1,000 mg/kg. When the cleanup in the Box began, there was widespread lead exposure from residential soils. After completion of exterior remediation, the main sources of lead are within the home: 1) residual reservoirs, 2) lead-based paint, 3) contaminated soils brought in from recreational areas. One-time interior cleaning does not appear to produce long-term reductions in dust lead concentrations.	Develop an assessment plan and explore risk management options that includes risks associated with alternative dust lead sources for individual homes with chronic elevated dust lead levels.
Implement an LHIP (see Section 3.1.6)	Ongoing.	Explore alternative incentive approaches if participation rates decline, in order to continue to monitor blood lead levels in the community and identify children that require intervention.

Risk Management Strategy Component	Conclusions	Recommendations
Establish an ICP (see Section 3.1.7)	Complete. The ICP, implemented by the local PHD, continues to successfully prevent recontamination and consequent exposure.	Continue to monitor long term funding sustainability by tracking settlement dollar investment yield and ICP costs.

Section 5.0 References

Consent Decree; Bunker Hill; United States of America and State of Idaho v. ASARCO Incorporated, Coeur d'Alene Mines Corporation, Callahan Mining Corporation, Hecla Mining Company, Sunshine Precious Metals, Sunshine Mining Company; Civil Action No. 94-0206-N-HLR; May 10, 1994.

Centers for Disease Control and Prevention (CDC), 2012. Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention. Report of the Advisory Committee on Childhood Lead Poisoning Prevention. January 2012.

CDC, 2013. Blood Lead Levels in Children Aged 1-5 Years - United States, 1999-2010. Morbidity and Mortality Weekly Report, 62(13);245-248.

CH2M Hill, 1991. Residential Soil Feasibility Study for the Bunker Hill CERCLA Site Populated Areas RI/FS (2 Vols.). Boise, ID, Prepared for Idaho Department of Health and Welfare.

Davis, J.J. and B.L. Gulson, 2005. "Ceiling (attic) dust: a 'museum' of contamination and potential hazard." Environmental Research. (99) 177-194.

Idaho Administrative Procedures Act (IDAPA) 41.01.01, "Rules of Idaho Public Health District #1."

Idaho Department of Environmental Quality (IDEQ), 2013. Final Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP) for the 2013 Property Sampling in the Bunker Hill Mining and Metallurgical Complex Superfund Site. Prepared by TerraGraphics Environmental Engineering, Inc. for Idaho Department of Environmental Quality. April 11.

Idaho Department of Health and Welfare (IDHW), 1976. Shoshone Lead Health Project. Work Summary. Monograph. Boise, ID, Prepared for the Idaho Department of Health and Welfare, January 1976.

IDHW, 2000. Coeur d'Alene River Basin Environmental Health Assessment. Agency for Toxic Substances and Disease Registry: Atlanta, GA. August 2000. p 67.

Jacobs Engineering Group (JEG), ICAIR, Life Systems Inc., and TerraGraphics Environmental Engineering Inc., 1989. Human Health Risk Assessment: Protocol for the Populated Areas of the Bunker Hill Superfund Site, U.S. Environmental Protection Agency Region 10.

Laidlaw, M. A., H. W. Mielke, G. M. Filippelli, D. L. Johnson, and C. R. Gonzales, 2005. "Seasonality and children's blood lead levels: developing a predictive model using climatic variables and blood lead data from Indianapolis, Indiana, Syracuse, New York, and New Orleans, Louisiana (USA)." Environ Health Perspect 113(6): 793-800.

Landrigan P., Baker E., Jr., Feldman R., Cox D., Eden K., Orenstein W., Mather J., Yankel A., and von Lindern I., 1976. Increased lead absorption with anemia and slowed nerve conduction in children near a lead smelter. Journal of Pediatrics, 89: 904 10.

Lanphear, B.P., and K.J. Roghmann, 1997. “Pathways of lead exposure in urban children.” Environ Res., 74, 67-73.

Lanphear, B.P., R. Hornung, M. Ho, C.R. Howard, S. Eberle, and K. Knauf, 2002. “Environmental lead exposure during early childhood.” Journal of Pediatrics, 140, 40-47.

Lanphear, B.P., P. Succop, S. Roda, and G. Henningsen, 2003. “The effect of soil abatement on blood lead levels in children living near a former smelting and milling operation.” Public Health Rep., 118, 83-91.

Lofgren, J.P., et al., 2000. Blood lead levels in young children - United States and selected states, 1996-1999. Morbidity and Mortality Weekly Report, 49(50);1133-1137.

Mahaffey KR, Rosen JF, Chesney RW, et al., 1982 Association between age, blood lead concentration, and serum 1,25-dihydroxycholecalciferol levels in children. Am J Clin Nutr.;35:1327–1331.

Manton, W. I., C. R. Angle, K. L. Stanek, Y. R. Reese and T. J. Kuehnemann, 2000. "Acquisition and retention of lead by young children." Environ Res 82(1): 60-80.

National Research Council (NRC) of the National Academies (NAS), 2005. Superfund and Mining Megasites-Lessons from the Coeur d'Alene River Basin. Committee on Superfund Site Assessment and Remediation in the Coeur d’Alene River Basin, Board on Environmental Studies and Toxicology, Division of Earth and Life Studies. The National Academies Press. July.

Panhandle Health District (PHD), 1986. Kellogg Revisited - 1983: Childhood Blood Lead and Environmental Status Report. Kellogg, ID, Panhandle Health District.

PHD and TerraGraphics, 2005. Final Report for the Comparison of HUD Risk Assessment Methodology to Methods Used at the Bunker Hill Superfund Site in Idaho for the Identification of the Risk from Lead in House Dust. Prepared for US Department of Housing and Urban Development, July.

Petrosyan, Varduhi, 2000. Lead Contamination and Exposure Issues in the United States and Armenia. A Thesis presented in partial fulfillment for the degree of Master of Science, University of Idaho. May.

Pirkle JL, Brody DJ, Gunter EW, et al., 1994. The decline in blood lead levels in the United States. The National Health and Nutrition Examination Surveys (NHANES) JAMA;272:284–291.

Pirkle JL, Kaufmann RB, Brody DJ, Hickman T, Gunter EW, Paschal DC, 1998. Exposure of the. U.S. population to lead, 1991–1994. Environ Health Perspect.;106(11):745–750.

Science Applications International Corporation (SAIC), 1992. Final Human Health Risk Assessment for the Non-populated Areas of the Bunker Hill NPL Site. Prepared for USEPA, June.

Spalinger, S.M., M.C. von Braun, V. Petrosyan and I.H. von Lindern, 2007. Northern Idaho House Dust and Soil Lead Levels Compared to the Bunker Hill Superfund Site. Environ Monit Assess; 130:57-72..

Succop, P., R. Bornschein, K. Brown and C.Y. Tseng, 1998. "An empirical comparison of lead exposure pathway models." Environ Health Perspect 106 Suppl 6: 1577-83.

TerraGraphics Environmental Engineering, Inc. (TerraGraphics), 1990. Risk Assessment Data Evaluation Report (RADER) for the Populated Areas of the Bunker Hill Superfund Site. Prepared for U.S. Environmental Protection Agency Region 10 and Idaho Department of Health and Welfare Division of Environmental Quality.

TerraGraphics, 1997. Summary of Lead Health Intervention and Source Removal Efforts 1985-1996, Idaho Department of Health and Welfare Division of Environmental Quality. October.

TerraGraphics, 2001. Technical Memorandum 1999 Five Year Review Report Bunker Hill Site Populated Areas Addendum and Extended Response to Technical Comments - April 26, 2001

TerraGraphics. 2002. Bunker Hill House Dust Pilot Final Remedial Effectiveness Report. Moscow, ID: Prepared for Idaho Department of Environmental Quality.

TerraGraphics, 2003. Final 2002 Interior House Dust Data Summary Report. Prepared for the Idaho Department of Environmental Quality. June.

TerraGraphics, 2004a. Human Health Remedial Evaluation Report (HHRE) for the Bunker Hill Superfund Site Box. Prepared for the Idaho Department of Environmental Quality. March.

TerraGraphics, 2004b. Final 2003 Interior House Dust Data Summary Report. Prepared for the Idaho Department of Environmental Quality. June.

TerraGraphics, 2005a. Final 2005 Interior House Dust Data Summary Report. Prepared for the Idaho Department of Environmental Quality.

TerraGraphics, 2005b. Final Bunker Hill Superfund Site OU 1 House Dust Status and Rights-of-Way Recontamination Report. October 2005.

TerraGraphics, 2006. Final 2005 Box Interior House Dust Data Summary Report. Prepared for the Idaho Department of Environmental Quality, December 15.

TerraGraphics, 2008. Background and Rationale for Proposed Modifications to the Bunker Hill Superfund Site OU 1 House Dust Remedial Action Objectives.

TerraGraphics, 2009. 2008 Data Summary Report for Rights-of-Way and House Dust Sampling within the Bunker Hill Box (OU1) of the Coeur d'Alene River Basin, Idaho. Prepared for Idaho Department of Environmental Quality. June 15, 2009.

TerraGraphics, 2014. Draft 2013 House Dust Data Summary Report for the Bunker Hill Mining and Metallurgical Complex Superfund Site. June 2014.

TerraGraphics and URS Greiner (URS), 2001. Final Human Health Risk Assessment for the Coeur d'Alene Basin Extending from Harrison to Mullan on the Coeur d'Alene River and Tributaries Remedial Investigation/Feasibility Study. June.

URS Greiner (URS), 1999. Draft Final Expedited Screening Level Risk Assessment for Common Use Areas Coeur d'Alene River Basin, Idaho. October 1999.

U.S. Census Bureau. 2010. http://www.census.gov, accessed on April 10, 2013.

U.S. Environmental Protection Agency (USEPA), 1991. Record of Decision for Bunker Hill Superfund Site Populated Areas. Kellogg, Idaho: USEPA Region 10.

USEPA, 1992. Record of Decision for Bunker Hill Superfund Site Non-Populated Areas. Seattle, WA: USEPA Region 10.

USEPA, 1994a. Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. Washington, D.C., USEPA.

USEPA, 1994b. OSWER Directive #9355.4-12 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. Washington, DC, USEPA. EPA/540/F-94/043.

USEPA, 1998. Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. Washington, D.C., USEPA. EPA/540/F-98/030.

U.S. Environmental Protection Agency (USEPA). 2000a. Bunker Hill Populated Areas Operable Unit First Five Year Review Report. Seattle, WA. USEPA Region 10. September 27, 2000.

U.S. Environmental Protection Agency (USEPA). 2000b. First 5-Year Review of the Non-Populated Area Operable Unit, Bunker Hill Mining and Metallurgical Complex, Shoshone County,Idaho. USEPA Report. September 28, 2000.

USEPA, 2002. Record of Decision for Bunker Hill Mining and Metallurgical Complex Operable Unit 3. Region 10, Seattle, WA, USEPA. Contract No. 68-W9-0054/0031.

USEPA, 2005. Second Five-Year Review for the Bunker Hill Mining and Metallurgical Complex Superfund Site Operable Units 1, 2, and 3. October 2005. EPA 910-R-05-006.

USEPA, 2008. Certification of Completion for the Reasonably Segregable Area, Kellogg North of Interstate 90. Letter from Daniel D. Opalski, Director, Environmental Cleanup Office to Al Czarnowsky, Upstream Mining Group. June 2008.

USEPA, 2010. 2010 Five-Year Review for the Bunker Hill Mining and Metallurgical Complex Superfund Site Operable Units 1, 2, and 3. November 2010.

USEPA, 2012. Interim Record of Decision (ROD) Amendment, Upper Basin of the Coeur d'Alene River, Bunker Hill Metallugical Complex Superfund Site. August.

von Lindern, I., S. Spalinger, V. Petroysan and M. von Braun, 2003a. "Assessing remedial effectiveness through the blood lead:soil/dust lead relationship at the Bunker Hill Superfund Site in the Silver Valley of Idaho." The Science of the Total Environment 303(1-2): 139-170.

von Lindern, I.H., Spalinger, S.M., Bero, B.N., Petrosyan, V. & von Braun, M.C. 2003b. "The influence of soil remediation on lead in house dust." The Science of the Total Environment, 303, 59-78.

Yankel A., von Lindern I., and Walter S., 1977. The Silver Valley lead study: the relationship between childhood blood lead levels and environmental exposure. Journal of Air Pollution Control Assoc 27: 763-7

Appendix A

House Dust Tables and Figures

Table A-1
Participation in the 2013 House Dust Survey

Area	Estimated Number of Homes in 2013 Based on PHD Property IDs	Number of Homes Sampled in 2013	Percent of Homes Sampled (compared to PHD's estimate)
Smelterville	410	50	12%
Kellogg[a]	1,434	122	9%
Pinehurst	900	84	9%
Wardner	124	12	10%
Page	69	11	16%
Total	2,937	279	9%

[a] Ross Ranch, Bisaro Park, Elizabeth Park, Galena Ridge, Silver Meadows, and Montgomery Gulch are included in Kellogg

Table A-2
Vacuum Dust Summary Statistics by Community and Year, 1988-2013

Year[a]	City	Number of Samples	Number Above Action Level	Percent (%) Above Action Level	Concentration Range (mg/kg)		House Dust Lead Concentration (mg/kg)			
					Minimum	Maximum	Arithmetic Mean	Standard Deviation	Geometric Mean	Standard Deviation
1988[b]	Kellogg	48	37	77	94	52,700	3,618	8,422	1,648	2.80
	Page	6	4	67	69	1,160	813	440	597	3.02
	Smelterville	17	10	59	209	4,640	1,657	1,293	1,212	2.39
	Wardner	3	1	33	427	1,480	839	563	728	1.90
	Box	74	52	70	69	52,700	2,827	6,876	1,368	2.78
1990[b]	Kellogg	68	49	72	117	16,800	1,920	2,180	1,405	2.20
	Page	4	3	75	898	2,070	1,315	517	1,249	1.43
	Pinehurst	43	10	23	119	7,990	1,022	1,272	739	2.05
	Smelterville	14	12	86	777	4,210	1,858	1,006	1,634	1.69
	Wardner	3	2	67	691	2,220	1,590	799	1,418	1.88
	Box	132	76	58	117	16,800	1,595	1,800	1,154	2.19
1991[b]	Kellogg	64	44	69	274	3,960	1,490	815	1,288	1.75
	Page	5	4	80	545	1,680	1,209	434	1,130	1.55
	Pinehurst	40	9	23	65	13,500	1,076	2,079	673	2.27
	Smelterville	17	14	82	790	2,700	1,496	552	1,406	1.44
	Wardner	6	3	50	307	4,800	1,786	1,596	1,284	2.52
	Box	132	74	56	65	13,500	1,368	1,338	1,065	2.03
1992[b]	Kellogg	81	42	52	65	5,860	1,236	1,002	937	2.21
	Page	4	2	50	473	1,500	932	435	856	1.62
	Pinehurst	50	12	24	139	6,670	906	1,042	648	2.14
	Smelterville	18	6	33	140	3,790	978	799	778	2.01
	Wardner	5	3	60	322	5,240	1,724	2,030	1,028	3.10
	Box	158	65	41	65	6,670	1,110	1,032	817	2.20

Table A-2
Vacuum Dust Summary Statistics by Community and Year, 1988-2013

					Concentration Range (mg/kg)		House Dust Lead Concentration (mg/kg)			
Year[a]	City	Number of Samples	Number Above Action Level	Percent (%) Above Action Level	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Geometric Mean	Standard Deviation
1993[b]	Kellogg	73	25	34	111	3,210	966	566	810	1.89
	Page	5	0	0	139	794	557	253	480	2.03
	Pinehurst	38	5	13	60	3,460	626	598	469	2.14
	Smelterville	16	11	69	201	3,350	1,347	843	1,125	1.93
	Wardner	6	2	33	382	1,290	785	344	724	1.56
	Box	138	43	31	60	3,460	894	633	707	2.07
1994[b]	Kellogg	61	25	41	88	3,770	940	591	772	2.00
	Page	6	2	33	90	1,340	655	521	458	2.78
	Pinehurst	36	1	3	76	1,490	510	284	424	1.97
	Smelterville	21	11	52	228	3,060	1,149	742	919	2.06
	Wardner	12	5	42	211	2,270	997	671	782	2.17
	Box	136	44	32	76	3,770	851	597	662	2.15
1995[b]	Kellogg	66	21	32	62	4,400	918	775	703	2.12
	Page	4	1	25	239	1,430	706	519	574	2.12
	Pinehurst	28	3	11	22	1,720	501	371	383	2.29
	Smelterville	11	3	27	297	3,470	923	895	702	2.05
	Wardner	4	0	0	245	892	570	265	517	1.72
	Box	113	28	25	22	4,400	795	705	594	2.21
1996[b]	Kellogg	64	7	11	85	2,300	633	387	528	1.90
	Page	2	0	0	--	--	--	--	--	--
	Pinehurst	27	2	7	100	2,100	525	429	423	1.90
	Smelterville	11	2	18	99	11,300	1,565	3,258	558	3.92
	Wardner	2	0	0	--	--	--	--	--	--
	Box	106	11	10	85	11,300	695	1,115	492	2.13

Table A-2
Vacuum Dust Summary Statistics by Community and Year, 1988-2013

Year[a]	City	Number of Samples	Number Above Action Level	Percent (%) Above Action Level	Concentration Range (mg/kg) Minimum	Concentration Range (mg/kg) Maximum	House Dust Lead Concentration (mg/kg) Arithmetic Mean	Standard Deviation	Geometric Mean	Standard Deviation
1997[c]	Kellogg	38	10	26	43	6,800	859	1,104	563	2.54
	Page	2	0	0	--	--	--	--	--	--
	Pinehurst	14	2	14	130	15,000	1,410	3,919	410	3.22
	Smelterville	121	51	42	50	9,570	1,098	1,253	714	2.67
	Wardner	4	1	25	220	1,100	488	412	392	2.05
	Box	179	64	36	43	15,000	1,051	1,571	637	2.69
1998[c, d]	Kellogg	124	46	37	68	7,470	1,066	1,076	765	2.29
	Page	5	1	20	220	1,500	722	474	605	1.99
	Pinehurst	30	2	7	71	2,000	442	340	336	2.13
	Smelterville	35	5	14	65	1,590	639	368	510	2.20
	Wardner	5	1	20	270	6,000	1,538	2,503	664	3.67
	Box	199	55	28	65	7,470	899	990	623	2.40
1999[c]	Kellogg	138	31	22	99	15,300	862	1,466	616	1.99
	Page	2	0	0	--	--	--	--	--	--
	Pinehurst	38	2	5	45	4,010	490	635	341	2.26
	Smelterville	41	10	24	14	6,680	803	1,072	497	2.79
	Wardner	11	5	45	254	2,760	1,196	823	919	2.26
	Box	230	48	21	14	15,300	800	1,269	543	2.27
2000[c, e]	Kellogg	156	33	21	37	11,200	771	1,028	529	2.34
	Page	5	0	0	86	941	495	362	362	2.67
	Pinehurst	54	5	9	40	2,640	541	506	408	2.08
	Smelterville	82	14	17	38	30,900	1,005	3,389	474	2.65
	Wardner	11	3	27	330	2,700	985	708	804	1.92
	Box	308	55	18	37	30,900	796	1,911	495	2.38

Table A-2
Vacuum Dust Summary Statistics by Community and Year, 1988-2013

Year[a]	City	Number of Samples	Number Above Action Level	Percent (%) Above Action Level	Concentration Range (mg/kg) Minimum	Concentration Range (mg/kg) Maximum	House Dust Lead Concentration (mg/kg) Arithmetic Mean	Standard Deviation	Geometric Mean	Standard Deviation
2001[c, e]	Kellogg	67	8	12	64	4,520	586	647	426	2.16
	Page	1	0	0	--	--	--	--	--	--
	Pinehurst	88	5	6	30	2,010	387	319	298	2.10
	Smelterville	43	9	21	93	1,570	606	331	530	1.85
	Wardner	16	3	19	180	1,460	660	396	549	1.91
	Box	215	22	10	30	4,520	512	464	380	2.15
2002[c]	Kellogg	78	11	14	32	7,090	659	922	435	2.38
	Page	4	0	0	250	376	289	59	285	1.21
	Pinehurst	22	1	5	51	1,200	287	269	211	2.17
	Smelterville	23	2	9	54	2,400	524	519	350	2.65
	Wardner	13	0	0	188	746	494	148	469	1.43
	Box	140	14	10	32	7,090	552	739	373	2.37
2003	Kellogg	106	14	13	37	3,890	614	664	422	2.39
	Page	11	0	0	138	689	468	182	428	1.62
	Pinehurst	45	1	2	19	1,680	343	312	241	2.47
	Smelterville	31	1	3	12	1,010	367	236	283	2.37
	Wardner	4	0	0	192	993	531	335	453	1.96
	Box	197	16	8	12	3,890	503	534	349	2.42
2004	Kellogg	83	5	6	25	2,030	479	333	385	2.02
	Page	4	0	0	282	846	535	242	494	1.60
	Pinehurst	28	1	4	33	2,200	359	415	239	2.50
	Smelterville	28	3	11	47	27,300	1,421	5,093	401	3.07
	Wardner	9	2	22	101	1,270	583	397	450	2.29
	Box	152	11	7	25	27,300	638	2,210	361	2.34

Table A-2
Vacuum Dust Summary Statistics by Community and Year, 1988-2013

Year[a]	City	Number of Samples	Number Above Action Level	Percent (%) Above Action Level	Concentration Range (mg/kg) Minimum	Concentration Range (mg/kg) Maximum	House Dust Lead Concentration (mg/kg) Arithmetic Mean	Standard Deviation	Geometric Mean	Standard Deviation
2005	Kellogg	45	8	18	25	10,900	891	1,702	439	3.08
	Page	6	0	0	146	521	315	146	286	1.63
	Pinehurst	20	2	10	68	4,680	553	1,056	282	2.61
	Smelterville	23	2	9	33	33,800	1,825	6,981	330	3.65
	Wardner	2	1	50	--	--	--	--	--	--
	Box	96	13	14	25	33,800	1,024	3,623	372	3.06
2008	Kellogg	81	5	6	6	11,800	533	1,314	298	2.61
	Page	4	0	0	124	861	405	331	310	2.35
	Pinehurst	55	2	4	28	1,860	279	306	201	2.13
	Smelterville	29	2	7	31	2,270	389	448	273	2.28
	Wardner	9	0	0	84	964	433	328	317	2.44
	Box	178	9	5	6	11,800	423	927	261	2.42
2013[c]	Kellogg	102	3	3	17	1,520	369	257	288	2.20
	Page	9	0	0	15	718	238	208	160	2.98
	Pinehurst	64	4	6	21	2,200	319	421	195	2.61
	Smelterville	41	0	0	17	859	243	146	202	1.96
	Wardner	8	0	0	112	454	268	109	248	1.56
	Box	224	7	3	15	2,200	323	297	235	2.32

Notes:

-- When the number of observations is ≤ 2, then data are not shown for confidentiality purposes.

