Health Consultation

LEAD IN DUST IN HOMES IN THE LINCOLN PARK NEIGHBORHOOD

CANON CITY, FREMONT COUNTY, COLORADO

EPA FACILITY ID: COD042167585

NOVEMBER 16, 2006

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

Health Consultation: A Note of Explanation

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

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

You May Contact ATSDR Toll Free at
1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

HEALTH CONSULTATION

LEAD IN DUST IN HOMES IN THE LINCOLN PARK NEIGHBORHOOD

CANON CITY, FREMONT COUNTY, COLORADO

EPA FACILITY ID: COD042167585

Prepared by:

The U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation

Statement of Issue

The Canon City area has been the historical site of a number of milling and smelting facilities. Based on environmental contamination from those operations, questions and concerns have been voiced by residents of the Lincoln Park neighborhood. Among the various issues are specific concerns that lead contaminated dust from current and historical operations may have migrated into the residential neighborhood. In response to those concerns, the US Environmental Protection Agency (EPA) has requested that the Agency for Toxic Substances and Disease Registry (ATSDR) review the data related to lead contamination in the Canon City area, and assess the health risk associated with the lead contamination. After an initial review of the available data, a site visit to the Lincoln Park area in July of 2004, and conversations with concerned community members, ATSDR focused assessments on two primary issues. The first issue was the blood lead levels in children living in the area, and the second was the lead contaminated dust in homes in the Lincoln Park area.

This health consultation specifically addresses concerns related to lead levels in the house dust in the Lincoln Park area. (A second health consultation will address the concerns related to blood lead levels in the Lincoln Park area, and will be released as a second document.) This health consultation addressing dust contaminants provides an assessment based on the data that has been compiled in the "Canyon City Lead Data Compilation Report" [1].

Background

Canon City was first settled in the mid 1800s and later was development as a center for mineral industries. Historical milling and smelting operations in the Canon City area are potential sources of various environmental contaminants. The larger of those industrial facilities have been the subject of previous investigations and a variety of clean-up activities have been conducted to remediate environmental contaminants [1]. The six larger of the potential sources of lead are located generally south and southwest, and within approximately 4 miles, of central Canon City. The Lincoln Park neighborhood is located generally east-southeast of the facilities and the general wind direction is west to east. Short summary descriptions of the prominent industrial facilities, developed from the "Canyon City Lead Data Compilation Report" [1], is provided in the text that follows.

Empire Zinc Smelter (aka New Jersey Zinc; also commonly known as the property of the College of the Canons) (~60 acres) operated from 1902 until its closure 1968. The Canon City Chemical Company purchased the site and used the tailings as a soil additive and operated until 1991. In 1996 a survey of 136 soil samples from nearby residential area showed that 4 samples exceeded 500 ppm lead in the soil and subsequent sampling (composite samples all below 600 ppm) and evaluation by EPA determined that no further work was needed. On-site lead contaminated soil (soil exceeding 1450 ppm) was consolidated and capped.

The Cotter Corporation owns approximately 2500 acres in the area, and since the mid 1950s, the ***Cotter Mill*** facility has been primarily concerned with uranium milling. In 1984 the site was placed on the National Priorities List, as was an adjacent residential neighborhood, the Lincoln Park Superfund site. Subsequent onsite investigations found lead contaminated areas that were the target of remediation activities. To date numerous clean-up activities have been conducted on-site with some areas having soil removed down to bedrock. Data collected for an EPA risk assessment (1994 through 1996) concluded that neither the soil nor the air at the Cotter Mill site posed a health risk to residents of the Lincoln Park neighborhood. Dust samples were not evaluated as part of that investigation.

The U.S. Smelter facility operated from the 1880s to 1912, and at one time was considered to be the largest lead and zinc smelter in the world. The primary products of the smelter were lead used as a paint pigment and metallic zinc. In 1922 a new owner used more modern techniques to re-work the tailings and slag at the site. The site is currently in the process of being sold and reclaimed.

The ***Canon City Copper Smelter***, the ***Ohio Zinc Company***, and the ***Royal Gorge Smelter*** were each in operation prior to 1920. However there is little or no information describing the ores and operations at each property. There is no known pervious site work associated with these three properties.

Investigation at Residential Areas

Collectively, 244 soil samples have been taken at residential areas in the Lincoln Park neighborhood. Of those samples, four had lead levels that exceeded 500 ppm and one of the samples exceeded 1000 ppm. Data collected for an EPA risk assessment of the Cotter Mill site (1994-1996) [2] evaluated soil and air exposure pathways and determined that soil and air were no further risk to Lincoln Park residents. However the risk evaluations did not consider dust. Currently, the clean-up activities in the Lincoln Park area are considered completed.

Dust samples fro area homes were collected by a lawyer's investigation (1992-1993) and by the Colorado Department of Public and Environmental Health (CDPEH) (2003). The results for the dust samples ranged from 308 parts per million (ppm) to 3651 ppm (Table 1). Details for the sampling protocols and sample locations for the lawyer's investigation are not available.

Discussion

Information guiding assessment of lead levels in house dust that result from migration of outdoor contaminants is sparse and/or lacking. Despite this limitation, ATSDR constructed two assessment strategies that were used to provide a "screening level" evaluation of the dust samples from the Lincoln Park area. The first strategy was to compare the lead levels in the Lincoln Park samples vs. data obtained from reports

published in the scientific literature. The second strategy involved using the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK), developed by the EPA, to assess the hazard related to lead exposures to dust in area buildings.

