Bunker Hill
Populated Areas Operable Unit
First Five Year Review Report

EPA Five Year Review Signature Cover

Key Review Information

Site Identification			
Site name: Bunker Hill Mining and Metallurgical			EPA ID: IDD048340921
Region: 10	State: Idaho	City/County: Shoshone	
Site Status			
NPL status: Final			
Remediation status (under construction, ongoing operation, complete): Under construction			
Multiple OU's* (highlight): Y* N *There are two operable units (OU). Separate Five Year Reviews are being prepared for each OU since each area is on a separate schedule and managed separately.			
Construction completion date: n/a			
Fund/PRP lead: PRP and Fund lead		Lead agency: EPA Region 10	
Recycling, reuse, redevelopment site (highlight): Y N			
Review Status			
Who conducted the review (EPA Region, state, Federal agency): EPA Region 10			
Author name: Sean Sheldrake			
Author title: Remedial Project Manager			
Author affiliation: EPA Region 10			
Review period: From: January, 1998 To: February, 2000			
Date(s) of site inspection: ongoing			
Highlight:	*Statutory* Policy	Policy Type (name):	
Triggering action event: Beginning of construction in Populated Areas			
Trigger action date: September 27, 1994			
Due date: September 27, 1999			

Deficiencies:
The following deficiencies, which may affect protectiveness, if corrective actions are not taken, were identified:

- Soft shoulder rights of way contamination;
- vacuum loan program could be used more broadly;
- more information on interior home cleaning is needed;
- lack of access control along the UPRR right of way ;
- inadequate vehicle decontamination at Page Pond and at the Smelter Complex;
- hillside erosion into remediated yards;
- disposal area for contaminated snow needed;
- lack of drainage infrastructure and maintenance by local entities;
- lack of adequate road infrastructure maintenance; and
- inadequate disposal capacity currently exists to handle ICP wastes.

Recommendations and Required Actions:

The following are recommendations:

- Additional ROW (and other areas subjected to vehicle tracking) sampling, evaluation of alternatives*;
- additional advertisement of vacuum loan program;
- creation of home cleaning informational pamphlets;
- continue air monitoring and take corrective actions on a real time basis;
- implement better access control on the UPRR ROW consistent with the proposed O&M plan;
- additional decontamination of vehicles at Page Pond and Smelter Complex;
- construction of additional walls to hold back hillside erosion in Smelterville as well as planning and zoning changes and/or BMPs to prevent additional hillside encroachment;
- develop snow disposal area;
- replace failing roads and conduct regular road maintenance*; and
- install drainage infrastructure and conduct regular drainage maintenance*.

(*) These recommended actions are required to ensure protectiveness.

Protectiveness Statements:
The remedial actions at the Populated Areas operable unit are expected to be protective of human health and the environment upon completion of the remedy, as long as corrective actions described above are taken.

Signature of EPA Office Director and Date

____ ________

Signature Date

Michael F. Gearheard, Office Director, Environmental Cleanup Office
Name and Title

Bunker Hill Populated Areas
Five Year Review Report

I. Introduction

EPA Region 10 has conducted the first five year review of the remedial actions implemented at the Bunker Hill Superfund Site (BHSS) located in Northern Idaho, which is separated into two operable units. This report documents the results of the review for the Populated Areas operable unit. Review of the Nonpopulated Areas operable unit is being conducted separately since this area has been dealt with separately throughout the remedial process. The purpose of five year reviews is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five year review reports. In addition, five year review reports identify deficiencies found during the review, if any, and identify recommendations to address them.

This review is required by statute. EPA must implement five year reviews consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA §121(c), as amended, states:

> If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented.

The NCP part 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR) states:

> If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

This is the first five year review for the BHSS, Populated Areas operable unit. A separate review is being conducted in parallel with this review for the Nonpopulated areas operable unit. The trigger for this statutory review is the start of construction date shown in EPA's CERCLIS 3/WasteLAN database September 27, 1994. Due to the fact that mining wastes are still contained onsite, a five year review must be conducted.

II. Site Chronology

Table 1 lists a selected chronology of events for the BHSS.

Table 1: Chronology of Site Events for Populated Areas

Event	Date
Lead Smelter startup	1917
Zinc Plant startup	1928
Baghouse Fire	1973
Lead Health Study	1974-1975
Construction of tall Smelter stacks	1977
Smelter shuts down	1981
NPL listing	September 8, 1983
Lead screening and intervention starts	1985
Removal action; common use areas	1986
Removal action; residential yards starts	1989
RI/FS complete	August 30, 1991
ROD signature	August 30, 1991
Remedial design start	March 29, 1993
Consent Decree with Upstream Mining Group (UMG)	September, 1994
Remedial design completion	November 17, 1994
Institutional Controls Program Ordinance Adoption	February, 1995
Superfund State Contract	April, 1995
Institutional Controls Program Implementation	April, 1995
Construction (Remedial Action) start	1995
Construction finish	Ongoing
Construction completion	n/a

III. Background

Overview

The Bunker Hill Superfund Site (BHSS) is a twenty-one square mile area surrounding the old Bunker Hill Company lead and zinc smelting complex in Kellogg, Idaho (See Maps, Attachment A). The Superfund effort conducted under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) is a large and complex project with a long history triggered by childhood lead poisoning and including health and environmental investigation, public health response, interim removals, and cleanup actions based on site-specific/risk-based criteria. The project was initiated in 1983 and is in its sixteenth year. Remedial Investigation and Feasibility Study (RI/FS) activities began in 1984. The RI/FS effort was conducted in two units, with the Populated (residential) Areas being completed in 1990 (CH2M Hill, 1991), and the Nonpopulated (river flood plain, hillsides, and industrial complex) Areas was completed in 1991 (Dames and Moore, 1991). A Record of Decision (ROD) for residential soils in the Populated Areas was completed in 1991, and a ROD encompassing the Nonpopulated Areas was signed in 1992 (USEPA, 1991, 1992).

Environmental response, public health intervention, and cleanup activities have been underway since the smelter closure in 1981. These response measures were implemented to minimize exposure to contaminated materials during investigatory and remedial action activities. Removals were undertaken, including cleanup of area parks, playgrounds, and roadsides in 1986, smelter stabilization efforts from 1989 to 1993, and hillsides re-vegetation and fugitive dust control efforts from 1990 to 1992. Beginning in 1989, the Yard Soil Removal Program (CERCLA time critical Removal Action) replaced contaminated soils in home yards of young children at highest risk of lead poisoning.

In 1985[1], the allied Lead Health Intervention Program (LHIP) was initiated to minimize blood lead levels in children through health education, parental awareness, and biological monitoring efforts. The LHIP, sponsored by the Centers for Disease Control (CDC) and the Agency for Toxic Substances and Disease Registry (ATSDR), is implemented by the local Panhandle Health District (PHD) under the auspices of the Idaho Department of Health and Welfare (IDHW). During the entire health intervention and Superfund effort, an extensive database has been maintained by IDHW that relates children's blood lead levels, media contaminant concentrations, environmental exposures, health intervention, and remedial activities on an individual basis.

The pathways and human health effects associated with exposure to heavy metals have been studied extensively since the early 1970s. Over the past 15 years, more than 4000 blood lead samples have been obtained from children living within the BHSS. Analyses of these data in conjunction with the

[1] Beginning in 1985, a capillary (fingerstick) blood-erythrocyte protoporphyrin (EP) test was used. Yearly venous blood lead sampling began in 1988.

RI/FS effort resulted in an integrated risk management and BHSS cleanup strategy designed to monitor and minimize children's exposures as the remediation occurred (Terragraphics, 1997).

The cleanup strategy adopted in the 1991 Populated Areas ROD was based on site-specific analyses of the relationship between observed blood lead levels among children and environmental media lead concentrations at the site. The first use of what later became known as the U.S. Environmental Protection Agency (USEPA) Integrated Exposure Uptake Bio-kinetic Model (IEUBK v.99D) for lead in formulating cleanup criteria for lead in soils and dusts was for the BHSS.

House dust has long been recognized as a primary source of lead exposure among children in numerous populations. House dusts are the predominant source of exposure for young children at the BHSS. Previous analyses have suggested that the success of the overall cleanup strategy ultimately depends on reduction of interior house dust lead levels to concentrations comparable to post-remedial soils. The Populated Areas ROD requires that should house dust lead levels remain elevated, homes with dust lead concentrations greater than 1000 mg/kg will be evaluated for interior remediation (USEPA, 1991).

This cleanup strategy was developed following pre-ROD studies suggesting that interior dust remediation alone was not effective in permanently reducing dust lead concentrations prior to completion of exterior source controls. Interiors of homes that were completely remediated in 1990 were recontaminated by outdoor sources within one year (CH2M Hill, 1991). As a result, remediation efforts were directed toward residential yard soils, commercial properties, and rights-of way (ROWs). In the interim, monitoring of blood lead levels and interior dust concentrations continued through the LHIP. Parents were counseled regarding home and personal hygiene and were encouraged to clean frequently. Access to high efficiency particulate air (HEPA) vacuums was provided for families not having access to vacuum cleaners (CH2M Hill, 1991).

Remedial Action under the Populated Areas ROD was not initiated by the PRPs until 1994. The LHIP and high-risk yard removals were continued by the PHD and EPA, respectively, as negotiations with BHSS Potentially Responsible Parties (PRPs) were undertaken. In 1994, agreements were reached with several PRPs to implement the Populated Areas cleanup, and the cleanup commenced in the same year. The agreements included the PRPs assuming responsibility for the ongoing high-risk, residential yard soil removal program; extending that program to all residential, commercial, and public properties; implementing well closures in contaminated aquifers; and financing an Institutional Controls Program (ICP), including provision of a disposal area.

Site Location and History
The BHSS is located in Shoshone County in northern Idaho, approximately 40 miles east of Coeur d'Alene, Idaho. The site encompasses approximately 21 square miles in the Silver Valley of the South Fork of the Coeur d'Alene River (SFCDR) and includes the 365-acre abandoned industrial complex of the former Bunker Hill Company lead/zinc mine and smelter in Kellogg, Idaho. The site is home to more than 7000 people in five residential areas or communities including the cities of Kellogg, Wardner, Smelterville, Pinehurst, and the unincorporated communities of Page, Ross Ranch, Elizabeth Park, and part of Montgomery Gulch. Most of the residential neighborhoods and the abandoned complex are located on the valley floor, side gulches, or adjacent bench areas (See Attachment B) cut into steep hillsides.

A century of discharges and emissions from mining, milling, and smelting activities has left several thousand acres contaminated with heavy metals. Among the most significant contaminants are antimony, arsenic, cadmium, copper, lead, mercury, and zinc. The principal sources of metal contamination were air emissions from primary smelter operations, waste rock, and mill tailings either discharged (slurried) to the river or its tributaries, or confined in large waste piles on site. Approximately 1100 acres of the valley floor are in the flood plain and were heavily contaminated by tailings from mining operations early in this century. There has been significant redistribution of smelter and mine wastes throughout the area due to reworking of soils by the river, wind, and anthropogenic activities. Decades of sulfur oxide emissions from smelter operations, forest fires, and extensive logging have denuded the adjacent hillsides, resulting in severe erosion.

The result of these various activities is ubiquitous heavy metal contamination of soils and dusts throughout the site. Typical lead concentrations of wastes and soils within the smelter complex ranged to 100,000 mg/kg (10%) or more. Tailings in the river's flood plain averaged greater than 20,000 mg/kg (2%) lead. Soils in residential yards in the smelter communities averaged 2500 mg/kg to 5000 mg/kg in the early 1980s, and house dust lead concentrations averaged 2000 mg/kg to 4000 mg/kg at that time.

The Bunker Hill Company mining and smelting complex closed in 1981. The site was added to the National Priorities List (NPL) in 1983, and the 1983 Lead Health Study was conducted jointly by state, federal, and local health agencies the following year (PHD, 1986). This comprehensive survey of lead poisoning and exposures in the community showed continued excess exposure among area children, including those born since the smelter closure. The data from this study were subsequently analyzed in several reports (Terragraphics, 1987, 1990, 1998). Residual contamination in community soils and dusts was identified as the primary source of lead exposure to children. Inadvertent ingestion of these soils and dusts by normal hand-to-mouth and play activities was considered the primary route of exposure.

The 1983 PHD Lead Health Study identified several co-factors which influenced the soil/dust pathway and were related to excessive blood lead levels. Significant co-factors included parental income and socioeconomic-economic status, parental education level, home hygiene practices, smokers in the home, nutritional status of the child, use of locally grown produce, play area cover (grass vs. exposed surfaces), number of hours spent outside, pica behavior, and child's age (PHD, 1986).

Some city parks and school playgrounds were cleaned up in 1986 (CERCLA removal actions). The yard soil removal program under CERCLA removal authority has been conducted each summer since 1989, and since 1994 as CERCLA remedial actions, pursuant to the 1991 ROD. Initially, approximately 100 home yards were targeted for completion each year. Individual yards were selected for removal on risk-based criteria combining sensitive sub-population and environmental contaminant level information. From 1989 to 1993, homes of pregnant women and children under 12 years of age were identified in an annual census conducted each spring. In 1994, the program was changed to begin cleanup of large tracts or geographic areas in addition to the high risk yards. The age criteria of high risk priority was reduced to six years in 1994. Additional members of the sensitive sub-population may self-identify for yard replacement during the summer. Children identified by the annual Lead Health Survey as having blood lead levels greater than 10 µg/dl become candidates for yard soil replacement.

Yards at each of these eligible homes are sampled and a priority list is established based on children's age and yard soil lead level. Pregnant women and children under six years of age living on yards with soil lead concentrations greater than 1000 mg/kg have the highest priority. Yards at these homes receive a clean soil barrier of at least one-foot depth throughout the yard and two-feet deep in garden areas. Commercial property soils exceeding 1000 mg/kg lead are excavated to six-inch or one-foot depths depending on lead concentration and intended use. A geotextile marker is installed if contamination remains at depth, and a locally enforced Institutional Controls Program (ICP) has been established to help ensure barrier integrity.

The remedy is being implemented by the PRPs in the currently established residential areas. Ongoing remediation is being performed in all towns, and has been completed in Smelterville and SilverKing. The PRPs are scheduled to remediate 200 residential parcels per year until all home yards, commercial properties, and ROWs with lead contaminated soils greater than or equal to 1000 mg/kg have been remediated. Completion of remedial activities in the remainder of the 21 square mile site is expected by 2003. Smelterville is the only town in which yard, commercial property, and ROW remediations have been completed.

Metal contamination of soils within the site is ubiquitous and often extends to depths difficult to remove in residential settings. As a result, the selected remedy for contaminated residential soils does not always include complete removal of the contamination. Rather, remediation focuses on creating barriers to isolate the contaminated materials from human exposure pathways, therefore five year reviews may always be necessary.

IV. Remedial Actions

A. Remedy Selection

The ROD for the Populated Areas (USEPA, 1991) calls for a one-time installation of barriers on residential and commercial properties. Following remediation, operation and maintenance (O&M) and cleanup or re-remediation of properties recontaminated by events, such as flooding, erosion, or redeposition of contaminated soils, becomes the responsibility of the property owner. The ROD also requires that an Institutional Controls Program (ICP) be established to regulate the long-term stability of these barriers in perpetuity and to enforce the property owners' obligations.

The ICP is a locally adopted set of rules and regulations designed to ensure barrier integrity throughout the site. The basic function of the ICP is to protect the public health and assist local land transactions within the Superfund site. The ICP has been established to oversee the tracking of property status, permitting contractors to complete work within the BHSS, to enforce rules and regulations, and to aid residents in interpreting these rules and regulations.

The ICP regulates construction and use-changes on all properties where barriers and caps have been installed. The program provides education, sampling assistance, clean soils for small projects (less than one cubic yard of material), pickup of soil removed from small projects, and a permanent disposal site for contaminated soils generated site wide. The ICP also regulates and provides assistance with construction and renovation projects on building interiors that involve ceiling and/or insulation removal, and work in dirt basements and crawl spaces. The ICP main enforcement mechanisms are linked to existing local building departments and land use planning activities and include:

C Contaminant management rules;
C Barrier design/ permitting criteria;
C Ordinances requiring PHD sign-off on building permits;
C Ordinance amendments to comprehensive plans and zoning regulations;
C Model subdivision ordinances;
C Storm water management requirements; and
C Road standards & design criteria.

Site-wide Remedial Action Objectives (RAOs) are defined in the 1991 and 1992 RODs. With respect to the blood lead level objectives, RAOs are to reduce the incidence of lead poisoning in the community to:

C less than five percent of children with blood lead levels of 10 micrograms per deciliter (Fg/dl) or greater; and
C less than one percent of children exceeding 15 Fg/dl.

These objectives are to be achieved by a strategy that includes the following environmental objectives:

- remediation of all yards, commercial properties, and right-of-ways (ROWs) that have lead concentrations greater than 1000 milligrams per kilogram (mg/kg);
- achieving a geometric mean yard soil lead concentration of less than 350 mg/kg for each community in the site;
- controlling fugitive dust and stabilizing and covering contaminated soils throughout the site; and
- achieving geometric mean interior house dust lead levels for each community of 500 mg/kg or less, with no individual house dust level exceeding 1000 mg/kg.

B. Remedy Implementation

Beginning in 1994, the PRPs implemented systematic removals of contaminated residential yards, rights of ways (ROWs), and commercial properties by city. Although high-risk yards continued to be remediated, the PRPs concentrated efforts on a city by city and block by block basis. Remediation of residential yards in Smelterville was completed during 1997, and certification of Smelterville cleanup activities was granted in 1998. Pinehurst was the focus of work in 1999 and should be completed in 2000, followed by Kellogg, Wardner, Page, Elizabeth Park, Montgomery Gulch, and Ross Ranch in subsequent years.

C. Operation and Maintenance

Since this remedy is still being implemented, a more comprehensive review of O&M costs will not be presented until the next Five Year Review. Costs to date for the Institutional Controls Program (ICP), implemented by the Panhandle Health District (PHD), are presented in the Table below.

Table 2; Annual ICP costs to date

	1995	1996	1997	1998
Populated Areas	$82,496.96	$175,320.52	$118,652.23	$58,227.02

Costs may fluctuate widely until the remedy is fully implemented and costs for maintenance of the ICP landfill (in the design phase as this review is being completed), etc. are more clearly established. As the remedy is implemented and additional areas fall within the scope of the ICP, it is expected that average annual costs will increase.

IV. Five Year Review Findings

A. Five Year Review Process

The Bunker Hill five year review utilizes information developed by the following entities:

- Agency for Toxic Substances and Disease Registry;
- Idaho Department of Health and Welfare;
- Idaho Division of Environmental Quality;
- Panhandle Health District (PHD);
- EPA Region 10;
- EPA National Center for Environmental Assessment; and
- Upstream Mining Group (UMG)[2].

This five year review consisted of the following activities: review of relevant documents (see Attachment A), sampling activities, data analyses, and site inspections cited in referenced reports. In addition, notification was made of the upcoming review at several BHSS task force meetings and in fact sheets in 1998 and 1999. The draft report for public comment and the completed report will be available in the information repository.

B. Findings

The following topics are analyzed in this review:

- Blood Lead Levels;
- Barrier Effectiveness;
- House Dust Lead Levels;
- Institutional Controls Program;
- Fugitive Dust;
- Potential Exposure or Recontamination Sources and Infrastructure;
- ARARs Review;
- Disposal; and
- Other Contaminants.

The above topics presented in this report are a combination of areas for which there are remedial objectives (barriers, blood lead levels, house dust lead levels, fugitive dust), areas where potential problems have been identified that could affect permanence of the remedy (disposal, infrastructure), concerns identified by the community Technical Assistance Grantee (other contaminants), and requirements for a Five Year Review (ARARs analysis). Each of the RAOs are individual triggers for action or completion; for example, while blood lead levels in the future may meet RAOs, environmental RAOs are also evaluated to ensure the long-term protectiveness of the remedy and to act as early indicators of any potential remedy failure.

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[2] The Upstream Mining Group consists of Sunshine Mining, Hecla, and ASARCO.

Blood Lead Levels

Blood lead levels have been monitored at the BHSS at varying frequencies since the early 1970's and [venous] yearly since 1988 for children up to 9 years, as described in earlier sections of this report. See the attached figures regarding historical data. The community is surveyed each year to determine the number of eligible children using a combination of door to door collection of information in tandem with school census information (Terragraphics, 1999, PHD, 1999). Estimates of the percentage of the eligible childhood population sampled range from 50 percent to better than 80 percent (Terragraphics, 1999), depending on what census data is used, which results in a sample group often over 300 children. Blood lead level trends have generally been in a downward direction, with the exception of limited instances, such as after the Milo Creek flood which uncovered previously capped contamination in Wardner and Kellogg and from contaminated areas above these towns (Terragraphics, 1999). Interpretation of blood lead trends is complicated because residents, who are not home owners, move as often as once every 6 months. The high mobility of the residents has kept the percentage of children on contaminated yards (between 15 and 30 percent) fairly constant from 1991 to 1996 despite the 200 yards remediated per year, although the trend has decreased to less than four percent in 1998 (Terragraphics, 2000). The presence of pets has also been shown to raise levels of indoor dust which can impact blood lead levels (Terragraphics, 2000). It has also been recently documented that approximately 30 percent of the population at the BHSS are below the poverty line, further complicating behavioral factors (and solutions to infrastructure issues, see "Barrier" section) (Spokesman, 2000). The following are additional factors that have been correlated with changes (increases or decreases from the mean) in blood lead levels (Terragraphics, 2000, PHD, 1986):

- 8 parental income 9 blood level;
- 8 socioeconomic status 9 blood level;
- 8 parental education level 9 blood level;
- 8 home hygiene9 blood level;
- 8 smokers in home 8 blood level;
- 8 nutritional status of child 9 blood level;
- 8 use of local produce 9 blood level;
- 8 bare play area 8 blood level;
- 8 number of hours outside 8 blood level;
- 8 pica behavior 8 blood level;
- 8 age of child 9 blood level;

In addition to the above factors which have been associated with changes in blood lead levels, it is also possible that the children tested may represent a portion of the population which is biased towards higher or lower blood lead levels relative to children who are not tested. For example, very concerned parents may be more likely to have their children tested. Alternately, parents who have diligently adhered to the guidance provided by the intervention program may feel that the blood lead testing is unnecessary[3]. In 1997 and 1998, 18 and 26 percent of parents contacted refused to participate, respectively. Since everyone is contacted and offered an opportunity to participate (PHD, 1999), there is no way of knowing what blood lead levels the remaining children may have without instituting a mandatory testing program, which is not a viable option.

Below is the most recent blood lead data (Terragraphics, 2000).

Table 3; 1999 Blood Lead Data			
City	Arithmetic Mean Level in µg/dl	Percentage above 10 µg/dl	Number of children giving samples
Smelterville	4.3	4	49
Kellogg	4.5	6	198
Wardner	5.4	11.1	9
Pinehurst	5	8.5	106
Page	4.1	0	8
Sitewide	4.7	6.2	370

While the RAO for blood lead at the site is five percent or less above 10 µg/dl and one percent or less above 15 µg/dl has not yet been [consistently] reached, the blood lead RAO cannot be completely evaluated until the remedy is fully in place, which will not occur until 2003.[4] The attached figure and the above data show a declining trend, which is expected to continue as remediation is completed. One concern to note is that current measurements of blood lead levels by age indicate that two year olds exhibit the highest incidence of blood lead poisoning[5] (15 percent in 1999). The observed, age-related peak in blood leads may coincide with period of greatest susceptibility to neuro-behavioral effects (Goldstein, 1990, Rodier, 1995). While this trend has been observed at other sites around the country, was predicted by the IEUBK model at the BHSS, and is expected given the behavior of young children, this should be monitored closely at this site as the remedy is completed. See the Table below (and Figure 6).

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[3] Of the total number of refusals, 23 percent in 1999 stated that since their kids have tested "low" in the past; they see no reason to get another sample.

[4] Until all properties have been sampled, it is unknown how many properties remain to be cleaned up, complicating accurate predictions of completion dates.

[5] "Blood lead poisoning" is meant to describe blood lead levels above 10 µg/dl.

Table 4; Incidence of Toxicity (percentage above 10 µg/dl) by Age												
Age / Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
One year olds	57.1	66.7	52.6	24.3	34.8	18	26.8	30.0	22.9	16.7	22.5	14.3
Two year olds	60.9	72.4	54.3	25.0	31.4	22.9	28.1	21.9	26.1	15.0	20.5	15.2
Three year olds	62.1	84.4	43.8	27.0	32.5	15.0	17.1	25.9	21.4	16.7	11.8	2.9
Four year olds	36.8	53.1	44.4	21.2	32.0	30.2	14.6	25.6	20.7	10.0	9.3	8.8
All children (up to age nine)	46	56	37	15	27	15	17	15	12	11	8	6

This observation is also good cause to direct further resources to interior house dust cleaning (a pilot began in August/September 2000). The dust pathway is thought to be the most significant pathway of exposure for young children who spend much of their time playing/crawling along floors (Lamphear, 1998). Analysis conducted for this review suggests that the partition of exposure is 40 percent from house dust, 30 percent from community soil and 30 percent from the neighborhood[6]/individual yard for all age groups (Terragraphics, 2000). Of the remediation conducted to date (absent child specific intervention activities), the following has been found via structural equation modeling for the average two year old (Terragraphics, 2000):

- 1.7 µg/dl reduction due to cleanup of the child's residential yard; and
- 5.6 µg/dl reduction due to cleanup of the neighborhood and greater community (with consequent house dust lead concentration reductions).

In addition, there is a good temporal correlation between the proportion of children on elevated yards and the proportion of children with elevated blood leads (Figure 7). As blood lead levels have been dropping at the site, air lead deposition from gasoline fuel and lead in food have also been dropping nationally. However, these declines in air lead concentrations from gasoline and declines in lead in food took place in the late 1980's before yard remediation began; therefore the declines seen here are likely predominantly due to reduced exposures from on site contaminants rather than these broader trends. Recent lead isotope studies have shown that lead measured in the blood and urine of young children was traceable to lead on their hands and lead sampled from the floors of their homes, which included both interior and exterior sources of lead; a dietary component was not found (Manton WI, Angle CR, Stanek KL, Reese YR, Kuehnemann TJ , 2000). Ongoing blood lead monitoring, at least until the next five year review, should document continuation of the declining trend and to serve as a tool for parents whose children may have encountered previously unknown lead sources in and around the home. In combination with

[6] Defined as the area within a 200 foot radius of the child's home.

meeting environmental concentration RAOs, the blood lead RAOs are protective of human health. The remedy once completed is expected to meet the blood lead RAO.

Barrier Effectiveness

There are several different types of barriers at the BHSS, including those on: residential yards, commercial properties, rights of ways, common use areas, and others. Each soil or gravel barrier may be of a different depth depending on contaminant concentration and prescribed depth due to use. Barriers are placed when soil in a particular area exceeds the action level of 1000 ppm lead and in order to meet the community wide average concentration goal of 350 ppm lead. When placed, the material making up each barrier contains less than 100 ppm lead, as seen in the table below (MFG, 1999). Each barrier receives different levels of use from pedestrian and vehicular traffic. These backfill concentrations for various constituents are useful as a baseline for the discussion of present day concentrations in rights of ways, residential yards, commercial properties, and in other areas remediated.