When a concentration is below detection limits, the reported value is used in summary statistics.

[a]No data collected in 1989, 2007, and 2009 through 2012; only three samples collected in 2006 (not shown for confidentiality purposes).

[b]1988-1996 vacuum bags collected as part of LHIP.

[c]1997-2002 and 2013 vacuum bags collected as part of LHIP & IDEQ sampling program.

[d]Includes 3 samples collected from Box homes sampled under the Basin sampling program.

[e]Does not include house dust pilot samples collected post-cleaning or 6 months after cleaning.

Table A-3
Dust Mat Summary Statistics by Community and Year, 1996-2013

					Concentration Range (mg/kg)		House Dust Lead Concentration (mg/kg)			
Year	City	Number of Samples	Number Above Action Level	Percent (%) Above Action Level	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Geometric Mean	Standard Deviation
1996	Kellogg	41	24	59	248	7,019	1,526	1,306	1,154	2.12
	Page	3	1	33	180	1,444	809	632	593	2.92
	Pinehurst	21	6	29	365	2,729	887	566	764	1.70
	Smelterville	8	5	63	360	3,477	1,677	1,204	1,270	2.33
	Wardner	2	1	50	--	--	--	--	--	--
	Box	75	37	49	180	7,019	1,329	1,124	1,013	2.08
1997	Kellogg	78	53	68	200	8,200	1,969	1,557	1,461	2.25
	Page	6	0	0	326	959	609	266	563	1.54
	Pinehurst	10	3	30	300	2,800	974	806	755	2.06
	Smelterville	202	71	35	11	4,800	984	696	793	2.01
	Wardner	5	2	40	447	3,020	1,516	1,275	1,101	2.47
	Box	301	129	43	11	8,200	1,240	1,088	926	2.17
1998[a]	Kellogg	312	173	55	43	35,600	1,766	3,244	1,141	2.22
	Page	8	2	25	270	1,560	681	442	584	1.77
	Pinehurst	57	7	12	120	15,500	905	2,047	551	2.15
	Smelterville	107	48	45	224	2,680	1,000	548	863	1.75
	Wardner	8	4	50	270	1,840	903	503	767	1.92
	Box	492	234	48	43	35,600	1,468	2,715	970	2.18
1999	Kellogg	206	88	43	90	7,750	1,167	906	928	1.96
	Page	7	1	14	170	8,930	1,677	3,206	632	3.66
	Pinehurst	53	6	11	146	32,100	1,132	4,358	465	2.38
	Smelterville	75	24	32	97	57,600	1,881	7,074	731	2.55
	Wardner	15	7	47	305	18,400	2,232	4,520	1,102	2.69
	Box	356	126	35	90	57,600	1,367	3,845	796	2.29

Table A-3

Dust Mat Summary Statistics by Community and Year, 1996-2013

Year	City	Number of Samples	Number Above Action Level	Percent (%) Above Action Level	Concentration Range (mg/kg) Minimum	Concentration Range (mg/kg) Maximum	House Dust Lead Concentration (mg/kg) Arithmetic Mean	Standard Deviation	Geometric Mean	Standard Deviation
2000[c]	Kellogg	177	74	42	174	15,500	1,288	1,668	913	2.13
	Page	8	1	13	180	1,400	533	400	431	1.97
	Pinehurst	67	9	13	70	7,830	625	981	437	2.05
	Smelterville	69	14	20	162	4,110	766	670	592	2.00
	Wardner	9	3	33	486	2,780	1,149	853	926	1.95
	Box	330	101	31	70	15,500	1,022	1,373	705	2.20
2001[c]	Kellogg	103	24	23	7	15,100	996	1,746	645	2.42
	Page	2	0	0	--	--	--	--	--	--
	Pinehurst	38	2	5	59	2,690	427	431	336	1.91
	Smelterville	51	9	18	45	3,590	742	664	561	2.23
	Wardner	8	3	38	232	4,980	1,528	1,607	973	2.76
	Box	202	38	19	7	15,100	840	1,360	555	2.38
2002[b]	Kellogg	167	11	7	43	4,210	425	551	291	2.20
	Page	8	0	0	15	546	192	160	135	2.84
	Pinehurst	79	0	0	36	611	202	127	169	1.82
	Smelterville	64	3	5	46	4,690	379	588	265	2.09
	Wardner	25	5	20	108	79,700	3,758	15,834	474	3.99
	Box	343	19	6	15	79,700	602	4,313	257	2.34
2003[b]	Kellogg	213	20	9	80	51,200	775	3,518	422	2.14
	Page	16	1	6	108	2,060	483	494	329	2.44
	Pinehurst	74	1	1	69	3,120	276	362	215	1.81
	Smelterville	51	6	12	47	4,320	538	657	386	2.12
	Wardner	8	2	25	85	2,220	732	713	460	2.97
	Box	362	30	8	47	51,200	626	2,723	359	2.19
2004[b]	Kellogg	177	12	7	55	28,100	630	2,222	334	2.29
	Page	15	2	13	99	6,340	825	1,582	393	2.83
	Pinehurst	85	2	2	32	1,530	190	228	136	2.12
	Smelterville	45	3	7	47	57,700	1,777	8,560	359	3.22
	Wardner	16	1	6	88	1,080	413	304	320	2.11
	Box	338	20	6	32	57,700	671	3,535	270	2.59

Table A-3
Dust Mat Summary Statistics by Community and Year, 1996-2013

Year	City	Number of Samples	Number Above Action Level	Percent (%) Above Action Level	Concentration Range (mg/kg)		House Dust Lead Concentration (mg/kg)			
					Minimum	Maximum	Arithmetic Mean	Standard Deviation	Geometric Mean	Standard Deviation
2005[b]	Kellogg	75	12	16	30	25,400	1,109	3,315	340	3.70
	Page	15	0	0	41	562	225	153	181	2.04
	Pinehurst	48	1	2	6	1,100	170	184	112	2.58
	Smelterville	48	2	4	25	10,500	520	1,492	227	3.02
	Wardner	10	1	10	35	3,420	624	1,001	300	3.56
	Box	196	16	8	6	25,400	642	2,218	222	3.36
2008[b]	Kellogg	133	6	5	27	6,380	426	617	285	2.36
	Page	6	0	0	93	520	287	154	247	1.88
	Pinehurst	78	1	1	13	1,830	205	225	148	2.23
	Smelterville	38	0	0	60	976	300	197	244	1.96
	Wardner	15	1	7	31	1,480	293	364	178	2.78
	Box	270	8	3	13	6,380	334	473	224	2.38
2013[b]	Kellogg	105	6	6	20	91,200	1,375	8,928	322	2.90
	Page	8	0	0	91	665	321	229	245	2.30
	Pinehurst	72	4	6	24	9,600	369	1,143	151	3.00
	Smelterville	46	1	2	25	1,060	276	204	209	2.20
	Wardner	10	0	0	52	605	285	173	231	2.10
	Box	241	11	5	20	91,200	784	5,934	231	2.90

Notes:
-- When the number of observation is ≤ 2, then data are not shown for confidentiality purposes.
Six samples were collected in 2006 but are not displayed due to small sample size.
[a]Includes 3 samples collected from Box homes under the Basin sampling program.
[b]Mat Multiplier is not applied to these concentrations.
[c]Does not include house dust pilot samples collected post-cleaning or 6 months after cleaning.
When a concentration is below detection limits, the reported value is used in summary statistics.

Table A-4
Dust Mat Loading Rates by Year, 1996-2013

			Dust Loading Rate ($mg/m^2/day$)					Lead Loading Rate ($mg/m^2/day$)			
Year	**City**	**Number of Samples**	**Arithmetic Mean**	**Standard Deviation**	**Geometric Mean**	**Standard Deviation**	**Number of Samples**	**Arithmetic Mean**	**Standard Deviation**	**Geometric Mean**	**Standard Deviation**
1996	Kellogg	65	1,029	1,250	576	3.08	41	1.94	2.00	1.31	2.52
	Page	3	2,332	1,344	2,052	1.90	3	1.63	1.29	1.22	2.76
	Pinehurst	27	1,079	1,101	682	3.09	21	1.09	0.84	0.80	2.34
	Smelterville	10	838	620	571	3.10	8	2.01	2.26	1.16	3.39
	Wardner	2	--	--	--	--	2	--	--	--	--
	Box	107	1,063	1,167	630	3.06	75	1.68	1.74	1.12	2.55
1997	Kellogg	78	656	696	431	2.46	78	1.28	1.59	0.63	3.41
	Page	6	1,517	1,346	1,128	2.29	6	0.94	0.80	0.64	2.77
	Pinehurst	10	679	1,024	371	2.78	10	0.64	0.74	0.28	4.31
	Smelterville	196	898	1,576	509	2.67	196	0.97	2.48	0.41	3.56
	Wardner	5	734	492	629	1.83	5	1.35	1.76	0.69	3.60
	Box	295	836	1,365	492	2.61	295	1.05	2.20	0.46	3.57
1998	Kellogg	310	507	835	297	2.69	310	1.12	4.26	0.34	3.68
	Page	8	927	988	647	2.35	8	0.58	0.52	0.38	2.82
	Pinehurst	53	1,074	1,157	638	2.98	53	0.67	0.98	0.33	3.31
	Smelterville	106	620	641	404	2.56	106	0.57	0.70	0.35	2.79
	Wardner	8	1,042	818	778	2.32	8	1.13	1.54	0.60	3.33
	Box	485	609	858	355	2.78	485	0.94	3.45	0.34	3.42
1999	Kellogg	204	700	1,384	319	3.50	204	0.72	1.03	0.30	4.45
	Page	7	2,127	1,440	1,803	1.81	7	6.86	16.19	1.14	5.68
	Pinehurst	53	1,145	969	769	2.67	53	1.90	9.70	0.36	3.77
	Smelterville	75	728	1,001	391	3.16	74	0.61	0.92	0.29	3.68
	Wardner	15	855	1,684	339	3.91	15	8.67	32.10	0.37	6.92
	Box	354	808	1,287	395	3.46	353	1.33	7.96	0.32	4.32

Table A-4
Dust Mat Loading Rates by Year, 1996-2013

			Dust Loading Rate ($mg/m^2/day$)					Lead Loading Rate ($mg/m^2/day$)			
Year	**City**	**Number of Samples**	**Arithmetic Mean**	**Standard Deviation**	**Geometric Mean**	**Standard Deviation**	**Number of Samples**	**Arithmetic Mean**	**Standard Deviation**	**Geometric Mean**	**Standard Deviation**
2000	Kellogg	177	562	737	361	2.51	177	0.62	0.93	0.33	3.15
	Page	8	1,323	1,116	967	2.37	8	0.56	0.37	0.42	2.67
	Pinehurst	67	950	1,347	529	3.30	67	0.50	0.78	0.23	3.79
	Smelterville	71	661	571	476	2.28	69	0.57	1.13	0.29	2.83
	Wardner	9	265	131	236	1.68	9	0.38	0.40	0.22	3.00
	Box	332	672	885	419	2.65	330	0.57	0.93	0.30	3.21
2001	Kellogg	120	525	895	268	3.04	103	0.46	0.62	0.23	3.73
	Page	3	1,293	1,021	1,051	2.18	2	0.43	0.02	0.43	1.05
	Pinehurst	41	679	708	395	3.32	38	0.29	0.41	0.16	3.10
	Smelterville	57	756	1,578	370	3.10	51	0.55	1.03	0.24	3.42
	Wardner	8	948	1,578	482	2.89	8	1.09	1.44	0.47	4.06
	Box	229	635	1,106	320	3.14	202	0.47	0.76	0.22	3.56
2002[a]	Kellogg	167	567	692	412	2.11	167	0.26	0.43	0.12	3.36
	Page	8	620	656	441	2.31	8	0.10	0.08	0.06	4.66
	Pinehurst	79	847	1,161	542	2.39	79	0.21	0.55	0.09	3.28
	Smelterville	64	875	1,116	551	2.54	64	0.43	1.18	0.15	3.84
	Wardner	25	740	480	593	2.04	25	1.12	2.79	0.28	4.87
	Box	343	703	902	477	2.27	343	0.34	1.01	0.12	3.66
2003[a]	Kellogg	214	424	504	279	2.52	213	0.37	1.55	0.12	3.62
	Page	16	1,430	1,984	822	2.85	16	0.54	0.52	0.27	4.33
	Pinehurst	75	579	795	339	3.04	74	0.18	0.37	0.08	3.46
	Smelterville	51	807	1,271	456	2.65	51	0.37	0.53	0.18	3.44
	Wardner	8	1,429	1,363	943	2.81	8	1.21	1.43	0.43	5.71
	Box	364	576	877	335	2.78	362	0.36	1.24	0.12	3.78
2004[a]	Kellogg	177	590	794	374	2.39	177	0.54	3.42	0.12	3.70
	Page	15	1,678	2,197	841	3.38	15	1.19	2.05	0.33	5.14
	Pinehurst	85	591	836	360	2.55	85	0.13	0.23	0.05	3.97
	Smelterville	46	905	1,592	458	3.05	45	1.25	5.38	0.17	5.34
	Wardner	16	1,152	2,229	561	2.84	16	0.78	1.89	0.18	4.98
	Box	339	708	1,152	402	2.62	338	0.57	3.22	0.11	4.44

Table A-4
Dust Mat Loading Rates by Year, 1996-2013

			Dust Loading Rate ($mg/m^2/day$)					Lead Loading Rate ($mg/m^2/day$)			
Year	**City**	**Number of Samples**	**Arithmetic Mean**	**Standard Deviation**	**Geometric Mean**	**Standard Deviation**	**Number of Samples**	**Arithmetic Mean**	**Standard Deviation**	**Geometric Mean**	**Standard Deviation**
2005[a]	Kellogg	74	998	4,228	339	3.03	74	13.22	107.61	0.11	7.63
	Page	15	692	538	511	2.26	15	0.18	0.23	0.09	3.59
	Pinehurst	48	575	1,076	279	2.98	48	0.11	0.21	0.03	5.65
	Smelterville	48	704	694	439	2.86	48	0.78	3.95	0.10	6.16
	Wardner	10	557	779	288	3.07	10	0.99	2.65	0.09	9.26
	Box	195	775	2,684	352	2.94	195	5.30	66.33	0.08	6.86
2008[a]	Kellogg	133	440	373	308	2.52	133	0.23	0.42	0.09	4.51
	Page	6	316	205	231	2.83	6	0.10	0.09	0.06	4.72
	Pinehurst	78	745	1,804	394	2.69	78	0.22	0.86	0.06	4.72
	Smelterville	38	955	990	548	3.36	38	0.29	0.33	0.13	4.79
	Wardner	15	441	536	257	2.90	15	0.17	0.33	0.05	6.61
	Box	270	595	1,087	353	2.76	270	0.23	0.57	0.08	4.79
2013[a]	Kellogg	105	846	925	500	3.00	105	1.06	4.91	0.16	5.84
	Page	8	3,394	3,768	1,813	3.50	8	0.93	1.03	0.44	4.49
	Pinehurst	72	749	1,006	462	2.70	72	0.44	2.07	0.07	5.90
	Smelterville	46	807	749	582	2.30	46	0.25	0.31	0.12	3.90
	Wardner	10	477	395	327	2.80	10	0.17	0.19	0.08	5.45
	Box	241	879	1,192	515	2.80	241	0.68	3.45	0.12	5.64

Notes:

[a]Mat Multiplier is not applied to these concentrations.

-- When the number of observation is ≤ 2, then data are not shown for confidentiality purposes.

Six samples were collected in 2006 but are not displayed due to small sample size.

When a concentration is below detection limits, the reported value is used in summary statistics.