Lead levels in the Lincoln Park In-Building Dust Samples vs. Data from the Scientific Literature.

A search of the scientific literature located limited but useful information for evaluating "background" levels of lead in dust, and for evaluating possible health impacts. Summary data used in this evaluation are described, and referenced in Appendix A. A very brief description of those data is presented below.

EPA Estimates of "Background Levels" of Lead in House Dust. Background estimates for lead in dust are suggested by the EPA. EPA uses a "default value" for lead in house dust of 150 ppm in their computer modeling estimates (see below and see Appendix B). The EPA has also, based on survey work in the Midwest area of the USA, reported a median value for lead in house dust of 134 ppm with a 95^{th} percentile of 1176 ppm [10].

Associations Between Blood Lead Levels and Lead in House Dust Levels. While not all studies find clear links, a number of studies have reported positive associations between elevated lead levels in house dust and elevated blood lead levels (BLLs) [3-7]. Notable in these studies is a report, based on analyses conducted at the Bunker Hill Site (Bunker Hill, ID), that estimates as much as 40-50 % of the blood lead absorbed from soils and dusts is through house dust [5]. In the late 1980s, after emergency removals were completed at the Bunker Hill site, house dust lead levels were between 1200 and 1500 ppm; by the late 1990s lead in house dust was estimated to be 500-600 ppm, and lead in dust was estimated at less than 500 ppm in 2001 [5]. Over this time span, BLLs in children living in the area ranged from approximately 50 % exceeding 10 ug/dL in 1989, to approximately 3 % exceeding 10 ug/dL in 2001 [5].

Lead in House Dust from "Background" and "Impacted" Areas . Estimates of lead in dust levels in "background" or areas described as "not impacted by historical mining industries" vary appreciably (see Appendix A). For instance, lead in dust levels in some areas, including large metropolitan areas which may be affected by historical leaded gasoline emissions, were relatively low in some reports (various statistical estimates between 9 and 250 ppm) while other reports document much higher levels (various statistical estimates between 350 and 600 ppm) (see appendix A). Industrial activities can affect lead in house dust levels; the Bunker Hill site is a notable example [5]. A report of dust lead levels from a mining district in Australia documented a lead in dust level of 470 ppm (median) that was judged to be the result of "take home" contamination on the clothing of mine workers [8]. Age of housing is also associated with elevated lead in dust levels. A study or older homes in New Zealand (built before 1950) found lead in dust levels at a mean level of 830 ppm, a level almost twice that of homes built after 1950 [9].

When viewed collectively, the variation in the data assembled for estimating "background" levels of lead in house dust is notable. However, regardless of that variation, it is also noted that all of the data describing lead in house dust for the Lincoln Park neighborhood exceed the lower estimates of "background", and most exceed the highest estimate of 595 ppm (see above, Table 1, and Appendix A). In addition, half of the available data for lead in dust levels in the Lincoln Park neighborhood exceed the 95th percentile estimate of 1170 ppm produced in EPA's survey of lead in house dust from the Midwestern United States [10]. Further, approximately half of the lead in dust levels found in the Lincoln Park Neighborhood are at concentrations that have been associated with elevated BLLs in children [5,6]

Computer Modeling to Assess the Blood Lead Levels for In-Building Dust Samples.

The Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK), is a biokinetic model for lead uptake in children that integrates an exposure model with the biokinetic model. The model utilizes four interrelated modules (exposure, uptake, biokinetic, and probability distribution) to estimate BLLs in children exposed to lead-contaminated media. The IEUBK allows the user to estimate, for a hypothetical child or population of children, a plausible distribution of BLL concentrations centered on a geometric mean BLL concentration. The geometric mean BLL is predicted from available information about the child's or children's exposure to lead. From this distribution, the model estimates the risk (i.e., probability) that a child's or a population of children's BLL concentration will exceed a certain level of concern (typically 10 µg/dL). ATSDR has used this model to estimate the effect dust lead levels might have on children's blood lead levels.

Based on the rationale presented below, the IEUBK was used to estimate BLLs in children exposed lead in dust using the following exposure scenario.

Attic was dust considered representative of house dust;

Because the data set (Table 1) is too weak to support a statistical analysis, 3 lead concentrations in dust were examined;

380 ppm (the lowest value above the model background; Table 1)
1130 ppm (the median value; Table 1)
3651 ppm (the highest value; Table 1).

All model inputs were left at default and only the indoor dust levels for the models were varied.

(Additional details and outputs from the model are included in Appendix B.)

The results show that indoor dust levels, when held constant over the 84 months of exposure for a child, result in unacceptable blood lead levels with the lowest dust lead level examined (380 ppm). Based on the modeled exposure scenario, eight of the ten available data points describing lead in dust in the Lincoln Park exceed the 380 ppm and would be are viewed as elevated.

There are many limitations with this type analysis. The greatest being the assumption that today's attic dust levels are equal to current residential indoor dust levels. Indoor dust results from a combination of many sources (outdoor soil, fabrics, carpeting, outdoor dust, pets, etc) which combines dust sources of lead and non sources of lead. It is also unlikely that attic dust truly represents indoor dust. In addition, ATSDR acknowledges that most of the samples available for review for this health consultation are from attic dust, and that most children will not have access to the attic of homes. However the levels of lead in the attic dust samples suggests that some of the area homes may contain dust in which lead levels exceed the threshold estimated by the IEUBK model. As employed in this report, the IEUBK model is not useful for predicting an individual's BLL, but is useful in determining exposure scenarios that need further evaluation.