Table 5; Weighted Average of residential/commercial/right of way backfill in parts per million (ppm)

City/Area	Lead	Arsenic	Cadmium
Kellogg North of Interstate 90	29.2	15.7	0.6
Smelterville	8.2	6.0	0.18

Rights of Way

Soft shouldered rights of ways (ROWs) along public roads have demonstrated significant and varying levels of recontamination (Terragraphics, 1999, 1998, 1997). Smelterville ROWs remediated in 1989, 1990, and 1991 have significantly higher concentrations than those remediated in later years (32 percent vs. 13 percent above 1000 ppm at the zero to one inch depth interval, respectively). The 1998 sampling data are for remediated ROWs only.

Table 6; 1998 ROW

	Smelterville	Kellogg
Percent of samples exceeding 1000 ppm in the top inch	14 (8 of 58 ROWs)	30 (3 of 10 ROWs)

Geometric means for remediated ROWs in Kellogg were 365 ppm in 1998. For Smelterville, geometric mean results for remediated ROWs were 252 ppm and 294 ppm in 1997 and 1998, respectively.

Recontamination on ROWs suggests several potential conclusions. The rate of recontamination in this limited data set suggests that either a) the rate of recontamination is very slow, b) recontamination is associated with the manner or pace of cleanup, c) pumping or exposure of contaminants from beneath the cap(s), or d) material is being tracked from unpaved areas within the BHSS or from outside the site. It is also not known whether the rate of recontamination will increase or decrease based on data collected to date. Because ROWs without drainage systems drain road debris onto a soft shoulder, vehicle tracking[7] and drainage could be primary mechanisms of recontamination. The rate of remediation may contribute to recontamination. Because it has taken several years to finish areas where remediated areas are nearby unremediated areas may be especially prone to recontamination. Vehicle tracking between remediated and un-remediated areas (including driveways) may be an important mechanism of recontamination and will be investigated further.

<u>Residential Yards</u>
Sampling was conducted by the State in 1999 on 11 randomly selected residential yards to determine what, if any, recontamination had taken place since the barriers were originally installed. Of the seven residential yards installed in Kellogg[8], sample concentrations ranged from 23 ppm to 162 ppm in the top one inch of soil. Of the four yards sampled in Smelterville sample concentrations ranged from 43 ppm to 102 ppm. 1998 UMG sampling conducted in Kellogg and Smelterville for yards put in place prior to 1994 indicate levels of 164 ppm and 188 ppm, respectively. The concentrations observed on residential yards seem to be somewhat higher than clean soil concentrations placed at the time of remediaton (see table above), however, less recontamination is observed on sampled residential yards than driveways and rights of ways which suggests that vehicle tracking is a potentially important mechanism for contaminant movement. Hillside sloughing into residential yards is dealt with below in the “Potential Exposure or Recontamination Sources and Infrastructure” section.

<u>Residential Driveways</u>
Driveways and other parking areas were also sampled in 1999 to determine if vehicle tracking facilitates transport of contaminated material or if vehicular traffic reduces the integrity of barriers

[7] Vehicles track material onto the roadway, which is washed onto soft shoulders. Also, parking of vehicles on soft shoulders may also result in deposition of material with higher concentrations of lead and other constituents. These materials may originate from unremediated areas during cleanup of a town which may take several years, from areas not scheduled for cleanup in the BHSS, or from outside site boundaries.

[8] The seven yards sampled were from across the spectrum of those installed from 1989 to 1997 and are not biased towards any particular remediation year(s).

in general. Driveways were sampled in 1998 and 1999. Four driveways were sampled in Kellogg and ranged from 50 ppm to 209 ppm in the top inch of gravel. Two driveways were sampled in Smelterville and ranged from 687 ppm to 1290 ppm. Although levels in Kellogg are near clean soil concentrations, those in Smelterville indicate some level of recontamination has occurred (Terragraphics, 1999). Other sampling was conducted in 1999 by the Potentially Responsible Parties (PRPs), the Upstream Mining Group (UMG). UMG sampling indicated that driveway concentrations in a variety of recently remediated yards ranged from 70 ppm to 323 ppm lead. Samples taken by UMG from pre-1994 properties indicate a range of 150 ppm to 573 ppm lead also indicating some level of contaminant migration onto driveways that is likely associated with vehicle tracking or and/or pumping[9] or exposure of contaminants from beneath the cap.

UPRR Right of Way

Union Pacific Railroad (UPRR) sampling results (MFG, 1999) indicate an average concentration of 153 ppm lead in the top one inch along this seven mile length of inactive railroad. Although the average is below the remedial action level of 1000 ppm lead, four samples exhibited concentrations above 500 ppm lead (sample ID 99-004, 99-017, 99-019, 99-020) indicating some level of recontamination as compared to backfill concentrations of lead. The first sample is near the east end of the site along a public road and is likely associated with vehicle tracking and lack of site control (no separation of the UPRR ROW from public roadways). Sample 17 is located parallel to McKinley Avenue and is likely associated with vehicle tracking or utility work. The third is located within the Smelter Complex exclusion zone, south of the Central Impoundment Area and Bunker Creek, north of the A4 gypsum pond, and between Magnet and Deadwood creeks and is likely associated with vehicle tracking from the government cleanup, ongoing Stauffer cleanup activities at the A4 gypsum pond closure, or erosion which could have compromised the clean barrier on the A4 pond and moved underlying contaminated soil. Sample 20 is located within the exclusion zone of the Smelter Complex and is also likely associated with vehicle tracking or utility work. While not widespread, contaminant migration onto the UPRR ROW is located near areas of potential vehicle tracking and utility work, and indicates a need for better access control and careful oversight and scheduling of Institutional Controls Program projects.

Commercial Properties

Only one remediated commercial property was sampled in 1999 (Terragraphics, 1999). Two samples in the top inch of soil are 371 ppm and 538 ppm lead. Results for the top inch of soil indicate a mechanism of recontamination likely associated with vehicle tracking. Soft barriers on commercial properties accessible by vehicles will require ongoing sampling.

Common Areas

[9] "Pumping" refers to movement of fine material from depth through larger materials at the surface .

Four park areas were sampled by the State in 1999. Results in the top inch ranged from 22 ppm to 210 ppm lead. These results are consistent with those on residential yards indicating some minor contaminant migration above clean backfill levels.

Barriers throughout the BHSS have experienced some amount of contaminant migration that could be put into several general categories; 1) vehicle tracking during and after remediation, 2) barrier disturbance (e.g. utility work), 3) other undefined sources. As source areas are better defined, it will be important to determine whether the pace of barrier placement –200 residential properties and a handful of commercial properties each year-- allows unacceptable amounts of contaminant transport within a community. While remediation of residential properties takes place block by block aside from high risk "hopscotching," vehicle tracking within a community that requires 3 years to clean up may negatively impact both unpaved driveways that were cleaned up early on as well as soft shoulder ROWs. Soft shoulder ROWs on public roads have exhibited the greatest amount of recontamination with a number of areas exceeding both the community wide goal of 350 ppm and a number exceeding the action level trigger of 1000 ppm lead. Ongoing sampling of driveways and ROWs will help to determine if the increases in lead concentrations are slowing down over time, which may suggest that the pace of remediation is the primary factor. Continued migration of lead [which is unmitigated after remediation completion] may suggest other source areas which need to be identified and addressed in some manner.

House Dust Lead Levels

House dust levels have been declining as residential yard cleanups progress (Terragraphics, 1999) as seen in Attachment B. Levels are being measured in order to assess progress toward the sitewide RAO of a 500 ppm lead average and an individual goal for each home of 1000 ppm lead or less. Two different methods are being utilized to track the concentration of dust in the home: vacuum bags and dust mats (Terragraphics, 2000). In addition to providing concentration data, dust mats also provide dust and lead loading rates. Lead loading rates are helpful in that they can establish the amount of lead originating from outside of the house being tracked into the interior. In general, dust mat data indicates higher lead concentrations than vacuum bag data, perhaps due to dilution in vacuum bags caused by other interior dust sources. It is estimated that 60 to 80 percent of lead in interior house dust originates from exterior soils (Terragraphics, 1999). While Pinehurst has been below the 500 ppm goal since 1993, other cities are just above 600 ppm lead on average in 1999[10]. Since all residential yards in Smelterville have been cleaned up as of 1997, a house dust cleaning pilot program has been designed to evaluate the efficacy of interior cleaning of homes above 1000 ppm lead. Ongoing sampling will evaluate trends in house dust levels to determine the extent to which vigorous interior cleaning of homes and carpet replacement will be necessary. As already noted in the analysis of blood lead data, two year olds spent a significant portion of their time on the floor of residential interiors; their higher incidence of blood lead poisoning further

[10] Similar age housing in other areas of northern Idaho have average lead levels of 200 ppm lead likely from lead based paint sources (Terragraphics, 2000).

supports completing ROD requirements to reduce interior dust lead levels. The RAO, although not yet achieved, is still expected to be protective of human health; this will be further evaluated in the next five year review.

Institutional Controls Program

Since the remedy is based on containment of mine wastes that extend to depth throughout much of the BHSS, long-term effectiveness of the remedy relies on the success of the Institutional Controls Program (ICP). Part of that success is inevitably tied to the Panhandle Health District ‘s commitment to its implementation, relying on key, long-time staff. The following is a summary and review of that program. Additional information can be found in the UMG Five Year Review Report, dated November 12, 1999, the Overview of the Silver Valley Intervention Program, dated March 25, 1999, and the Terragraphics Five Year Review Report, dated April, 2000.

Intervention / Education Program

The BHSS Intervention Program is a cooperative effort amongst the Panhandle Health District (PHD), State of Idaho Department of Health and Welfare, Division of Health, Bureau of Environmental Health and Safety, Centers for Disease Control (CDC), and the Agency for Toxic Substances and Disease Registry (ATSDR). Children from the age of 9 months through 9 years are offered blood lead screening each year in Kellogg along with educational materials on preventing lead exposure pathways (PHD, 1999). Prenatal screening is also offered. Children exhibiting blood lead levels above 10 µg/dl are offered follow-up with a public health nurse with the goal of determining possible routes of exposure as a means of secondary prevention[11]. Community wide education also is offered. The PHD also sponsors a program of physician awareness to ensure that exposure problems are diagnosed to the extent possible. Also, the PHD goes out to kindergarten through third grade classrooms to teach how to prevent lead exposure (PHD, 1999). The curriculum includes a doll house puppet show for younger children to show household sources of lead and a hand washing exercise for older students with “glow germs” activated by black lights to illustrate how lead gets onto kids’ hands. Participation rates for children 9 months to 9 years are shown below in the table below (Terragraphics, 1999).

Table 7; Participation Rates		
Year	Total Number of Children Identified in the 21 square mile area	Percent of Identified Children with Blood Lead Samples

[11] Primary prevention is defined as preventative measures that are taken, for example residential yard cleanup, to reduce lead exposure to a child before it occurs, while secondary prevention is the term used to define activities to reduce a recognized exposure once it has occurred.

1988	See Footnote[12]	67%
1989	" "	74%
1990	871	65%
1991	833	68%
1992	807	70%
1993	771	70%
1994	767	76%
1995	762	66%
1996	769	70%
1997	770	72%
1998	729	59%

For two year olds, an average 3.9 µg/dl reduction in blood lead levels has been observed as a result of intervention activities where no residential yard remediation has taken place (Terragraphics, 2000).

The PHD also offers a vacuum loan program, which is funded by the UMG, where high efficiency particulate air filter (HEPA) vacuums are loaned out (PHD, 1999) to site residents. These vacuums are useful for those who either do not have their own, or are conducting dusty interior renovations. While the ROD goal is to reduce house dust levels to a sitewide average of 500 ppm lead (see Housedust section), the HEPA vacuum loan program has been a valuable part of the ICP for interior projects and also to help keep dust levels down for those with no vacuum. The average number of checkouts per month between 1992 and 1998 is 24, indicating that the resource is being utilized by the community. PHD has made the following recommendations in their 1999 vacuum loan report: increasing the program advertising budget, placing flyers in local outlets each month, and providing recommendations for maintaining a clean home interior and cleaning methods. These recommendations should be implemented in order to fully take advantage of the vacuum loan program, and to better mitigate interior dust exposures.

<u>Permitting Program</u>

[12] Pinehurst was not included in the sitewide survey in 1988 and 1989; therefore, no comparable number of sitewide children identified is available for these years.

Both UMG (MFG, 1999) and the State (Terragraphics, 1999) conducted evaluations of the Institutional Controls Program (ICP), implemented by the Panhandle Health District (PHD) under local statute, described above. Both small residential and large commercial projects are in the purview of the ICP. The PHD's ICP has been effective in identifying exterior projects by visually locating them and talking with homeowners/renters about local ordinances and compliance. The ICP has had limited success in monitoring interior projects since it is more difficult to identify where these projects are taking place. However, interested property owners have often obtained information from the PHD on how to go about interior projects before they are commenced. For large projects, there have been two recent experiences in 1998 and 1999 which have given insight to special challenges associated with the installation and maintenance of barriers: the Milo Creek drainage project and the Shoshone County Water District Water Line Installation. Both projects illustrated the necessity of specifying ICP requirements explicitly in bid documents and the additional cost for a construction project that is related to ICP (to prevent inadvertent recontamination). Placing temporary or permanent barriers, Best Management Practices (BMPs), and disposal and decontamination all increased project cost nominally between two and five percent. Examples of these types of costs for Milo Creek include: 4000 tons of gravel to establish temporary "clean" barriers, dust control, and erosion control. Most of these costs are part of standard construction practices; however, when the above measures are implemented improperly, cost increases can be far more substantial. For example, along the water pipeline installation, excavations performed during wet periods of the year resulted in recontamination of adjacent areas, increasing the utility project cost by an estimated 43 percent. Based on PHD questionnaires given to contractors that have worked under the ICP (Terragraphics, 1999), the following suggestions have been made to improve the program: closer disposal site(s) (see Disposal, this Section), pre-project sampling, and having more than one person to give out ICP permits. The last suggestion was related to one specific project and is not considered necessary at this time; however, it should be noted that as additional properties are remediated towards the end of the Populated Areas cleanup, additional permitting personal will likely be necessary.

Fugitive Dust

The Populated Areas and Nonpopulated Areas RODs required control of fugitive dust sources. Some identified fugitive dust sources included: the hillsides, waste piles, and uncapped commercial properties. With the exception of the Central Impoundment Area (being closed/capped in 2000), fugitive dust sources identified in the RI/FS have been controlled. Since 1994, UMG air monitoring during yard remediation activities indicates four exceedances out of 2300 monitoring records, all of which were from personal air monitoring equipment worn by workers within exclusion zones (UMG, 1999). Levels monitored by the UMG are from personal air monitors which are compared to worker safety levels (called permissible exposure levels, or PELs) prescribed by OSHA. This data would suggest that airborne releases from ongoing yard cleanup activities are being sufficiently controlled and therefore are not a recontamination source to adjacent properties.

For the safety of the general public, the applicable levels for comparison to measured data are the National Ambient Air Quality Standards (NAAQS) for particulate matter less than 10 microns (PM10). Air monitors were installed around ongoing government cleanup efforts implemented by the U.S. Army Corps of Engineers (USACE) and overseen by EPA and DEQ. The following Table is a summary of total suspended particulate (TSP) ambient air quality results for the years 1995 to 1998 (CH2M Hill, 2000)[13] and a breakdown by season.

Table 8; TSP Ambient Air Quality Monitoring Results - Aggregate Results	
Total number of days monitored	814
Total Number of 24-Hour Concentrations that Exceed NAAQS - 0.150 mg/m^3 in the period from June 1995 to January 1999	47
Number of 24-Hour Exceedances by Season	Spring - 10 Summer - 18 Autumn - 11 Winter - 8

The following table presents air quality exceedances for each site by year.

Table 9; TSP Ambient Air Quality Exceedances- Individual Sites by Year					
Site / Year	1995	1996	1997	1998	Total Exceedances / Total Measurements / Percentage
Bunker Avenue	0	0	0	6	6 out of 49 / 12%

[13] Suspended particulate matter measured at 10 microns or less (PM10) is a subset of total suspended particulate (TSP).

East Gate	0	3	2	2	7 out of 173 / 4%
East Gate - Collocated	0	2	4	1	7 out of 174 / 4%
Multiplate	0	0	2	9	12 out of 54 / 22%
Pinehurst	0	0	3	1	4 out of 46 / 9%
Smelterville Gate	0	2	4	0	6 out of 135 / 4%
West Gate	0	0	3	2	5 out of 182 / 3%
Total Exceedances	0	7	18	21	47 out of 817 / 6%

The data in the Table above indicates that a number of exceedances concentrate around heavy haul-route areas such as the "multiplate" (overpass) structure built in Smelterville to convey tailings parallel with Interstate 90 from the Smelterville Flats to the CIA, which has been disassembled[14], therefore no further action is warranted with respect to these exceedances. All of the areas in the Table above used by cleanup equipment are frequently watered by truck to control dust and are in some cases (such as the CIA and haul road) sprayed with dust suppressants including lignin and magnesium chloride on a periodic basis. The air monitoring data indicates a need to continue and perhaps increase dust suppression work near active work areas, such as the ongoing CIA work that began in 1999 and is scheduled to be completed in 2000. This monitoring will occur as part of the CIA closure contract and be evaluated as part of the contractor's performance. If dust on the CIA becomes uncontrollable by regular water truck spraying, work then on the CIA may be temporarily shut down to control the visible dust. No new sources of fugitive dust have been identified since the RI/FS.

[14] This route was constructed with clean fill material, and trucks entering the haul route were decontaminated before traveling the route.

Potential Exposure or Recontamination Sources and Infrastructure

There are several potential mechanisms of recontamination linked with both erosion and vehicle tracking processes. This section addresses recontamination in general, such as vehicle tracking, and in specific areas, including: hillside sloughing, other erosion, and mine dumps. It is not presently known what impact the recontamination observed has had (or could have) on blood lead levels.

<u>Page Pond</u>
The Page repository is maintained by the UMG primarily for receipt of residential yard wastes. Vehicle tracking of contaminants onto old Highway 10 from the Page repository has been documented by ICP samples. Once on Highway 10, vehicles may track this material into the remediated area of Smelterville. Samples taken by the ICP range from 546 ppm lead to 5937 ppm lead (Terragraphics, 1999). These samples were taken both near the gate for the landfill and on the road. Additional decontamination/drainage control procedures at the Page repository are necessary to mitigate vehicle tracking.

<u>Smelter Complex Gated Area</u>
Vehicle tracking at the east and west gates of the Smelter Complex exclusion zone has been documented in two samples containing 4279 ppm lead and 6691 ppm lead respectively (Terragraphics, 1999). The area surrounding the west gate has not yet been remediated, however, additional road cleaning may be necessary until remediation has been completed in addition to sampling to confirm that trackable materials have been controlled. Areas surrounding the east gate have been remediated but the high concentration shows a problem still exists; therefore, additional decontamination/drainage control measures may be necessary at this gate. The measures might include paving of areas leading to and away from the decontamination station or regular replacement of gravels.

<u>Hillside Sloughing</u>
Hillsides adjacent to Smelterville, SilverKing (Government Gulch Area), Wardner, and Kellogg are contaminated with Smelter emissions (Terragraphics, 1999). Below is a table of arithmetic mean hillside lead concentrations.

Table 10; Hillsides Concentrations Above Residential Areas

Area	Arithmetic Mean Lead Concentration/ppm
Smelterville	4555
Silver King	8166
Smelterville (southeast)	9089
Smelterville (Grouse Creek)	2361
Wardner (east)	1216
Wardner (west)	5633
Kellogg (south)	1917
Kellogg (north)	1776
Ross Ranch	846
Trailer Park	3046

The above table represents surface concentrations, as surface material is most likely to be subject to erosion. In all cases, concentrations decrease with depth on hillsides to varying degrees, since contamination occurred due to smelter emissions (Terragraphics, 2000). In some instances, soil chemistry in contaminated hillsides has been altered (low pH limiting availability of nutrients, for example) making erosion control through plant establishment difficult. Another contribution to this problem is that local zoning does not prohibit removal of the base of these hillsides, making some erosion inevitable due to development induced slope instability. In Smelterville[15], Gulf/Pintlar had installed gabion basket walls behind several homes to hold back eroding, contaminated soil from entering residential yards. This pilot program was continued by EPA in 1996. Continuation of wall construction and other best management practices (BMPs) in Smelterville (and in any other areas where sloughing is recontaminating clean areas) should be considered as well as appropriate planning and zoning changes to prevent development immediately adjacent to contaminated hillsides/modification to hillsides that exacerbate erosion.

Flood and Storm Events / Storm Water Conveyance Systems

A series of sampling events starting with floods that occurred in 1996 have documented varying levels of contaminated sediments that have been moved by flood waters ranging from the hundreds of parts per million to thousands of ppm lead (Terragraphics, 1999). In the 1997 Milo Creek flood, the deposition of sediments with high lead levels[16] were found to have adversely impacted the

[15] Hillsides bordering the town of Smelterville on the south-east side were primarily under Gulf-Pintlar ownership originally and were shifted to EPA/State control through the bankruptcy proceeding in the early 1990's.

[16] Soil around an apartment on east Portland Street in Kellogg was remediated in 1989 and when flooded in 1997 was measured at 8656 ppm lead.

blood lead levels of 13 children (Terragraphics, 1999). Since contaminants have only been removed during cleanup to a one foot depth, then capped with one foot of clean soil (leaving contamination from one foot in depth to eight or more feet in some places) in most areas, inadequate infrastructure to convey flood waters and associated sediments can often lead to: 1) erosion of the clean barrier, 2) entrainment of contaminated material in floodwaters, and 3) deposition of contaminated material on remediated areas. While the Milo Creek drainage is now in the process of being piped through Wardner and southeastern Kellogg[17], other areas of Kellogg do not have adequate storm water conveyance, including: the Shoshone Apartments, McKinley Avenue between the BHSS gate and Division Avenue, and Railroad Avenue. Studies of Smelterville drainage infrastructure indicate that it is undersized to handle moderate snow melt and rain events, causing premature road damage and exposing lead beneath paved road surfaces. Grouse Creek, on the south side of Smelterville, is undersized and is inadequately maintained to prevent overbank flows into residential areas of town. Hillside drainage in Smelterville is dependent on drywells with unknown flow capacity. These drywells are often allowed to fill up with sediment and overflow before being cleaned out, if at all. Ongoing construction of walls and other BMPs at the base of the hills behind residences to control erosion should continue. Drainage problems have also been identified on Pine Creek. Pine Creek enters the City of Pinehurst from the south. Sediment and bedload that in-part originate from upstream mining and metals impacted areas, accumulate along the creek reach which boarders the southern edge of the city. Historically, these accumulations were regularly removed from the creek bottom as an aggregate source. In recent years, this practice was suspended because of contamination concerns. Without the removals, sediment and bedload could raise the creek's bottom such that the existing dike would be over topped and the City of Pinehurst would flood. Flooding is anticipated to result in the following potential problems: recontamination of installed barriers through the transport and deposition of metal laden sediments, destruction of installed barriers due to erosion, and damage to the City's southern flood protection dike. New infrastructure and regular maintenance of existing drainage infrastructure by the state, local entities, business owners, and residents will be necessary (in cooperation with the ICP) in order to ensure success of the remedy[18].

<u>Roadways</u>

Roadways are discussed below both from the construction and maintenance perspective as well as materials applied in the winter as both may relate to recontamination.

Many sections of Interstate 90 and State of Idaho roads in the BHSS were built on or somehow utilized mine waste tailings. Exploratory pits dug in Kellogg roads indicate an average lead level of 9562 ppm (Terragraphics, 1999). Similar pits in Smelterville had an average concentration of 3262 ppm lead. Roads in Smelterville are currently in very poor conditions to the point that many

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[17] Phase I of the Milo Creek project went through most of Wardner in 1998, Phase II completed Wardner in 1999. It is hoped that Phase III in the year 2000 will finish the project by completing the pipeline to the South Fork of the Coeur d'Alene River.

[18] Local tax revenues by themselves may not be sufficient for these improvements.

potholes expose contaminated soils exhibiting the above concentrations, which could contribute to vehicle tracking of contaminants. Further degradation of site roads could contaminate clean areas. Regular maintenance of roads and replacement of roads in total disrepair (including replacement of contaminated subgrade material, as necessary) is necessary to ensure the long-term protectiveness of the remedy[19].

Roads throughout the 21 square area are sanded in the winter to increase traction. The sanded material was suggested as a potential recontamination source by the UMG in their comments on the Five Year Review. The PHD has taken several steps to ensure that sanding material is clean by ICP standards:

-All county and city crews are trained and licensed by the ICP;
-Rock pit operators sample materials that are used at the site;
-ICP implementers go to currently operating rock pits and sample them (to supplement owner sampling if necessary); and
-Material being placed on roads is tested on an intermittent basis at the discretion of the ICP (personal communication, Jerry Cobb, August 21, 2000).

Therefore, road sand is unlikely a source of recontamination.

<u>Mine Dumps</u>
The RODs call for stabilization of mine dumps as they relate to erosion off of hillsides. Although some mine dumps have been removed or stabilized by the Bunker Limited Partnership, various mine dumps still exist on hillsides in the Milo Creek drainage in the city of Wardner and other areas of the site. Concentrations of lead average 5931 ppm amongst Wardner dumps. Average arsenic concentrations were 78.7 ppm sitewide with one sample above Pinehurst at 3080 ppm. (Terragraphics, 1999). Since no known erosion or exposure is currently occurring on these mine dumps, no further action is warranted at this time from a human health perspective.

Disposal

As ongoing maintenance of the BHSS remedy takes place, there will be an ongoing need for disposal to ensure that barriers put in place remain intact such that the overall cleanup is protective of human health and the environment.

<u>Additional Materials Requiring Disposal</u>
As snow, leaves, and various street sweepings are collected throughout the site, lead particles become entrained in the collected material. While leaves and street sweepings are properly disposed of at onsite repositories, such as Page, snow is piled up in various locations by the cities, county, businesses, and residents. Average concentrations in material at these various piles left

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[19] Local tax revenues by themselves may not be sufficient for these improvements.

after the snow has melted was 4754 ppm lead in 1997, indicative of generally high levels of lead present on roadways. An ongoing, managed area(s) for snow disposal needs to be established to ensure areas are not recontaminated.

Disposal Capacity
Since the remedy relies on surficial containment, breaches of barriers to conduct utility work, put up a fence, build a road, and other projects will require ongoing contaminated material disposal. For example, road building and maintenance is estimated to generate 5900 cubic yards (cy) per mile, since most roads in place were built on inadequate subgrade material containing mine waste. Developments may generate up to 10,000 cy for a 12 unit subdivision (Terragraphics, 1999). The Milo Creek project has generated over 30,000 cy of contaminated material to date. Since the Page Repository, maintained by UMG, has only 60,000 cy of remaining capacity, additional disposal area(s) must be established for ongoing maintenance of the remedy. Development of an ICP landfill design is currently taking place with a shared funding responsibility between EPA, the State of Idaho, and UMG. Other disposal options may be investigated as well.