Table A-5
Paired House Dust Data

Year	City	Number of Pairs	Geometric Mean Mat Lead Concentration (mg/kg)	Geometric Mean Vacuum Lead Concentration (mg/kg)	Correlation Coefficient - R	Paired T-test P-value
2008	Kellogg	88	275	300	0.4	0.39
	Page	4	259	310	--	--
	Pinehurst	51	166	210	0.5	0.03
	Smelterville	28	257	272	0.5	0.71
	Wardner	--	--	--	--	--
	Box-wide	171	234	265	0.5	0.05
2013	Kellogg	80	295	308	0.3	0.67
	Page	6	235	174	--	--
	Pinehurst	50	181	210	0.5	0.33
	Smelterville	37	195	202	0.7	0.68
	Wardner	6	236	241	--	--
	Box-wide	179	233	247	0.5	0.37

Table A-6. Summary of Homes with Repeat Elevated Dust Lead Concentrations

House	Yard Remediation Year	Sample Type	1988	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2008	2013
1	1994	vacuum												X							
		mat								X				x	X						
2	1990	vacuum																			
		mat									X	X		X	X		X				
3	1994	vacuum												x				X			
		mat									X	X		X				x			
4	1996- Discrete	vacuum											X								
		mat										X	X								
5	1996	vacuum																	X		
		mat										X				X	X	X	X		
6	1992	vacuum												X		X					
		mat										X		X		x					
7	1992	vacuum																			
		mat										X	X								
8	1992	vacuum																			
		mat								X	X						X			X	
9	1992	vacuum																			
		mat															X			X	X
10	1989	vacuum															x				x
		mat															X				X
11	2002	vacuum																			X
		mat																		X	x
12	1989	vacuum							X	x				X							
		mat								X				X		X					
13	1997	vacuum																		X	
		mat										X					X			x	
14	1990	vacuum											x							X	
		mat											X							x	
15	1996	vacuum															X		X		
		mat															x		x		

Table A-6. Summary of Homes with Repeat Elevated Dust Lead Concentrations

House	Yard Remediation Year	Sample Type	1988	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2008	2013
16	1989	vacuum															X				
		mat											X				x				
17	1989	vacuum												x	x						
		mat												X	X						
18	1995	vacuum													X	X					
		mat										X	X	X	x	x					
19	2002	vacuum																X	X	X	X
		mat										X						x	x	x	x
20	1993	vacuum											x	x							
		mat								X			X	X							
21	1992	vacuum												X			X				
		mat												X			X				
22	1991	vacuum									X		x								
		mat								X	X		X								
23	2000-Discrete	vacuum													X						
		mat										X									
24	2001-Discrete	vacuum					X			X											
		mat								X											
25	1989	vacuum																			
		mat									X	X									
26	1996-Discrete	vacuum				X	X	X													
		mat								X				X		X					

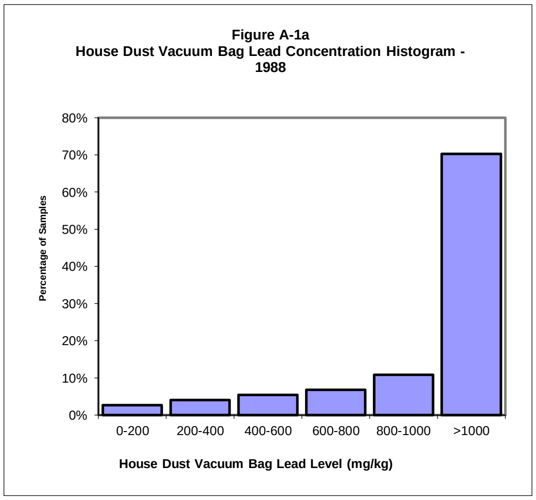
Gray shading indicates years prior to yard remediation through six years after remediation

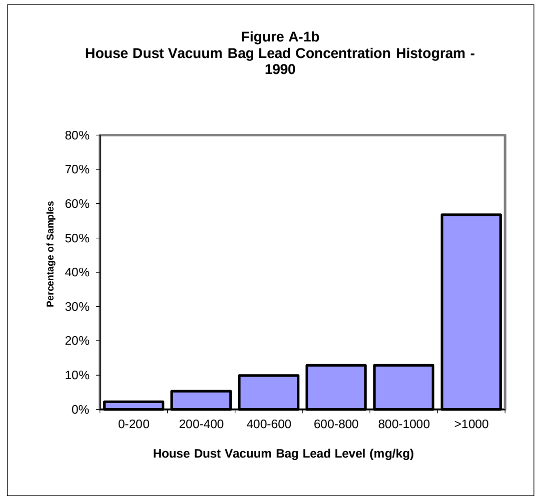
x result less than 1,000 mg/kg lead

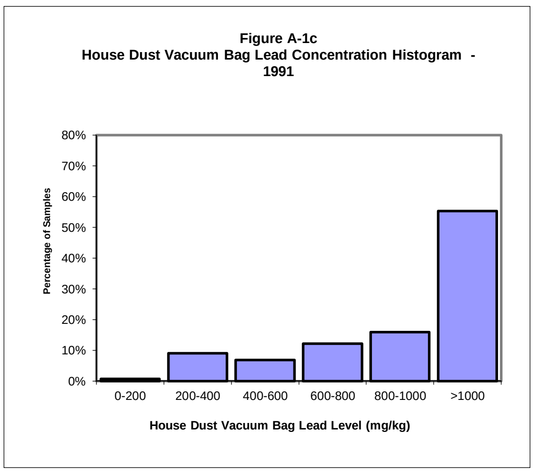
X result greater than or equal to 1,000 mg/kg lead

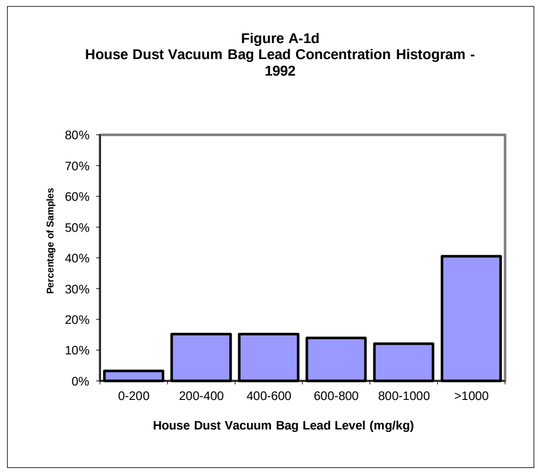
Figure A-1

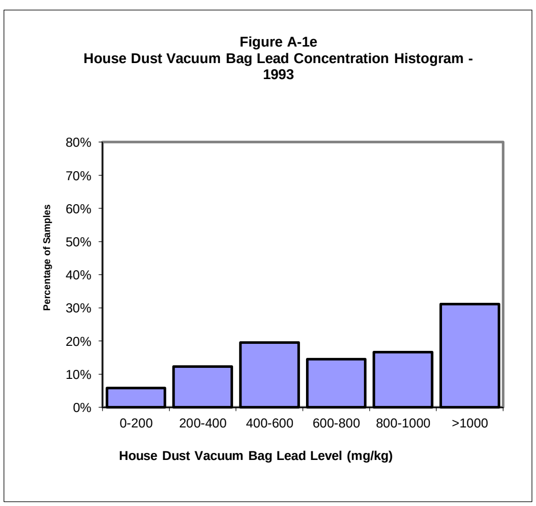
House Dust Vacuum Bag Concentration Histograms - Box-wide, 1988-2013











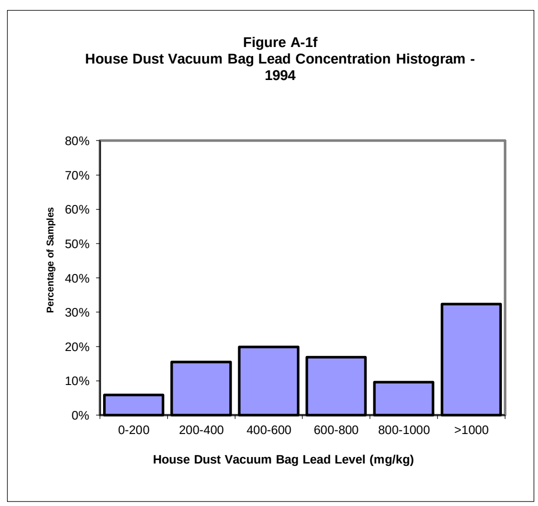


Figure A-1 a-s (continued)

House Dust Vacuum Bag Concentration Histograms - Box-wide, 1988-2013

Figure A-1g
House Dust Vacuum Bag Lead Concentration Histogram - 1995

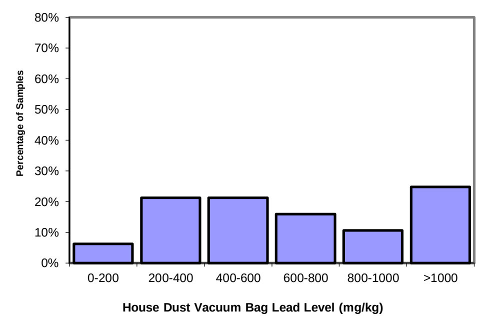


Figure A-1h
House Dust Vacuum Bag Lead Concentration Histogram - 1996

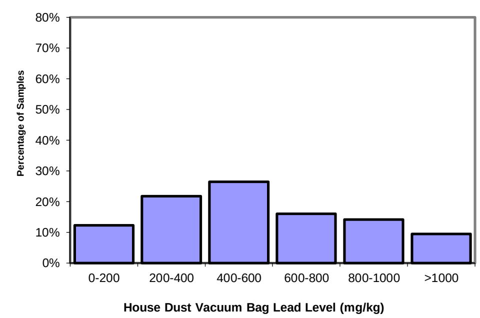


Figure A-1i
House Dust Vacuum Bag Lead Concentration Histogram - 1997

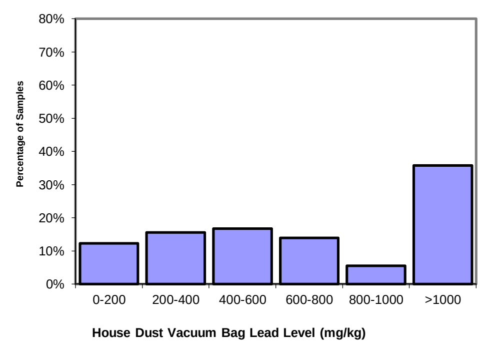


Figure A-1j
House Dust Vacuum Bag Lead Concentration Histogram - 1998

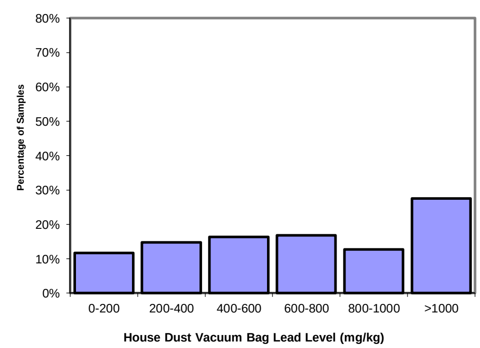


Figure A-1k
House Dust Vacuum Bag Lead Concentration Histogram - 1999

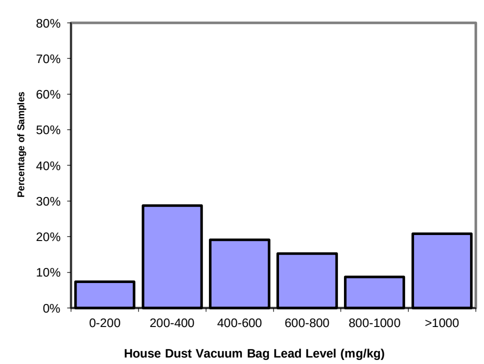


Figure A-1l
House Dust Vacuum Bag Lead Concentration Histogram - 2000

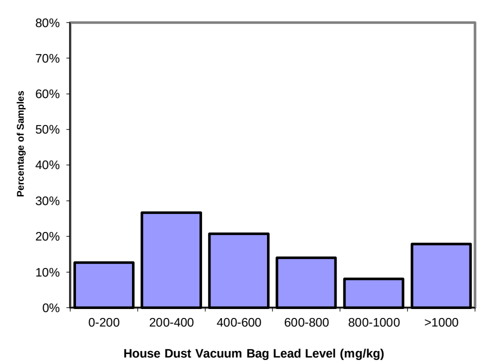


Figure A-1 a-s (continued)

House Dust Vacuum Bag Concentration Histograms - Box-wide, 1988-2013

Figure A-1m
House Dust Vacuum Bag Lead Concentration Histogram - 2001

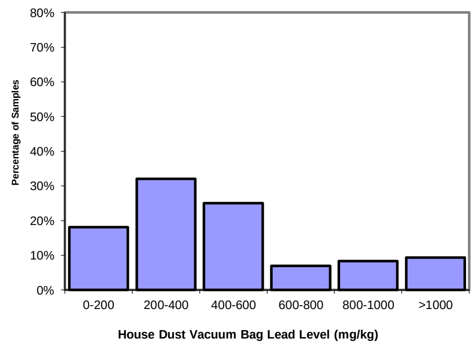


Figure A-1n
House Dust Vacuum Bag Lead Concentration Histogram - 2002

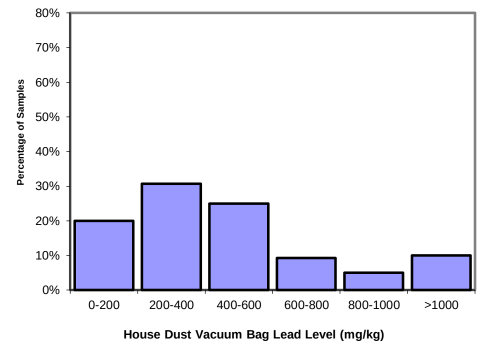


Figure A-1o
House Dust Vacuum Bag Lead Concentration Histogram - 2003

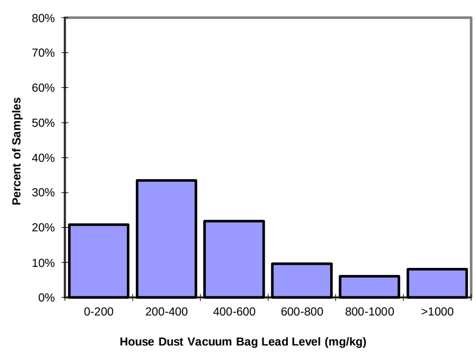


Figure A-1p
House Dust Vacuum Bag Lead Concentration Histogram - 2004

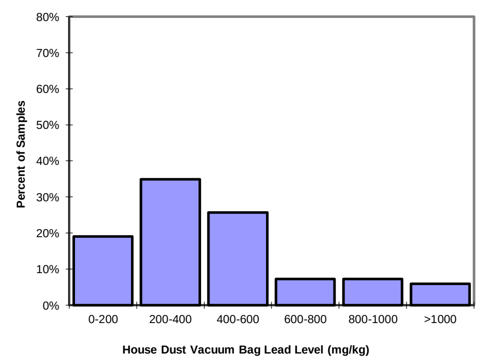


Figure A-1q
House Dust Vacuum Bag Lead Concentration Histogram - 2005

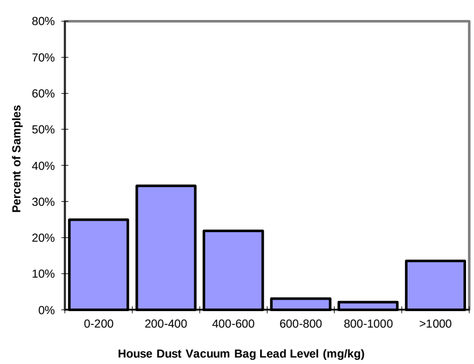


Figure A-1r
House Dust Vacuum Bag Lead Concentration Histogram - 2008

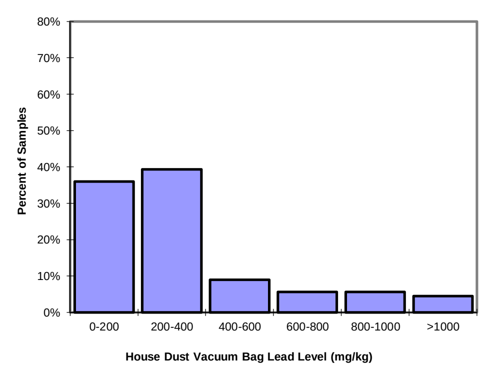


Figure A-1 a-s (continued)

House Dust Vacuum Bag Concentration Histograms - Box-wide, 1988-2013

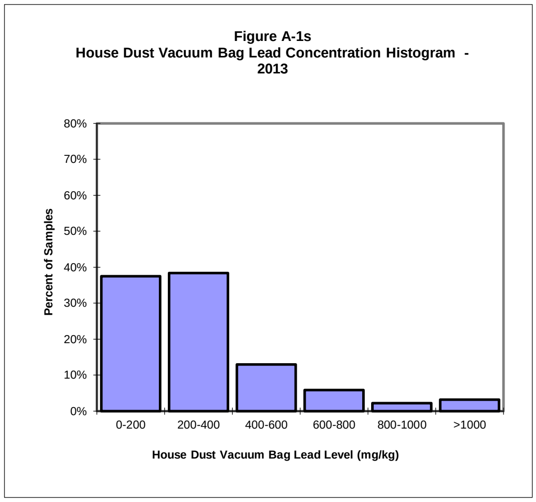
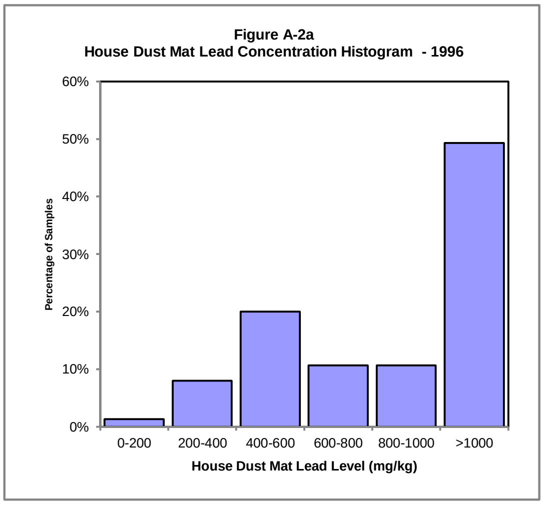
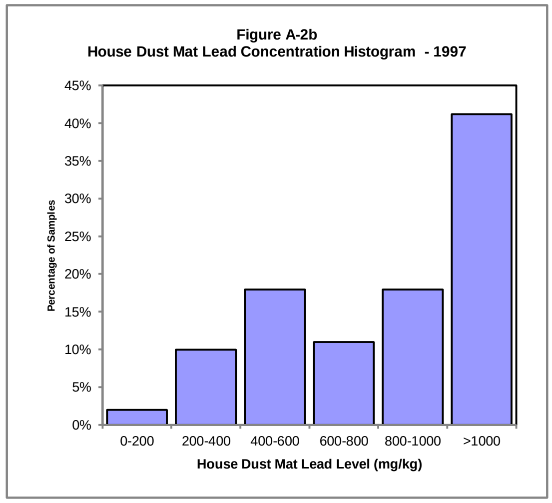
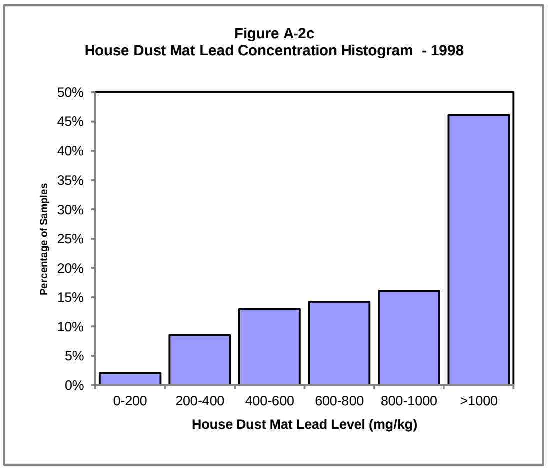
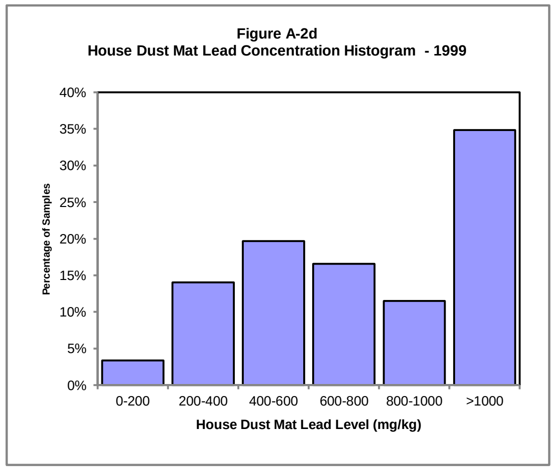


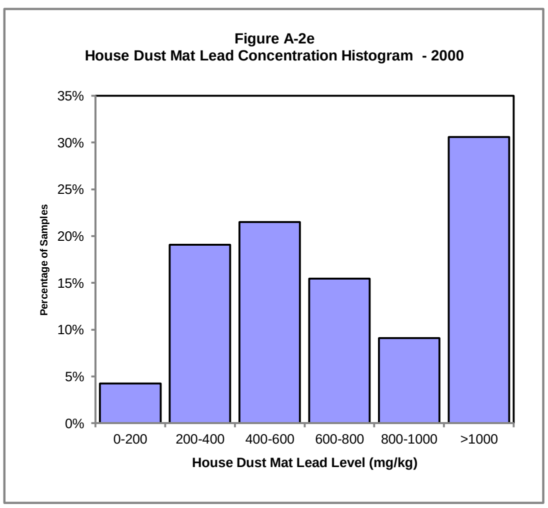
Figure A-2
House Dust Mat Concentration Histograms - Box-wide, 1988-2013