Assessment of Hazard

Both the characterization of levels of lead in samples of in-home dust, and the estimates obtained from the IEUBK model, generate concerns related to possible lead exposures in the Lincoln Park neighborhood. Collectively, the available information, while limited and containing numerous uncertainties, suggests that exposures to the lead in dust could impact the health of children residing at properties in the Lincoln Park neighborhood.

Because of the numerous data limitations, making a definitive statement regarding the adverse health effects is not possible. Therefore, ATSDR concludes that the **house dust lead levels in the Lincoln Park area represent an indeterminate health hazard.**

Gaps in our understanding could be filled with an investigation that is aimed at characterizing in-home dust lead levels of the Lincoln Park community. Such an investigation is recommended.

Conclusion:

The available data are not sufficient to determine the magnitude or extent of a hazard that may be associated with in-building lead levels in the Lincoln Park area. This conclusion is based primarily on the limited available data and the uncertainties associated with that data. However, the limited data suggest that lead levels in the dust at some homes in the Lincoln Park neighborhood may be at levels that are a health concern. This finding warrants further characterization of lead in dust in the Lincoln Park neighborhood.

Recommendation

Conduct an investigation that is designed to characterize the lead in dust levels in homes in the Lincoln Park area. *(ATSDR completed this recommended exposure investigation and expects to release the report that describes the results in the Fall of 2006.)*

Public Health Action Plan:

ATSDR will conduct an "Exposure Investigation" that is aimed at characterizing the lead levels in the homes of volunteers from the Lincoln Park neighborhood. This exposure investigation is expected to include analyses of samples from approximately 20 homes in the Lincoln Park neighborhood, and has been planned and will be conducted with the input and assistance of persons living in the community. Plans for the Exposure Investigation is in development at ATSDR, and those plans will integrate suggestions made by local community members, as well as encourage operational support from members of the community. ATSDR expects to conduct the Exposure Investigation in the late Summer / early Autumn of 2005.

The data gathered from the Exposure Investigation will be evaluated to determine if exposures to lead in dust represent a public health hazard. The findings of the Exposure Investigations will be made available to the Lincoln Park community as well as the general public. The report will contain conclusions and recommendations and may include recommendations for further investigations to fill additional data gaps identified by the Exposure Investigation. *(ATSDR completed this exposure investigation and expects to release the report that describes the results in the Fall of 2006.)*

Prepared by:
Clement J Welsh, PhD, MPH
Senior Environmental Health Scientist
Exposure Investigations and Consultation Branch
Division of Health Assessment and Consultation

John Wheeler, PhD
Senior Environmental Health Scientist
Exposure Investigations and Consultation Branch
Division of Health Assessment and Consultation

Reviewed by:

Peter Kowalski
Senior Environmental Health Officer
Team Leader
Exposure Investigations and Consultation Branch
Division of Health Assessment and Consultation

Susan Moore
Branch Chief
Exposure Investigations and Consultation Branch
Division of Health Assessment and Consultation

References

1. US Environmental Protection Agency. 2004. Canon City Lead Data Compilation Report. Tetra Tech EM, Inc. (Contract No. 68-W-00-118). 2004.

2. US Environmental Protection Agency. Lincoln Park/Cotter Superfund Site HHRA – Phase III Evaluation – 1994/1996.

3. Laxen, DP, GM Raab, and M. Fulton. 1987. Children's Blood Lead and Exposure to Lead in the Household Dust and Water—A basis for an Environmental Standard for lead in Dust.

4. Cambra, K. and E. Alonoso. 1995. Blood Lead Levels in 2- to 3-Year Old Children in the GreaterBilbao Area (Basque Country, Spain): Relation to Dust and Water Lead Levels. Arch Environ Health. 50(5):362-366.

5. von Lindern, I, S Spalinger, S Petroysan, and M von Braun. 2003. Assessing Remedial Effectiveness through the Blood Lead: Soil/Dust Lead Relationship at the Bunker Hill Superfund Site in the silver Valley of Idaho. Sci Total Environ. 303:139-170.

6. Agency for Toxic Substances and Disease Registry. 1995. Multisite Lead and Cadmium Exposure Study with Biological Markers Incorporated. U. S. Department of Health and Human Services.

7. von Lindern, I H., S M Splinger, B N Bero, V. Petrosyan, and M C von Braun. 2003. The Influence of Soil Remediation on Lead in House Dust. Sci Total Environ. 303(1-2): 59-78.

8. Chiaradia, M, BL Gulson, and K MacDonald. 1997. Contamination of Houses by Workers Occupationally Exposed in a Lead-Zinc-Cpper Mine and Impact on Blood Lead Concentrations in Families. Occup Environ Med. 54:117-124.

9. Ferguson, JE, and RJ Schroeder. 1985. Lead in House Dust of Christchurch, New Zealand: Sampling, Levels and Sources. Sci Total Environ. 46:61-72.

10. Clayton, CA, ED Pellizzari, and JJ Quackenboss. 2002. National Human Exposure Assessment Survey: Analysis of Exposure Pathways and routes for Arsenic and Lead in EPA Region 5. J Exposure Anal Environ Epidemiol 12:29-43.