Other Contaminants

Initial investigations at the BHSS identified 13 contaminants of concern, including: antimony, arsenic, beryllium, cadmium, cobalt, copper, lead, mercury, selenium, silver, zinc, asbestos, and polychlorinated biphenyls (PCBs). Of these 13, PCBs and asbestos were found primarily in Smelter Complex areas only. Based on subsequent health studies, lead was selected as the primary contaminant of concern. Concern over the possibility that arsenic or cadmium concentrations on unremediated properties may pose an ongoing health risk was raised after over half of the residential properties had been remediated. Data sets used for the Remedial Investigation and Feasibility Study for the BHSS (over 50 percent of the residences within the site) were compared to the list of properties remediated and their backfill concentrations for arsenic and cadmium. The results indicate that approximately 80 percent of residential yard concentrations have been reduced from a geometric mean of 51 ppm to 13 ppm arsenic (Terragraphics, 1999). Three of roughly 1000 homes sampled in the RI/FS have levels exceeding 100 ppm and thirteen homes exceed 50 ppm arsenic. Nine homes show cadmium levels in excess of 20 ppm. There are approximately 60 homes in both the 11 ppm to 20 ppm cadmium and 6 ppm to 10 ppm cadmium ranges. These results indicate that risk from collocated cadmium and arsenic has been sufficiently addressed via lead trigger levels based on a database that includes more than half of the residences in the site.

ARARs Review

The ARARs from the 1991 Populated Areas operable unit ROD were reviewed and any changes or newly promulgated standards were identified. See Attachment C, Table 1. There are several changes described in the Table that may be broken down into the following categories:

- Air. The standards adopted by the ROD in 1991 have since been changed to reflect more strict requirements with respect to 10 micron and smaller particles. The change in air standards does not affect the protectiveness of the original ROD goals or the present monitoring plan because the standards in the ROD are sufficiently protective.
- Blood Lead Level Goals. The CDC goal for young children has changed from 25 µg/dl to 10 µg/dl (CDC, 1997). EPA goals have changed from a five percent population based goal of being at or above 10 µg/dl to a five percent individual probability of being at or above 10 µg/dl. The change in blood lead standard by the CDC does not affect protectiveness since a goal similar to the 10 µg/dl standard was proactively adopted in the ROD before this change was made. Based on the ongoing decline in blood lead levels, the changed EPA standard does not affect the protectiveness of the original ROD goals. This trend will be reevaluated in the next five year review with available data.

Most standards affecting human health protectiveness have remained unchanged. Those standards that have been modified will not affect the protectiveness of the remedy selected in the 1991 ROD.

V. Assessment

The following conclusions support the determination that the remedy at the Bunker Hill Superfund Site will be protective of human health and the environment upon completion provided that additional steps are taken to control contaminant tracking and migration as identified in the recommendations section of this report:

- ***Implementation of the Remedy:*** The barrier remedy has not yet been completely implemented in Kellogg, Page, Pinehurst, Wardner, and Elizabeth Park. Complete implementation of the remedy is not expected until 2003 and will be reviewed in the second Populated Areas five year review. Implementation of the remedy continues to lower concentrations of soils throughout the site in a systematic manner, including residential yards, schools, commercial properties, and parks with consequent household lead concentration reductions.

- ***Adequacy of O&M:*** The ICP has done an excellent job at monitoring ongoing homeowner projects, utility work, and other routine barrier disturbances or operation and maintenance (O&M). As the remedy is put in place, more O&M activities will necessarily take place to maintain the remedy. However, data collected to date indicates that the level of O&M performed for drainage areas and roadways is inadequate. O&M activities, while just beginning, have not yet negatively impacted the overall effectiveness of the remedy but should be closely monitored to ensure the remedy is protected.

- ***Early Indicators of Potential Remedy Failure:*** Environmental data collected to date has shown levels of recontamination on soft shouldered ROWs and other areas affected by vehicle tracking as well as areas impacted by flooding. It is not currently known whether these are early indicators of remedy failure, or simply temporary trends limited to the duration of cleanup activities (while towns are only partially remediated).

- ***Achievement of Remedial Action Objectives/Cleanup Levels:*** The RAOs for the site are still protective of human health, which are based primarily on the decline of observed blood lead levels as cleanup has been ongoing. The average Housedust RAO for Smelterville (500 ppm lead) has been nearly met, but individual homes often exhibit concentrations above the 1000 ppm trigger. The blood lead trend continues to decline toward the ROD goal of no more than five percent above 10 µg/dl and one percent or less above 15 µg/dl overall at the site. Blood lead data indicate that the remedy continues to be successful, but continued monitoring is warranted to ensure this trend continues. Cleanup of home interiors may be necessary to lower blood lead levels of one and two year olds, who exhibit the highest average blood lead levels among all age groups of children. Evaluation in the second five year review is warranted to determine whether the RAOs have been met once the entire remedy has been completed and in place for several years.

- C ***Changes in ARARs, To be considered(s), or Other Risk-Related Factors:*** There have been changes in two categories of standards and other risk-related factors since the ROD was written in 1991: 1) air standards and 2) blood lead level goals, described in Attachment C, Table 1. These new changes in standards do not call into question the protectiveness of the remedy.
- C ***Changes in Known Contaminants, Sources, or Pathways at the Site:*** There are no known changes in site contaminants, sources, or pathways at the site from those documented in the ROD.

VI. Deficiencies

Deficiencies were discovered during the five year review and are noted in the following Table. None of these appear sufficient to affect protectiveness of the remedy upon completion as long as corrective actions are taken.

Table 11; Identified Deficiencies

Deficiencies	May Affect Protectiveness (T)
Soft Shoulder ROWs have become recontaminated in Smelterville, potentially linked to the pace of cleanup[20] or yet to be identified sources	T
Vacuum loan program could be used more broadly	
Additional information on interior home cleaning is needed	
Air monitors around the Smelter Complex have indicated 47 air quality violations from 1996 to 1998	
Lack of access control along UPRR right-of-way has led to tracking of contamination onto remediated areas	
Inadequate decontamination of vehicles at Page Pond Disposal Area	
Inadequate decontamination of vehicles at Smelter Complex (east gate, potentially west gate)	
Hillside erosion of contaminated material into residential areas	
Disposal area for contaminated snow needed	
Lack of drainage maintenance by local entities and need for infrastructure improvements has resulted in recurrent flooding in many areas	T
Lack of road maintenance and need to replace failing road infrastructure has exposed underlying contamination in several areas	T
Inadequate disposal capacity presently exists to handle future ICP wastes which may soon compromise the ability of the ICP to function	

[20] The longer clean properties sit adjacent to contaminated properties in each town the more likely the potential for tracking of contaminated material into clean areas will be, e.g. from a remediated driveway to an unremediated driveway.

VII. Recommendations and Required Actions

The following Table lists activities that must be performed as a result of this Populated Areas Operable Unit five year review. Specifics of these activities, if not provided for in one of the RODs, the 1996 ROD Amendment, or in either of the two ESDs, may need to be documented in a separate decision document.

Table 12; Recommendations and Required Actions

Required Action	Party Responsible	Milestone Date	Oversight Agency	Required Action--May Affect Protectiveness upon Completion (T)
ROW (and other areas subjected to vehicle tracking) sampling	UMG	2002	DEQ	
ROW evaluation of alternatives/determine schedule for implementation	DEQ	2003	EPA	T
Vacuum Loan Program; additional advertisement	PHD	2000	DEQ	
Home cleaning informational pamphlets	PHD	2000	DEQ	
Continue air monitoring, with a focus towards areas that indicate off-site migration of contaminants while work is ongoing	USACE	ongoing	EPA	
Implement better access control on the UPRR ROW consistent with the proposed O&M plan	UPRR	2000	DEQ	
Page Pond vehicle tracking reduction / additional decontamination / ongoing confirmatory sampling	UMG	measures in place by construction season 2000	DEQ	

Table 12; Recommendations and Required Actions

Required Action	Party Responsible	Milestone Date	Oversight Agency	Required Action--May Affect Protectiveness upon Completion (T)
USACE west/east gate vehicle tracking reduction/ additional water trucks to move contaminants onto shoulder (until surrounding area is remediated) sampling to confirm additional decontamination procedures have worked	USACE	measures in place by construction season 2000	EPA/DEQ	
Continue construction of walls and/or other BMPs between hillsides and residential yards in Smelterville	USACE	obtain access 2000; implement 2001.	EPA/DEQ	
Planning and zoning changes in areas near/on contaminated hillsides not suitable for construction and/or continued implementation of BMPs.	Cities/County	begin discussions with Cities, 2000	ICP	
Establish a controlled area that can accept snow for disposal	PHD	2000	DEQ	
Replacement of failing road infrastructure and road maintenance needs to occur to maintain them as ICP barriers	Cities/County/ others	ongoing	ICP	T
Increase drainage maintenance by local entities and infrastructure improvements to protect barrier remedy	Cities/County/ others	ongoing	ICP	T
Install drainage infrastructure in areas where it does not exist or is undersized	Cities/County/ others	ongoing	State	T
Design and Construct ICP Landfill	EPA (with UMG funding, as per 1994 Consent Decree)	2000	DEQ	

VIII. Comments Received

The Populated Areas Five Year review has gone both through public review and at least two forms of peer review[21]. The comment period on the Five Year review began with a Bunker Hill Task Force hosted public meeting on April 27, 2000. A draft Five Year Review document was sent out to the repositories and posted on EPA's Bunker Hill web page[22] for public review. The comment deadline was originally June 9, 2000. Upon written request by the UMG dated June 6, 2000, and Silver Valley People's Action Coalition (SVPAC) dated June 1, 2000, the comment deadline was extended to July 10, 2000. Three sets of comments were received in addition to the peer reviews conducted; all are summarized below.

<u>Coeur d'Alene Tribe</u>
The Tribe submitted comments dated May 22, 2000. Their comments pertained to both the Populated and Nonpopulated Five Year Reviews. Populated area comments focused on the Institutional Controls Program (ICP). Specifically, the Tribe is concerned that the remedy is heavily reliant on an ICP and that a focused review of the ICP did not occur (See Section IVB Five Year Review Findings, Institutional Controls Program. See also ATSDR consultations, below.).

<u>UMG</u>
The UMG submitted comments dated July 10, 2000. Although the UMG concurred with the EPA draft finding that the remedy is protective, they took exception to many of the specific analyses and findings in the report itself, as well as the scope and purpose of the exercise. For example, the UMG does not agree that yard remediation has made substantial progress in lowering blood lead levels sitewide; instead the UMG suggest that this trend is better correlated with national blood lead reductions and with the site specific education/intervention program. In addition, UMG took exception to much of the deficiencies and recommendations highlighted in the report, stating that these areas in general are "not a problem." Due to the highly technical nature of the comments, a separate comment letter will be prepared to respond to the concerns raised by the UMG. Comments that require revision to this report have been incorporated.

<u>SVPAC</u>
The SVPAC comments were sent via email from Tina Paddock on July 9, 2000. These comments have been previously received by EPA and incorporated to the extent possible in the design of the five year review, before it was initiated. In general, these comments state the position that the remedy is inadequate to protect human health and that more needs to be done. For example, house dust, arsenic and cadmium contamination, Title X disclosure regulations, and local implementation of the ICP (causing a potential conflict of interest) are highlighted by SVPAC letters as concerns

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[21] At this time, there may be two additional peer reviews conducted on the report after finalization.

[22] The Bunker Hill web page may be found at: http://yosemite.epa.gov/r10/cleanup.nsf/sites/BH

that need to be addressed.   These concerns have been addressed to the extent possible by this report and by the Five Year Review process.

EPA also requested that ATSDR conduct consultations on the Populated Areas Five Year Review. ATSDR's consultations underway fall into three categories: 1) rights of ways, 2) indoor dust, and 3) fugitive dust. There were no additional recommendations in these reports beyond those already included in the draft Five Year Review released for public comment. These reports may be found in the administrative record. ATSDR is also considering additional evaluation of the ICP, at the request of community members and the Tribe (see comments above). In addition to the public comment process, the Five Year Review was reviewed by other large lead cleanup site project managers at EPA, known as the Lead Site Workgroup (LSW). The LSW reviewers had no comments on the report; their memorandum is in the administrative record. The comments received through both peer review and public review have been taken into consideration and incorporated to the extent possible. All public notices, meeting minutes from the April public meeting, and comments received have been incorporated into the administrative record.

IX. Protectiveness Statement(s)

The remedy being implemented in the populated areas operable unit is protective of human health and the environment provided that corrective actions are taken as noted above. Although the remedy hasn't fully been implemented, environmental data (excepting right of way data) indicate that levels of lead are decreasing sitewide and will be able to meet remedial action objectives. The next five year review will evaluate whether the remedial action objectives have been met once the remedy has been completed.

X. Next Review

This is a statutory site that requires ongoing five year reviews. EPA will conduct the next review within five years of the due date of this first five year review report. The completion date is the date of the signature shown on the signature cover attached to the front of the report.

XI. Attachments

Attachment A: Documents Reviewed
Attachment B: Figures
Figure 1 - Coeur d'Alene River Basin Map
Figure 2 - Bunker Hill Superfund Site 21 Square Mile Area Map
Figure 3 - House Dust Lead Exposure by City
Figure 4 - Blood Lead Levels by Year
Figure 5 - Blood Lead Levels by City
Figure 6 - Blood Lead Levels by Age
Figure 7 - Blood Lead Levels by Year Compared to Percentage of Children on Contaminated Yards
Attachment C: Tables
Table 1 - ARARs

Attachment A
Documents Reviewed

Centers for Disease Control, “Screening Young Children for Lead Poisoning: Guidance for State and Local Public Health Officials,” November, 1997.

CH2M Hill, “Bunker Hill Five Year Review - Populated Area Fugitive Dust Evaluation,” February, 2000.

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Attachment B
Figures

Attachment C
Tables

TABLE 1
Summary of Newly Promulgated or Revised Standards

Change Status	Regulation and Citation	Entity	Prerequisite	Current Requirement	Previous Requirement	Location
Chemical-Specific Standards						
Air	Potentially Applicable Requirement					
Revised	Clean Air Act National Ambient Air Quality Standards(NAAQS) - 42 U.S.C. Section 7401 et seq; 40 CFR Part 50	Federal	Establishes ambient air quality standards for emissions of chemicals and particulate matter.	Emissions of particulates and chemicals that occur during remedial activities will meet the applicable NAAQS that are as follows: Particulate Matter as PM_{10}, (particles with diameters <= 10 microns ($1x10^{-6}$ meters): 150 µg /m^3 24-hour average concentration, 50 µg/m^3 annual arithmetic mean $PM_{2.5}$ (particles with diameters <= 2.5 microns ($1x10^{-6}$ meters)): 65 µg /m^3 24-hour average concentration, 15 µg/m^3 annual arithmetic mean Lead: 1.5 µg Pb/m^3 Quarterly arithmetic mean.	Emissions of particulates and chemicals that occur during remedial activities will meet the applicable NAAQS that are as follows:. Particulate Matter: 150 µg/m^3 24-hour average concentration, 50 µg/m^3 annual arithmetic mean. Lead: 1.5 µg Pb/m^3 Quarterly arithmetic mean.	Site Wide

Added	IDAPA §16.01. 01	State	Emission of air contaminants that are toxic to human health, animal life, or vegetation	Emissions of air contaminants which occur during remedial activities will not be in such quantities or concentrations with other contaminants that injure or unreasonably affect human health, animal life or vegetation. Particulate Matter as PM_{10}: 150 µg /m^3 24-hour average concentration (1-expected per calendar year), 50 µg/m^3 annual arithmetic mean. The PM_{10} maximum allowable increase for a Class III area: 60 µg/m^3 24-hour average concentration and 34 µg/m^3 annual arithmetic mean.	None	Site Wide
Soil and Dust	Potential To Be Considered Materials					
Revised	Advisory Committee on Childhood Lead Poisoning Prevention - Centers for Disease Control's statement on Preventing Lead Poisoning in Young Children, 1991	Federal	Removal of contaminated soils.	New data indicate significant adverse effects of lead exposure in children at blood lead levels lower than previous believed to be safe. The 1985 intervention level of 25 µg/dl is, therefore, revised downwards to 10 µg/dl.	The 1985 CDC statement indicates that lead in soil/dust appears to be responsible for blood lead levels in children increasing above background levels when the concentrations in the soil/dust exceed 500-1000 ppm. This concentration is based upon the established CDC blood lead level of 25 µg/dl in children. When soil/dust lead concentrations exceed 500-1000 ppm, blood lead levels in children are found to exceed 25 µg/dl.	Site Wide

Revised	Revised U.S. EPA Interim Soil Lead Guidance for CERCLA Sites - OSWER Directive #9355.4-12, August 1994	Federal	Establishes a streamlined approach for determining protective levels for lead in soil	The 1994 revised guidance document recommends a 400 ppm screening level for lead in soil, describes how to develop site-specific preliminary remediation goals (PRGs), and describes a strategy for management of lead contamination at sites that have multiple sources of lead. The screening level for lead was calculated using the Integrated Exposure Uptake Biokinetics Model IEUBK. A typical child exposed to a soil lead level of 400 ppm would have an estimated risk of no more than 5% exceeding the 10 µg Pb/dl blood lead level.	The 1989 guidance adopts the recommendation in the 1985 CDC statement on childhood lead poisoning (an interim soil cleanup level for residential settings of 500-1000 ppm total lead), and is to be followed when the current or predicted land use of contaminated areas is residential.	Site Wide
New	U.S. EPA Clarification to1994 Interim Soil Lead Guidance for CERCLA Sites - OSWER Directive #9200.4-27P (August 1998)	Federal	Establishes a streamlined approach for determining protective levels for lead in soil	Clarified the existing 1994 Soil-lead directive to promote national consistency in decision-making at CERCLA sites.	None	Site Wide

Figure 1: Coeur d'Alene River Basin

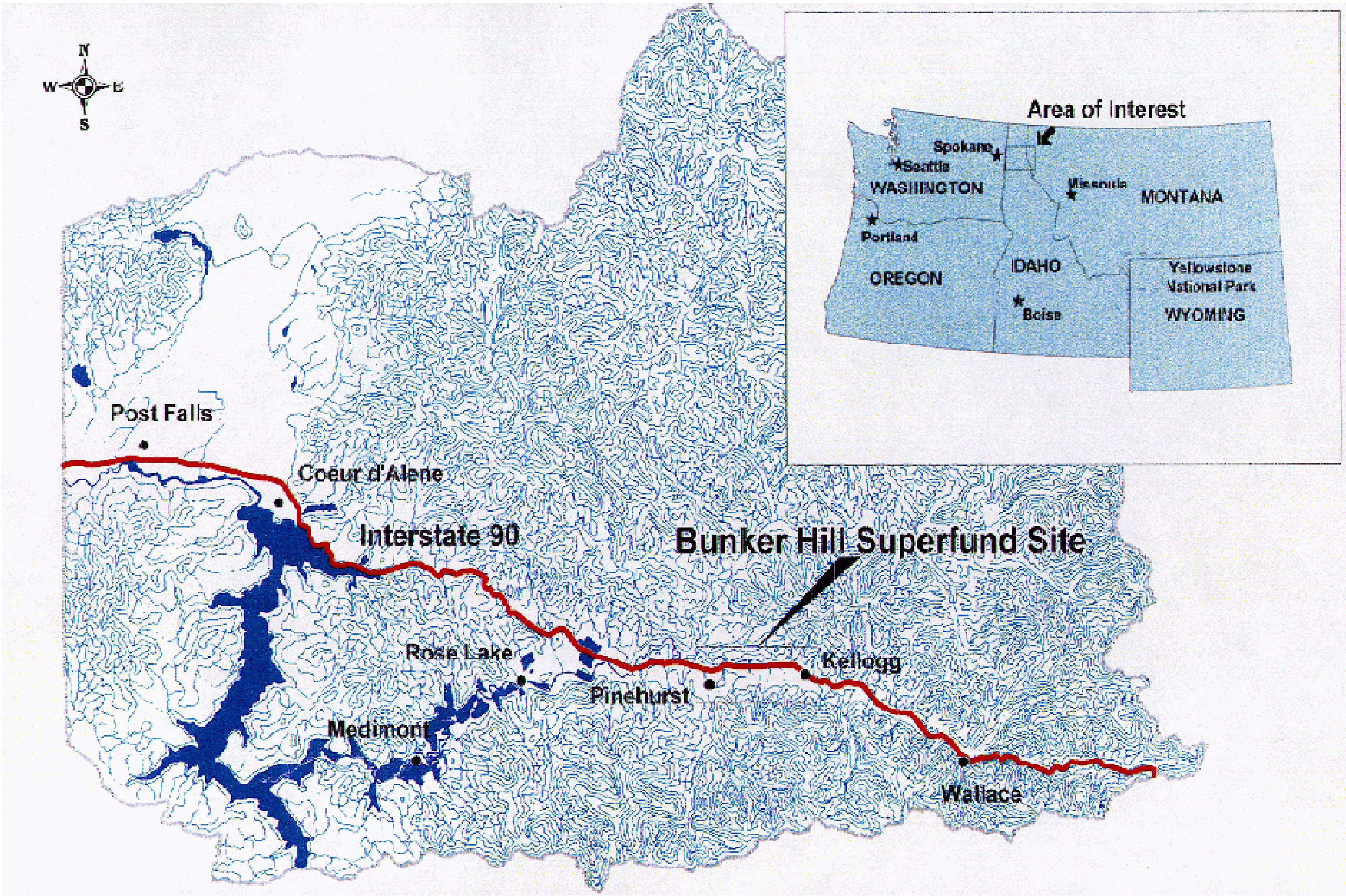
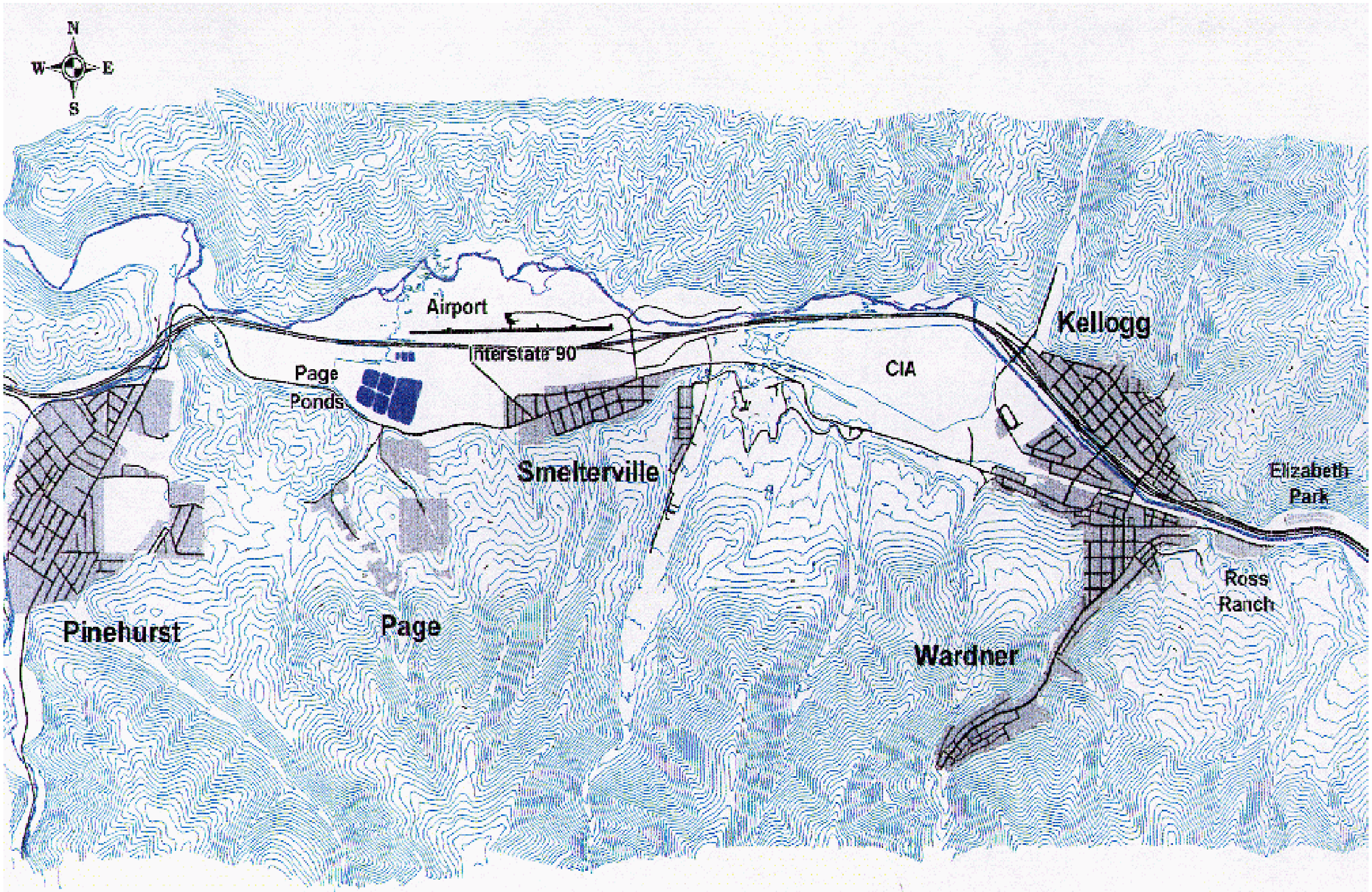


Figure 2: Bunker Hill Superfund Site 21 Square Mile Area



ARITH. MEAN BLPB

	1988	1989	1990	1991	1992	1993	1994	1995
KELLOGG	9.2	10.8	9.3	6.9	8.1	6.3	6.7	6.4
PAGE	10.3	12.5	11.0	6.5	6.1	6.1	5.5	6.1
PINEHURST			7.4	5.1	6.0	3.5	5.4	4.6
SMELTERVILLE	14.2	14.6	9.9	6.6	8.3	6.7	6.0	7.2
WARDNER	8.3	11.8	9.1	5.6	7.2	7.3	4.9	5.5

1996	1997	1998	1999
6.4	5.9	4.9	4.5
5.0	6.3	4.8	4.1
4.1	4.2	4.1	5.0
6.4	5.6	6.4	4.3
7.4	4.9	4.7	5.4

%children with BLPB >=10

Year	Kellogg	Page	Pinehurst	Smelterville	Wardner	site wide	RAO
1988	41%	58%		72%	33%	46%	0.05
1989	52%	27%		78%	54%	56%	0.05
1990	40%	53%	29%	31%	44%	37%	0.05
1991	20%	20%	5%	23%	11%	15%	0.05
1992	32%	9%	18%	31%	22%	27%	0.05
1993	18%	21%	5%	20%	22%	15%	0.05
1994	20%	9%	11%	21%	6%	17%	0.05
1995	17%	20%	5%	28%	17%	15%	0.05
1996	17%	9%	1%	12%	29%	12%	0.05
1997	15%	0%	3%	9%	8%	11%	0.05
1998	10%	0%	3%	14%	8%	8%	0.05
1999	6%	0%	9%	4%	11%	6%	0.05