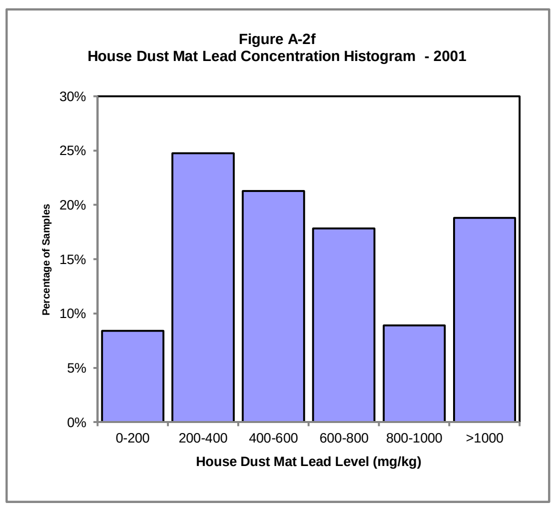


Figure A-2

House Dust Mat Concentration Histograms - Box-wide, 1988-2013

Figure A-2g
House Dust Mat Lead Concentration Histogram - 2002

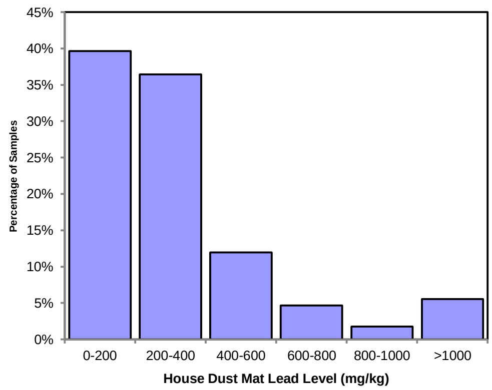


Figure A-2h
House Dust Mat Lead Concentration Histogram - 2003

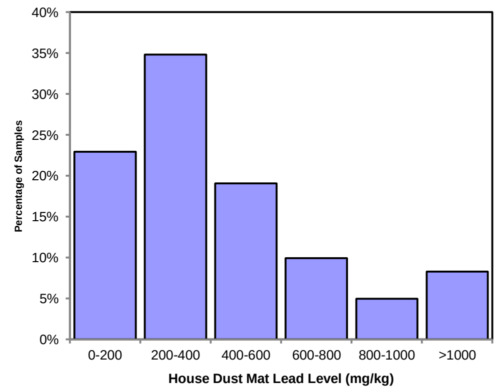


Figure A-2i
House Dust Mat Lead Concentration Histogram - 2004

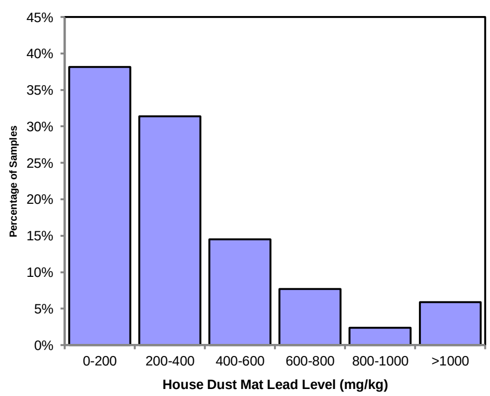


Figure A-2j
House Dust Mat Lead Concentration Histogram - 2005

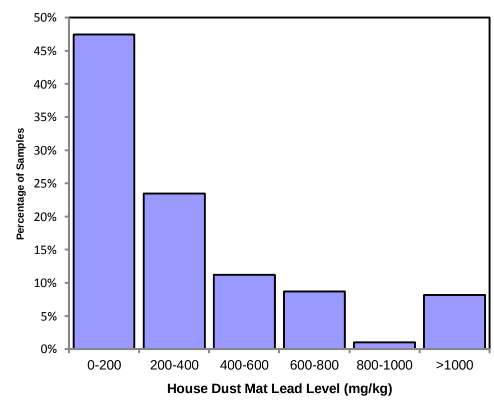


Figure A-2l
House Dust Mat Lead Concentration Histogram - 2008

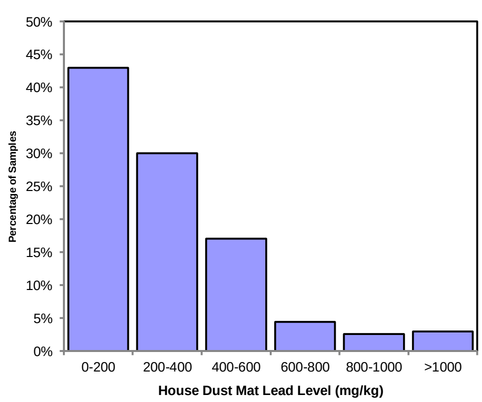
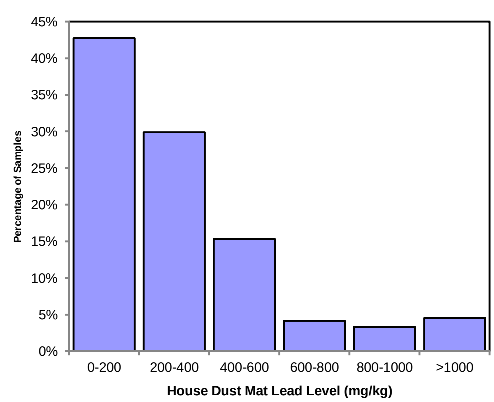


Figure A-2m
House Dust Mat Lead Concentration Histogram - 2013



*2006 Not displayed due to small sample size

Appendix B

Dust Mat Questionnaire Supporting Text, Tables, and Figures

House Id# ______________________ GISID: _____________ Parcel #_____________________

2013 Household Questionnaire

[Interviewer: Pick the mat up first! Then complete this questionnaire on all households in which a mat is picked up. ***Let the participant know that it may take a few minutes to complete this questionnaire.*****]**

Mat Retrieved? _____ Date __________ Vacuum Bag?______

House ID #:	**Date:**	**Interviewer Initials:**
Name:		
*** Street Address:**		
*** Mailing Address:**		
Home Phone Number: (208)	**Work Phone Number:** ( )	**Cell Phone Number:** ( )

* Must have both street and mailing address. If mailing address is the same, write "same." Please include zip code.

1. Did you vacuum the mat?
   1) yes 2) no 9) don't know

2. How many times did you pick up or shake the mat?
   1) only once 2) 2-4 times 3) More than 4 times
   4) None 9) don't know

3. Did you move it from its original location to a new location?
   1) yes 2) no 9) don't know

4. Did the mat get wet?
   1) yes 2) no 9) don't know

5. Did the mat get physically damaged by animals or otherwise?
   1) yes 2) no 9) don't know

6. How many days did you go on vacation/ stay away from the house since the mat was placed?
   _____ days

7. How many people regularly live in the home?
   Adults __________ Children ____________ Pregnant Women_____________

   If children live in the home, go to Question 8. If not, go to Question 10.

8. If children live at the home, what are their ages? [Circle appropriate unit (years or months) for each child's age.]
   Child 1 ______ years / months   Child 2 ______ years / months
   Child 3 ______ years / months   Child 4 ______ years / months

9. How many hours per day does the most active or oldest child spend outside?
   During the summer: _______ hours
   During the winter: _______ hours

10. How many dogs, cats, or other pets regularly go in and out of the house?
    1) 1 animal   2) 2 or more animals
    4) none   9) Don't know

If pets are owned, go to Question 11. If not, go to Question 12.

11. Since the mat was placed, did your pet(s) regularly use the door where the mat was located?
    1) yes   2) no   9) don't know

12. From the following choices, how often were the windows or doors left open in the past month?
    1) everyday   2) 2-3 times a week
    3) 2-3 times   4) never
    9) don't know

13. Do you have a forced air heating or cooling system in your home (i.e., air ducts)?
    1) yes   2) no   9) don't know

14. Do you use a woodstove in the household?
    1) yes   2) no

If yes, go to Question 15. If no, go to Question 16.

15. What do you use for fuel (e.g., logs, railroad ties, scrap wood, coal)?
    ____

16. How many rooms are in the home (count all *regularly accessed* rooms including bedrooms, bathrooms, kitchen, living rooms, family rooms and others)? __________

17. How many of those rooms are carpeted? __________

    [Based on Questions 16 and 17, what percentage of the total rooms are carpeted?]
    1) <50% of the rooms   2) ≥50% of the rooms

House Id# ______________________ GISID: _____________ Parcel #_____________________

18. From the following choices, how old is the oldest carpet in your home?
    1) less than 1 year old 2) 1-5 years old 3) 6-10 years old
    4) older than 10 years 9) don't know

19. From the following choices, how often is the carpet usually vacuumed?
    1) every day 2) once a week 3) once a month
    4) once every few months 5) never

20. Are there throw rugs/entrance mats at the entrances to this home?
    1) Yes 2) No

If yes, go to Question 21. If no, go to Question 22.

21. From the following choices, how often are they cleaned (i.e., vacuumed, swept, laundered)?
    1) every day 2) once a week 3) once a month
    4) once every few months 5) never 9) don't know

22. Do people generally remove their shoes before entering the home?
    1) yes 2) no

23. What year was this home built? (oldest part) Year: _________________
    1) before 1960 2) 1960 - 1978 3) 1979 or later
    9) don't know

24. Do you own or rent your home?
    1) rent 2) own

25. How long have you lived in this home?
    1) <1 year 2) 1-5 years 3) >5 years

26. Has any part of the home been remodeled?
    1) yes 2) no 9) don't know

If yes, go to Question 27. If no or don't know, go to Question 28.

27. When did the work take place?
    1) within the last year 2) one to two years ago
    3) more than 2 years ago 9) don't know

28. Have you sanded or removed paint from any part of the interior of the house or furniture?
    1) yes When?_________ 2) no 9) don't know

29. Have you sanded or removed paint from any part of the exterior of the house?
    1) yes When?_________ 2) no 9) don't know

30. Does your home contain lead-based paints?
1) yes 2) no 9) don't know

31. Do you have an official report or letter confirming this?
1) yes 2) no 9) don't know

32. Do members of your family or your pets access a crawl space or other areas under your house or porch on a regular basis?
1) yes 2) no 9) don't know

33. Has any new dirt, gravel, or sand been added to your yard or other areas around the house, not associated with yard cleanup?
1) yes 2) no 9) don't know

34. Has any excavation, grading, or other construction work been done to the yard or area around the house, not associated with yard cleanup?
1) yes 2) no 9) don't know

35. Has the yard (or ground immediately surrounding this residence) or the inside of this home been flooded?
1) yes When?__________ 2) no 9) don't know

36. Is there a daycare run out of this home?
1) yes 2) no

If yes, go to Question 37. If no, go to Question 39.

37. How many children are on site each day?
1) 1-4 2) 5-8 3) 9-16
4) >16 9) don't know

38. For how many days each week?
1) 1-2 2) 3-5 3) 6-7
9) don't know

39. If children live in the home or visit regularly, describe the condition of children's play areas using the following condition codes. [Use 9 if not applicable.]
(on next page)

Condition codes:
1 = grassy, vegetated, no bare soil
2 = some bare soil, partly grassy
3 = moderate amount of bare soils, gravel, dust
4 = area is mostly or totally bare soil, garden, gravel, riverbed
9 = N/A

Location	**Condition**
Yard	
Play area	
Day care	
Neighbors	
Vacant lot	
Hillsides	
Relatives	
Other	

40. Do any members of the household smoke?
1) Yes 2) No

41. Do any members of the household (including you) do the following activities? [First check Yes, No, or Don't Know for each activity. Complete the remaining columns only for activities checked Yes. Be sure to circle the appropriate unit (# times or # days) for all activities checked Yes.]

Activity	**No**	**Don't Know**	**Yes**	**# Times or Days in the Past Three Months**	**Location(s)**
Dirt biking/4-wheeling				times / days	
Mountain biking				times / days	
Mudding				times / days	
Camping				times / days	
Boating				times / days	
Swimming				times / days	
Hunting – upland game				times / days	
Hunting – waterfowl				times / days	
Fishing				times / days	
Other				times / days	

[Total number of activities: __________] (from chart above).

42. Do any members of the household (including you) do any activities in the Coeur d'Alene river flood basin that put them in contact with soil, other than those just listed? If yes, what activities and where?

    ____

43. In the last 3 months, has any member of this household (including you) been employed in the following jobs?

Occupation	**Yes**	**No**	**Don't Know**
Milling or concentrating ore	1	2	9
Carpentry or remodeling work	1	2	9
Foundry work	1	2	9
Professional plumbing/plumber	1	2	9
Mining	1	2	9
Landscaping/excavation	1	2	9
Construction Work in the Silver Valley	1	2	9

44. Within the last 3 months, has any member of this household (including you) done any of the following activities in this home more than once?

Activity	**Yes**	**No**	**Don't Know**
Painted pictures with artist's paints	1	2	9
Worked with stained glass or made metal jewelry	1	2	9
Cast lead into fishing sinkers, bullets or anything else	1	2	9
Worked with soldering in electronics or plumbing	1	2	9
Worked in a vegetable or flower garden around the home	1	2	9
Made pottery	1	2	9
Made tole paintings	1	2	9
Painted cars or bicycles	1	2	9
Reloaded bullets	1	2	9

[The following blanks are to be filled out by the interviewer upon inspection of the home.]

1. Condition of paint:

Inside:	1) good condition	2) chipping, chalking, peeling or bite marks
Outside:	1) good condition	2) chipping, chalking, peeling or bite marks

2. Rate the grass coverage in yard:

   1) mostly soil/dirt   2) half bare/half covered
   3) mostly grass

3. Rate the coverage in the drip line:
   1) mostly bare soil/dirt 2) half bare/half covered
   3) mostly vegetated (i.e. flowerbeds, grass)

4. Rate general household hygiene
   1) poor: a lot of noticeable dust/odor/dirt 2) good

Appendix B - Questionnaire Regression Analysis

In order to maintain a larger set of records, 27 variables that had the largest number of responses were included in the exploratory analysis. Questionnaire responses were transformed into dummy variables (e.g., 0=no and 1=yes, or 1=homes built prior to 1960, otherwise 0). The most recent information was retained for homes sampled in multiple years (2005, 2008, and/or 2013).

The stepwise selection starts with the model $y=\beta_0+\varepsilon$ and adds one variable at a time (Ott 1993). That variable's F statistic reflects its contribution to the model, and the associated p-value is compared to a criterion of 0.1. The stepwise selection procedures employed in the SAS software also examine all the variables included in the model after a variable is added and delete any variables that do not produce an F statistic significant at the same criterion of 0.1. The stepwise process ends when none of the variables outside the model are significant at the criterion (SAS Institute Inc. 1989). The criterion of 0.1 was used in the stepwise procedure because it was considered exploratory and less limiting.

The number of records used in each stepwise regression analysis was based on the number of records without missing values: 356 records for mats and 233 records for vacuums. Tables B-2 and B-3 summarize the selected variables and associated information for each stepwise regression. The stepwise procedure identified eight variables for mat lead levels and four variables for vacuum lead levels, as follows:

- Mat lead concentration:
    - Total number of people living in the home – Question 7
    - Interior paint condition – Interviewer inspection, Observation 1
    - Total number of recreational activities in which any members of the household partake (biking, camping, boating, swimming, hunting, etc.) – Question 41
    - House Age (whether the home was built between 1960 and 1978 or not) – Question 23
    - House Age (whether the home was built prior to 1960 or not) – Question 23
    - Flooding (whether the ground immediately surrounding the residence had been flooded or not) – Question 35
    - Presence of air ducts (forced air heating or cooling) – Question 13
    - Remodeling that included sanding or removing paint from any part of the interior of the home – Question 28
- Vacuum lead concentration:
    - Total number of recreational activities in which any members of the household partake (biking, camping, boating, swimming, hunting, etc.) – Question 41
    - House Age (whether the home was built between 1960 and 1978 or not) – Question 23
    - House Age (whether the home was built prior to 1960 or not) – Question 23
    - Exterior paint condition – Interviewer inspection, Observation 1

The selected variables for each dust sampling method were then entered into the respective multiple regression model (SAS software V8® PROC GLM), and assumptions were checked using residual plots (for constant variance), normal probability plots (for normally distributed residuals), and residual time series plots (for serial correlation). Inspection of the plots revealed one obvious outlier in the dust mat lead regression; the outlier was subsequently removed. The assumptions of constant variance and normally distributed residuals generally hold true using the log transformed lead concentrations in both regression models. Tables B-4 and B-5 summarize the multiple regression analysis. No interaction terms were included in the multiple regression models because this analysis was conducted for exploratory purposes, and interactions potentially complicate interpretation of each model and its use to predict values.

Table B-1. SAS Output for Questionnaire Response Frequencies

HIHOME = 0 if either or both the mat and vacuum lead concentrations < 1,000 mg/kg
HIHOME = 1 if either or both the mat and vacuum lead concentrations ≥ 1,000 mg/kg

The FREQ Procedure

Table of HIHOME by TOTLPEEP_

HIHOME   TOTLPEEP_ = Total number of people regularly living in the home

HIHOME Frequency Percent Row Pct Col Pct	1 = 1 person	2 = 2-3	3 = 4-5	4 = >5	Total
0	105 15.24 16.48 97.22	304 44.12 47.72 92.40	176 25.54 27.63 90.26	52 7.55 8.16 91.23	637 92.45
1	3 0.44 5.77 2.78	25 3.63 48.08 7.60	19 2.76 36.54 9.74	5 0.73 9.62 8.77	52 7.55
Total	108 15.67	329 47.75	195 28.30	57 8.27	689 100.00

Frequency Missing = 4

Table of HIHOME by Summerhrs_

HIHOME   Summerhrs_ = Summer hours per day child spends outside

HIHOME Frequency Percent Row Pct Col Pct	0 = 0 hours	1 = 1-2	2 = 3-4	3 = ≥5	Total
0	20 5.73 6.33 86.96	33 9.46 10.44 89.19	62 17.77 19.62 91.18	201 57.59 63.61 90.95	316 90.54
1	3 0.86 9.09 13.04	4 1.15 12.12 10.81	6 1.72 18.18 8.82	20 5.73 60.61 9.05	33 9.46
Total	23 6.59	37 10.60	68 19.48	221 63.32	349 100.00

Frequency Missing = 344

Table of HIHOME by Winterhrs_

HIHOME — Winterhrs_ = winter hours per day child spends outside

Frequency / Percent / Row Pct / Col Pct	0 = 0 hours	1 = 1-2	2 = 3-4	3 = ≥5	Total
0	63	162	55	33	313
	18.21	46.82	15.90	9.54	90.46
	20.13	51.76	17.57	10.54	
	87.50	90.00	91.67	97.06	
1	9	18	5	1	33
	2.60	5.20	1.45	0.29	9.54
	27.27	54.55	15.15	3.03	
	12.50	10.00	8.33	2.94	
Total	72	180	60	34	346
	20.81	52.02	17.34	9.83	100.00

Frequency Missing = 347

Table of HIHOME by PET_

HIHOME — PET_ = Number of pets going in and out of home

Frequency / Percent / Row Pct / Col Pct	0 = No pets	1 = ≥1	Total
0	200	437	637
	29.03	63.43	92.45
	31.40	68.60	
	90.50	93.38	
1	21	31	52
	3.05	4.50	7.55
	40.38	59.62	
	9.50	6.62	
Total	221	468	689
	32.08	67.92	100.00

Frequency Missing = 4

Table of HIHOME by PETSDOOR_

HIHOME PETSDOOR_ = Pets using door where mat was located

Frequency / Percent / Row Pct / Col Pct	0 = No	1 = Yes	Total
0	122	332	454
	25.10	68.31	93.42
	26.87	73.13	
	94.57	93.00	
1	7	25	32
	1.44	5.14	6.58
	21.88	78.13	
	5.43	7.00	
Total	129	357	486
	26.54	73.46	100.00

Frequency Missing = 207

Table of HIHOME by Windows_

HIHOME Windows_ = Frequency of windows and doors were left open

Frequency / Percent / Row Pct / Col Pct	0 = Rarely	1 = Frequently	9 = don’t know	Total
0	137	497	4	638
	19.86	72.03	0.58	92.46
	21.47	77.90	0.63	
	93.20	92.21	100.00	
1	10	42	0	52
	1.45	6.09	0.00	7.54
	19.23	80.77	0.00	
	6.80	7.79	0.00	
Total	147	539	4	690
	21.30	78.12	0.58	100.00

Frequency Missing = 3

Table of HIHOME by ForcedAir_

HIHOME — ForcedAir_ = Forced air heating or cooling

HIHOME Frequency Percent Row Pct Col Pct	0 = no	1 = yes	9 = Don't know	Total
0	222 32.13 34.74 93.28	413 59.77 64.63 92.19	4 0.58 0.63 80.00	639 92.47
1	16 2.32 30.77 6.72	35 5.07 67.31 7.81	1 0.14 1.92 20.00	52 7.53
Total	238 34.44	448 64.83	5 0.72	691 100.00

Frequency Missing = 2

Table of HIHOME by PCarpet_

HIHOME — PCarpet_ = Percent of rooms carpeted

HIHOME Frequency Percent Row Pct Col Pct	0 = <50% of rooms	1 = ≥50%	Total
0	228 33.04 35.74 91.20	410 59.42 64.26 93.18	638 92.46
1	22 3.19 42.31 8.80	30 4.35 57.69 6.82	52 7.54
Total	250 36.23	440 63.77	690 100.00