Table 1. Lead Levels in Dust from Buildings in the Lincoln Park Neighborhood.

Investigation	Sample Number	Location / Description	Concentration (ppm)
Lawyer Investigation (1992-1993)	1	"attic, residence"	775
	2	"attic, residence"	1130
	3	"attic, residence"	380
	4	"attic, residence"	2540
	5	"attic, res. & shop"	1600
	6	"attic dust"	1260
	7	"attic dust"	1230
	8	"attic dust"	855
CDPHE (2003)	1	"residence attic"	644
	2	"barn attic"	3651

ppm = parts per million

Responses to Public Comments

This health consultation was released for "public comment" on September 7, 2005. Numerous comments were received from community members. Comments regarding the text and issues that are considered in the health consultation are listed below. Responses follow the specific comments. For the sake of brevity, most of the comments were paraphrased and similar comments were summarized to provide a single statement.

Comment: College of the Cannons should be recognized / listed as the property / location of the former Empire Zinc Co. (aka New Jersey Zinc)

> **Response:** The text has been revised to reflect this information. (Note: the community member also included materials that support the revision.)

Comment: The Cotter Corporation owns about 2500 acres in the general Canon City/ Lincoln Park area.

> **Response:** The text has been revised to reflect this information. (Note: the community member also included materials that support the revision.)

Comment: The previous lead sampling was limited to the Lincoln Park area. Since there were other areas where there were smelters, there are concerns about contaminants in other areas. I recommend that the current studies be completed and the scope of future studies be expanded.

> **Response:** The activities concerning lead contamination that are discussed in this health consultation were conducted as a measured response to community concerns. The two projects (blood lead screening and house dust and soil sampling) found no evidence indicating a concern for community wide lead exposures. Therefore the data do not indicate a need for additional studies of lead exposures.

Comment: ATSDR should inform the community of the health risks related to the lead contamination in the area.

> **Response:** ATSDR is now releasing documents that describe our activities to address the community concerns related to lead contamination in the Lincoln Park area. In addition to the documents, ATSDR will be holding public availability meetings to allow members of the community to ask questions about the information contained in the documents.

ATSDR also expects to investigate concerns about other contaminants in the Lincoln Park area. Documents describing those activities and findings will be released as they are completed

Comment: I think it is vitally important to determine the source of the lead. This could be done by analyzing for lead 210, and since you already have samples it should not be overly expensive to perform those analyses.

Response: The data collected to date found no evidence indicating a concern for community wide lead exposures. Therefore, the data do not indicate a need to look for sources of lead.

Comment: Requests for a health risk evaluation were made in 1988. EPA required a health risk survey when the site went on the NPL (National Priority List). But the Lincoln Park site fell through the cracks.

Response: Recent activities have been initiated to address community concerns for environmental contaminants in the Lincoln Park area. ATSDR is now releasing four documents that describe our activities to address the community concerns related to lead contamination in the Lincoln Park area. In addition to the documents, ATSDR will be holding pubic availability meetings to allow members of the community to ask questions about the information contained in the documents.

ATSDR also expects to investigate concerns about other contaminants in the Lincoln Park. Documents describing those activities and findings will be released as they are finalized.

Comment: College of the Canons had nothing to do with milling or mining.

Response: Comment noted. Also see the revision in text describing the College of the Canons.

Comment: Cotter began construction in 1957 and began operations in 1959 (late 1950s, not mid 50s).

Response: The text has been revised to reflect this information.

Comment: Cannon City began as a place for persons recovering from TB to convalesce in hot springs.

Response: Comment noted.

Comment: Note that Lincoln Park is an unincorporated area, and is not part of the city of Canon City.

Response: Comment noted.

Appendices

Appendix A. Summary Information for Estimating Levels of Lead in House Dust.

Source / Study Area	Year of Study	Lead Concentration in House Dust (ppm)	Statistic	Reference
Bilbao, Spain	1992	595	goemean	1
Christchurch, New Zealand	1993	573	geomean	2
Bunker Hill, ID, USA[a]	1996-9	500-600	geomean	3
Bunker Hill, ID, USA[a]	2000	<500	geomean	3
Bunker Hill, ID, USA[a]	2000	200[b]	geomean	3
Ottawa, Canada	2001	233	geomean	4
Birmingham, England	1990	516	geomean	5
London, England	1988	370	geomean	6
Midwest, USA	1995-7	134	median	7
Warsaw, Poland	1997	210	high in range	8
Hong Kong	2000	145	median	9
Denmark	1992	9	geomean	10
Christchurch, New Zealand	1985	460	mean	11

a data collected during and after remediation efforts
b estimated "background" based on a comparison population
ppm = parts per million; "geomean" = geometric mean.