%above15

Year	Kellogg	Page	Pinehurst	Smeltervill	Wardner	Site Wide
1988	13	17		31	7	
1989	22	36		42	31	
1990	11	35	5	24	6	
1991	7	0	3	2	0	
1992	13	0	1	4	6	
1993	4	0	0	2	0	
1994	6	0	2	0	0	
1995	6	0	1	8	0	
1996	5	0	0	2	14	
1997	3	0	1	0	0	
1998	1	0	1	2	0	1
1999	0	0	2	2	0	1

Comm. Soil [PB]

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Kellogg	2128	2128	1529	1202	1029	888	847	780	717	485	319	222
Page	732	732	607	529	479	433	397	374	358	358	358	333
Pinehurst	435	435	434	434	434	402	383	376	367	359	350	338
Smelterville	2308	2308	1974	1649	1272	1148	1098	493	147	135	135	132
Wardner	1548	1548	1412	1014	924	873	794	652	652	636	597	597
RAO	350	350	350	350	350	350	350	350	350	350	350	350

Community wide Soil

	1988	1989	1990	1991	1992	1993	1994	1995	1996
Kellogg	2128	2128	1529	1202	1029	888	847	780	717
Page	732	732	607	529	479	433	397	374	358
Pinehurst	435	435	434	434	434	402	383	376	367
Smelterville	2308	2308	1974	1649	1272	1148	1098	493	147
Wardner	1548	1548	1412	1014	924	873	794	652	652

Yard Soil Exposure

Kellogg	2582	2374	693	298	302	223	256	435	245
Page	1365	848	440	138	187	241	260	207	198
Pinehurst			436	434	419	360	282	234	234
Smelterville	2198	1858	719	319	311	339	202	184	110
Wardner	919	1106	766	100	100	179	179	561	935

House Dust

Kellogg	1516	1652	1245	1283	928	806	660	679	577
Page	432	547	1159	1202	719	486	450	622	231
Pinehurst			747	603	601	490	420	299	403
Smelterville	1237	1193	1849	1393	881	1086	872	703	667
Wardner	637	610	1064	712	997	695	764	374	469

1997	1998	1999
485	319	222
358	358	333
359	350	338
135	135	132
636	597	597
176	128	130
255	267	351
305	277	287
137	133	179
100	100	162
631	654	620
398	779	215
397	302	337
354	595	459
509	738	742

% kids with contam yards

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Kellogg	92%	90%	56%	33%	31%	21%	24%	39%	27%	13%	6%	6%
Page	64%	38%	35%	0%	18%	21%	9%	0%	0%	0%	4%	0%
Pinehurst			12%	11%	10%	8%	4%	5%	6%	5%	1%	1%
Smeltervill	83%	71%	54%	33%	29%	30%	19%	16%	0%	0%	0%	0%
Wardner	50%	73%	29%	0%	0%	21%	14%	60%	67%	0%	0%	11%
Site Wide	87%	83%	43%	25%	24%	19%	18%	29%	19%	9%	4%	4%

house dust lead by year
Area 1: SMELTERVILLE
Area 2: KELLOGG, PAGE, & WARDNER
Area 3: PINEHURST

		Geom Dust		
AREA 1		10789	1974	
		3492	1975	
		2922		1976
		1237		1977
		1193		1978
		1849		1979
		1393		1980
		881		1981
		1086		1982
		872	1983	
		703		1984
		667		1985
		402		1986
		604		1987
		459	1988	
AREA 2	1974	6492	1989	
	1975	4504	1990	
	1983	2585	1991	
	1988	1356	1992	
	1989	1437	1993	
	1990	1230	1994	
	1991	1243	1995	
	1992	924	1996	
	1993	780	1997	
	1994	656	1998	
	1995	662	1999	
	1996	403		
	1997	610		
	1998	672		
	1999	603		
AREA 3	1974	2087		
	1975	1707		
	1983	471		
	1988			
	1989			
	1990	747		
	1991	603		
	1992	596		
	1993	490		
	1994	420		
	1995	299		
	1996	403		
	1997	397		
	1998	302		
	1999	337		

House Dust

	1988	1989	1990	1991	1992	1993	1994	1995	1996
Kellogg	1516	1652	1245	1283	928	806	660	679	577
Page	432	547	1159	1202	719	486	450	622	231
Pinehurst			747	603	601	490	420	299	403
Smelterville	1237	1193	1849	1393	881	1086	872	703	667
Wardner	637	610	1064	712	997	695	764	374	469
RAO	500	500	500	500	500	500	500	500	500

1997	**1998**	**1999**
631	654	620
398	779	215
397	302	337
354	595	459
509	738	742
500	500	500

site wide

	% on contam	% above 10	%above15
1988	87	46	15
1989	83	56	26
1990	43	37	11
1991	25	15	5
1992	24	27	7
1993	19	15	2
1994	18	17	4
1995	29	15	5
1996	19	12	3
1997	9	11	2
1998	4	8	1
1999	4	6	1

	%on contam	smv% >=10	smv%>=15
1988	83	72	31
1989	71	78	42
1990	54	31	24
1991	33	23	2
1992	29	31	4
1993	30	20	2
1994	19	21	0
1995	16	28	8
1996	0	12	2
1997	0	9	0
1998	0	14	2.3
1999	0	4	2

	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8
# >10 ug/dl	7.0	5.0	1.0	3.0	2.0	1.0	2.0	1.0
# > 15 ug/dl	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0
# > 25 ug/dl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

% > 10 ug/dl	14.3	15.2	2.9	8.8	4.0	2.5	3.9	2.9
% > 15 ug/dl	2.0	3.0	0.0	0.0	0.0	0.0	0.0	2.9
% > 25 ug/dl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

age 9

1.0
0.0
0.0

2.3
0.0
0.0

Figure 2
Blood Lead Level by City, 1988-1999

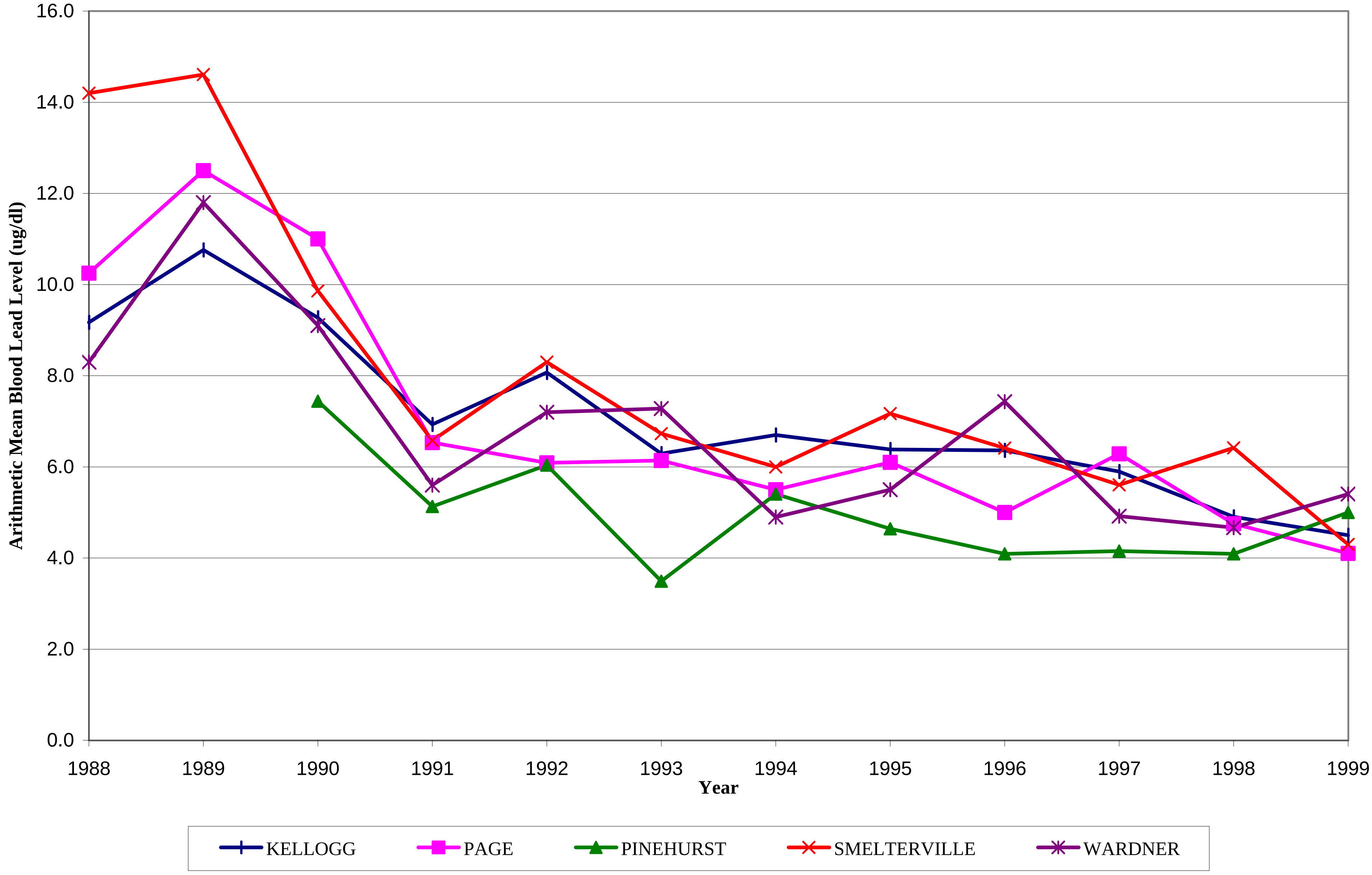


Figure 5
Percent Children with Blood Lead Above 10 ug/dl, by City, 1988-1999

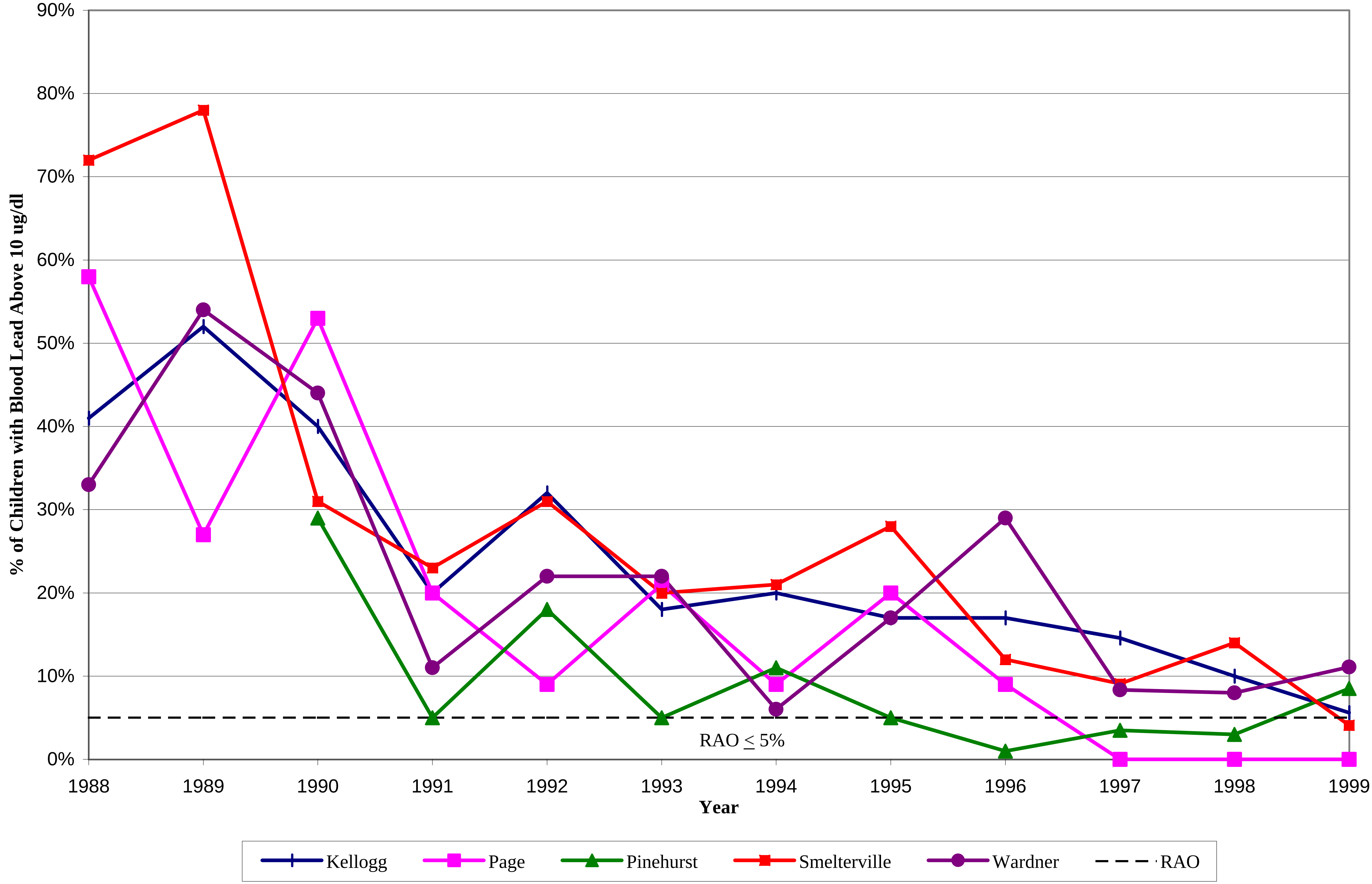


Figure 4
Percent Children with Blood Lead Levels ≥15 ug/dl, by City, 1988-1999

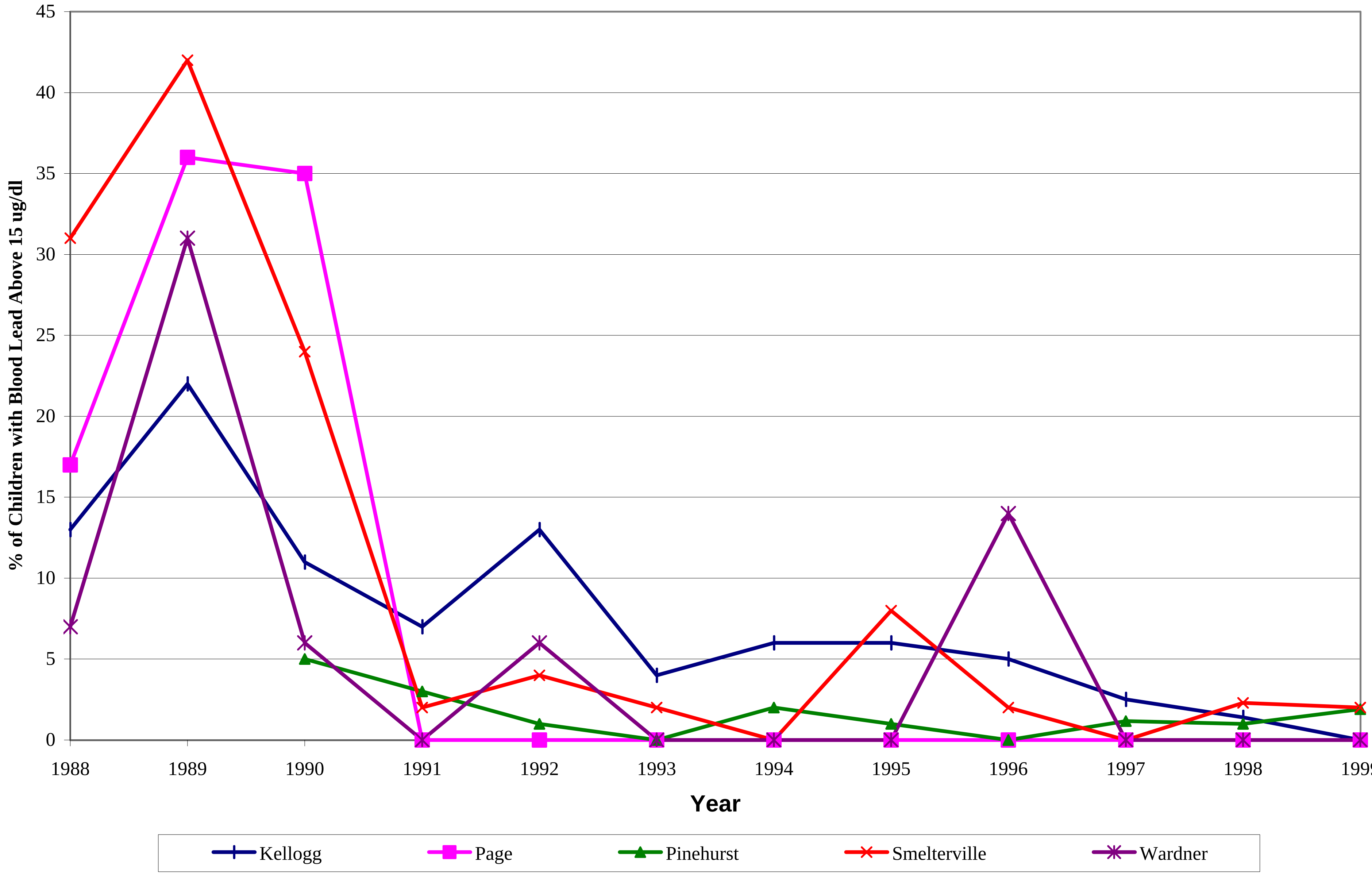


Figure 5
Community Geometric Mean Soil Lead Concentrations and Progress Toward Remedial Action Objective (RAO), 1988-1999