Frequency Missing = 3

Table of HIHOME by AgeCarpet_

HIHOME AgeCarpet_ = Age of carpet

Frequency / Percent / Row Pct / Col Pct	0 = ≤5 yrs	1 = ≥6	9 = Don't know	Total
0	121	259	214	594
	19.00	40.66	33.59	93.25
	20.37	43.60	36.03	
	93.08	92.17	94.69	
1	9	22	12	43
	1.41	3.45	1.88	6.75
	20.93	51.16	27.91	
	6.92	7.83	5.31	
Total	130	281	226	637
	20.41	44.11	35.48	100.00

Frequency Missing = 56

Table of HIHOME by VacCarp_

HIHOME VacCarp_ = Frequency of carpet vacuuming

Frequency / Percent / Row Pct / Col Pct	0 = Frequently	1 = Rarely	5 = Never	Total
0	537	53	5	595
	84.17	8.31	0.78	93.26
	90.25	8.91	0.84	
	93.07	96.36	83.33	
1	40	2	1	43
	6.27	0.31	0.16	6.74
	93.02	4.65	2.33	
	6.93	3.64	16.67	
Total	577	55	6	638
	90.44	8.62	0.94	100.00

Frequency Missing = 55

Table of HIHOME by Shoes_

HIHOME — Shoes_ = Shoes removed before entering home

Frequency / Percent / Row Pct / Col Pct	0 = No	1 = Yes	Total
0	479	155	634
	69.83	22.59	92.42
	75.55	24.45	
	91.94	93.94	
1	42	10	52
	6.12	1.46	7.58
	80.77	19.23	
	8.06	6.06	
Total	521	165	686
	75.95	24.05	100.00

Frequency Missing = 7

Table of HIHOME by YearBuiltCode

HIHOME — YearBuiltCode = Age of home

Frequency / Percent / Row Pct / Col Pct	1 = < 1960	2 = 1960-1978	3 = ≥1979	9 = Don't know	Total
0	219	106	79	233	637
	31.79	15.38	11.47	33.82	92.45
	34.38	16.64	12.40	36.58	
	88.31	96.36	97.53	93.20	
1	29	4	2	17	52
	4.21	0.58	0.29	2.47	7.55
	55.77	7.69	3.85	32.69	
	11.69	3.64	2.47	6.80	
Total	248	110	81	250	689
	35.99	15.97	11.76	36.28	100.00

Frequency Missing = 4

Table of HIHOME by OwnRent_

HIHOME — OwnRent_ = Rents or owns home

Frequency / Percent / Row Pct / Col Pct	0 = Rent	1 = Own	Total
0	241 34.98 37.83 92.34	396 57.47 62.17 92.52	637 92.45
1	20 2.90 38.46 7.66	32 4.64 61.54 7.48	52 7.55
Total	261 37.88	428 62.12	689 100.00

Frequency Missing = 4

Table of HIHOME by Lived_

HIHOME — Lived_ = Tenure living in home

Frequency / Percent / Row Pct / Col Pct	0 < 1 year	1 = ≥ 1 year	Total
0	100 14.56 15.75 92.59	535 77.87 84.25 92.40	635 92.43
1	8 1.16 15.38 7.41	44 6.40 84.62 7.60	52 7.57
Total	108 15.72	579 84.28	687 100.00

Frequency Missing = 6

Table of HIHOME by Remodeled_

HIHOME   Remodeled_ = Home has been remodeled

HIHOME (Frequency / Percent / Row Pct / Col Pct)	0 = no	1 = Yes	9 = Don't know	Total
0	306	284	42	632
	44.74	41.52	6.14	92.40
	48.42	44.94	6.65	
	93.58	90.45	97.67	
1	21	30	1	52
	3.07	4.39	0.15	7.60
	40.38	57.69	1.92	
	6.42	9.55	2.33	
Total	327	314	43	684
	47.81	45.91	6.29	100.00

Frequency Missing = 9

Table of HIHOME by WhenRem_

HIHOME   WhenRem_ = Time since remodel

HIHOME (Frequency / Percent / Row Pct / Col Pct)	0 = < 1 yr	1 = $\geq$1 yr	9 = Don't know	Total
0	87	190	11	288
	27.36	59.75	3.46	90.57
	30.21	65.97	3.82	
	84.47	93.14	100.00	
1	16	14	0	30
	5.03	4.40	0.00	9.43
	53.33	46.67	0.00	
	15.53	6.86	0.00	
Total	103	204	11	318
	32.39	64.15	3.46	100.00

Frequency Missing = 375

Table of HIHOME by IntSAND_

HIHOME — IntSAND_ = Sanding of Interior surfaces of home or furniture

Frequency / Percent / Row Pct / Col Pct	0 = No	1 = Yes	9 = Don't know	Total
0	520	109	7	636
	75.69	15.87	1.02	92.58
	81.76	17.14	1.10	
	93.02	91.60	77.78	
1	39	10	2	51
	5.68	1.46	0.29	7.42
	76.47	19.61	3.92	
	6.98	8.40	22.22	
Total	559	119	9	687
	81.37	17.32	1.31	100.00

Frequency Missing = 6

Table of HIHOME by EXTSAND_

HIHOME — EXTSAND_ = Sanding or paint removal from home exterior

Frequency / Percent / Row Pct / Col Pct	0 = No	1 = Yes	9 = Don't know	Total
0	550	75	11	636
	79.94	10.90	1.60	92.44
	86.48	11.79	1.73	
	93.54	86.21	84.62	
1	38	12	2	52
	5.52	1.74	0.29	7.56
	73.08	23.08	3.85	
	6.46	13.79	15.38	
Total	588	87	13	688
	85.47	12.65	1.89	100.00

Frequency Missing = 5

Table of HIHOME by LeadPaint_

HIHOME — LeadPaint_ = Lead-based paint on home

Frequency / Percent / Row Pct / Col Pct	0 = No	1 = Yes	9 = Don’t know	Total
0	358	50	228	636
	52.03	7.27	33.14	92.44
	56.29	7.86	35.85	
	93.23	83.33	93.44	
1	26	10	16	52
	3.78	1.45	2.33	7.56
	50.00	19.23	30.77	
	6.77	16.67	6.56	
Total	384	60	244	688
	55.81	8.72	35.47	100.00

Frequency Missing = 5

Table of HIHOME by CrawlSpace_

HIHOME — CrawlSpace_ = Regular crawl-space access by people or pets

Frequency / Percent / Row Pct / Col Pct	0 = No	1 = Yes	9 = Don’t know	Total
0	418	195	14	627
	61.65	28.76	2.06	92.48
	66.67	31.10	2.23	
	92.48	91.98	100.00	
1	34	17	0	51
	5.01	2.51	0.00	7.52
	66.67	33.33	0.00	
	7.52	8.02	0.00	
Total	452	212	14	678
	66.67	31.27	2.06	100.00

Frequency Missing = 15

Table of HIHOME by NewDirt_

HIHOME — NewDirt_ = Addition of yard soil or gravel other than that involved in cleanup

Frequency / Percent / Row Pct / Col Pct	0 = No	1 = Yes	9 = Don't know	Total
0	504	106	25	635
	73.36	15.43	3.64	92.43
	79.37	16.69	3.94	
	92.65	90.60	96.15	
1	40	11	1	52
	5.82	1.60	0.15	7.57
	76.92	21.15	1.92	
	7.35	9.40	3.85	
Total	544	117	26	687
	79.18	17.03	3.78	100.00

Frequency Missing = 6

Table of HIHOME by Excavation_

HIHOME — Excavation_ = Excavation or construction other than that involved in cleanup

Frequency / Percent / Row Pct / Col Pct	0 = No	1 = Yes	9 = Don't know	Total
0	540	73	23	636
	78.49	10.61	3.34	92.44
	84.91	11.48	3.62	
	92.78	89.02	95.83	
1	42	9	1	52
	6.10	1.31	0.15	7.56
	80.77	17.31	1.92	
	7.22	10.98	4.17	
Total	582	82	24	688
	84.59	11.92	3.49	100.00

Frequency Missing = 5

Table of HIHOME by Flood_

HIHOME   Flood_ = Yard flooded

Frequency / Percent / Row Pct / Col Pct	0 = No	1 = Yes	9 = Don't know	Total
0	504	85	46	635
	73.36	12.37	6.70	92.43
	79.37	13.39	7.24	
	92.99	89.47	92.00	
1	38	10	4	52
	5.53	1.46	0.58	7.57
	73.08	19.23	7.69	
	7.01	10.53	8.00	
Total	542	95	50	687
	78.89	13.83	7.28	100.00

Frequency Missing = 6

Table of HIHOME by Daycare_

HIHOME   Daycare_ = Day care established in home

Frequency / Percent / Row Pct / Col Pct	0 = No	1 = Yes	Total
0	19	31	50
	33.93	55.36	89.29
	38.00	62.00	
	86.36	91.18	
1	3	3	6
	5.36	5.36	10.71
	50.00	50.00	
	13.64	8.82	
Total	22	34	56
	39.29	60.71	100.00

Frequency Missing = 637

Table of HIHOME by HOMEAREA_

HIHOME — HOMEAREA_ = Condition of yard around home

Frequency / Percent / Row Pct / Col Pct	0 = Mostly bare	1 Mostly grass	9 = NA	Total
0	27	309	45	381
	6.51	74.46	10.84	91.81
	7.09	81.10	11.81	
	90.00	91.96	91.84	
1	3	27	4	34
	0.72	6.51	0.96	8.19
	8.82	79.41	11.76	
	10.00	8.04	8.16	
Total	30	336	49	415
	7.23	80.96	11.81	100.00

Frequency Missing = 278

Table of HIHOME by PlayArea_

HIHOME — PlayArea_ = Condition of children's play area

Frequency / Percent / Row Pct / Col Pct	0 = Mostly bare	1 Mostly grass	9 = NA	Total
0	34	250	97	381
	8.19	60.24	23.37	91.81
	8.92	65.62	25.46	
	89.47	90.91	95.10	
1	4	25	5	34
	0.96	6.02	1.20	8.19
	11.76	73.53	14.71	
	10.53	9.09	4.90	
Total	38	275	102	415
	9.16	66.27	24.58	100.00

Frequency Missing = 278

Table of HIHOME by NeiAREA_

HIHOME NeiAREA_= Condition of neighbor's area

Frequency / Percent / Row Pct / Col Pct	0 = Mostly bare	1 Mostly grass	9 = NA	Total
0	16	206	159	381
	3.86	49.64	38.31	91.81
	4.20	54.07	41.73	
	84.21	91.15	93.53	
1	3	20	11	34
	0.72	4.82	2.65	8.19
	8.82	58.82	32.35	
	15.79	8.85	6.47	
Total	19	226	170	415
	4.58	54.46	40.96	100.00

Frequency Missing = 278

Table of HIHOME by FloodBasin_

HIHOME FloodBasin_ = Participation in activities in the Coeur d'Alene River flood basin

Frequency / Percent / Row Pct / Col Pct	0 = No	1 = Yes	9 = Unknown	Total
0	576	42	22	640
	83.24	6.07	3.18	92.49
	90.00	6.56	3.44	
	92.31	93.33	95.65	
1	48	3	1	52
	6.94	0.43	0.14	7.51
	92.31	5.77	1.92	
	7.69	6.67	4.35	
Total	624	45	23	692
	90.17	6.50	3.32	100.00

Frequency Missing = 1

Table of HIHOME by Smoke

HIHOME Smoke = If members of home smoke

Frequency / Percent / Row Pct / Col Pct	0	1= No	2= Yes	Total
0	9 1.30 1.41 90.00	290 41.91 45.31 91.48	341 49.28 53.28 93.42	640 92.49
1	1 0.14 1.92 10.00	27 3.90 51.92 8.52	24 3.47 46.15 6.58	52 7.51
Total	10 1.45	317 45.81	365 52.75	692 100.00

Frequency Missing = 1

Table of HIHOME by PaintIn_

HIHOME PaintIn_= Condition of Paint inside of home

Frequency / Percent / Row Pct / Col Pct	0 = Good	1 = Damaged	Total
0	603 89.07 96.48 92.63	22 3.25 3.52 84.62	625 92.32
1	48 7.09 92.31 7.37	4 0.59 7.69 15.38	52 7.68
Total	651 96.16	26 3.84	677 100.00

Frequency Missing = 16

Table of HIHOME by PaintOut_

HIHOME — PaintOut_= Condition of Paint outside of home

Frequency / Percent / Row Pct / Col Pct	0 = Good	1 = Damaged	Total
0	553 81.68 88.34 93.57	73 10.78 11.66 84.88	626 92.47
1	38 5.61 74.51 6.43	13 1.92 25.49 15.12	51 7.53
Total	591 87.30	86 12.70	677 100.00

Frequency Missing = 16

Table of HIHOME by CoverYard_

HIHOME — CoverYard_ = Grass coverage in yard

Frequency / Percent / Row Pct / Col Pct	0 = mostly grass	1 = mostly soil	Total
0	578 85.38 92.33 92.48	48 7.09 7.67 92.31	626 92.47
1	47 6.94 92.16 7.52	4 0.59 7.84 7.69	51 7.53
Total	625 92.32	52 7.68	677 100.00

Frequency Missing = 16

Table of HIHOME by Hygiene_

HIHOME — Hygiene_ = General home hygiene

Frequency / Percent / Row Pct / Col Pct	0 = Poor	1 = Good	Total
0	33	593	626
	4.87	87.59	92.47
	5.27	94.73	
	97.06	92.22	
1	1	50	51
	0.15	7.39	7.53
	1.96	98.04	
	2.94	7.78	
Total	34	643	677
	5.02	94.98	100.00

Frequency Missing = 16

Table of HIHOME by NumOfAct

HIHOME NumOfAct = Number of positive responses to the activities listed below a household member may have participated in:

Dirt biking / 4-wheeling
Mountain biking
Mudding
Camping
Boating
Swimming
Hunting – upland game
Hunting – waterfowl
Fishing
Other

Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	Total
0	200	108	105	87	63	640
	28.90	15.61	15.17	12.57	9.10	92.49
	31.25	16.88	16.41	13.59	9.84	
	93.46	91.53	96.33	92.55	90.00	
1	14	10	4	7	7	52
	2.02	1.45	0.58	1.01	1.01	7.51
	26.92	19.23	7.69	13.46	13.46	
	6.54	8.47	3.67	7.45	10.00	
Total	214	118	109	94	70	692
	30.92	17.05	15.75	13.58	10.12	100.00

(Continued)

Table of HIHOME by NumOfAct

HIHOME NumOfAct

Frequency / Percent / Row Pct / Col Pct	5	6	7	8	Total
0	50	20	5	2	640
	7.23	2.89	0.72	0.29	92.49
	7.81	3.13	0.78	0.31	
	87.72	90.91	83.33	100.00	
1	7	2	1	0	52
	1.01	0.29	0.14	0.00	7.51
	13.46	3.85	1.92	0.00	
	12.28	9.09	16.67	0.00	
Total	57	22	6	2	692
	8.24	3.18	0.87	0.29	100.00

Frequency Missing = 1

Table of HIHOME by NUMOFOCC

HIHOME   NUMOFOCC = Number of positive responses to specific occupations listed below:
Milling or concentrating ore
Carpentry or remodeling
Foundry work
Professional Plumbing
Mining
Landscaping / excavation
Construction in the Silver Valley

Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	452	113	56	15	4	1	641
	65.22	16.31	8.08	2.16	0.58	0.14	92.50
	70.51	17.63	8.74	2.34	0.62	0.16	
	93.78	88.28	94.92	83.33	100.00	50.00	
1	30	15	3	3	0	1	52
	4.33	2.16	0.43	0.43	0.00	0.14	7.50
	57.69	28.85	5.77	5.77	0.00	1.92	
	6.22	11.72	5.08	16.67	0.00	50.00	
Total	482	128	59	18	4	2	693
	69.55	18.47	8.51	2.60	0.58	0.29	100.00

Table of HIHOME by NUMOFCRAFT

HIHOME NUMOFCRAFT = Number of positive responses to specific craft activities listed below:
Painting w/ artists paints
Stained glass or metal jewelry
Casting lead
Soldering in electronic or plumbing
Vegetable or flower gardening
Pottery
Tole painting
Painting cars or bicycles
Reloading ammunition

Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	6	Total
0	284	277	53	18	6	1	2	641
	40.98	39.97	7.65	2.60	0.87	0.14	0.29	92.50
	44.31	43.21	8.27	2.81	0.94	0.16	0.31	
	93.73	90.82	92.98	100.00	85.71	100.00	100.00	
1	19	28	4	0	1	0	0	52
	2.74	4.04	0.58	0.00	0.14	0.00	0.00	7.50
	36.54	53.85	7.69	0.00	1.92	0.00	0.00	
	6.27	9.18	7.02	0.00	14.29	0.00	0.00	
Total	303	305	57	18	7	1	2	693
	43.72	44.01	8.23	2.60	1.01	0.14	0.29	100.00

Table B-2. Summary of Stepwise Selection for Dust Mat; SAS Output (LNPBMAT, N=356)

Step	Variable Entered	Variable Removed	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	TOTLPEEP		1	0.0794	0.0794	31.7414	30.54	<.0001
2	PaintIn_		2	0.0256	0.1050	23.0662	10.10	0.0016
3	NumOfAct		3	0.0214	0.1264	16.1478	8.62	0.0035
4	YrBLT_70S		4	0.0175	0.1439	10.8705	7.16	0.0078
5	Flood_		5	0.0142	0.1581	6.9523	5.90	0.0156
6	ForcedAir_		6	0.0139	0.1720	3.1669	5.85	0.0161
7	IntSAND_		7	0.0085	0.1804	1.6355	3.60	0.0587
8	YrBLT_60S		8	0.0084	0.1888	0.1288	3.60	0.0587

Notes:

TOTLPEEP = Total number of people living in the home

PaintIn_ = Interior paint condition

NumOfAct = Total number of recreational activities in which any members of the household partake

YrBlt_70S = House age: whether the home was built between 1960 and 1978 or not

Flood_ = Whether the ground immediately surrounding the residence had been flooded or not

ForcedAir_ = Presence of air ducts (forced air heating or cooling)

IntSAND_ = Remodeling that included sanding or removing paint from any part of the interior of the home

YrBlt_60S = House age: whether the home was built prior to 1960 or not

Table B-3. Summary of Stepwise Selection for Vacuum; SAS Output (LNPBVAC, N=233)

Step	Variable Entered	Variable Removed	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	NumOfAct		1	0.0319	0.0319	-1.5437	7.61	0.0063
2	PaintOut_		2	0.0190	0.0509	-4.0063	4.60	0.0330
3	YrBLT_60S		3	0.0147	0.0656	-5.4587	3.60	0.0590
4	YrBLT_70S		4	0.0117	0.0773	-6.2030	2.89	0.0907

Notes:

NumOfAct = Total number of recreational activities in which any members of the household partake

PaintOut_ = Exterior paint condition

YrBlt_70S = House age: whether the home was built between 1960 and 1978 or not

YrBlt_60S = House age: whether the home was built prior to 1960 or not

Table B-4. Regression Summary for Mat Lead Concentrations; SAS Output

Dependent Variable: LNPBMAT N=442

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	60.5855220	7.5731902	9.86	<.0001
Error	433	332.5663723	0.7680517		
Corrected Total	441	393.1518942			

R-Square	Coeff Var	Root MSE	LNPBMAT Mean
0.154102	16.22407	0.876386	5.401761

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	4.992139544	0.11306936	44.15	<.0001
TOTLPEEP	0.110939429	0.02552236	4.35	<.0001
PaintIn_	0.821324962	0.21871404	3.76	0.0002
NumOfAct	0.081875809	0.02356075	3.48	0.0006
YrBLT_70S	-0.203695180	0.12329662	-1.65	0.0992
Flood_	0.264600385	0.12357007	2.14	0.0328
ForcedAir_	-0.270123626	0.08841516	-3.06	0.0024
IntSAND_	-0.199774643	0.12179623	-1.64	0.1017
YrBLT_60S	0.194272661	0.09432722	2.06	0.0400

Notes:

TOTLPEEP = Total number of people living in the home

PaintIn_ = Interior paint condition

NumOfAct = Total number of recreational activities in which any members of the household partake

YrBlt_70S = House age: whether the home was built between 1960 and 1978 or not

Flood_ = Whether the ground immediately surrounding the residence had been flooded or not

ForcedAir_ = Presence of air ducts (forced air heating or cooling)

IntSAND_ = Remodeling that included sanding or removing paint from any part of the interior of the home