References:
1. Cambra, K. and E. Alonoso. 1995. Blood Lead Levels in 2- to 3-Year Old Children in the GreaterBilbao Area (Basque Country, Spain): Relation to Dust and Water Lead Levels. Arch Environ Health. 50(5):362-366.
2. Kim, N. and J. Fergusson. 1993. Concentrations and Sources of Cadmium, Copper, Lead, and Zink in House Dust in Christchurch, New Zealand. Sci Total Environ. 138(1-3):1-21.
3. von Lindern, I H., S M Splinger, B N Bero, V. Petrosyan, and M C von Braun. 2003. The Influence of Soil Remediation on Lead in House Dust. Sci Total Environ. 303(1-2): 59-78.
4. Rasmussen, P E., K S Subramanian, and B J Jessiman. 2001. A Multi-element Profile of Housedust in Relation to Exterior Dust in Soils of Ottawa, Canada. Sci Total Environ. 267(1-3)124-140.
5. Thorton, I, D J Davies, J M Watt, and M J Quinn. 1990. Lead in Young Children from Dust and Soil in the United Kingdom. Environ Helath Perspect. 89:55-60.
6. Schwar, M J, J S Morcroft, D P Laxton, M Thompson, and C. Armorgie. 1988. Baseline Metal-in-Dust Concentrations in Greater London. Sci Total Environ. 68:25-43.

7. Clayton, CA, ED Pellizzari, and JJ Quackenboss. 2002. National Human Exposure Assessment Survey: Analysis of Exposure Pathways and routes for Arsenic and Lead in EPA Region 5. J Exposure Anal Environ Epidemiol 12:29-43.
8. Lisiewicz, M, R Heimburger, and J Golimowski. 2000. Granulometry and the Content of Toxic and Potentially toxic elements in Vacuum-Cleaner Collected, Indoor Dusts of the City of Warsaw. Sci Total Environ 263:69-78.
9. Tong, ST and KC Lam. 2000. Home Sweet Home? A Case study of Household Dust Contamination in Hong Kong. Sci Total Environ. 256:115-123.
10. Jensen, H. 1992. Lead in Household Dust. Sci Total Environ. 114:1-6.
11. Ferguson, JE, and RJ Schroeder. 1985. Lead in House Dust of Christchurch, New Zealand: Sampling, Levels and Sources. Sci Total Environ. 46:61-72

Appendix B. Using the IEUBK Model to Estimate Blood Lead Levels in the Lincoln Park Neighborhood .

Using the IEUBK Model to Estimate Blood Lead Levels in the Lincoln Park Neighborhood .

The Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK), is a biokinetic model for lead uptake in children that integrates an exposure model with the biokinetic model. The model utilizes four interrelated modules (exposure, uptake, biokinetic, and probability distribution) to estimate blood lead levels (BLL) in children exposed to lead-contaminated media. The IEUBK allows the user to estimate, for a hypothetical child or population of children, a plausible distribution of BLL centered on a geometric mean BLL. The geometric mean BLL is predicted from available information about the child's or children's exposure to lead. From this distribution, the model estimates the risk (i.e., probability) that a child's or a population of children's BLL will exceed a certain level of concern (typically 10 µg/dL). ATSDR has used this model here to estimate the effect dust lead levels might have on children's blood lead levels.

Between the years 1992 - 2003 11 dust samples were collected in the Lincoln Park/Canon City area by different groups. Dust samples were not collected in a manner that allows a statistical analysis of how well the samples represent the overall levels of dust lead. Nor is quality control/quality assurance (QA/QC) data available to demonstrate the variability in the analysis being performed. The data are shown in the table below.

Lead conc (ppm)	Dust source	Data source
380	Residential attic	Law firm
644	Residential attic	CDPHE
775	Residential attic	Law firm
855	Unknown attic	Law firm
1130	Residential attic	Law firm
1230	Unknown attic	Law firm
1260	Unknown attic	Law firm
1600	Residential attic and shop	Law firm
2540	Residential attic	Law firm
3651	Barn attic	CDPHE

To evaluate the potential for attic dust to add to body burdens of lead 2 different scenarios were employed.

1) If attic dust can be considered representative of house dust one can assume that relatively little time is spent in the attic compared to residential living quarters and use the US EPA's IEUBK model to model the contribution of lead dust levels to blood leads. Predicted blood leads that exceed 10 ug/dl for greater than 5% of a population exposed to a similar levels is considered of concern and warrants further study.

Because the data set is too weak to support a statistical analysis of the data 3 values were selected to examine with the IEUBK model. 1) The lowest value above the model background; 2) the median value and, 3) the highest value. All model inputs were left at default and only the indoor dust levels for the models were varied.

The results show that indoor dust levels when held constant over the 84 month child exposure result in unacceptable blood lead levels at the median exposure value and the dust lead levels associated with the barn. The blood lead levels associated with the lowest dust lead level exceeding background (380 ppm) were at the threshold of becoming a concern.

There are, of course, many limitations with this type analysis. The greatest being the assumption that today's attic dust levels are equal to historical residential indoor dust levels. Indoor dust results from a combination of many sources (outdoor soil, fabrics, carpeting, outdoor dust, pets, etc) which combines dust sources of lead and non-dust sources of lead. It is unlikely that attic dust truly represents indoor dust.

The limited nature of the supplied data and the lack QA/QC criteria do not permit a quantitative assessment of attic dust contributions to blood lead levels. The data however can be used in a qualitative manner in established models to make recommendations. The modeled data suggest that the higher levels of dust lead may be problematic whether attic dust is an indicator of house dust lead levels or is independent of house dust. Most likely there is some correlation between attic dust and house dust levels and there are scenarios in which attic exposures occur independent of ongoing environmental exposures. The magnitude of these exposures is unknown. Further data sampling and environmental analysis is recommended to fill the data gaps

Output from the IEUBK Model Runs

The following are outputs from running the IEUBK model under default values for three altered dust levels. The dust levels were assumed to be constant from 0-84 months. The levels were 380 ppm, 1130 ppm, and 3651 ppm.