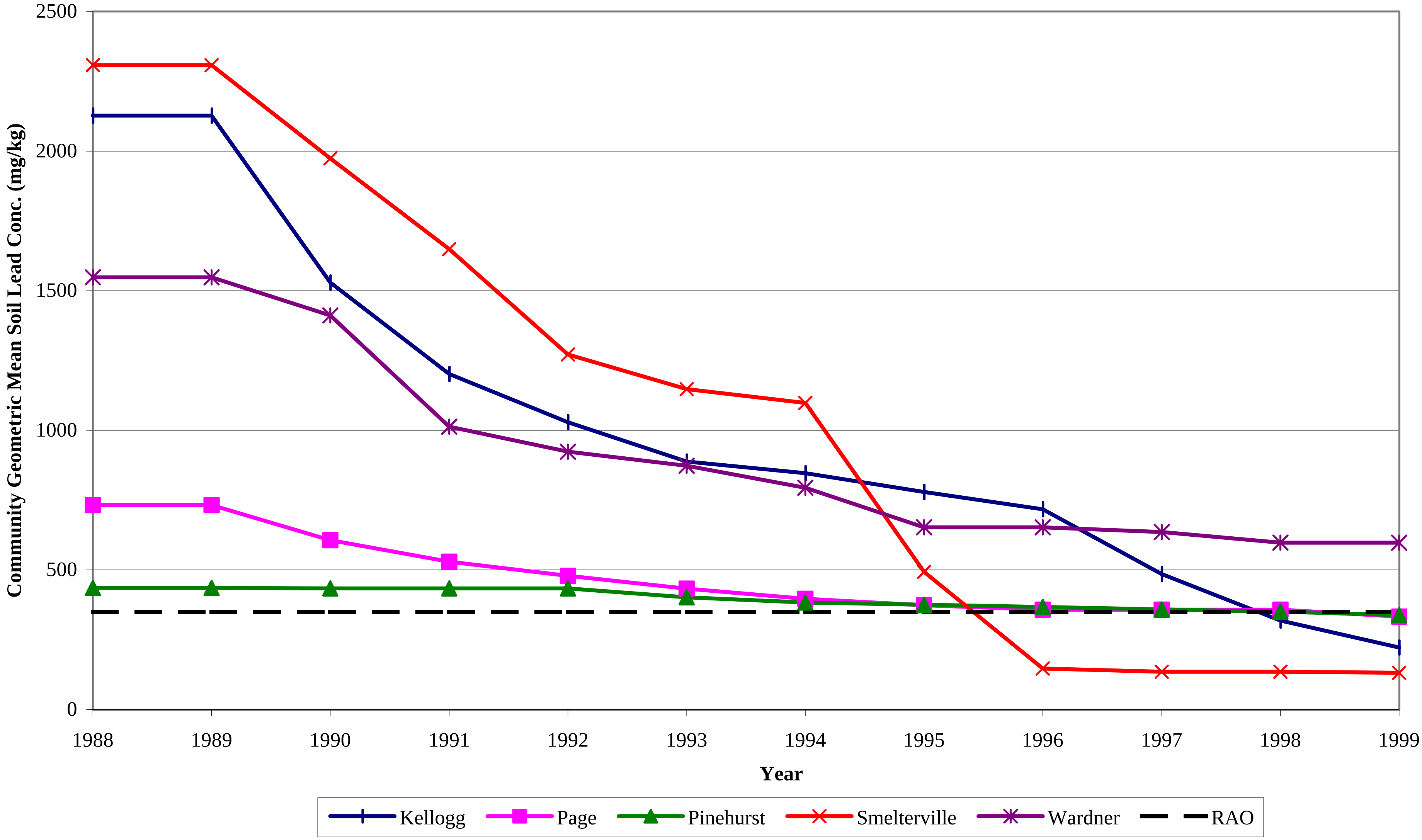


Figure 6a
Yard Soil and House Dust Lead Concentrations 1988-1999, Kellogg

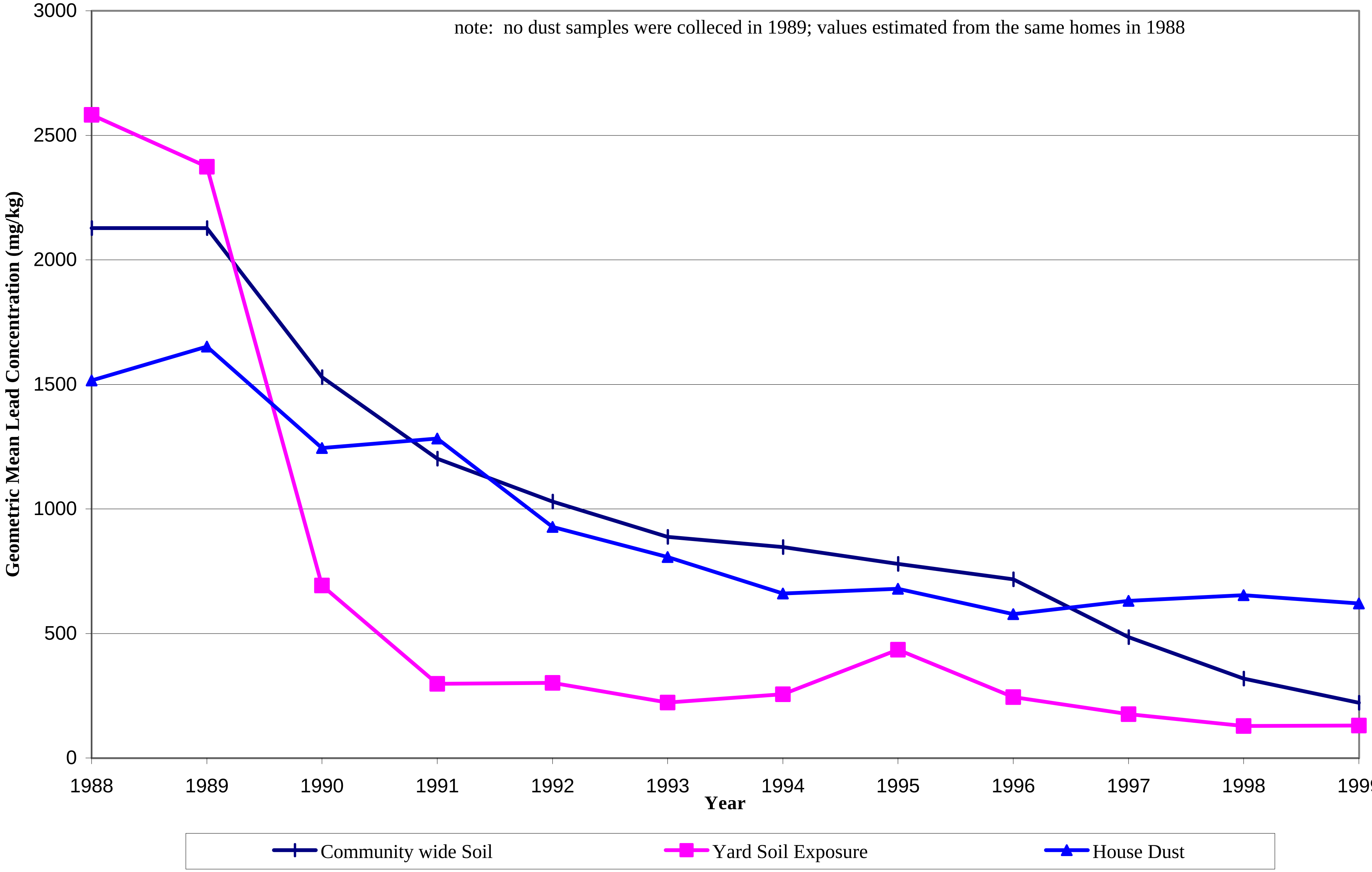


Figure 6b
YardSoil and House Dust Lead Concentration 1988-1999, Page

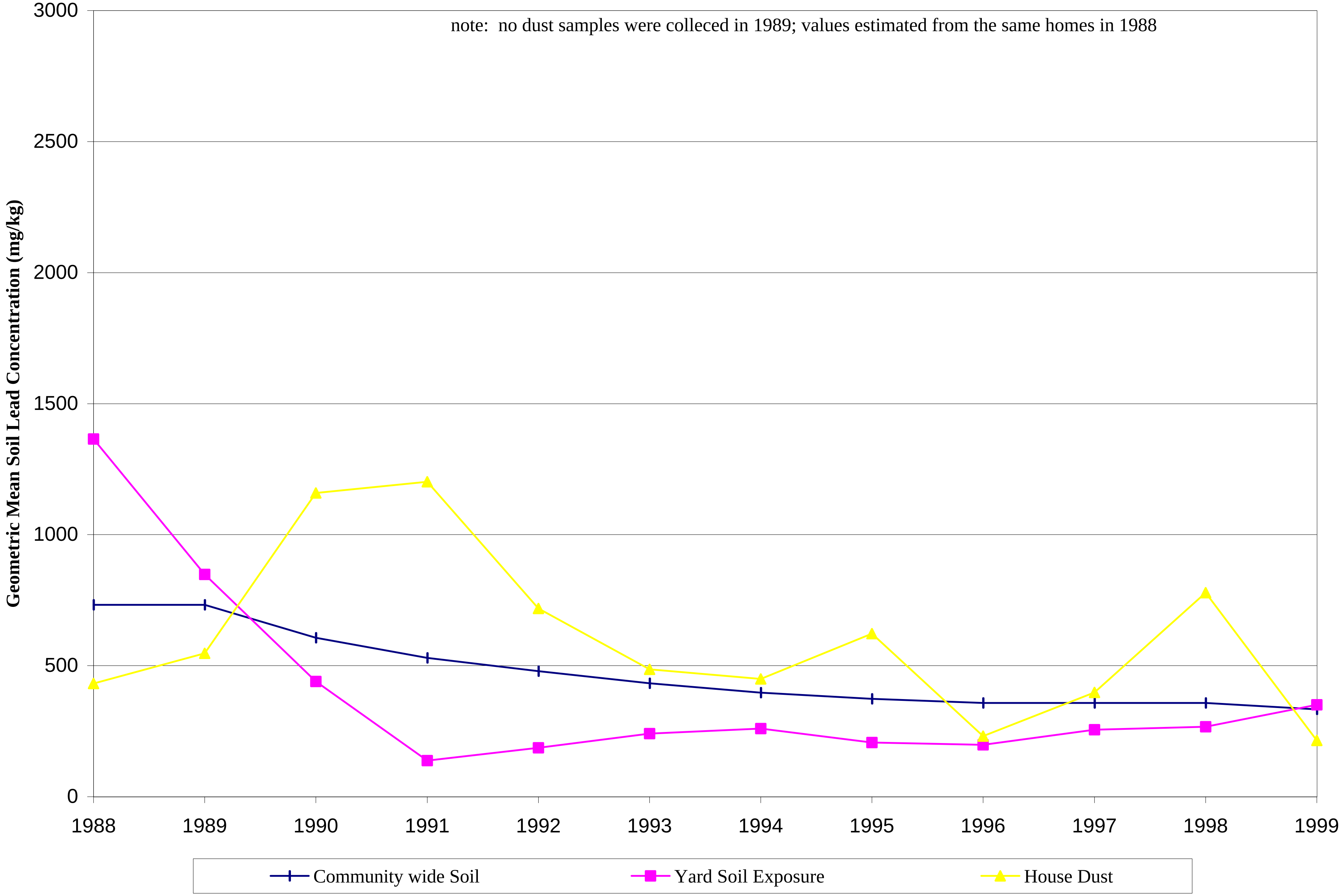


Figure 6c
Yard Soil and House Dust Concentrations, 1988-1999, Pinehurst

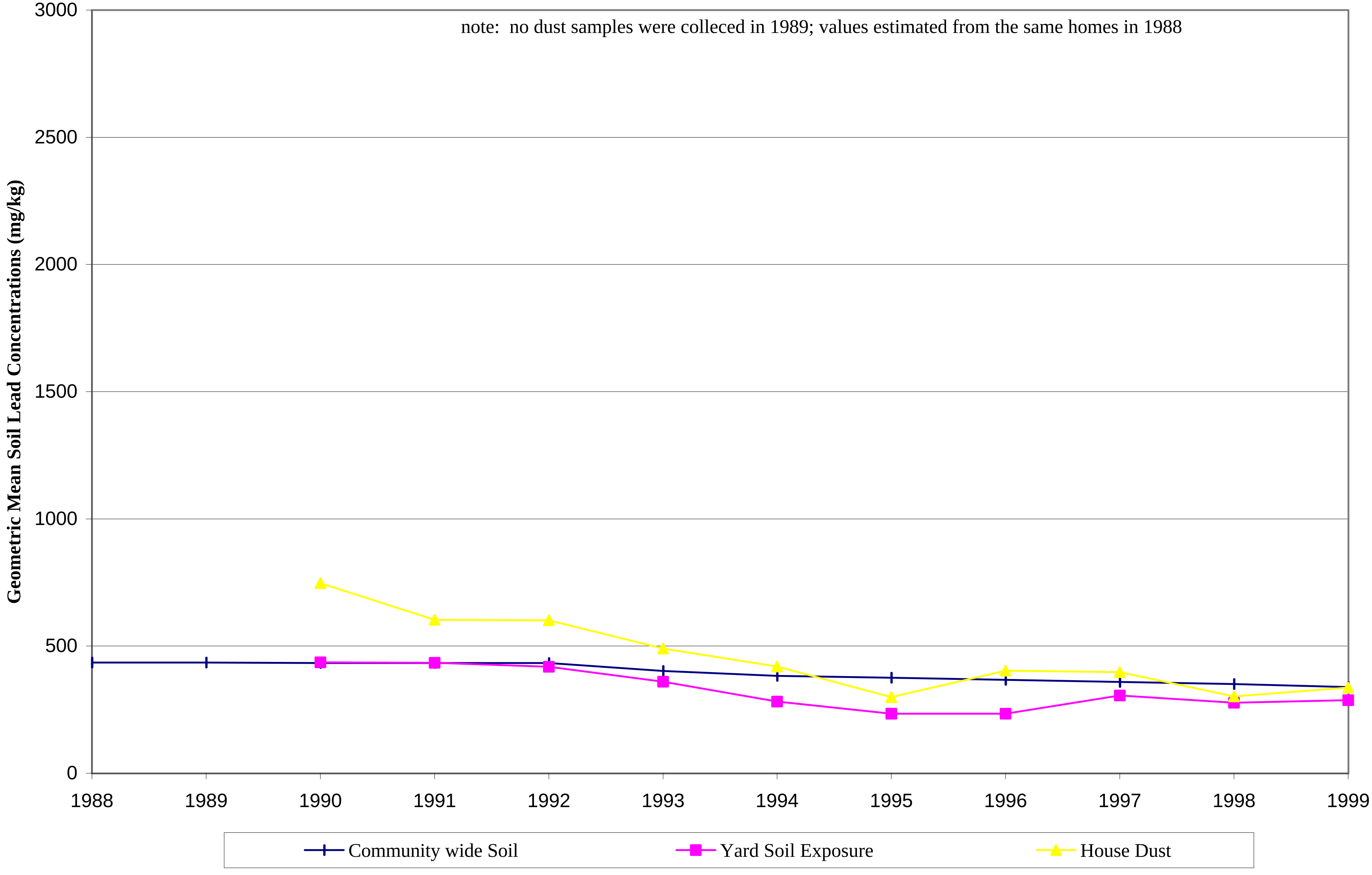


Figure 6d
Yard Soil and House Dust Lead Concentrations 1988-1999, Smelterville

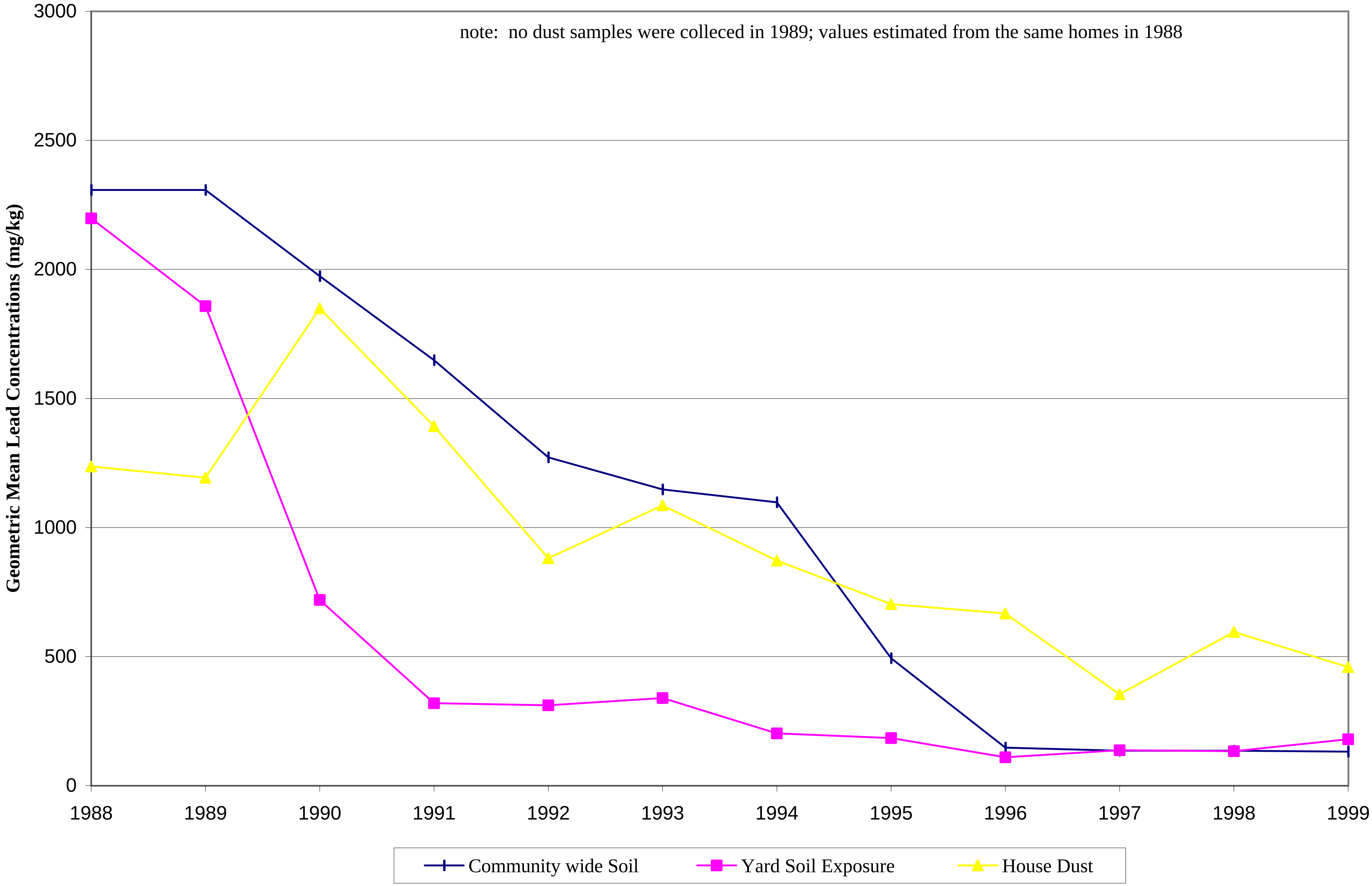


Figure 6e
Yard Soil and House Dust Lead Concentrations 1988-1999, Wardner

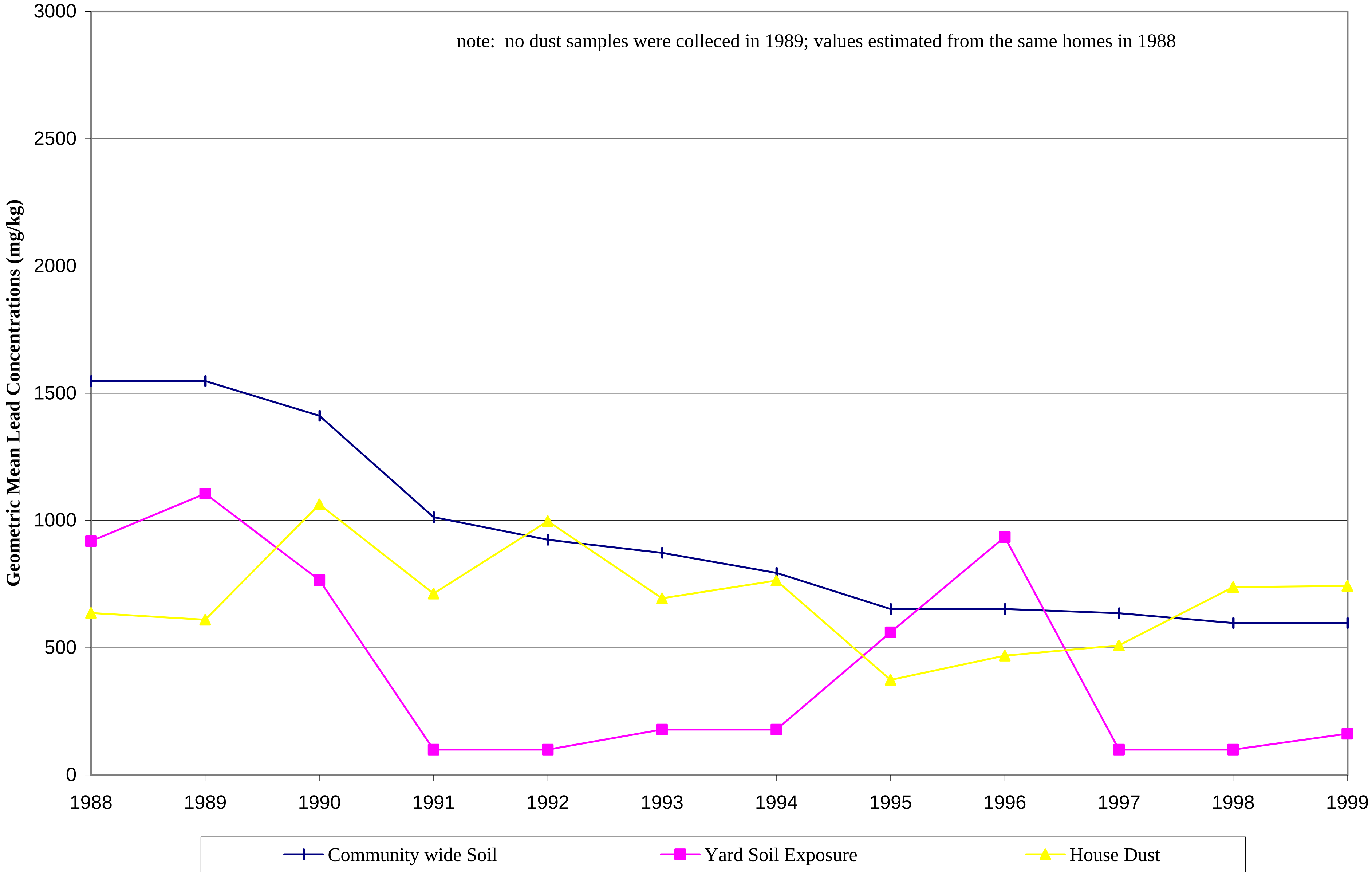


Figure 7.
Percent of Children Residing in Homes with Contaminated Yards, 1988-1999

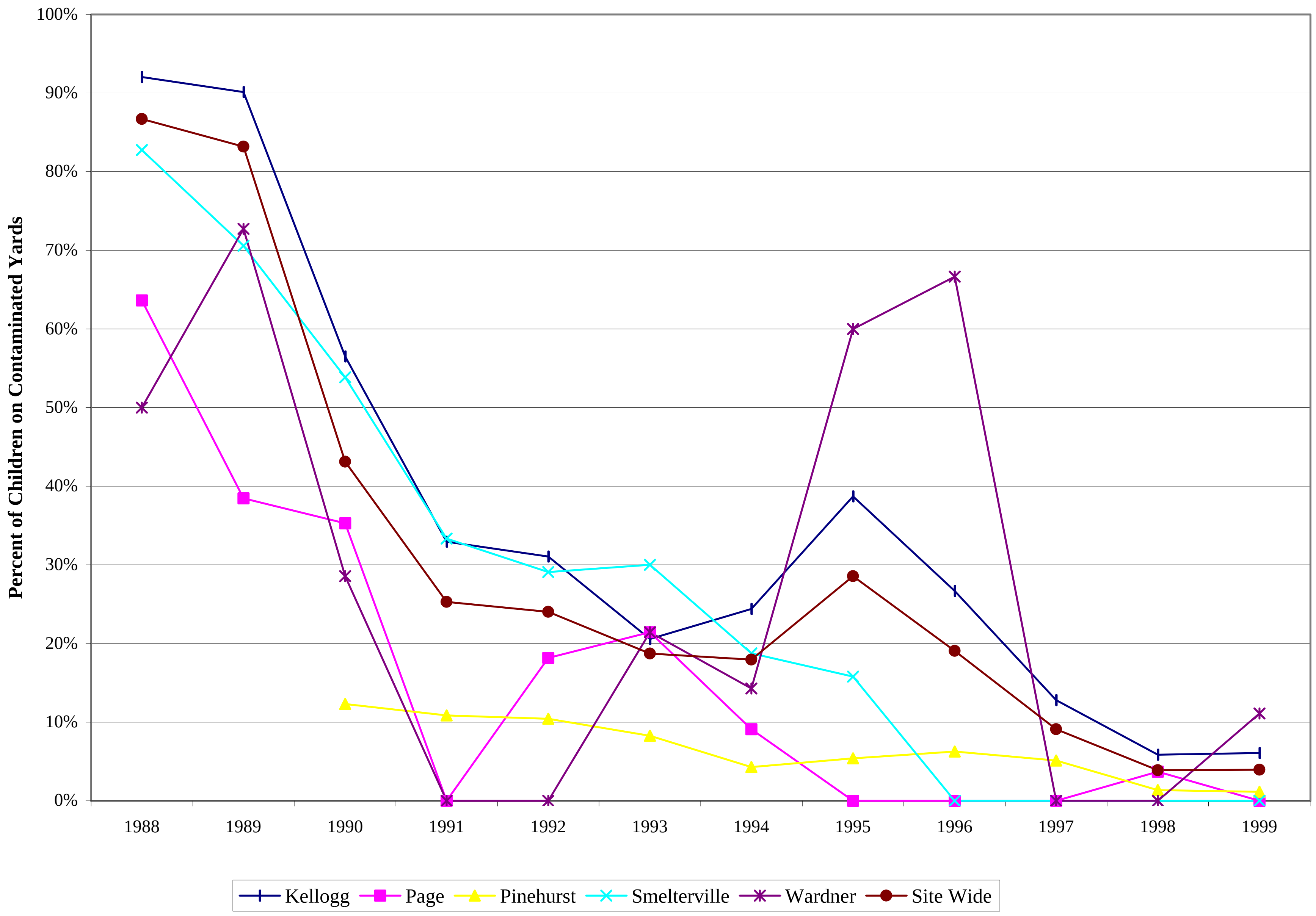


Figure 8. House Dust Lead Exposure by Year, 1974-1999

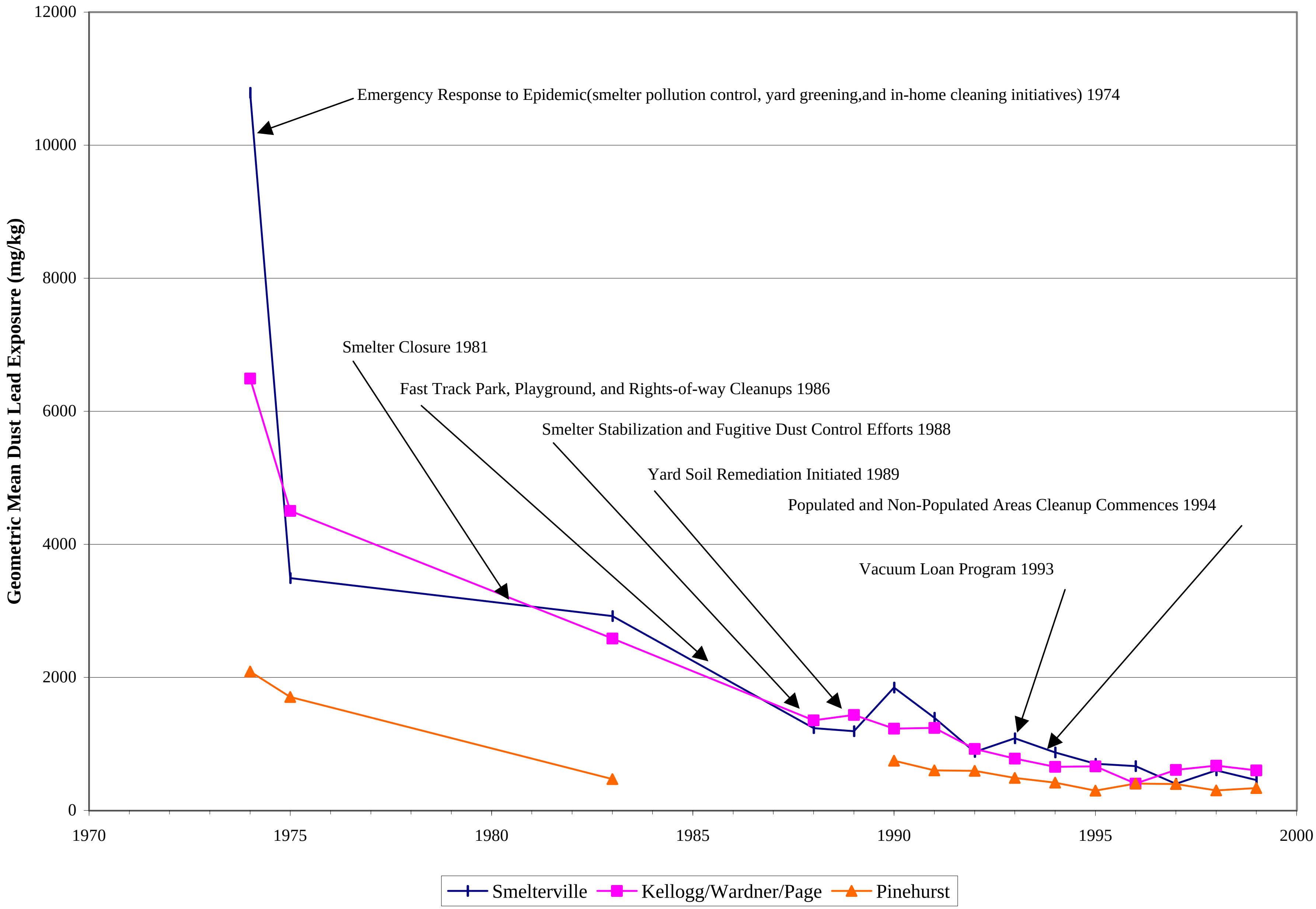


Figure 3
House Dust Lead Exposure by City, 1988-1999

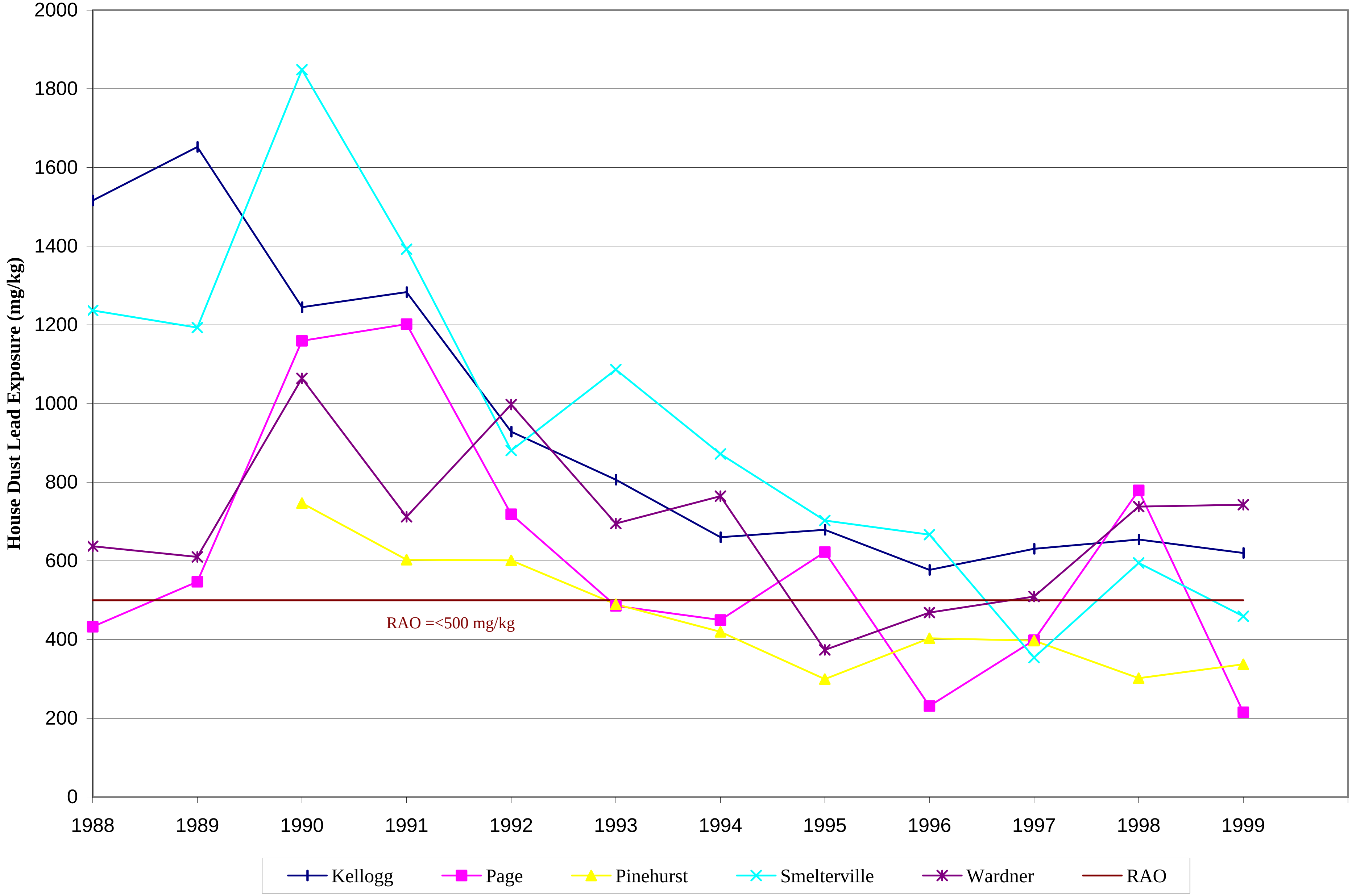


Figure 10a
Percent Children with BlPb ≥ 10 mg/dL v. Percent Children on Contaminated Yards, Site Wide, 1988-1999