YrBlt_60S = House age: whether the home was built prior to 1960 or not

Table B-5. Regression Summary for Vacuum Lead Concentrations; SAS Output

Dependent Variable: LNPBVAC (N=323)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	16.2890303	4.0722576	5.92	0.0001
Error	318	218.6352647	0.6875323		
Corrected Total	322	234.9242951			

R-Square	Coeff Var	Root MSE	LNPBVAC Mean
0.069337	14.84147	0.829176	5.586885

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	5.255170556	0.08572306	61.30	<.0001
PaintOut_	0.368862141	0.13627834	2.71	0.0072
NumOfAct	0.066697861	0.02481694	2.69	0.0076
YrBLT_60S	0.325603406	0.10126592	3.22	0.0014
YrBLT_70S	0.230026505	0.14023493	1.64	0.1019

Notes:

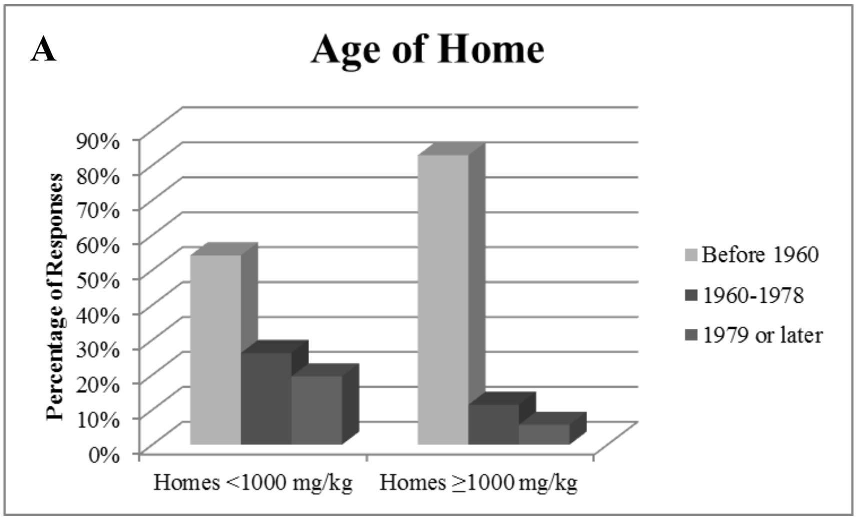
NumOfAct = Total number of recreational activities in which any members of the household partake

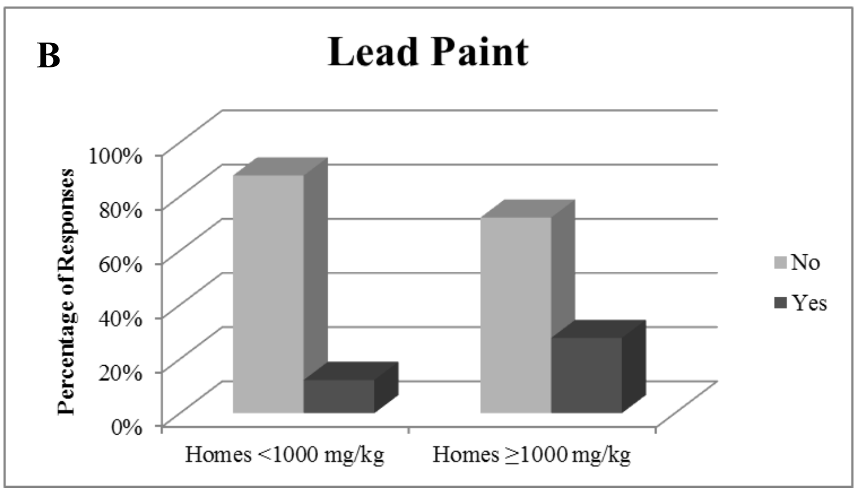
PaintOut_ = Exterior paint condition

YrBlt_70S = House age: whether the home was built between 1960 and 1978 or not

YrBlt_60S = House age: whether the home was built prior to 1960 or not

Figure B-1. Potential Influential Factors Identified in Comparative Analysis (2 pages)





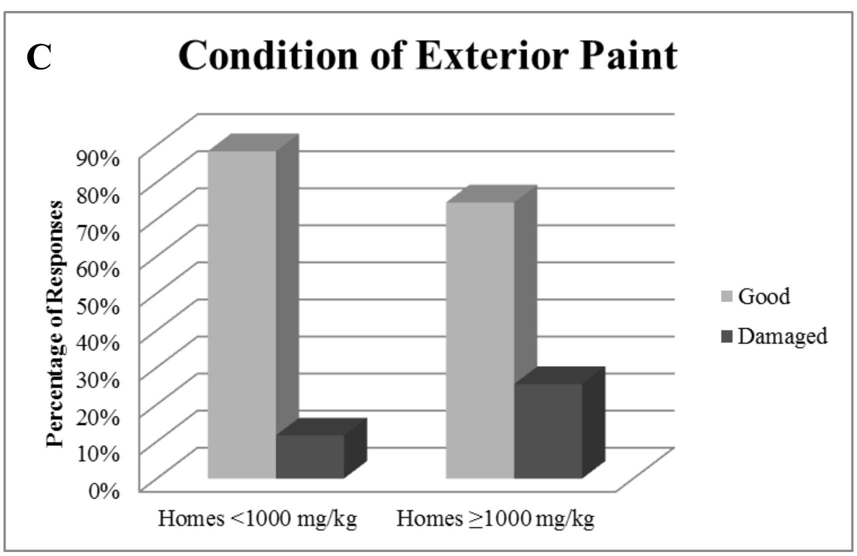
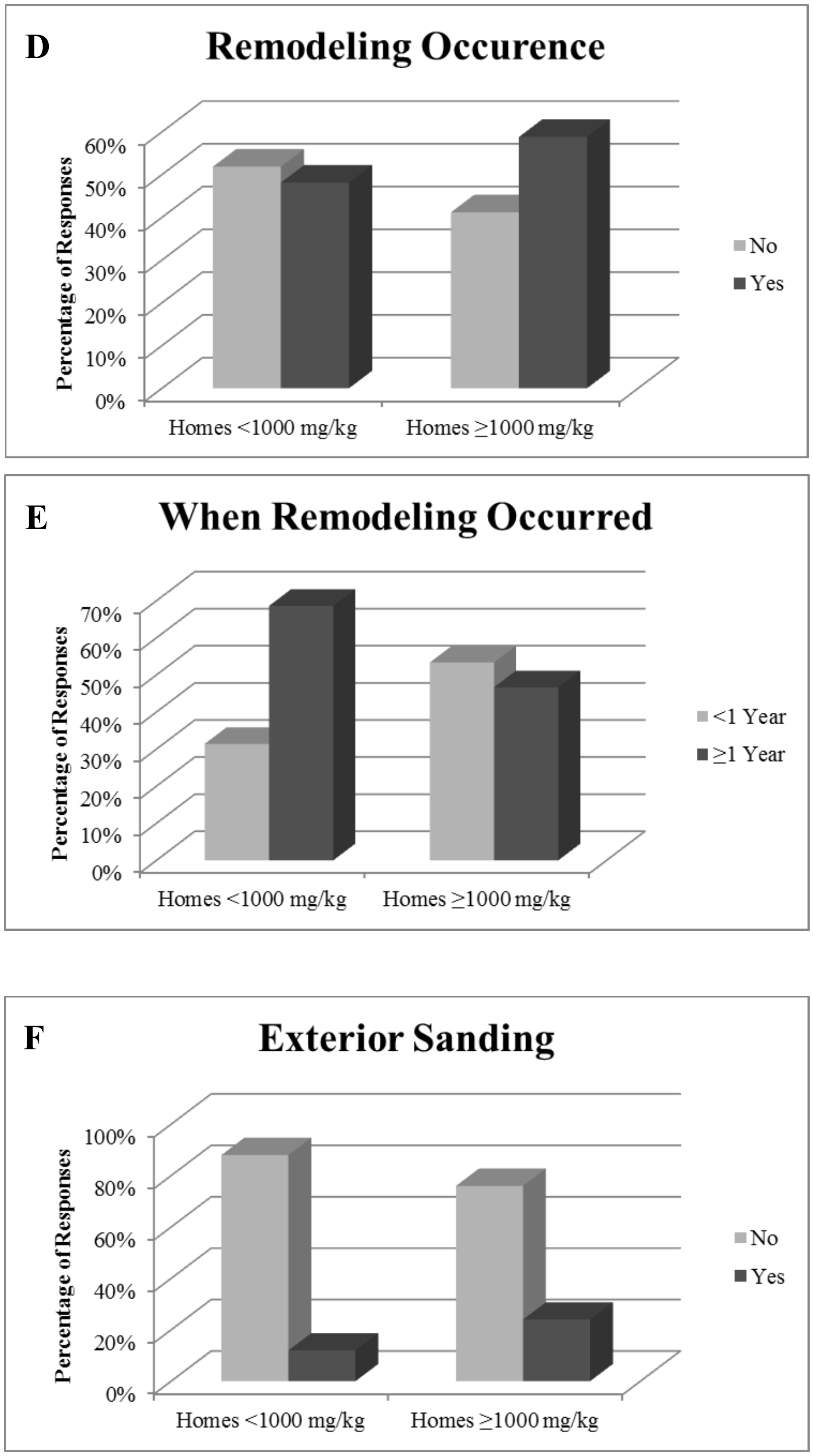


Figure B-1. Potential Influential Factors Identified in Comparative Analysis (2 pages)



Appendix C

Blood Lead Supporting Text, Tables, and Figures

Appendix C - 2013 LHIP Participation Assessment Methods

Enrollment data listing the age and the primary residence zip code for each student enrolled in School District #391 in the fall of 2014 were reviewed in order to assess participation in the 2013 LHIP blood lead survey. Because this school district includes children who live both within and outside of the Box, the proportion of students living within the Box was estimated and assumed to be the same in 2013 as 2014. Within each zip code, the proportion of homes within the Box was estimated based on the number of parcels that had a numerical address assigned by the tax assessor. The proportions were applied to the enrollment data to obtain an estimate of children residing in the Box by age.

Approximately 6 percent of 5 and 6 year olds and 2 percent of 7 through 9 year olds were not enrolled in school in 2013 (Census http://www.census.gov/hhes/school/data/cps/2013/tables.html). The estimates of Box children were adjusted to account for this, and the following formula was used to estimate the number of children eligible for the LHIP blood survey, assuming an even distribution between newborns and 6 year olds and 7 to 9 year olds:

$$\left(6.5 \times \frac{EstimatedBoxChildrenAged5and6 * 1.06}{2}\right) + EstimatedBoxChildrenAged7through9 * 1.02$$

TABLE C-1
Summary of Blood Lead Levels for OU 1 Children, 1988-2013

Year	City	Number of Observations	Blood Lead Level Range (µg/dL) Minimum	Maximum	Blood Lead Level (µg/dL) Arithmetic Mean	Arithmetic Standard Deviation	Geometric Mean	Geometric Standard Deviation	Children with Blood Lead Levels ≥15 µg/dL Number	Percent	Children with Blood Lead Levels ≥10 µg/dL Number	Percent
1988	Kellogg	171	4	39	9.2	5.1	8.0	1.7	22	13%	70	41%
	Page	12	4	26	10.3	6.6	8.5	1.9	2	17%	7	58%
	Smelterville	32	4	55	14.2	11.1	11.6	1.8	10	31%	23	72%
	Wardner	15	4	18	8.5	3.7	7.8	1.5	1	7%	5	33%
	Box-wide	**230**	**4**	**55**	**9.9**	**6.5**	**8.5**	**1.7**	**35**	**15%**	**105**	**46%**
1989	Kellogg	212	3	40	10.8	6.0	9.3	1.7	47	22%	111	52%
	Page	14	6	22	12.5	5.6	11.4	1.6	5	36%	8	57%
	Smelterville	36	5	41	14.6	7.1	13.2	1.6	15	42%	28	78%
	Wardner	13	6	20	11.8	4.5	11.0	1.5	4	31%	7	54%
	Box-wide	**275**	**3**	**41**	**11.4**	**6.2**	**9.9**	**1.7**	**71**	**26%**	**154**	**56%**
1990	Kellogg	193	4	25	9.3	4.6	8.3	1.6	22	11%	78	40%
	Page	17	4	21	11.0	6.0	9.4	1.8	6	35%	9	53%
	Pinehurst	107	4	20	7.4	3.7	6.7	1.6	5	5%	31	29%
	Smelterville	29	4	30	9.9	5.6	8.8	1.6	7	24%	9	31%
	Wardner	16	4	15	9.1	3.3	8.5	1.5	1	6%	7	44%
	Box-wide	**362**	**4**	**30**	**8.9**	**4.5**	**7.8**	**1.6**	**41**	**11%**	**134**	**37%**
1991	Kellogg	177	4	31	6.9	4.6	6.0	1.6	12	7%	35	20%
	Page	15	4	14	6.5	3.4	5.9	1.6	0	0%	3	20%
	Pinehurst	116	4	26	5.1	3.0	4.7	1.4	4	3%	6	5%
	Smelterville	48	4	16	6.6	3.3	5.9	1.6	1	2%	11	23%
	Wardner	9	4	11	5.6	2.4	5.2	1.4	0	0%	1	11%
	Box-wide	**365**	**4**	**31**	**6.3**	**3.9**	**5.5**	**1.6**	**17**	**5%**	**56**	**15%**
1992	Kellogg	211	4	26	8.1	4.9	6.9	1.7	27	13%	67	32%
	Page	11	4	10	6.1	1.9	5.8	1.4	0	0%	1	9%
	Pinehurst	120	4	15	6.0	2.8	5.5	1.5	1	1%	21	18%
	Smelterville	55	4	30	8.3	4.8	7.4	1.6	2	4%	17	31%
	Wardner	18	4	15	7.2	2.8	6.8	1.4	1	6%	4	22%
	Box-wide	**415**	**4**	**30**	**7.4**	**4.3**	**6.5**	**1.6**	**31**	**7%**	**110**	**27%**

TABLE C-1
Summary of Blood Lead Levels for OU 1 Children, 1988-2013

Year	City	Number of Observations	Blood Lead Level Range (µg/dL)		Blood Lead Level (µg/dL)				Children with Blood Lead Levels ≥15 µg/dL		Children with Blood Lead Levels ≥10 µg/dL	
			Minimum	Maximum	Arithmetic Mean	Arithmetic Standard Deviation	Geometric Mean	Geometric Standard Deviation	Number	Percent	Number	Percent
1993	Kellogg	228	1	24	6.3	4.0	5.2	1.9	9	4%	40	18%
	Page	14	3	12	6.1	2.8	5.6	1.5	0	0%	3	21%
	Pinehurst	119	1	13	3.5	2.8	2.6	2.2	0	0%	6	5%
	Smelterville	66	1	26	6.7	3.9	5.8	1.8	1	2%	13	20%
	Wardner	18	3	14	7.3	3.1	6.7	1.5	0	0%	4	22%
	Box-wide	**445**	**1**	**26**	**5.6**	**3.9**	**4.4**	**2.1**	**10**	**2%**	**66**	**15%**
1994	Kellogg	232	1	41	6.7	4.6	5.5	1.9	13	6%	47	20%
	Page	11	2	12	5.5	2.8	4.9	1.6	0	0%	1	9%
	Pinehurst	109	1	19	5.4	3.3	4.6	1.8	2	2%	12	11%
	Smelterville	48	2	13	6.0	3.3	5.3	1.7	0	0%	10	21%
	Wardner	16	2	11	4.9	2.5	4.3	1.7	0	0%	1	6%
	Box-wide	**416**	**1**	**41**	**6.2**	**4.1**	**5.2**	**1.8**	**15**	**4%**	**71**	**17%**
1995	Kellogg	252	1	30	6.4	4.3	5.2	1.9	16	6%	43	17%
	Page	10	2	12	6.1	3.4	5.3	1.8	0	0%	2	20%
	Pinehurst	97	1	15	4.6	2.5	4.0	1.8	1	1%	5	5%
	Smelterville	40	2	17	7.2	3.9	6.2	1.7	3	8%	11	28%
	Wardner	6	3	10	5.5	2.6	5.1	1.5	0	0%	1	17%
	Box-wide	**405**	**1**	**30**	**6.0**	**4.0**	**5.0**	**1.9**	**20**	**5%**	**62**	**15%**
1996	Kellogg	225	1	54	6.4	5.2	5.1	1.9	11	5%	39	17%
	Page	11	2	13	5.0	3.4	4.2	1.9	0	0%	1	9%
	Pinehurst	103	1	12	4.1	2.0	3.7	1.6	0	0%	1	1%
	Smelterville	51	2	15	6.4	3.0	5.8	1.6	1	2%	6	12%
	Wardner	7	3	15	7.4	4.3	6.4	1.8	1	14%	2	29%
	Box-wide	**397**	**1**	**54**	**5.8**	**4.4**	**4.7**	**1.9**	**13**	**3%**	**49**	**12%**
1997	Kellogg	199	1	22	5.9	3.4	5.0	1.8	5	3%	29	15%
	Page	7	2	9	6.3	2.4	5.7	1.7	0	0%	0	0%
	Pinehurst	86	1	17	4.2	3.0	3.5	1.8	1	1%	3	3%
	Smelterville	33	2	10	5.6	2.3	5.2	1.5	0	0%	3	9%
	Wardner	12	1	10	4.9	3.1	3.9	2.2	0	0%	1	8%
	Box-wide	**337**	**1**	**22**	**5.4**	**3.2**	**4.5**	**1.8**	**6**	**2%**	**36**	**11%**

TABLE C-1
Summary of Blood Lead Levels for OU 1 Children, 1988-2013

Year	City	Number of Observations	Blood Lead Level Range (µg/dL)		Blood Lead Level (µg/dL)				Children with Blood Lead Levels ≥15 µg/dL		Children with Blood Lead Levels ≥10 µg/dL	
			Minimum	Maximum	Arithmetic Mean	Arithmetic Standard Deviation	Geometric Mean	Geometric Standard Deviation	Number	Percent	Number	Percent
1998	Kellogg	212	1	19	4.9	3.1	4.0	1.9	3	1%	21	10%
	Page	8	3	6	4.8	1.3	4.6	1.3	0	0%	0	0%
	Pinehurst	100	1	17	4.1	2.6	3.5	1.7	1	1%	3	3%
	Smelterville	43	3	20	6.4	3.2	5.8	1.5	1	2%	6	14%
	Wardner	12	1	13	4.7	3.4	3.7	2.1	0	0%	1	8%
	Box-wide	**375**	**1**	**20**	**4.8**	**3.0**	**4.0**	**1.9**	**5**	**1%**	**31**	**8%**
1999	Kellogg	198	1	14	4.5	2.7	3.7	1.9	0	0%	11	6%
	Page	8	1	8	4.1	2.2	3.5	1.9	0	0%	0	0%
	Pinehurst	106	1	17	5.0	3.1	4.2	1.8	2	2%	9	8%
	Smelterville	49	1	17	4.3	2.9	3.6	1.9	1	2%	2	4%
	Wardner	9	1	12	5.4	3.2	4.5	2.0	0	0%	1	11%
	Box-wide	**370**	**1**	**17**	**4.7**	**2.9**	**3.9**	**1.9**	**3**	**1%**	**23**	**6%**
2000	Kellogg	170	1	16	4.3	2.3	3.7	1.7	1	1%	6	3%
	Page	8	1	11	4.5	3.0	3.7	2.0	0	0%	1	13%
	Pinehurst	91	1	19	4.0	3.3	3.1	2.0	2	2%	6	7%
	Smelterville	44	1	22	4.9	4.3	3.7	2.1	2	5%	4	9%
	Wardner	7	1	8	4.3	2.7	3.3	2.4	0	0%	0	0%
	Box-wide	**320**	**1**	**22**	**4.3**	**3.0**	**3.5**	**1.9**	**5**	**2%**	**17**	**5%**
2001	Kellogg	182	1.4	18.0	3.4	2.7	2.8	1.8	4	2%	7	4%
	Page	7	1.4	9.4	4.7	3.3	3.7	2.1	0	0%	0	0%
	Pinehurst	101	1.0	11.0	2.7	1.8	2.4	1.7	0	0%	2	2%
	Smelterville	23	1.4	7.7	2.8	1.8	2.4	1.7	0	0%	0	0%
	Wardner	9	1.4	11.5	4.3	3.4	3.3	2.2	0	0%	1	11%
	Box-wide	**322**	**1.0**	**18.0**	**3.2**	**2.4**	**2.7**	**1.8**	**4**	**1%**	**10**	**3%**
2002	Kellogg	195	1.4	21.3	3.2	2.3	2.8	1.6	2	1%	4	2%
	Page	8	1.8	5.1	3.4	1.2	3.2	1.4	0	0%	0	0%
	Pinehurst	115	1.4	21.0	2.9	2.5	2.4	1.7	1	1%	3	3%
	Smelterville	45	1.4	7.7	3.0	1.6	2.6	1.7	0	0%	0	0%
	Wardner	5	1.4	3.8	2.0	1.0	1.8	1.5	0	0%	0	0%
	Box-wide	**368**	**1.4**	**21.3**	**3.1**	**2.3**	**2.6**	**1.7**	**3**	**1%**	**7**	**2%**