Level: 380 ppm

LEAD MODEL FOR WINDOWS Version 1.0

==========

Model Version: 1.0 Build 259
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research

==========

The time step used in this model run: 1 - Every 4 Hours (6 times a day).

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (ug Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake (ug/day)
.5-1	5.530
1-2	5.780
2-3	6.490

3-4	6.240
4-5	6.010
5-6	6.340
6-7	7.000

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 ug Pb/L

****** Soil & Dust ******

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	200.000	380.000
1-2	200.000	380.000
2-3	200.000	380.000
3-4	200.000	380.000
4-5	200.000	380.000
5-6	200.000	380.000
6-7	200.000	380.000

****** Alternate Intake ******

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

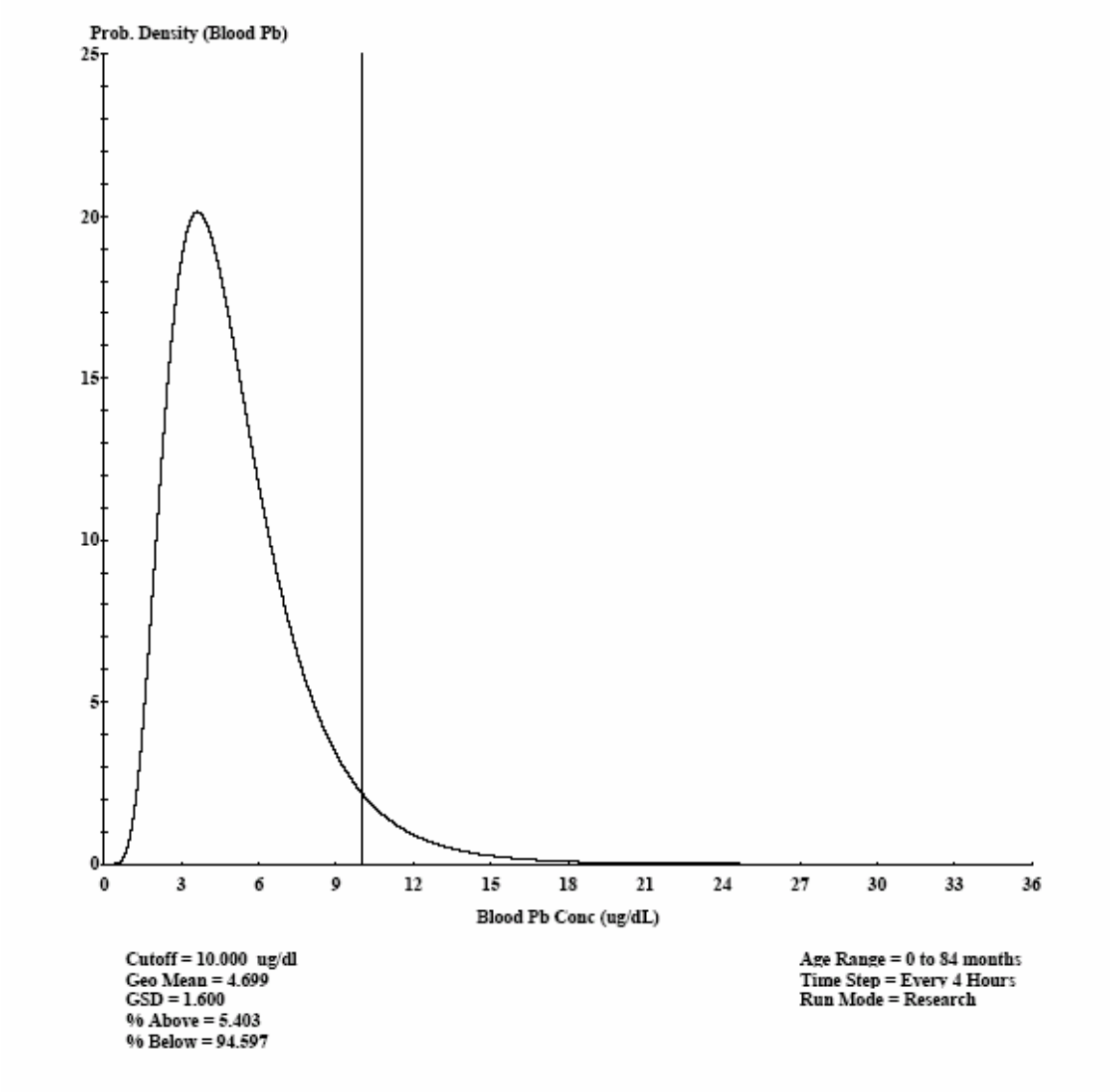
****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 2.500 ug Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (ug/dL)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
.5-1	0.021	2.474	0.000	0.358
1-2	0.034	2.550	0.000	0.882
2-3	0.062	2.906	0.000	0.931
3-4	0.067	2.837	0.000	0.964
4-5	0.067	2.809	0.000	1.028
5-6	0.093	2.994	0.000	1.096
6-7	0.093	3.322	0.000	1.120

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
.5-1	6.823	9.676	5.2
1-2	10.683	14.150	5.8
2-3	10.843	14.742	5.5
3-4	11.012	14.880	5.2
4-5	8.386	12.291	4.4
5-6	7.625	11.808	3.7
6-7	7.237	11.772	3.4



Output for indoor dust concentration held at a constant 380 ppm.