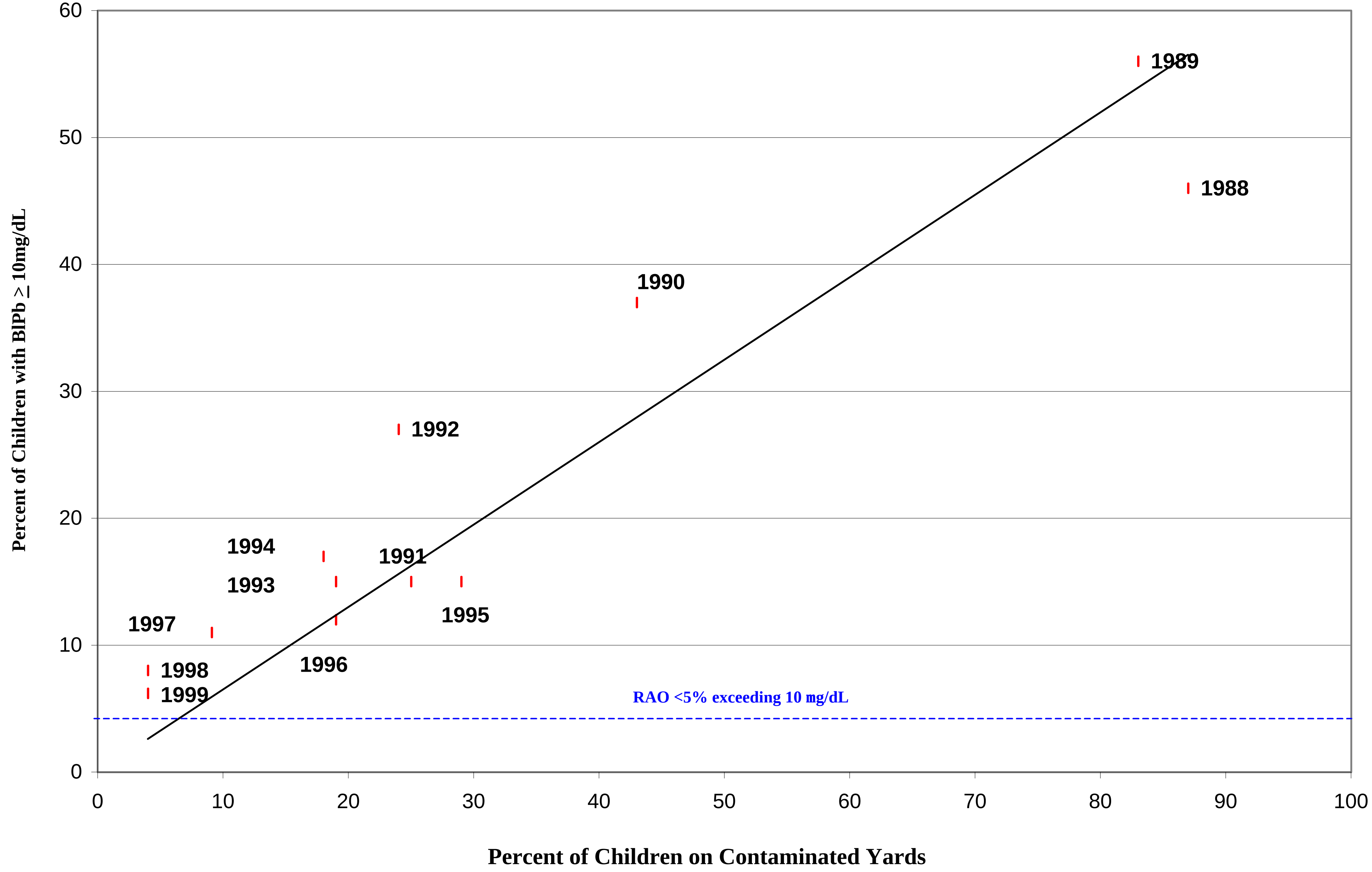
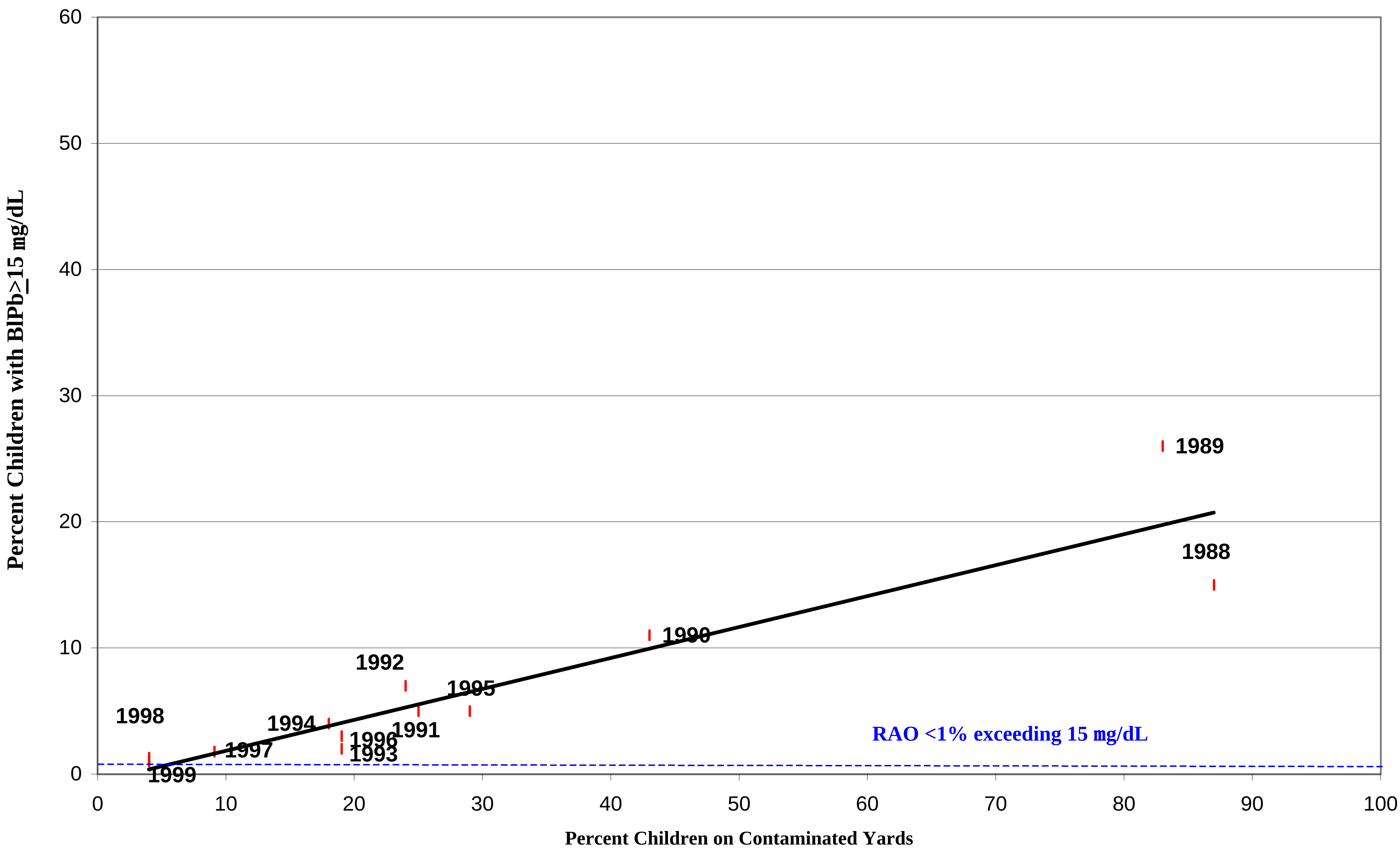


Figure 12b
Percent of Children with BlPb > 15 mg/dL v. Percent Children on Contaminated Yards, Site Wide, 1988-1999



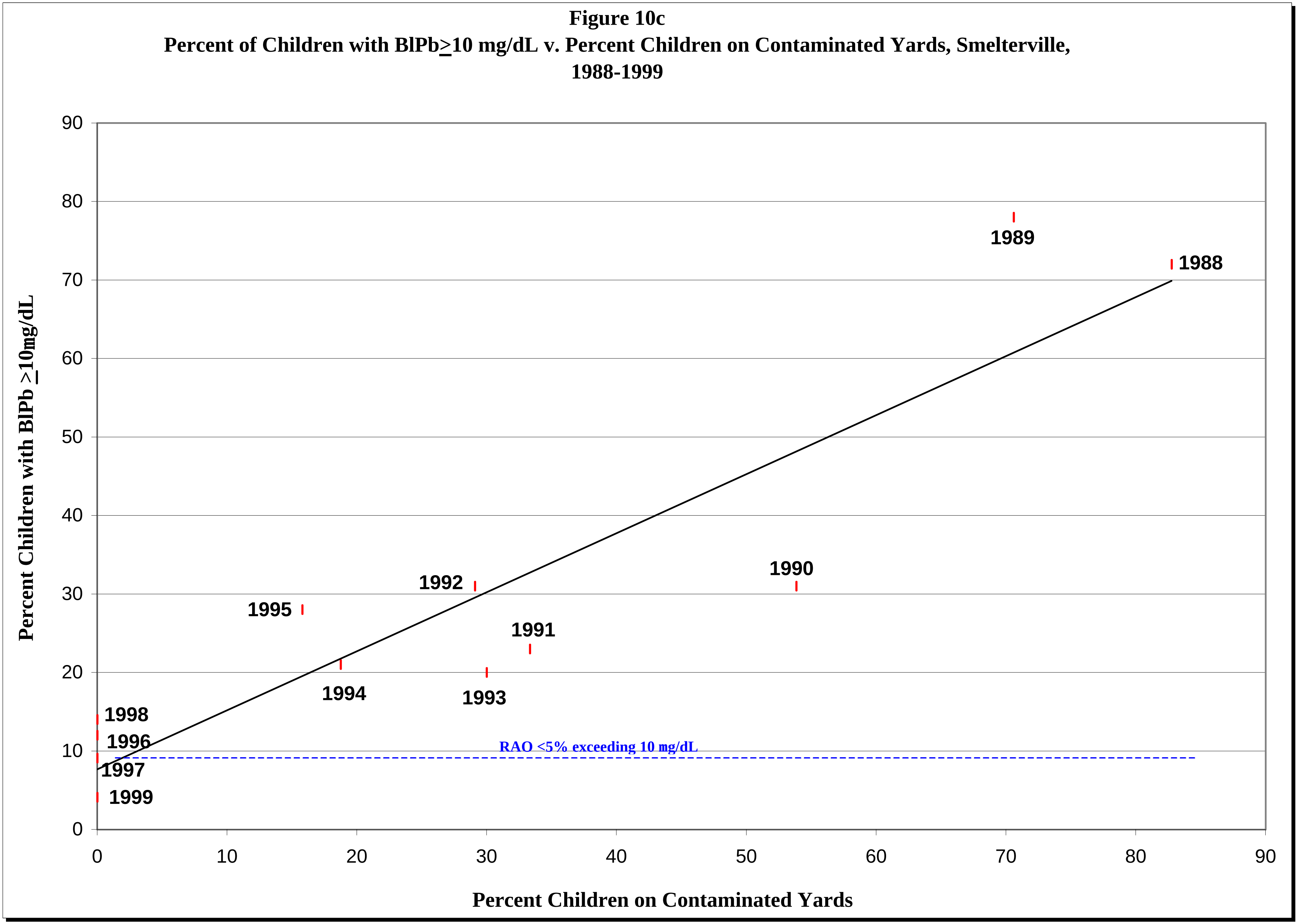


Figure 10c
Percent of Children with BlPb≥10 mg/dL v. Percent Children on Contaminated Yards, Smelterville, 1988-1999
Percent Children with BlPb ≥10mg/dL
Percent Children on Contaminated Yards
0
10
20
30
40
50
60
70
80
90
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
RAO <5% exceeding 10 mg/dL

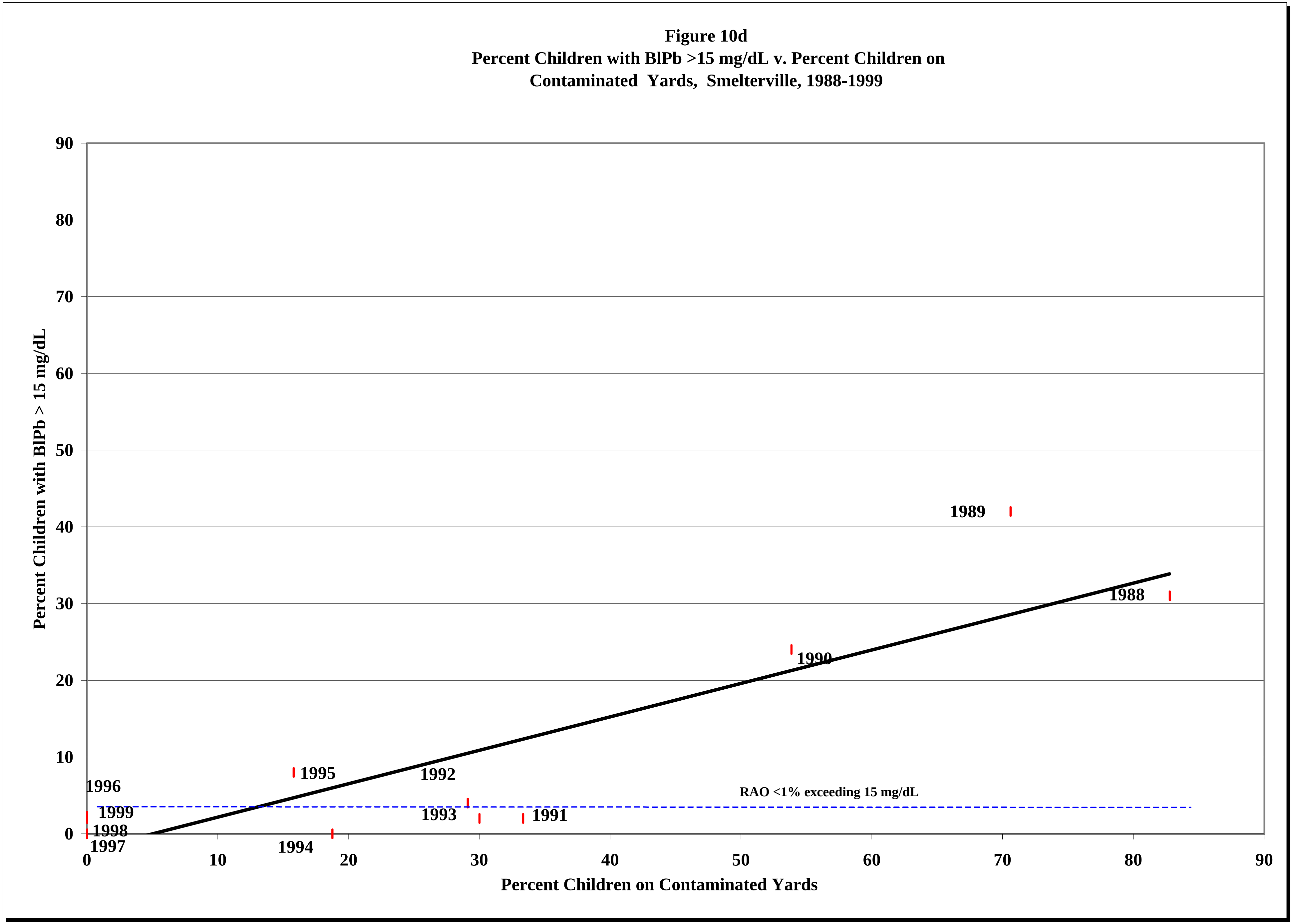


Figure 10d
Percent Children with BlPb >15 mg/dL v. Percent Children on Contaminated Yards, Smelterville, 1988-1999
Percent Children with BlPb > 15 mg/dL
Percent Children on Contaminated Yards
0
10
20
30
40
50
60
70
80
90
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
RAO <1% exceeding 15 mg/dL

Figure 11
Site Wide Percentages of Children Above 10 and 15 ug/dl, by Age, 1999

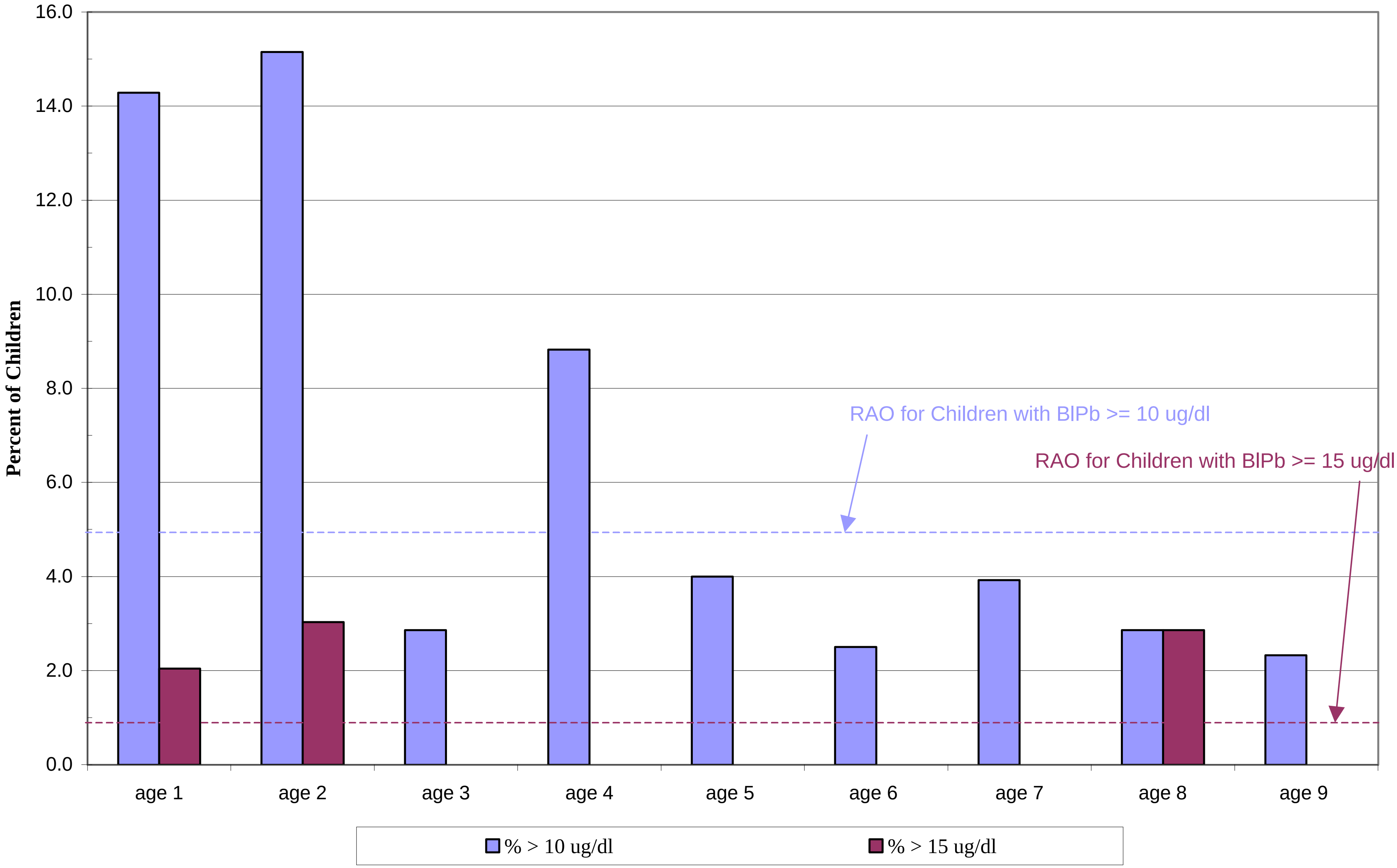
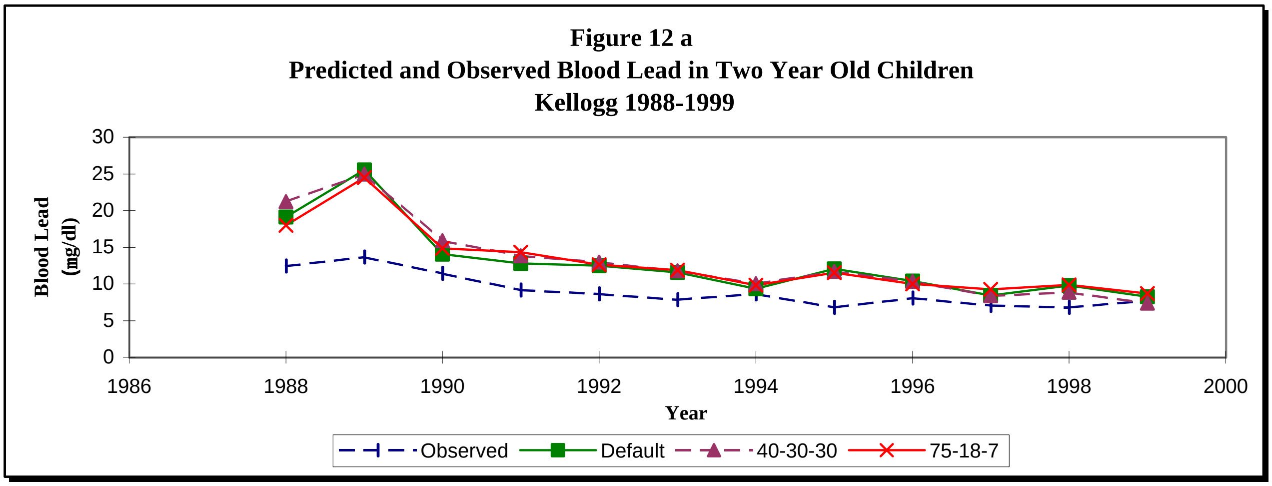
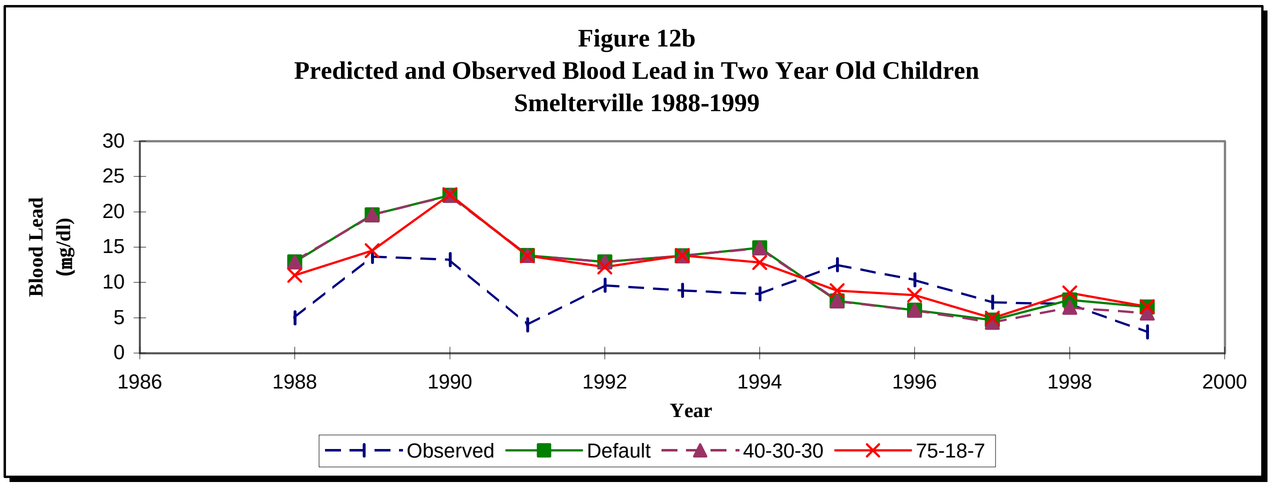


Figure 12 a-c
Predicted and Observed Blood Lead Levels
Default Parameters - Three Dust:Soil Partition Scenarios





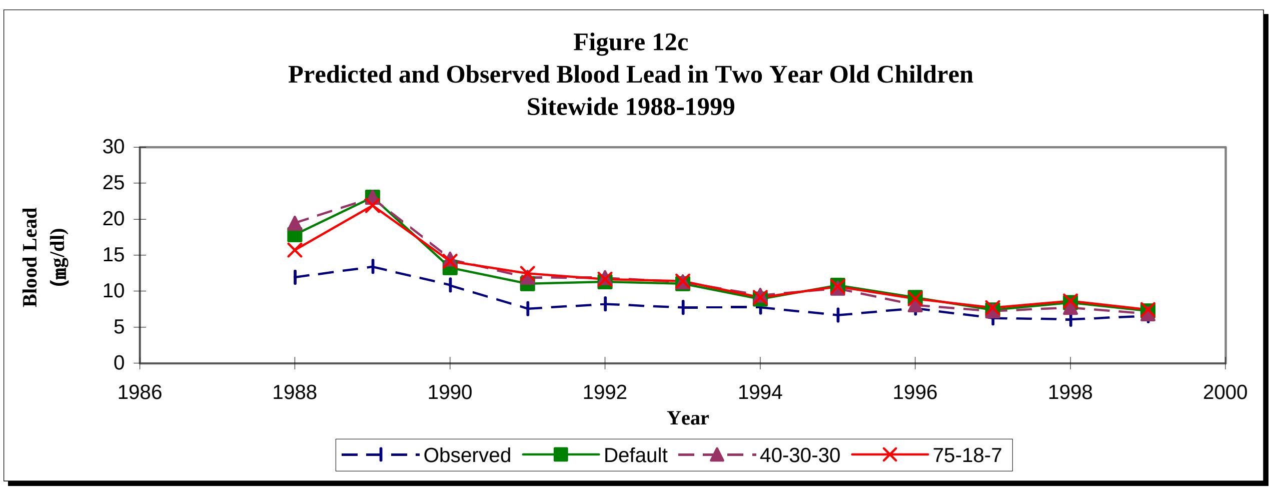


Figure 13 a-c
Predicted and Observed Lead Toxicity
Default Parameters - Three Dust:Soil Partition Scenarios

Figure 13 a
Predicted and Observed Percent of Children with Blood Lead Level Exceeding 10 mg/dl, Kellogg 1988-1999

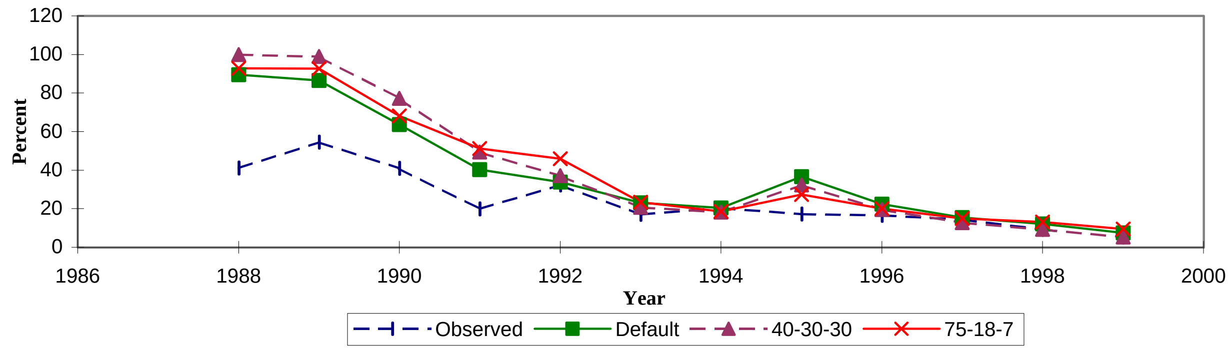


Figure 13 b
Predicted and Observed Percent of Children with Blood Lead Level Exceeding 10 mg/dl, Smelterville 1988-1999

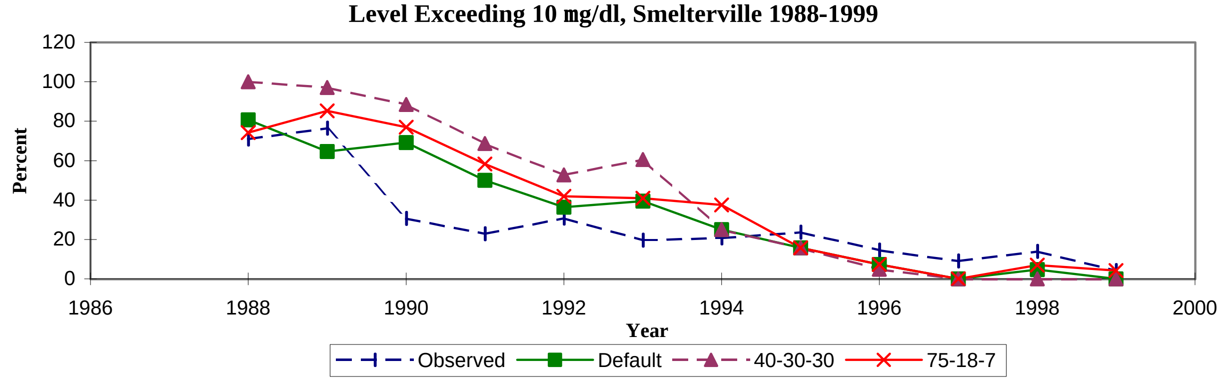


Figure 13 c
Predicted and Observed Percent of Children with Blood Lead Level Exceeding 10 mg/dl, Sitewide 1988-1999