TABLE C-1
Summary of Blood Lead Levels for OU 1 Children, 1988-2013

Year	City	Number of Observations	Blood Lead Level Range (µg/dL)		Blood Lead Level (µg/dL)				Children with Blood Lead Levels ≥15 µg/dL		Children with Blood Lead Levels ≥10 µg/dL	
			Minimum	Maximum	Arithmetic Mean	Arithmetic Standard Deviation	Geometric Mean	Geometric Standard Deviation	Number	Percent	Number	Percent
2003	Kellogg	4	2.3	10	0.67	1.0	6.16	2.0	0	0%	1	25%
	Page	0	-	-	-	-	-	-	-	-	-	-
	Pinehurst	2	-	-	-	-	-	-	-	-	-	-
	Smelterville	1	-	-	-	-	-	-	-	-	-	-
	Wardner	1	-	-	-	-	-	-	-	-	-	-
	Box-wide	**8**	**1**	**10.8**	**5.6**	**4.0**	**4.0**	**2.6**	**0**	**0%**	**2**	**25%**
2004	Kellogg	7	2.9	6.3	4.9	1.2	4.7	1.3	0	0%	0	0%
	Page	0	-	-	-	-	-	-	-	-	-	
	Pinehurst	2	-	-	-	-	-	-	-	-	-	-
	Smelterville	0	-	-	-	-	-	-	-	-	-	-
	Wardner	0	-	-	-	-	-	-	-	-	-	-
	Box-wide	**9**	**2.2**	**6.3**	**4.4**	**1.5**	**4.1**	**1.4**	**0**	**0%**	**0**	**0%**
2005	Kellogg	10	1.4	5	2.1	1.2	1.9	1.6	0	0%	0	0%
	Page	1	-	-	-	-	-	-	-	-	-	-
	Pinehurst	5	1.4	1.4	1.4	0.0	1.4	1.0	0	0%	0	0%
	Smelterville	1	-	-	-	-	-	-	-	-	-	-
	Wardner	0	-	-	-	-	-	-	-	-	-	-
	Box-wide	**17**	**1.4**	**6.1**	**2.1**	**1.4**	**1.8**	**1.6**	**0**	**0%**	**0**	**0%**
2006	Kellogg	6	1.4	5.0	3.0	1.2	2.8	1.5	0	0%	0	0%
	Page	0	-	-	-	-	-	-	-	-	-	-
	Pinehurst	6	1.4	11	3.6	3.9	2.5	2.4	0	0%	1	17%
	Smelterville	3	1.4	3	2.0	0.9	1.85	1.5	0	0%	0	0%
	Wardner	1	-	-	-	-	-	-	-	-	-	-
	Box-wide	**16**	**1.4**	**11**	**3.0**	**2.4**	**2.5**	**1.8**	**0**	**0%**	**1**	**6%**
2007	Kellogg	4	2.1	4.8	3.4	1.2	3.2	1.4	0	0%	0	0%
	Page	0	-	-	-	-	-	-	-	-	-	-
	Pinehurst	4	1.4	1.4	1.4	0.0	1.4	1.0	0	0%	0	0%
	Smelterville	0	-	-	-	-	-	-	-	-	-	-
	Wardner	0	-	-	-	-	-	-	-	-	-	-
	Box-wide	**8**	**1.4**	**4.8**	**2.4**	**1.3**	**2.1**	**1.7**	**0**	**0%**	**0**	**0%**

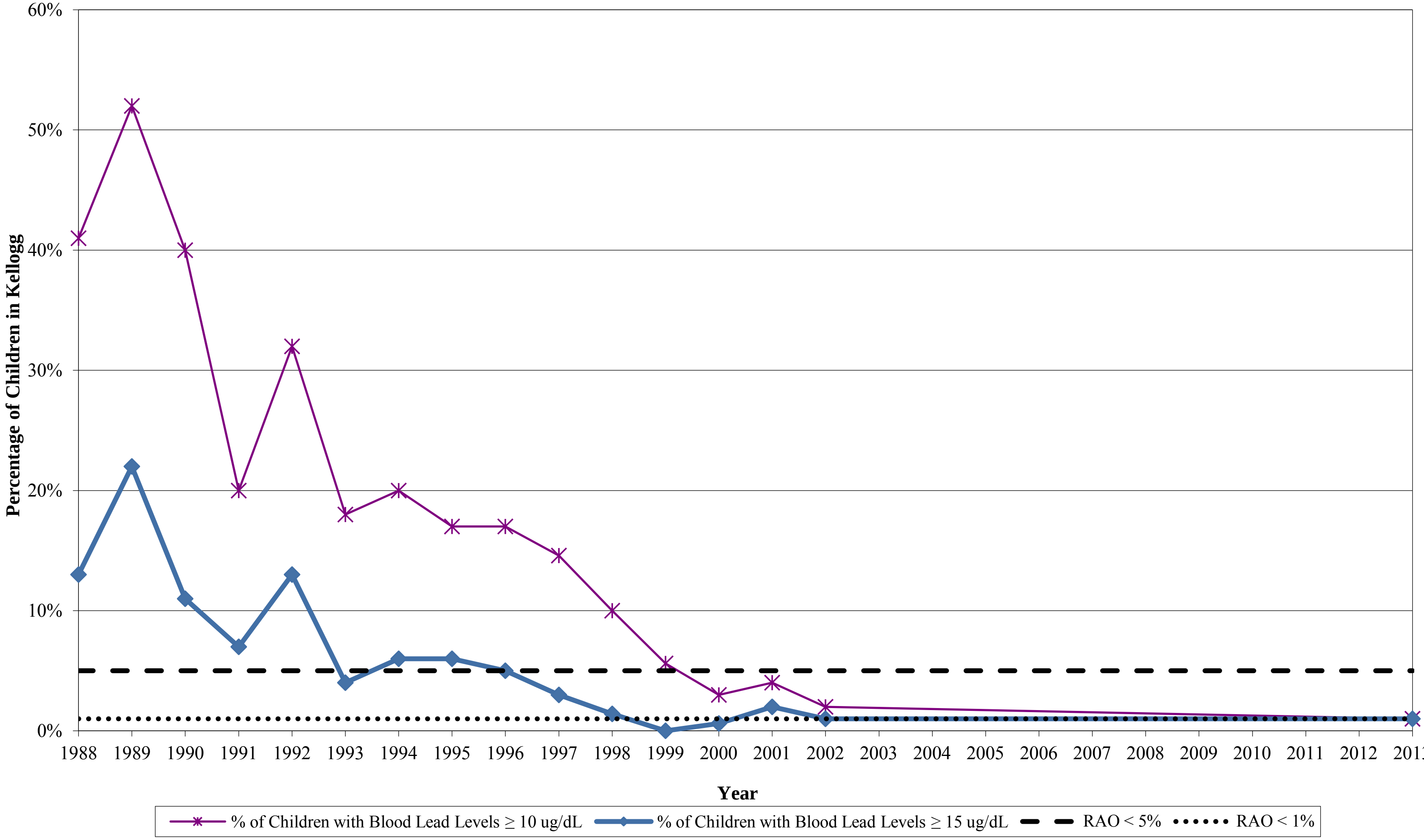
TABLE C-1
Summary of Blood Lead Levels for OU 1 Children, 1988-2013

Year	City	Number of Observations	Blood Lead Level Range (µg/dL)		Blood Lead Level (µg/dL)				Children with Blood Lead Levels ≥15 µg/dL		Children with Blood Lead Levels ≥10 µg/dL	
			Minimum	Maximum	Arithmetic Mean	Arithmetic Standard Deviation	Geometric Mean	Geometric Standard Deviation	Number	Percent	Number	Percent
2008	Kellogg	10	1.4	4.9	2.6	1.2	2.3	1.7	0	0%	0	0%
	Page	1	-	-	-	-	-	-	-	-	-	-
	Pinehurst	4	1.4	1.5	1.4	0.05	1.4	1.0	0	0%	0	0%
	Smelterville	3	4.2	9.0	6.0	2.6	5.7	1.5	0	0%	0	0%
	Wardner	0	-	-	-	-	-	-	-	-	-	-
	Box-wide	**18**	**1.4**	**9.0**	**2.8**	**2.1**	**2.3**	**1.8**	**0**	**0%**	**0**	**0%**
2009	Kellogg	9	2.0	10	3.5	2.5	3.1	1.6	0	0%	1	11%
	Page	0	-	-	-	-	-	-	-	-	-	-
	Pinehurst	6	1.3	2.9	2.2	0.69	2.1	1.4	0	0%	0	0%
	Smelterville	3	2.0	7.2	4.2	2.7	3.7	1.9	0	0%	0	0%
	Wardner	0	-	-	-	-	-	-	-	-	-	-
	Box-wide	**18**	**1.3**	**10**	**3.2**	**2.1**	**2.8**	**1.6**	**0**	**0%**	**1**	**0%**
2010	Kellogg	9	2.0	10	4.0	2.5	3.4	1.7	0	0%	1	11%
	Page	-	-	-	-	-	-	-	-	-	-	-
	Pinehurst	2	-	-	-	-	-	-	-	-	-	-
	Smelterville	2	-	-	-	-	-	-	-	-	-	-
	Wardner	-	-	-	-	-	-	-	-	-	-	-
	Box-wide	**13**	**1.6**	**10**	**3.5**	**2.2**	**3.0**	**1.7**	**0**	**0%**	**1**	**8%**
2011	Kellogg	8	1.4	5.0	2.4	1.4	2.1	1.7	0	0%	0	0%
	Page	-	-	-	-	-	-	-	-	-	-	-
	Pinehurst	7	1.4	4.6	2.1	1.2	1.9	1.6	0	0%	0	0%
	Smelterville	-	-	-	-	-	-	-	-	-	-	-
	Wardner	-	-	-	-	-	-	-	-	-	-	-
	Box-wide	**15**	**1.4**	**5.0**	**2.3**	**1.3**	**2.0**	**1.6**	**0**	**0%**	**0**	**0%**
2012	Kellogg	6	2.0	4.1	2.8	0.82	2.7	1.3	0	0%	0	0%
	Page	2	-	-	-	-	-	-	-	-	-	-
	Pinehurst	-	-	-	-	-	-	-	-	-	-	-
	Smelterville	-	-	-	-	-	-	-	-	-	-	-
	Wardner	-	-	-	-	-	-	-	-	-	-	-
	Box-wide	**8**	**1.6**	**4.1**	**2.6**	**0.84**	**2.4**	**1.4**	**0**	**0%**	**0**	**0%**

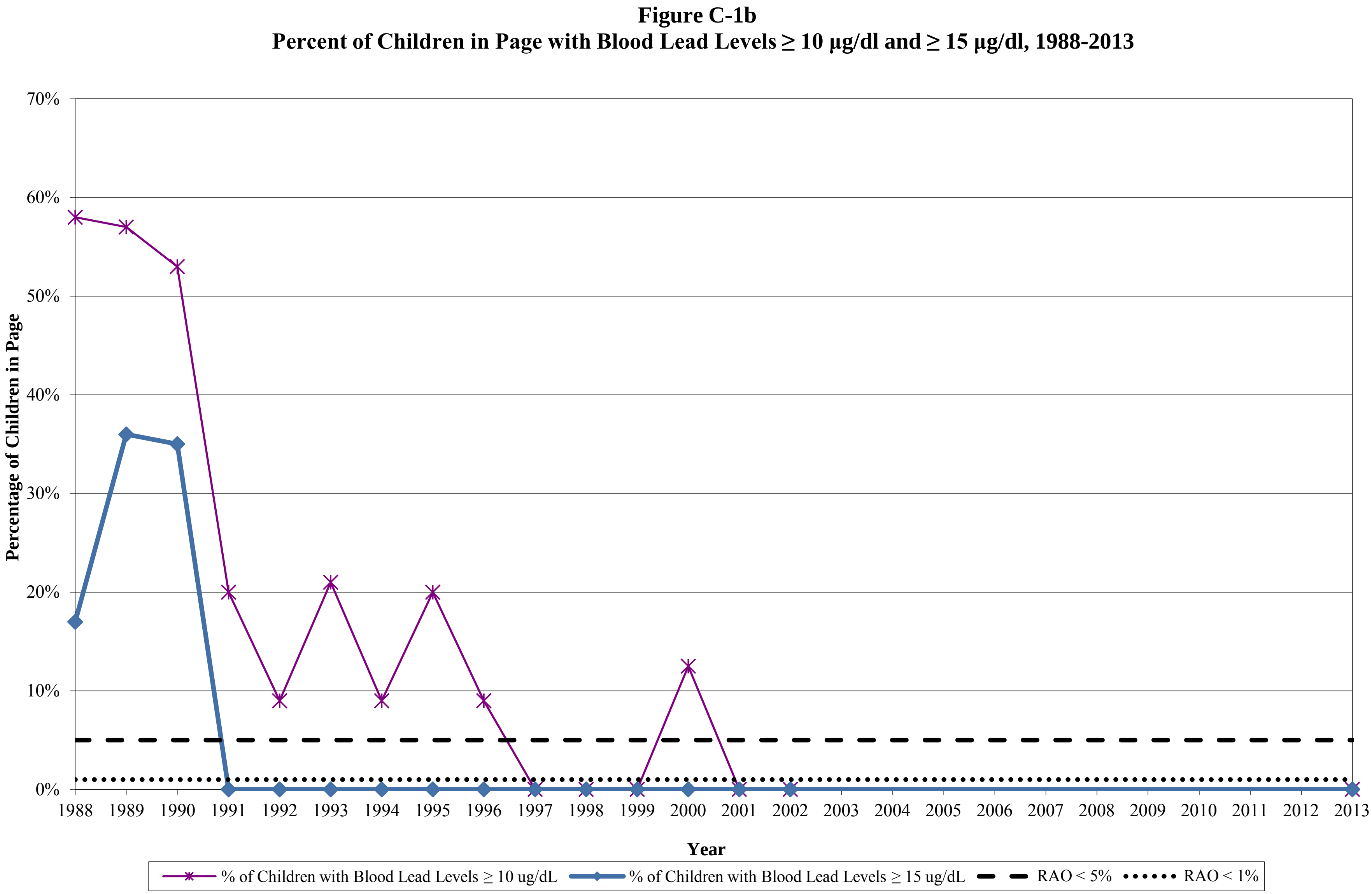
TABLE C-1
Summary of Blood Lead Levels for OU 1 Children, 1988-2013

Year	City	Number of Observations	Blood Lead Level Range (µg/dL)		Blood Lead Level (µg/dL)				Children with Blood Lead Levels ≥15 µg/dL		Children with Blood Lead Levels ≥10 µg/dL	
			Minimum	Maximum	Arithmetic Mean	Arithmetic Standard Deviation	Geometric Mean	Geometric Standard Deviation	Number	Percent	Number	Percent
2013	Kellogg	147	1.0	20	2.6	2.1	2.3	1.6	1	1%	2	1%
	Page	6	1.4	4.4	2.6	1.1	2.4	1.6	0	0%	0	0%
	Pinehurst	68	1.4	6	2.1	1.0	1.9	1.5	0	0%	0	0%
	Smelterville	45	1.4	6	2.3	1.0	2.1	1.5	0	0%	0	0%
	Wardner	10	1.4	4.6	2.5	1.1	2.3	1.5	0	0%	0	0%
	Box-wide	**276**	**1.0**	**20**	**2.4**	**1.7**	**2.2**	**1.6**	**1**	**0%**	**2**	**1%**

Figure C-1a
Percent of Children in Kellogg with Blood Lead Levels ≥ 10 µg/dl and ≥ 15 µg/dl, 1988-2013

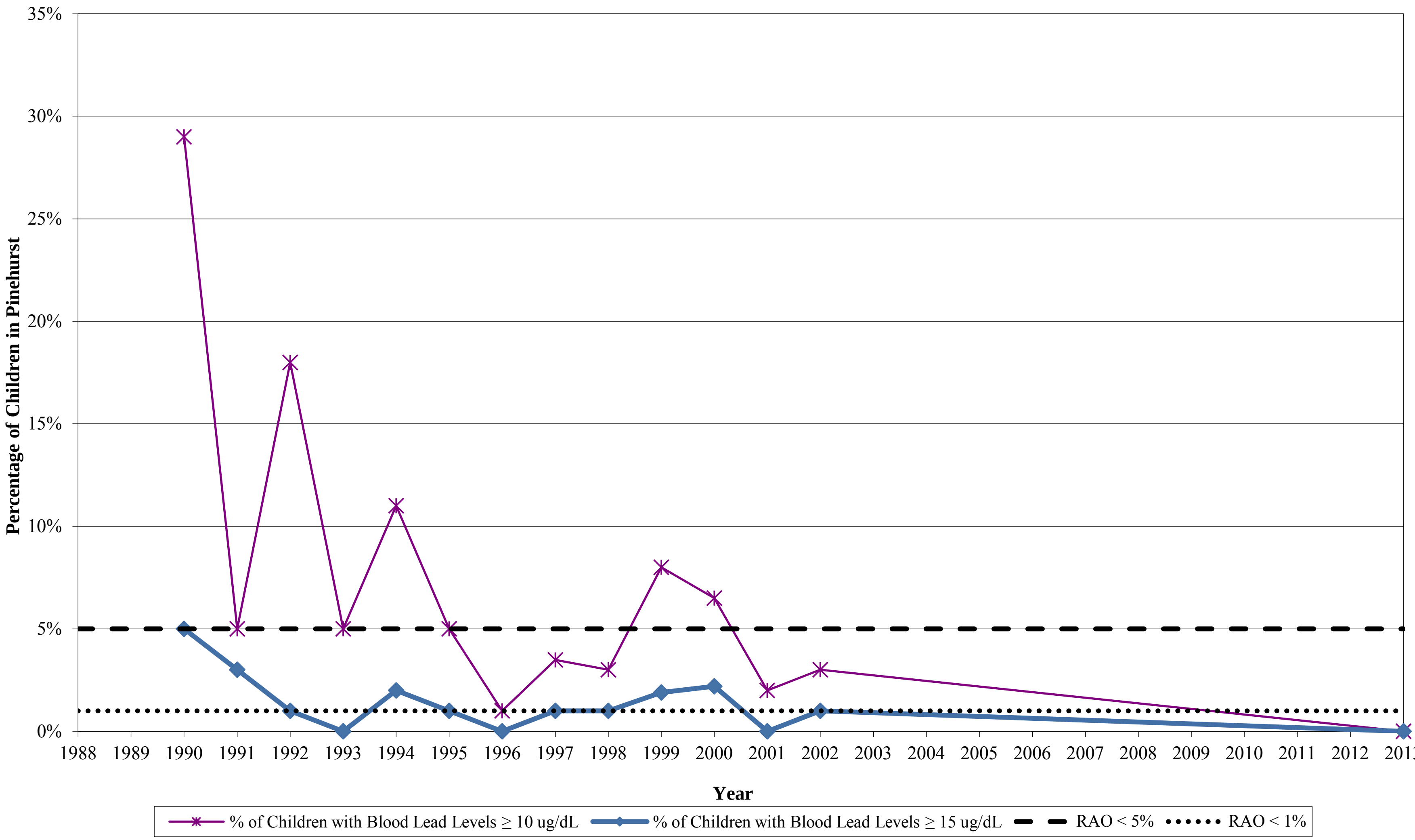


Note: Data from 2003 through 2012 are not displayed because there were few participants.