Level 1130 ppm

LEAD MODEL FOR WINDOWS Version 1.0

==========

Model Version: 1.0 Build 259
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research

==========

The time step used in this model run: 1 - Every 4 Hours (6 times a day).

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (ug Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(ug/day)
.5-1	5.530
1-2	5.780
2-3	6.490
3-4	6.240
4-5	6.010
5-6	6.340
6-7	7.000

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 ug Pb/L

****** Soil & Dust ******

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	200.000	1130.000
1-2	200.000	1130.000
2-3	200.000	1130.000
3-4	200.000	1130.000
4-5	200.000	1130.000
5-6	200.000	1130.000
6-7	200.000	1130.000

****** Alternate Intake ******

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

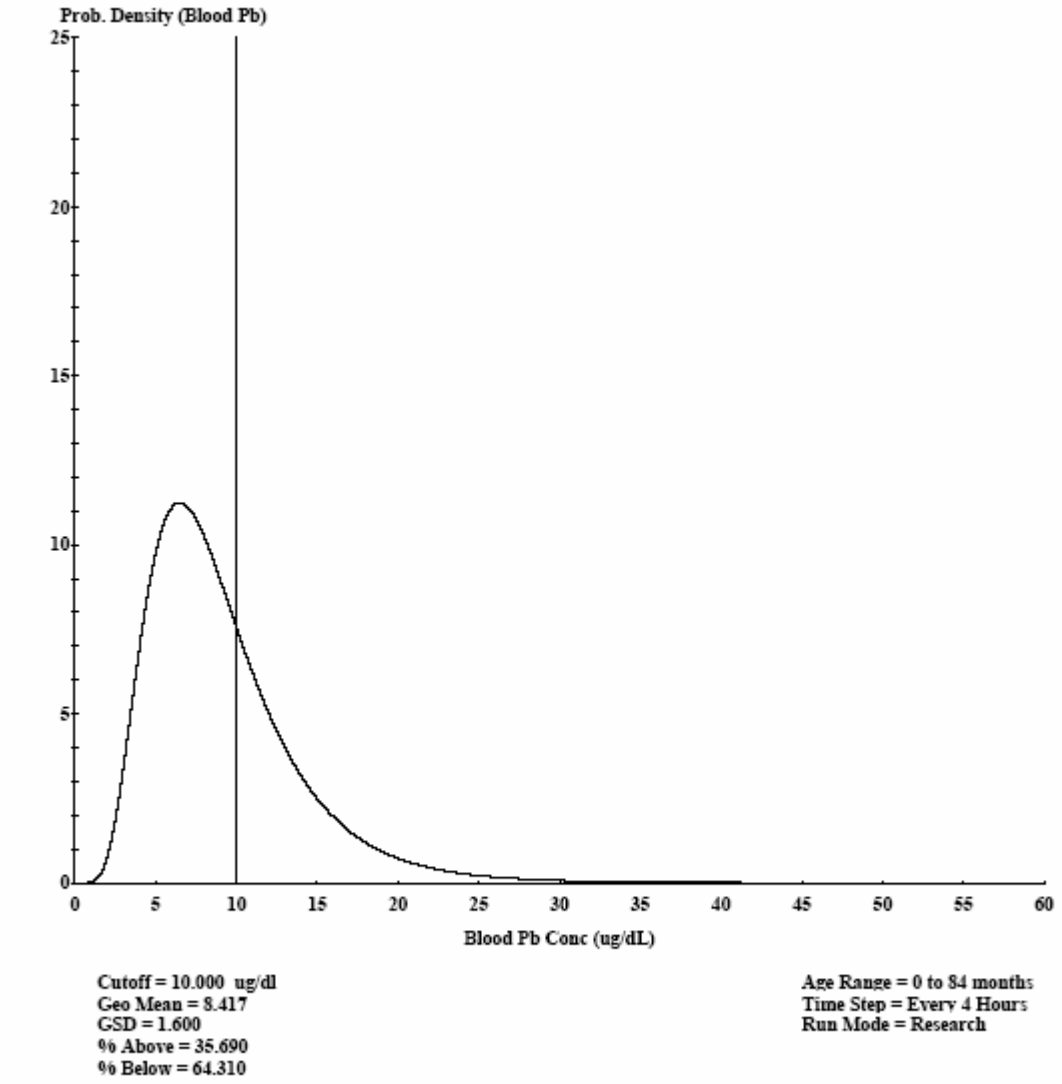
****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 2.500 ug Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (ug/dL)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
.5-1	0.021	2.257	0.000	0.326
1-2	0.034	2.287	0.000	0.791
2-3	0.062	2.640	0.000	0.846
3-4	0.067	2.607	0.000	0.886
4-5	0.067	2.652	0.000	0.971
5-6	0.093	2.856	0.000	1.045
6-7	0.093	3.187	0.000	1.074

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
.5-1	14.807	17.412	9.2
1-2	22.804	25.917	10.5
2-3	23.447	26.995	9.9
3-4	24.078	27.638	9.5
4-5	18.835	22.524	7.9
5-6	17.306	21.300	6.7
6-7	16.521	20.875	6.0



Output for indoor dust concentration held at a constant 1130 ppm.