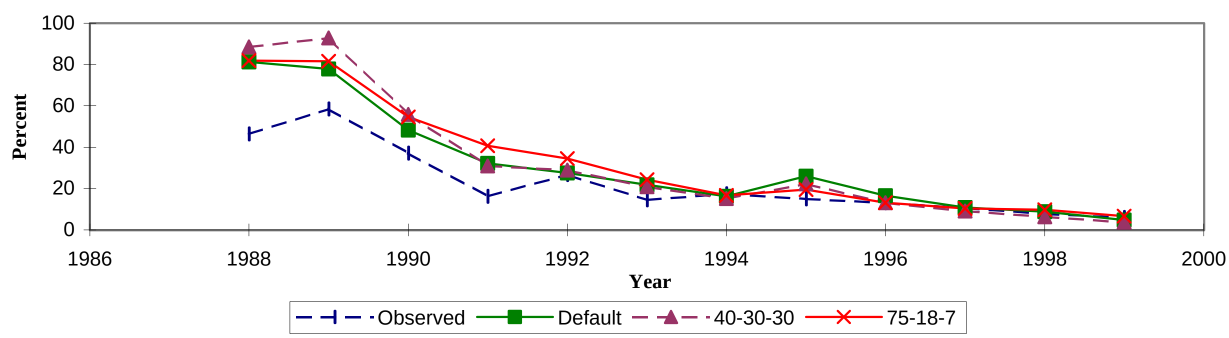


Figure 14 a-c
Predicted and Observed Geometic Standard Deviations
Default Parameters - Three Dust:Soil Partition Scenarios

Figure 14 a
Predicted and Observed Geometric Standard Deviation
Kellogg 1988-1999

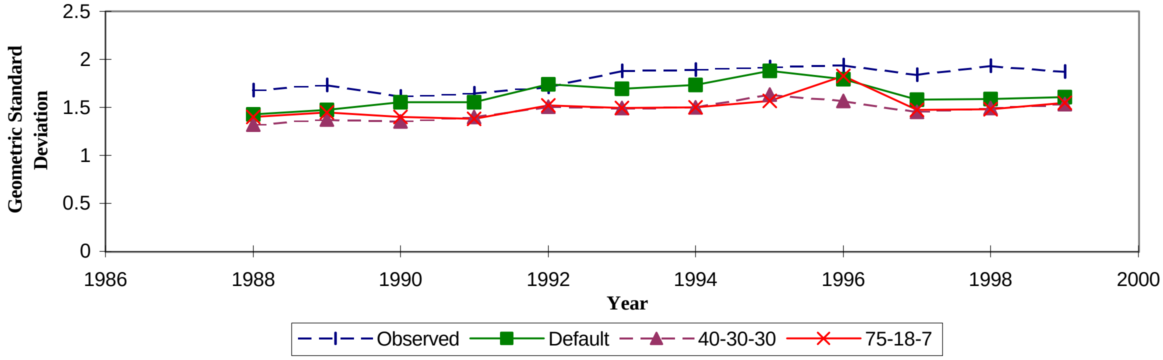


Figure 14 b
Predicted and Observed Geometric Standard Deviation
Smelterville 1988-1999

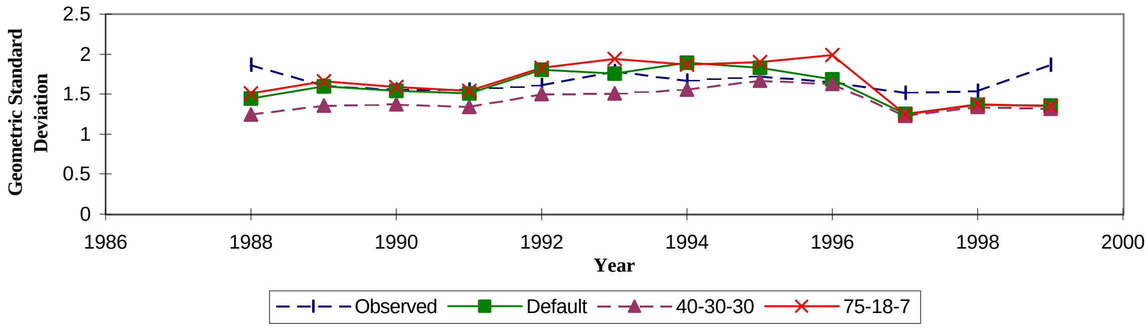


Figure 14 c
Predicted and Observed Geometric Standard Deviation
Sitewide 1988-1999

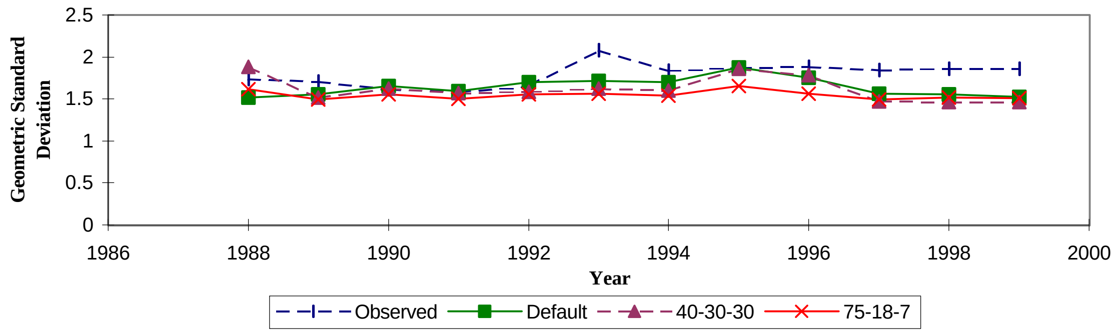
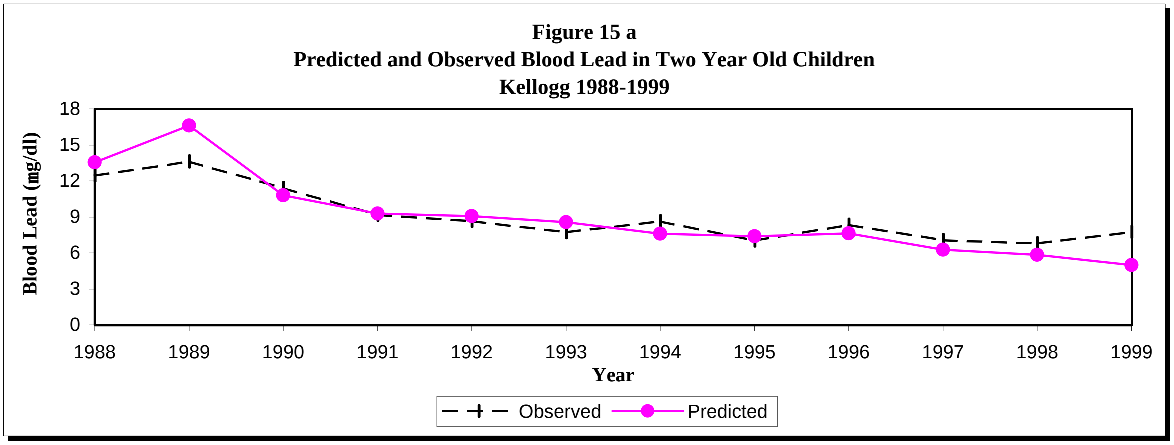
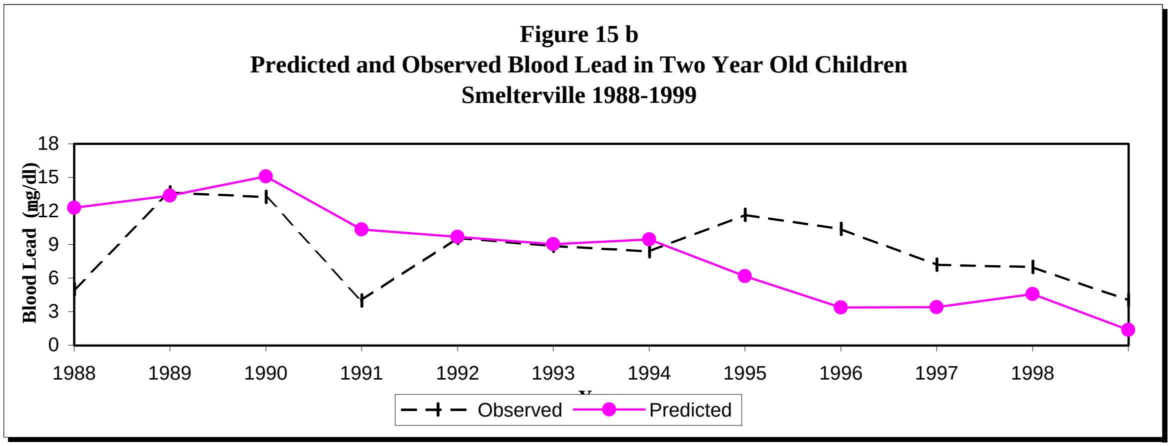


Figure 15 a-c
Predicted and Observed Blood Lead Levels
42:27:19:12 Dust:Soil Partition Scenarios at 18% Bioavailability





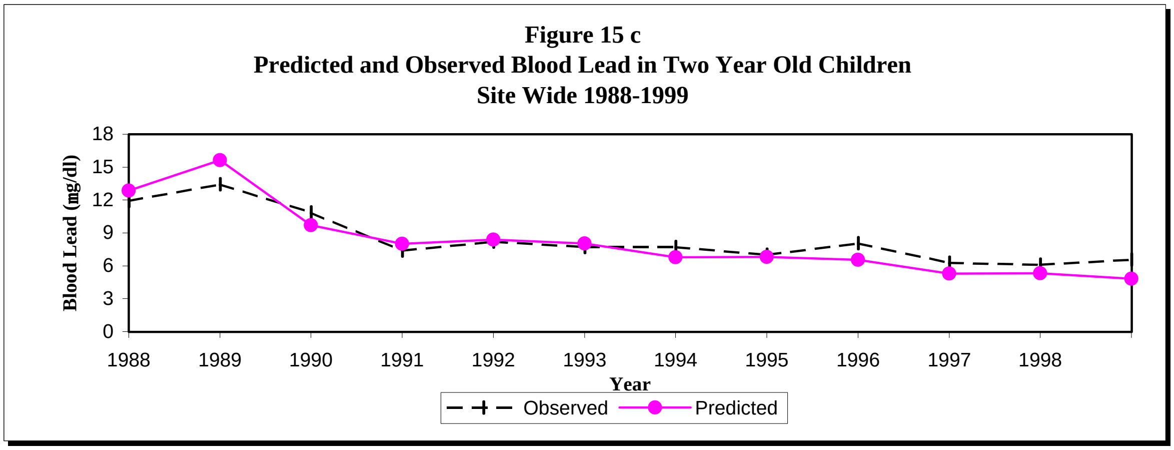


Figure 16 a-c
Predicted and Observed Geometric Standard Deviations
42:27:19:12 Dust:Soil Partition Scenarios at 18% Bioavailability

Figure 16 a
Predicted and Observed Geometric Standard Deviation
Kellogg 1988-1999

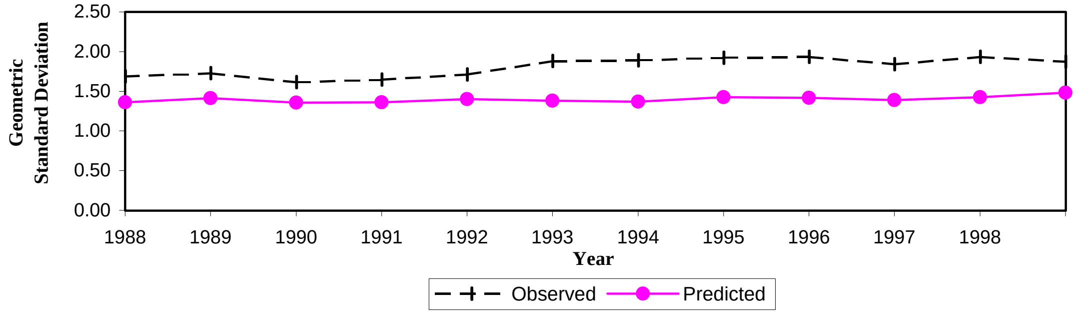


Figure 16 b
Predicted and Observed Geometric Standard Deviation
Smelterville 1988-1999

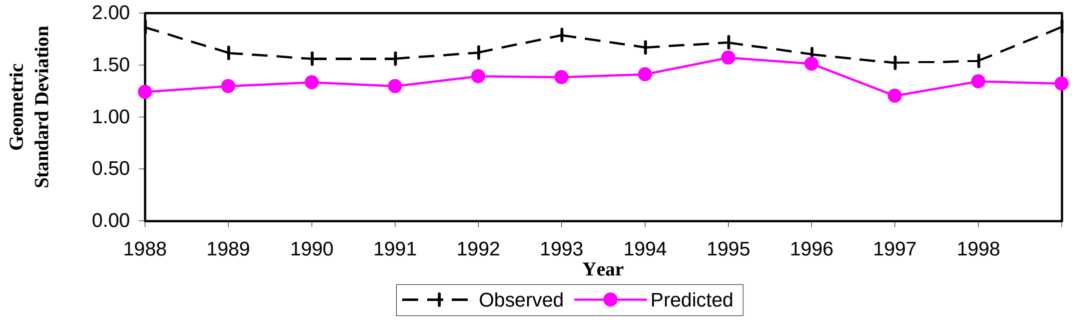


Figure 16 c
Predicted and Observed Geometric Standard Deviation
Site Wide 1988-1999

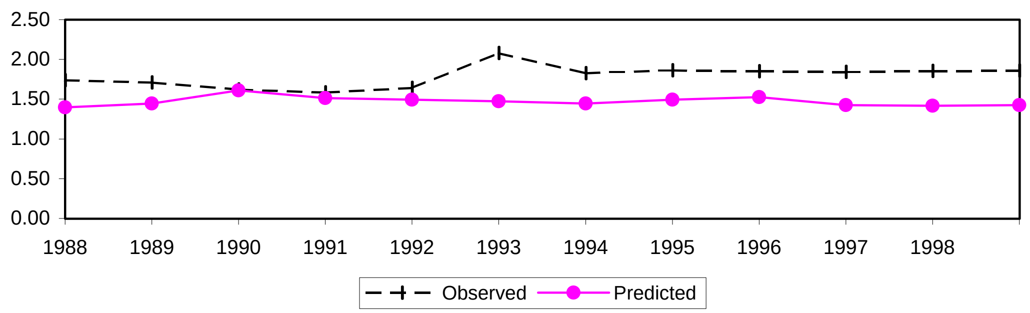


Figure 17 a-c
Predicted and Observed Lead Toxicity
42:27:19:12 Dust:Soil Partition Scenarios at 18% Bioavailability

Figure 17 a
Predicted and Observed Percent of Children with Blood Lead Level Exceeding 10 mg/dl, Kellogg 1988-1999

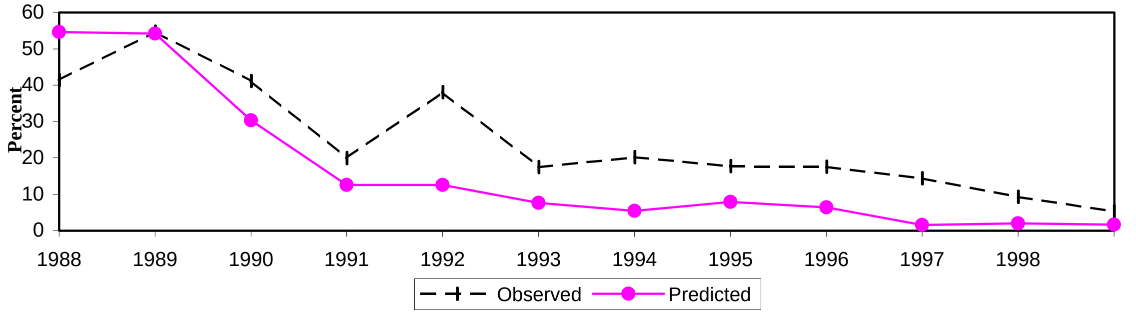


Figure 17 b
Predicted and Observed Percent of Children with Blood Lead Level Exceeding 10 mg/dl, Smelterville 1988-1999

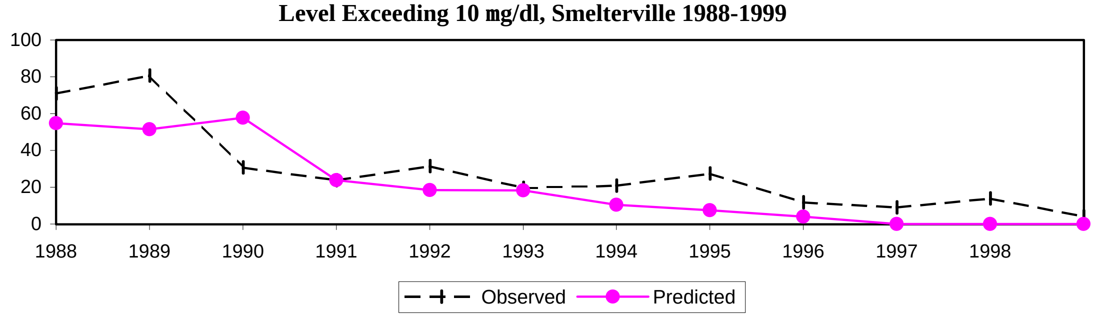
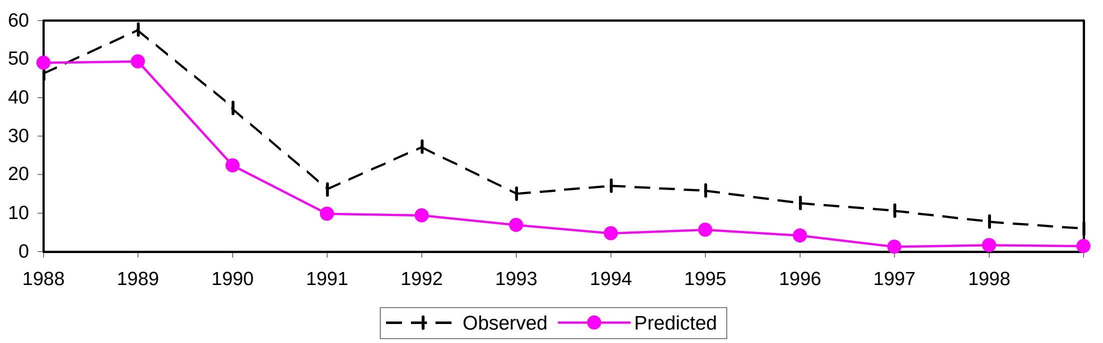
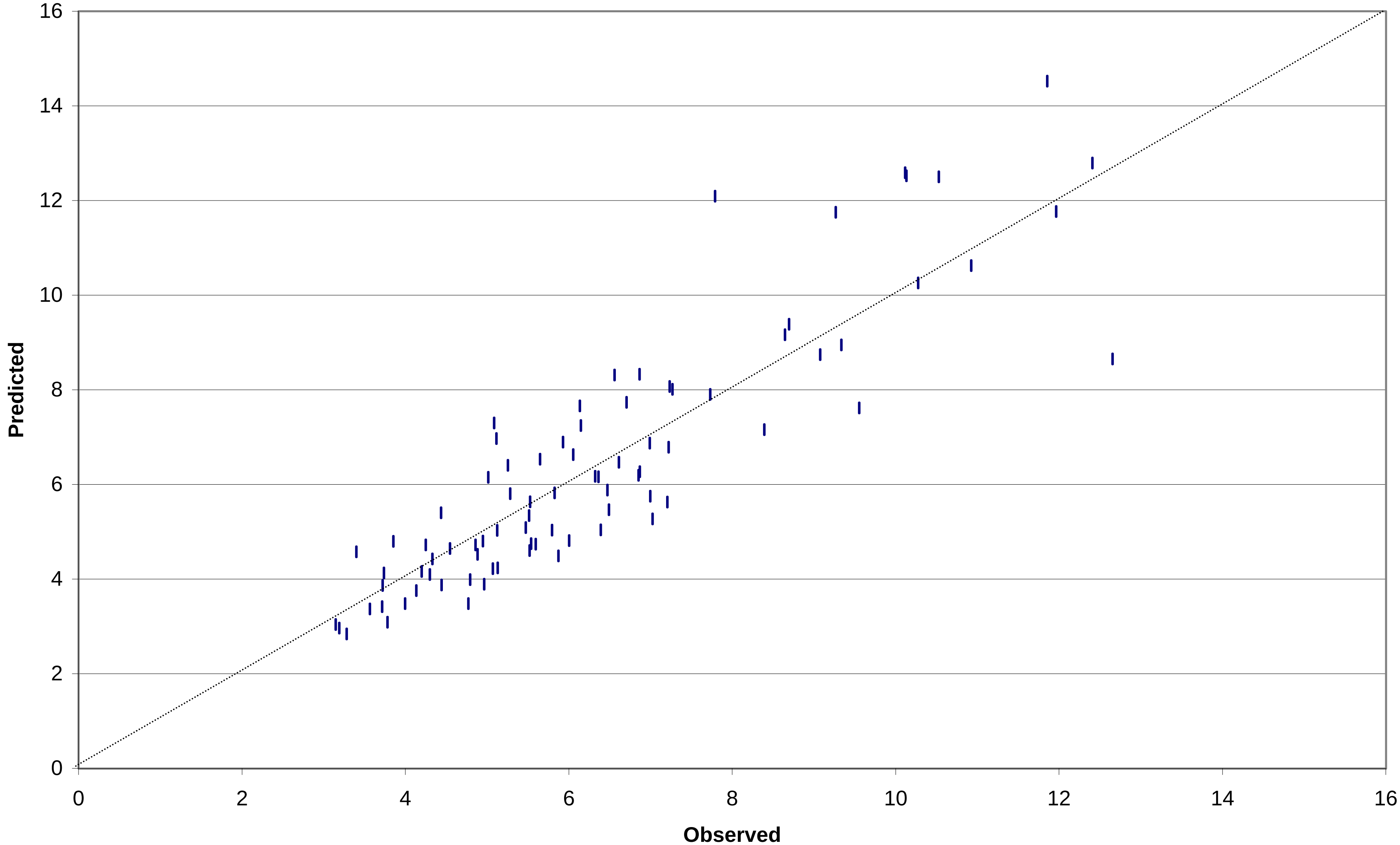
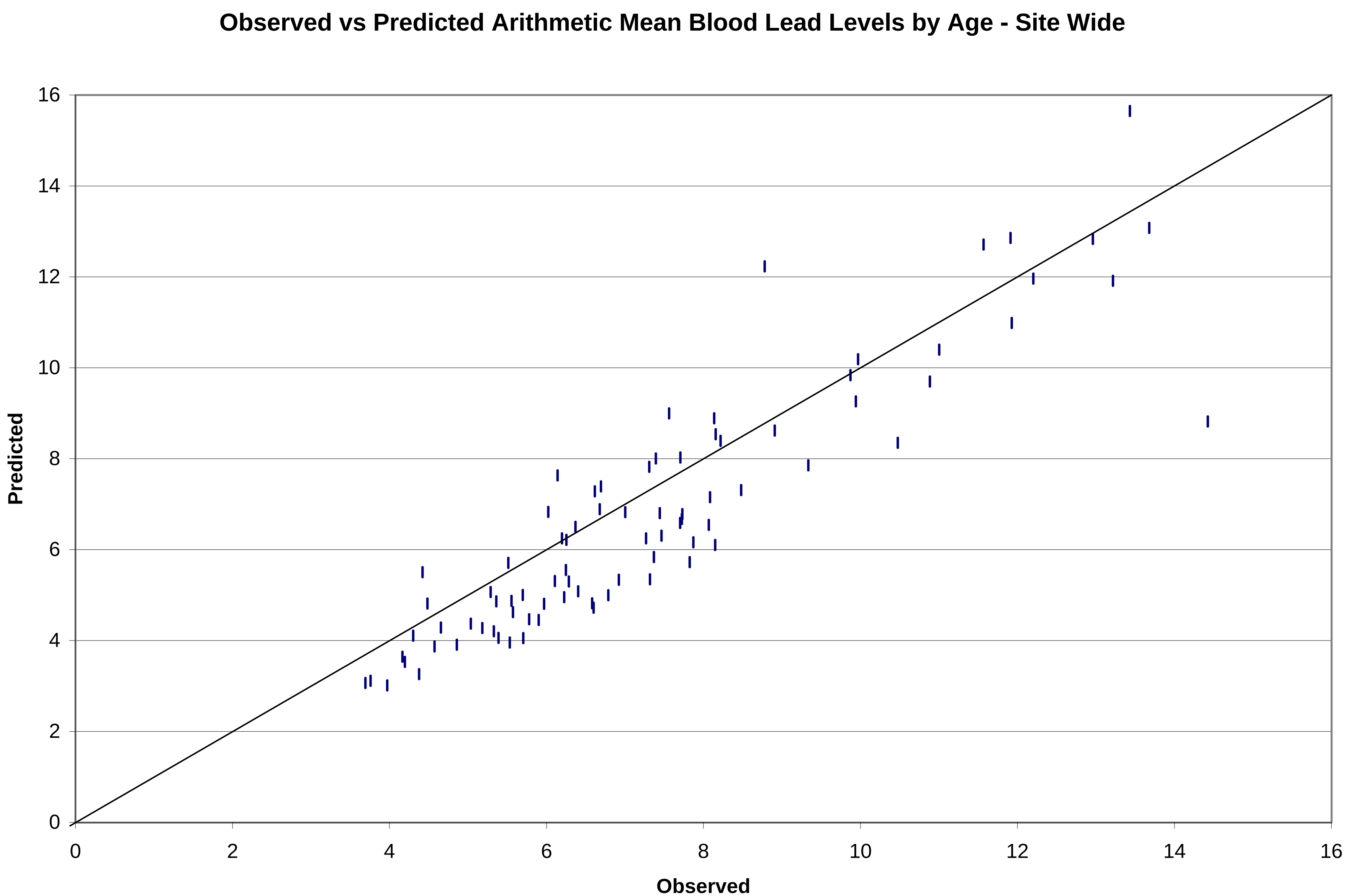


Figure 17 c
Predicted and Observed Percent of Children with Blood Lead Level Exceeding 10 mg/dl, Site Wide 1988-1999