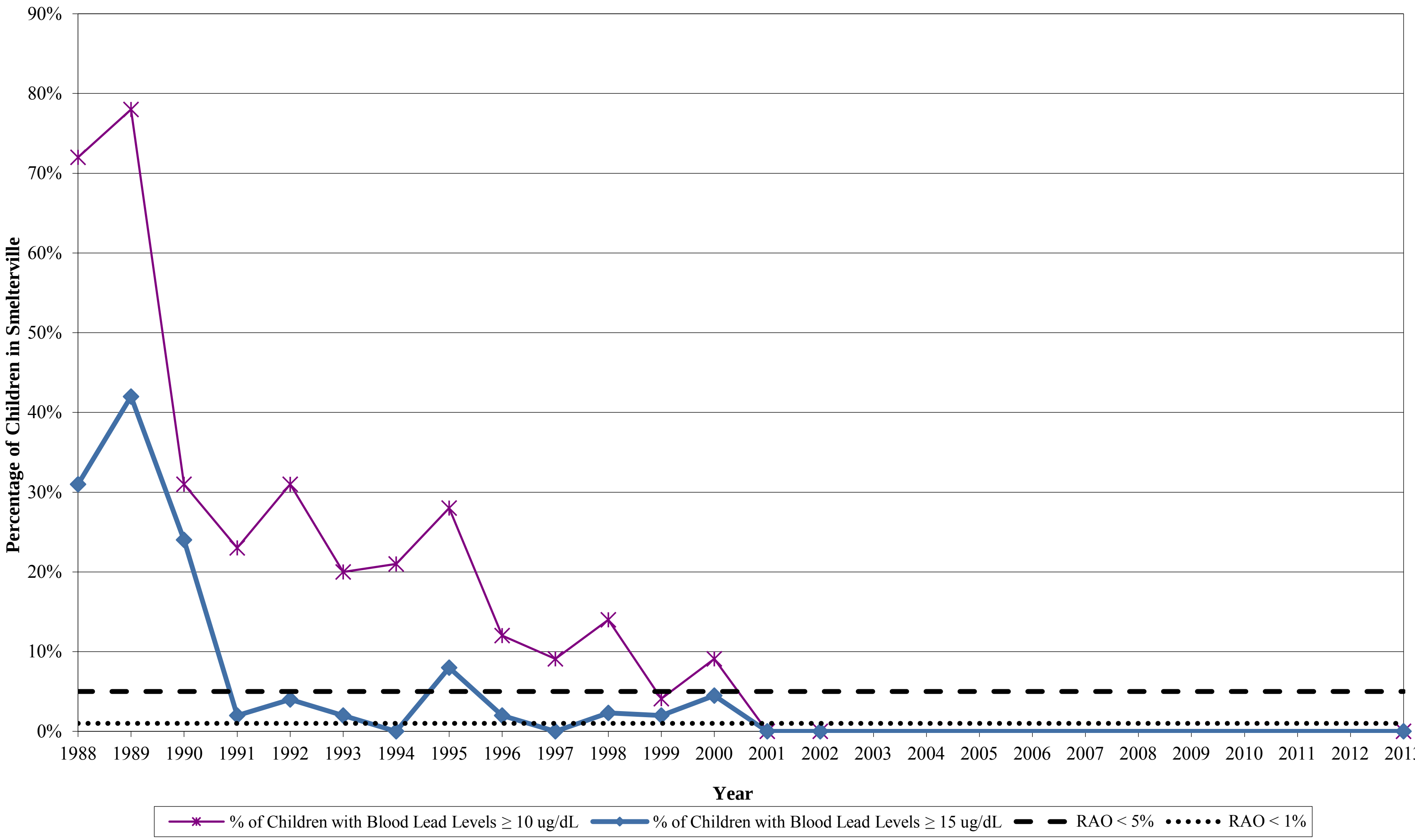
Note: Data from 2003 through 2012 are not displayed because there were few participants.

Figure C-1c
Percent of Children in Pinehurst with Blood Lead Levels ≥ 10 µg/dl and ≥ 15 µg/dl, 1988-2013



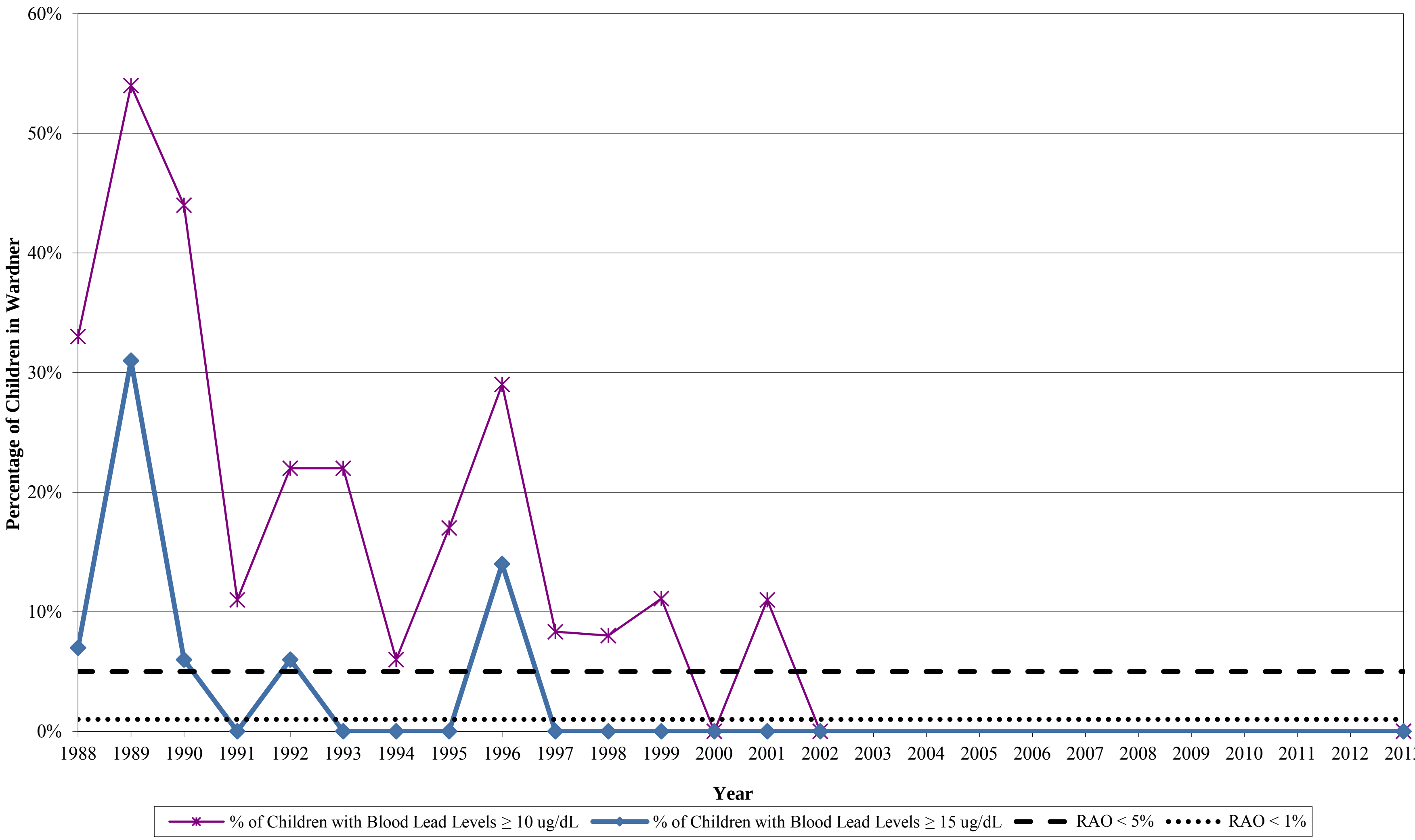
Note: Data from 2003 through 2012 are not displayed because there were few participants.

Figure C-1d
Percent of Children in Smelterville with Blood Lead Levels ≥ 10 µg/dl and ≥ 15 µg/dl, 1988-2013



Note: Data from 2003 through 2012 are not displayed because there were few participants.

Figure C-1e
Percent of Children in Wardner with Blood Lead Levels ≥ 10 µg/dl and ≥ 15 µg/dl, 1988-2013



Note: Data from 2003 through 2012 are not displayed because there were few participants.

Figure C-2
Blood Lead Distribution Histograms - Box-wide, 1988-2013

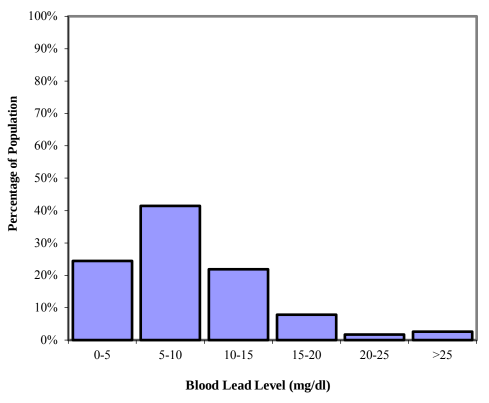


Figure C-2a
Blood Lead Histogram - 1988[1]

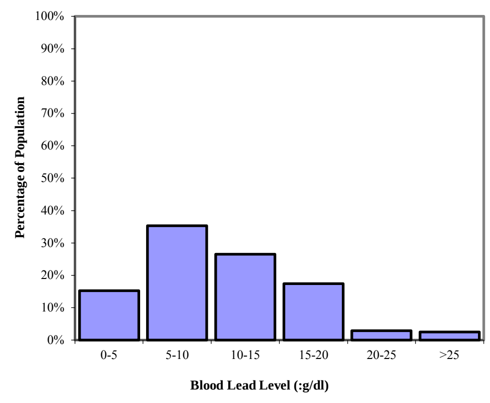


Figure C-2b
Blood Lead Histogram - 1989[1]

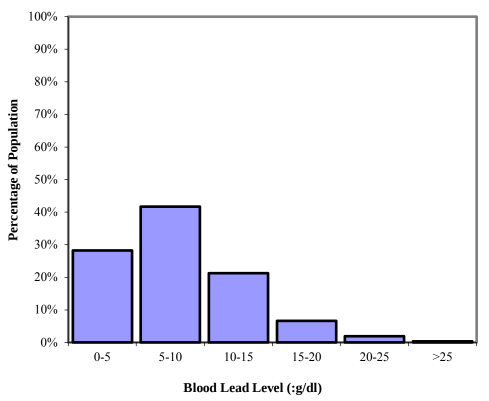


Figure C-2c
Blood Lead Histogram - 1990

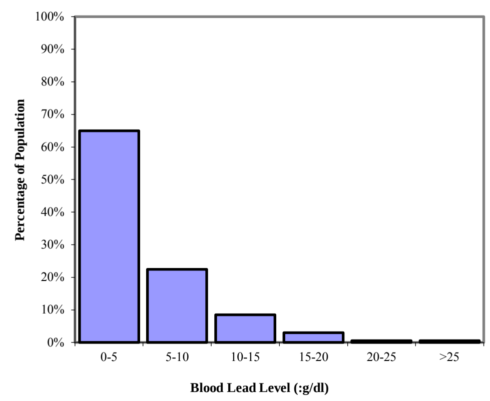


Figure C-2d
Blood Lead Histogram - 1991

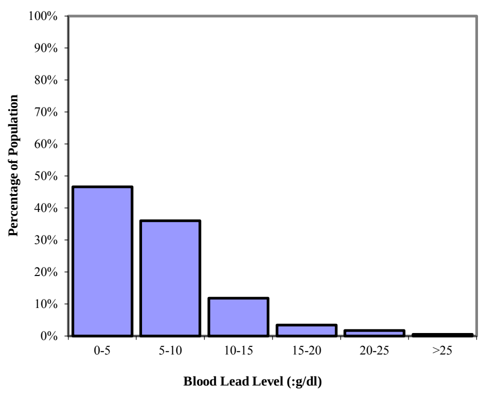


Figure C-2e
Blood Lead Histogram - 1992

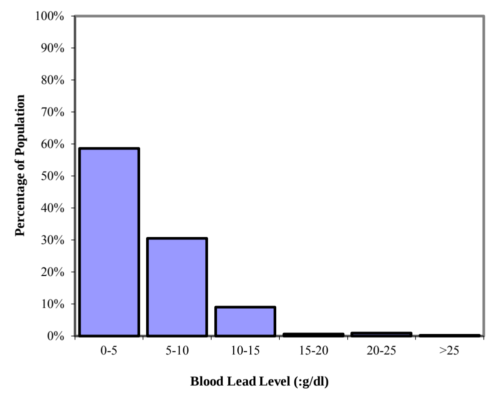


Figure C-2f
Blood Lead Histogram - 1993

Figure C-2a-p (continued)
Blood Lead Distribution Histograms - Box-wide, 1988-2013

Figure C-2g
Blood Lead Histogram - 1994

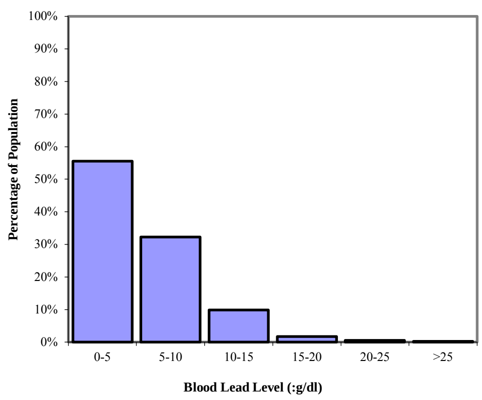


Figure C-2h
Blood Lead Histogram - 1995

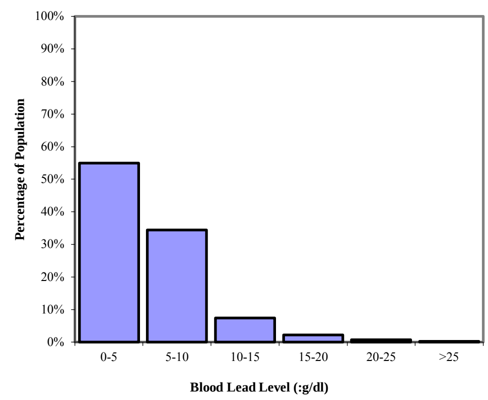


Figure C-2i
Blood Lead Histogram - 1996

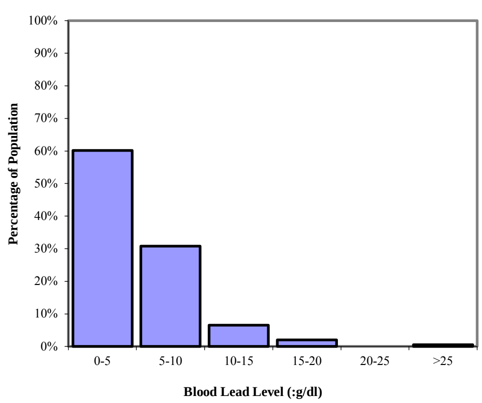


Figure C-2j
Blood Lead Histogram - 1997

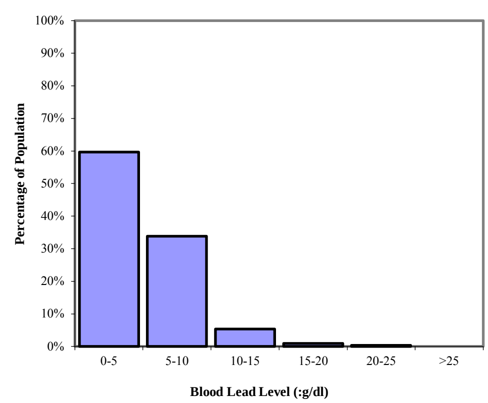


Figure C-2k
Blood Lead Histogram - 1998

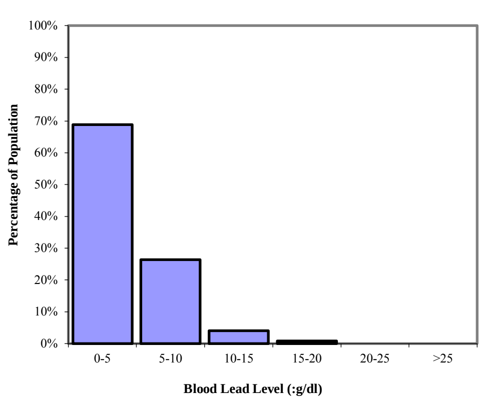


Figure C-2l
Blood Lead Histogram - 1999

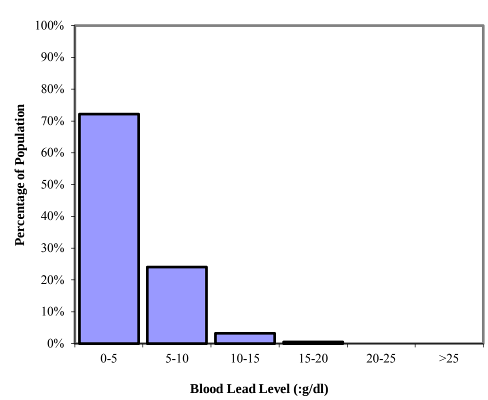
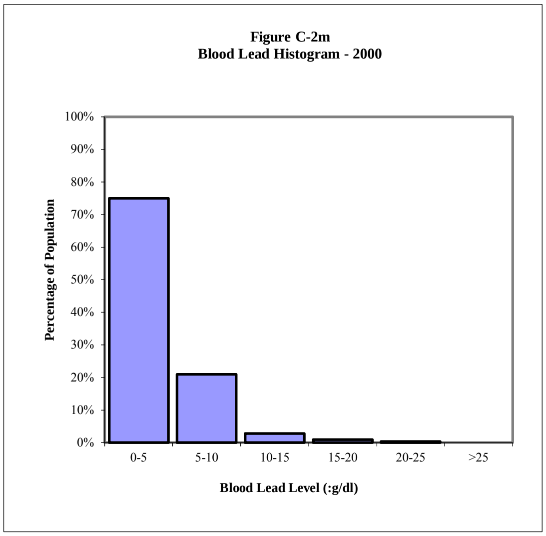
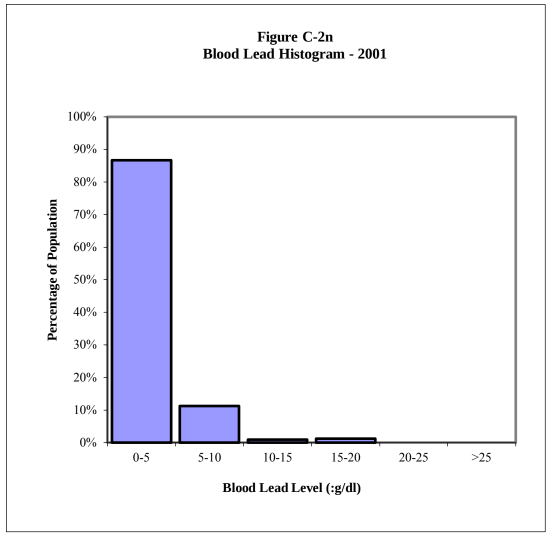
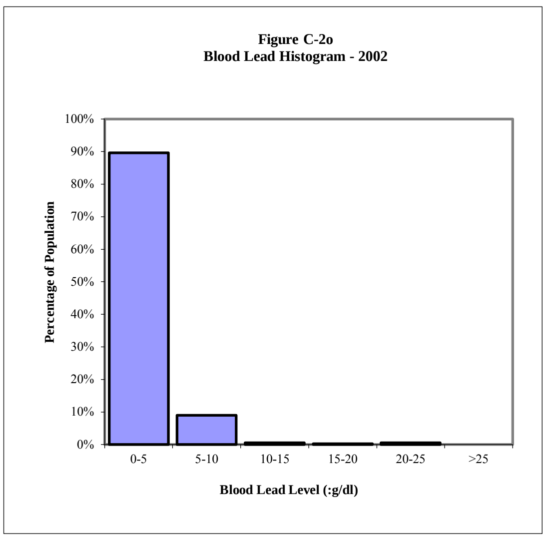
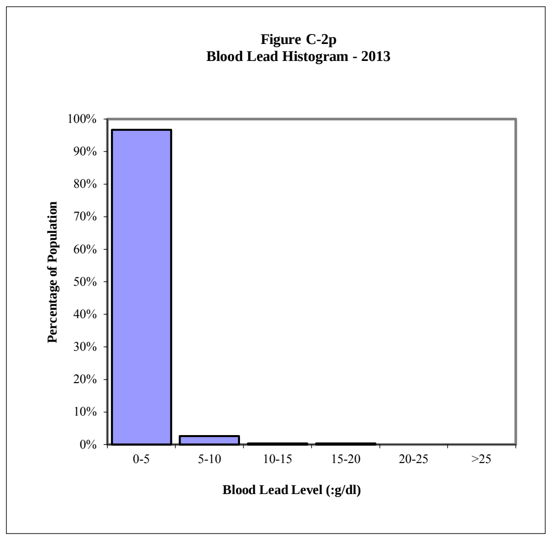


Figure C-2a-p (continued)
Blood Lead Distribution Histograms - Box-wide, 1988-2013









[1] No data collected in Pinehurst.
Note: 2003 through 2012 not shown due to small number of participants.