Level 3651 ppm

LEAD MODEL FOR WINDOWS Version 1.0

==========

Model Version: 1.0 Build 259
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research

==========

The time step used in this model run: 1 - Every 4 Hours (6 times a day).

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (ug Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(ug/day)
.5-1	5.530
1-2	5.780
2-3	6.490
3-4	6.240
4-5	6.010
5-6	6.340
6-7	7.000

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 ug Pb/L

****** Soil & Dust ******

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	200.000	3651.000
1-2	200.000	3651.000
2-3	200.000	3651.000
3-4	200.000	3651.000
4-5	200.000	3651.000
5-6	200.000	3651.000
6-7	200.000	3651.000

****** Alternate Intake ******

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

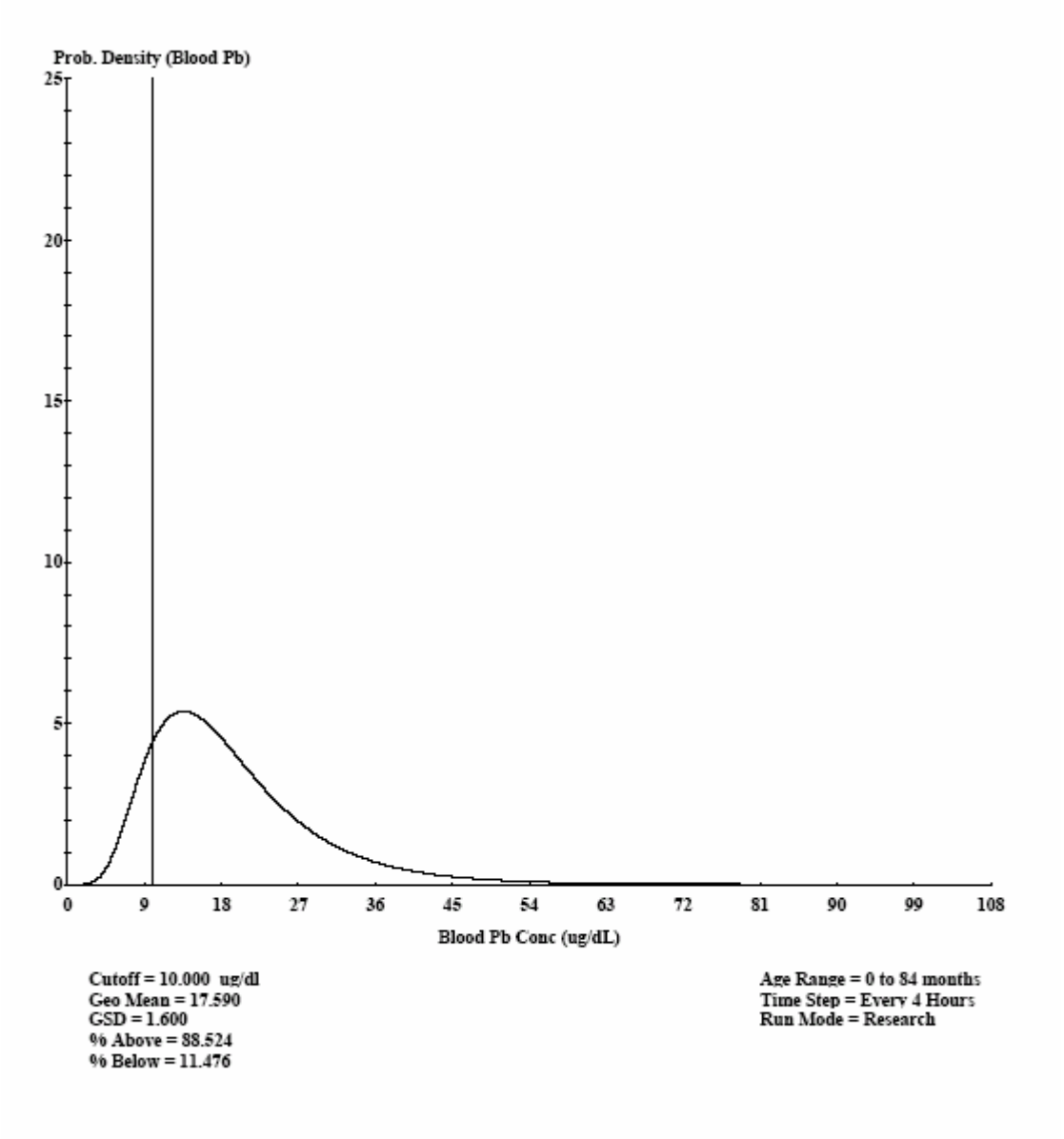
****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 2.500 ug Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (ug/dL)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
.5-1	0.021	1.788	0.000	0.259
1-2	0.034	1.759	0.000	0.609
2-3	0.062	2.077	0.000	0.666
3-4	0.067	2.093	0.000	0.711
4-5	0.067	2.255	0.000	0.825
5-6	0.093	2.490	0.000	0.911
6-7	0.093	2.820	0.000	0.951

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
.5-1	34.589	36.656	18.6
1-2	51.714	54.116	21.4
2-3	54.378	57.182	20.4
3-4	57.013	59.884	20.0
4-5	47.223	50.370	17.2
5-6	44.495	47.990	14.8
6-7	43.104	46.968	13.3



Output for indoor dust concentration held at a constant 3651 ppm.