Observed vs. Predicted Geometric Mean Blood Lead Levels by Age - Site Wide





Observed vs Predicted Arithmetic Mean Blood Lead Levels by Age - Site Wide
Predicted
Observed
0
2
4
6
8
10
12
14
16

Table 4.7 Percent of Children with Blood Lead ≥ 10 mg/dl

Year	Kellogg	Page	Pinehurst	Smelterville	Wardner	Site wide
1988	41%	58%		72%	33%	46%
1989	52%	27%		78%	54%	56%
1990	40%	53%	29%	31%	44%	37%
1991	20%	20%	5%	23%	11%	15%
1992	32%	9%	18%	31%	22%	27%
1993	18%	21%	5%	20%	22%	15%
1994	20%	9%	11%	21%	6%	17%
1995	17%	20%	5%	28%	17%	15%
1996	17%	9%	1%	12%	29%	12%
1997	15%	0%	3%	9%	8%	11%
1998	10%	0%	3%	14%	8%	8%
1999	6%	0%	9%	4%	11%	6%

Table 1
Summary of Children with Elevated Blood Lead Levels, 1988-1999

Year	City	Number of Observations	Blood Lead Level Range (ug/dl)		Number and Percent of Children with Elevated Blood Lead Levels			
					Blood Lead ^{3} 15 mg/dl		Blood Lead ^{3} 10 mg/dl	
			Minimum	Maximum	Number	Percent	Number	Percent
1988	KELLOGG	171	4	39	22	13%	70	41%
	PAGE	12	4	26	2	17%	7	58%
	SMELTERVILLE	32	4	55	10	31%	23	72%
	WARDNER	15	4	18	1	7%	5	33%
	SITE WIDE	**230**	**4**	**55**	**35**	**15%**	**105**	**46%**
1989	KELLOGG	212	3	40	47	22%	111	52%
	PAGE	14	6	22	5	36%	8	57%
	SMELTERVILLE	36	5	41	15	42%	28	78%
	WARDNER	13	6	20	4	31%	7	54%
	SITE WIDE	**275**	**3**	**41**	**71**	**26%**	**154**	**56%**
1990	KELLOGG	193	4	25	22	11%	78	40%
	PAGE	17	4	21	6	35%	9	53%
	PINEHURST	107	4	20	5	5%	31	29%
	SMELTERVILLE	29	4	30	7	24%	9	31%
	WARDNER	16	4	15	1	6%	7	44%
	SITE WIDE	**362**	**4**	**30**	**41**	**11%**	**134**	**37%**
1991	KELLOGG	177	4	31	12	7%	35	20%
	PAGE	15	4	14	0	0%	3	20%
	PINEHURST	116	4	26	4	3%	6	5%
	SMELTERVILLE	48	4	16	1	2%	11	23%
	WARDNER	9	4	11	0	0%	1	11%
	SITE WIDE	**365**	**4**	**31**	**17**	**5%**	**56**	**15%**
1992	KELLOGG	211	4	26	27	13%	67	32%
	PAGE	11	4	10	0	0%	1	9%
	PINEHURST	120	4	15	1	1%	21	18%
	SMELTERVILLE	55	4	30	2	4%	17	31%
	WARDNER	18	4	15	1	6%	4	22%
	SITE WIDE	**415**	**4**	**30**	**31**	**7%**	**110**	**27%**
1993	KELLOGG	228	1	24	9	4%	40	18%
	PAGE	14	3	12	0	0%	3	21%
	PINEHURST	119	1	13	0	0%	6	5%
	SMELTERVILLE	66	1	26	1	2%	13	20%
	WARDNER	18	3	14	0	0%	4	22%
	SITE WIDE	**445**	**1**	**26**	**10**	**2%**	**66**	**15%**
1994	KELLOGG	232	1	41	13	6%	47	20%
	PAGE	11	2	12	0	0%	1	9%
	PINEHURST	109	1	19	2	2%	12	11%
	SMELTERVILLE	48	2	13	0	0%	10	21%
	WARDNER	16	2	11	0	0%	1	6%
	SITE WIDE	**416**	**1**	**41**	**15**	**4%**	**71**	**17%**
1995	KELLOGG	252	1	30	16	6%	43	17%
	PAGE	10	2	12	0	0%	2	20%
	PINEHURST	97	1	15	1	1%	5	5%
	SMELTERVILLE	40	2	17	3	8%	11	28%
	WARDNER	6	3	10	0	0%	1	17%
	SITE WIDE	**405**	**1**	**30**	**20**	**5%**	**62**	**15%**
1996	KELLOGG	225	1	54	11	5%	39	17%
	PAGE	11	2	13	0	0%	1	9%
	PINEHURST	103	1	12	0	0%	1	1%
	SMELTERVILLE	51	2	15	1	2%	6	12%
	WARDNER	7	3	15	1	14%	2	29%
	SITE WIDE	**397**	**1**	**54**	**13**	**3%**	**49**	**12%**

Table 1
Summary of Children with Elevated Blood Lead Levels, 1988-1999

Year	City	Number of Observations	Blood Lead Level Range (ug/dl) Minimum	Blood Lead Level Range (ug/dl) Maximum	Number and Percent of Children with Elevated Blood Lead Levels: Blood Lead ^{3} 15 mg/dl Number	Blood Lead ^{3} 15 mg/dl Percent	Blood Lead ^{3} 10 mg/dl Number	Blood Lead ^{3} 10 mg/dl Percent
1997	KELLOGG	199	1	22	5	3%	29	15%
	PAGE	7	2	9	0	0%	0	0%
	PINEHURST	86	1	17	1	1%	3	3%
	SMELTERVILLE	33	2	10	0	0%	3	9%
	WARDNER	12	1	10	0	0%	1	8%
	SITE WIDE	**337**	**1**	**22**	**6**	**2%**	**36**	**11%**
1998	KELLOGG	212	1	19	3	1%	21	10%
	PAGE	8	3	6	0	0%	0	0%
	PINEHURST	100	1	17	1	1%	3	3%
	SMELTERVILLE	43	3	20	1	2%	6	14%
	WARDNER	12	1	13	0	0%	1	8%
	SITE WIDE	**375**	**1**	**20**	**5**	**1%**	**31**	**8%**
1999	KELLOGG	198	1	14	0	0%	11	6%
	PAGE	8	1	8	0	0%	0	0%
	PINEHURST	106	1	17	2	2%	9	8%
	SMELTERVILLE	49	1	17	1	2%	2	4%
	WARDNER	9	1	12	0	0%	1	11%
	SITE WIDE	**370**	**1**	**17**	**3**	**1%**	**23**	**6%**

Table 2
Blood Lead Levels (mg/dl) by Year 1974-1999

Year	City	Number of Observations	Blood Lead Level Range (ug/dl)		Mean Blood Lead Level			
					Arithmetic		Geometric	
			Minimum	Maximum	Mean	S. D.	Mean	S. D.
1974	KELLOGG	179	25	88	49.6	13.3	47.9	1.3
	PAGE	7	39	69	48.7	9.6	48.0	1.2
	PINEHURST	193	19	64	34.9	8.2	33.9	1.3
	SMELTERVILLE	174	34	164	68.1	19.9	65.6	1.3
	WARDNER	16	11	63	42.9	12.6	40.4	1.5
1975	KELLOGG	408	16	76	39.1	11.7	37.4	1.4
	PINEHURST	102	15	58	31.7	10.0	30.1	1.4
	SMELTERVILLE	115	24	85	46.4	12.4	44.8	1.3
	WARDNER	9	21	43	34.2	7.6	33.4	1.3
1983	SMELTERVILLE	43	6	35	21.4	8.0	19.6	1.6
	AREA 2 *	199	5	45	17.1	7.6	15.5	1.5
	PINEHURST	122	1	40	12.2	6.1	10.8	1.7
1988	KELLOGG	171	4	39	9.2	5.1	8.0	1.7
	PAGE	12	4	26	10.3	6.6	8.5	1.9
	SMELTERVILLE	32	4	55	14.2	11.1	11.6	1.8
	WARDNER	15	4	18	8.5	3.7	7.8	1.5
1989	KELLOGG	212	3	40	10.8	6.0	9.3	1.7
	PAGE	14	6	22	12.5	5.6	11.4	1.6
	SMELTERVILLE	36	5	41	14.6	7.1	13.2	1.6
	WARDNER	13	6	20	11.8	4.5	11.0	1.5
1990	KELLOGG	193	4	25	9.3	4.6	8.3	1.6
	PAGE	17	4	21	11.0	6.0	9.4	1.8
	PINEHURST	107	4	20	7.4	3.7	6.7	1.6
	SMELTERVILLE	29	4	30	9.9	5.6	8.8	1.6
	WARDNER	16	4	15	9.1	3.3	8.5	1.5
1991	KELLOGG	177	4	31	6.9	4.6	6.0	1.6
	PAGE	15	4	14	6.5	3.4	5.9	1.6
	PINEHURST	116	4	26	5.1	3.0	4.7	1.4
	SMELTERVILLE	48	4	16	6.6	3.3	5.9	1.6
	WARDNER	9	4	11	5.6	2.4	5.2	1.4
1992	KELLOGG	211	4	26	8.1	4.9	6.9	1.7
	PAGE	11	4	10	6.1	1.9	5.8	1.4
	PINEHURST	120	4	15	6.0	2.8	5.5	1.5
	SMELTERVILLE	55	4	30	8.3	4.8	7.4	1.6
	WARDNER	18	4	15	7.2	2.8	6.8	1.4
1993	KELLOGG	228	1	24	6.3	4.0	5.2	1.9
	PAGE	14	3	12	6.1	2.8	5.6	1.5
	PINEHURST	119	1	13	3.5	2.8	2.6	2.2
	SMELTERVILLE	66	1	26	6.7	3.9	5.8	1.8
	WARDNER	18	3	14	7.3	3.1	6.7	1.5
1994	KELLOGG	232	1	41	6.7	4.6	5.5	1.9
	PAGE	11	2	12	5.5	2.8	4.9	1.6
	PINEHURST	109	1	19	5.4	3.3	4.6	1.8
	SMELTERVILLE	48	2	13	6.0	3.3	5.3	1.7
	WARDNER	16	2	11	4.9	2.5	4.3	1.7

Table 2
Blood Lead Levels (mg/dl) by Year 1974-1999 (continued)

			Blood Lead Level Range (ug/dl)		Mean Blood Lead Level			
					Arithmetic		Geometric	
Year	**City**	**Number of Observations**	**Minimum**	**Maximum**	**Mean**	**S. D.**	**Mean**	**S. D.**
1995	KELLOGG	252	1	30	6.4	4.3	5.2	1.9
	PAGE	10	2	12	6.1	3.4	5.3	1.8
	PINEHURST	97	1	15	4.6	2.5	4.0	1.8
	SMELTERVILLE	40	2	17	7.2	3.9	6.2	1.7
	WARDNER	6	3	10	5.5	2.6	5.1	1.5
1996	KELLOGG	225	1	54	6.4	5.2	5.1	1.9
	PAGE	11	2	13	5.0	3.4	4.2	1.9
	PINEHURST	103	1	12	4.1	2.0	3.7	1.6
	SMELTERVILLE	51	2	15	6.4	3.0	5.8	1.6
	WARDNER	7	3	15	7.4	4.3	6.4	1.8
1997	KELLOGG	199	1	22	5.9	3.4	5.0	1.8
	PAGE	7	2	9	6.3	2.4	5.7	1.7
	PINEHURST	86	1	17	4.2	3.0	3.5	1.8
	SMELTERVILLE	33	2	10	5.6	2.3	5.2	1.5
	WARDNER	12	1	10	4.9	3.1	3.9	2.2
	SITE WIDE	337	1	22	5.4	3.2	4.5	1.8
1998	KELLOGG	212	1	19	4.9	3.1	4.0	1.9
	PAGE	8	3	6	4.8	1.3	4.6	1.3
	PINEHURST	100	1	17	4.1	2.6	3.5	1.7
	SMELTERVILLE	43	3	20	6.4	3.2	5.8	1.5
	WARDNER	12	1	13	4.7	3.4	3.7	2.1
	SITE WIDE	375	1	20	4.8	3.0	4.0	1.9
1999	KELLOGG	198	1	14	4.5	2.7	3.7	1.9
	PAGE	8	1	8	4.1	2.2	3.5	1.9
	PINEHURST	106	1	17	5.0	3.1	4.2	1.8
	SMELTERVILLE	49	1	17	4.3	2.9	3.6	1.9
	WARDNER	9	1	12	5.4	3.2	4.5	2.0
	SITE WIDE	370	1	17	4.7	2.9	3.9	1.9

* Kellogg, Wardner, and Page Combined

Table 3 Yard Soil Remediation Progress, 1988-1999

Year	City	Number of Residential Units	Number (%) Above Action Level [a]	Number (%) Remediated This Year	Number (%) Remediated Total	Mean Soil Lead Concentration Prior To Remediation (mg/kg)	
						Arithmetic	Geometric
1988	Kellogg	1454	1294 (89%)	0 (0%)	0 (0%)	2805	2128
	Page	71	26 (37%)	0 (0%)	0 (0%)	1005	732
	Pinehurst	790	158 (20%)	0 (0%)	0 (0%)	567	435
	Smelterville	321	298 (93%)	0 (0%)	0 (0%)	3431	2308
	Wardner	137	95 (69%)	0 (0%)	0 (0%)	2586	1548
	Total	2773	1871 (67%)	0 (0%)	0 (0%)	---	---
1989	Kellogg	1454	1294 (89%)	86 (6%)	86 (6%)	2805	2128
	Page	71	26 (37%)	4 (6%)	4 (6%)	1005	732
	Pinehurst	790	158 (20%)	0 (0%)	0 (0%)	567	435
	Smelterville	321	282 (88%)	18 (6%)	18 (6%)	3431	2308
	Wardner	137	95 (69%)	3 (2%)	3 (2%)	2586	1548
	Total	2773	1855 (67%)	111 (4%)	111 (4%)	---	---
1990	Kellogg	1454	1208 (83%)	117 (8%)	203 (14%)	2490	1529
	Page	71	22 (31%)	3 (4%)	7 (10%)	931	607
	Pinehurst	790	158 (20%)	0 (0%)	0 (0%)	565	434
	Smelterville	321	264 (82%)	20 (6%)	38 (12%)	3258	1974
	Wardner	137	92 (67%)	20 (15%)	23 (17%)	2522	1412
	Total	2773	1744 (63%)	160 (6%)	271 (10%)	---	---
1991	Kellogg	1454	1091 (75%)	60 (4%)	263 (18%)	2288	1202
	Page	71	19 (27%)	2 (3%)	9 (13%)	838	529
	Pinehurst	790	158 (20%)	0 (0%)	0 (0%)	565	434
	Smelterville	321	244 (76%)	21 (7%)	59 (18%)	3069	1649
	Wardner	137	72 (52%)	5 (4%)	28 (20%)	2255	1014
	Total	2773	1584 (57%)	88 (3%)	359 (13%)	---	---
1992	Kellogg	1454	1031 (71%)	67 (5%)	330 (23%)	2131	1029
	Page	71	17 (24%)	3 (4%)	12 (17%)	759	479
	Pinehurst	790	158 (20%)	15 (2%)	15 (2%)	565	434
	Smelterville	321	223 (70%)	11 (3%)	70 (22%)	2713	1272
	Wardner	137	67 (49%)	4 (3%)	32 (23%)	2187	924
	Total	2773	1496 (54%)	100 (4)	459 (17%)	---	---
1993	Kellogg	1454	964 (66%)	19 (1%)	349 (24%)	1994	888
	Page	71	14 (20%)	3 (4%)	15 (21%)	722	433
	Pinehurst	790	143 (18%)	8 (1%)	23 (3%)	530	402
	Smelterville	321	212 (66%)	5 (2%)	75 (23%)	2608	1148
	Wardner	137	63 (46%)	4 (3%)	36 (26%)	2161	873
	Total	2773	1396 (50%)	39 (1%)	498 (18%)	---	---
1994	Kellogg	1454	945 (65%)	33 (2%)	382 (26%)	1948	847
	Page	71	11 (16%)	2 (3%)	17 (24%)	673	397
	Pinehurst	790	135 (17%)	39 (5%)	62 (8%)	503	383
	Smelterville	321	207 (65%)	77 (24%)	152 (47%)	2548	1098
	Wardner	137	59 (43%)	8 (6%)	44 (32%)	2076	794
	Total	2773	1357 (49%)	159 (6%)	657 (24%)	---	---

Table 3 Yard Soil Remediation Progress, 1988-1999 (continued)

		Number of	Number (%)	Number (%)	Number (%)	Mean Soil Lead Concentration

Year	City	Residential Units	Above Action Level[a]	Remediated This Year	Remediated Total	Prior To Remediation (mg/kg)	
						Arithmetic	Geometric
1995	Kellogg	1454	912 (63%)	30 (2%)	412 (28%)	1851	780
	Page	71	9 (13%)	0 (0%)	17 (24%)	654	374
	Pinehurst	790	96 (12%)	8 (1%)	70 (9%)	496	376
	Smelterville	321	130 (40%)	127 (40%)	279 (87%)	1630	493
	Wardner	137	51 (37%)	0 (0%)	44 (32%)	1883	652
	Total	2773	1198 (43%)	165 (6%)	822 (30%)	---	---
1996	Kellogg	1454	882 (61%)	157 (11%)	569 (39%)	1768	717
	Page	71	9 (13%)	0 (0%)	17 (24%)	629	358
	Pinehurst	790	88 (11%)	3 (0.4%)	73 (9%)	487	367
	Smelterville	321	3 (1%)	7 (2%)	286 (89%)	370	147
	Wardner	137	51 (37%)	2 (1%)	46 (34%)	1883	652
	Total	2773	1033 (37%)	169 (6%)	991 (36%)	---	---
1997	Kellogg	1454	725 (50%)	186 (13%)	755 (52%)	1374	485
	Page	71	9 (13%)	0 (0%)	17 (24%)	629	358
	Pinehurst	790	85 (11%)	3 (0.4%)	76 (10%)	480	359
	Smelterville	321	0 (0%)	0 (0%)	286 (89%)	245	135
	Wardner	137	49 (35%)	3 (2%)	49 (36%)	1863	636
	Total	2773	864 (31%)	192 (7%)	1183 (43%)	---	---
1998	Kellogg	1454	539 (37%)	153 (11%)	908 (62%)	1039	319
	Page	71	9 (13%)	2 (3%)	19 (27%)	629	358
	Pinehurst	790	82 (10%)	5 (1%)	81 (10%)	466	350
	Smelterville	321	0 (0%)	12 (4%)	298 (93%)	245	135
	Wardner	137	46 (33%)	0 (0%)	49 (36%)	1824	597
	Total	2773	676 (24%)	172 (6%)	1355 (49%)	---	---
1999[b]	Kellogg	1454				745	222
	Page	71				598	333
	Pinehurst	790				452	338
	Smelterville	321				222	132
	Wardner	137				1824	597
	Total	2773				---	---

[a]Estimated from the Record of Decision

[b]Yard remediation data not yet available for 1999

mg/kg: milligrams per kilogram

---: Not applicable

Table 4 Yard Soil Lead Exposure by Year 1974-1999[b]

Year	City	Number of Children	Concentration Range (mg/kg) [d]		Mean Soil Lead Concentration (mg/kg)			
			Minimum	Maximum	Arithmetic Mean	Standard Deviation	Geometric Mean	Standard Deviation
1974	Kellogg	171	35	14000	3073	2199	2255	2.62
	Page	7	730	6800	3609	2477	2652	2.58
	Pinehurst	184	84	10400	1169	1434	768	2.41
	Smelterville	174	120	24600	7386	5157	5770	2.19
	Wardner	16	1000	23200	4863	5365	3405	2.29
1975	Kellogg	328	144	25800	3918	3652	2658	2.60
	Pinehurst	88	108	4020	676	617	497	2.18
	Smelterville	104	268	31800	5581	4721	3907	2.52
	Wardner	9	316	4800	2372	2311	1186	3.92
1983	Smelterville	43	83	17550	6231	3945	4188	3.60
	Area 2[a]	185	108	41200	3201	3722	2334	2.28
	Pinehurst	117	97	4375	814	842	534	2.54
1988	Kellogg	138	136	10400	3140	1796	2582	2.00
	Page	11	589	2720	1591	817	1365	1.86
	Smelterville	29	356	10700	2932	2180	2198	2.33
	Wardner	10	271	1930	1047	514	919	1.78
1989[c]	Kellogg	162	136	9230	2846	1600	2374	1.92
	Page	13	53	2720	1156	775	848	2.72
	Smelterville	34	356	8740	2975	2594	1858	2.94
	Wardner	11	271	2250	1304	632	1106	1.98
1990	Kellogg	154	100	10600	1741	1815	693	5.03
	Page	17	53	3480	953	1019	440	4.21
	Pinehurst	65	169	3060	561	474	436	2.00
	Smelterville	26	100	8170	1906	2190	719	5.21
	Wardner	14	100	13200	1675	3340	766	3.28
1991	Kellogg	176	100	7380	1088	1741	298	4.83
	Page	12	100	811	200	238	138	2.13
	Pinehurst	83	117	3060	597	597	434	2.13
	Smelterville	48	100	10700	1235	2063	319	5.16
	Wardner	9	100	100	100	0	100	1.00
1992	Kellogg	206	100	6930	1068	1639	302	4.80
	Page	11	100	1190	353	452	187	2.96
	Pinehurst	96	79	3060	571	530	419	2.15
	Smelterville	55	100	8800	1254	2329	311	4.99
	Wardner	15	100	100	100	0	100	1.00
1993	Kellogg	214	100	10600	772	1531	223	3.96
	Page	14	100	1670	493	570	241	3.43
	Pinehurst	109	79	3060	525	575	360	2.31
	Smelterville	60	100	7650	1639	2644	339	5.88
	Wardner	14	100	1850	409	623	179	3.20
1994	Kellogg	213	100	13400	952	1901	256	4.37
	Page	11	100	1670	463	512	260	3.12
	Pinehurst	93	79	2860	407	412	282	2.32
	Smelterville	48	100	8740	1074	2374	202	4.56
	Wardner	14	100	2568	453	801	179	3.28

Table 4 Yard Soil Lead Exposure by Year 1974-1999[b] (continued)

| | | | Concentration | Mean Soil Lead Concentration (mg/kg) |

Year	City	Number of Children	Range (mg/kg) [d]		Arithmetic Mean	Standard Deviation	Geometric Mean	Standard Deviation
			Minimum	Maximum				
1995	Kellogg	231	100	10500	1663	2486	435	5.60
	Page	10	100	664	309	274	207	2.57
	Pinehurst	74	100	2670	373	483	234	2.44
	Smelterville	38	100	7370	873	1932	184	4.19
	Wardner	5	100	2568	1142	1051	561	4.91
1996	Kellogg	195	100	6880	855	1487	245	4.28
	Page	11	100	664	301	278	198	2.57
	Pinehurst	64	37	1380	377	360	234	2.72
	Smelterville	40	100	3900	195	601	110	1.78
	Wardner	6	100	3180	1949	1458	935	5.66
1997	Kellogg	178	100	4770	472	942	176	3.12
	Page	7	100	664	341	236	255	2.42
	Pinehurst	74	37	2860	470	561	305	2.50
	Smelterville	31	100	766	176	165	137	1.87
	Wardner	11	100	100	100	0	100	1.00
1998	Kellogg	205	100	4957	322	827	128	2.46
	Page	27	100	1322	412	355	267	2.70
	Pinehurst	73	37	1850	368	280	277	2.23
	Smelterville	42	100	616	169	150	133	1.83
	Wardner	12	100	100	100	0	100	1.00
1999	Kellogg	181	100	5590	294	814	130	2.29
	Page	7	100	664	444	244	351	2.36
	Pinehurst	87	100	1020	372	254	287	2.12
	Smelterville	45	100	627	240	188	179	2.12
	Wardner	9	100	1040	274	354	162	2.61

[a] Kellogg, Wardner, and Page Combined

[b]Only homes where children's blood samples were obtained

[c]1989 exposures are projected from 1988 samples of the same homes

[d]Yards are assigned a lead concentration of 100 mg/kg once remediated

mg/kg: milligram per kilogram

Table 5 Number of Children on Remediated and Non-Remediated Yards 1988-1999[b]

Year	City	Number and Percent of Children on Yards Below the Action Level			Number and Percent of Children on Contaminated Yards	
		Remediated Yards	Yards < 1000 mg/kg Lead	Percent of Children	Yards > 1000 mg/kg Lead	Percent of Children
1988	Kellogg	-	11	8%	127	92%
	Page	-	4	36%	7	64%
	Smelterville	-	5	17%	24	83%
	Wardner	-	5	50%	5	50%
	Site Wide[a]	-	25	13%	163	87%
1989	Kellogg	-	16	10%	146	90%
	Page	-	8	62%	5	38%
	Smelterville	-	10	29%	24	71%
	Wardner	-	3	27%	8	73%
	Site Wide[a]	-	37	17%	183	83%
1990	Kellogg	60	7	44%	87	56%
	Page	6	5	65%	6	35%
	Pinehurst	0	57	88%	8	12%
	Smelterville	9	3	46%	14	54%
	Wardner	2	8	71%	4	29%
	Site Wide	77	80	57%	119	43%
1991	Kellogg	117	1	67%	58	33%
	Page	10	2	100%	0	0%
	Pinehurst	0	74	89%	9	11%
	Smelterville	31	1	67%	16	33%
	Wardner	9	0	100%	0	0%
	Site Wide	167	78	75%	83	25%
1992	Kellogg	135	7	69%	64	31%
	Page	8	1	82%	2	18%
	Pinehurst	0	86	90%	10	10%
	Smelterville	35	4	71%	16	29%
	Wardner	15	0	100%	0	0%
	Site Wide	193	98	76%	92	24%
1993	Kellogg	153	17	79%	44	21%
	Page	9	2	79%	3	21%
	Pinehurst	11	89	92%	9	8%
	Smelterville	39	3	70%	18	30%
	Wardner	11	0	79%	3	21%
	Site Wide	223	111	81%	77	19%
1994	Kellogg	145	16	76%	52	24%
	Page	6	4	91%	1	9%
	Pinehurst	19	70	96%	4	4%
	Smelterville	39	0	81%	9	19%
	Wardner	11	1	86%	2	14%
	Site Wide	220	91	82%	68	18%

Table 5 Number of Children on Remediated and Non-Remediated Yards 1988-1999[b] (continued)

Year	City	Number and Percent of Children on Yards Below the Action Level			Number and Percent of Children on Contaminated Yards	
		Remediated Yards	Yards < 1000 mg/kg Lead	Percent of Children	Yards > 1000 mg/kg Lead	Percent of Children
1995	Kellogg	126	15	61%	89	39%
	Page	6	4	100%	0	0%
	Pinehurst	27	43	95%	4	5%
	Smelterville	32	0	84%	6	16%
	Wardner	2	0	40%	3	60%
	Site Wide	193	62	71%	102	29%
1996	Kellogg	139	4	73%	52	27%
	Page	7	4	100%	0	0%
	Pinehurst	29	31	94%	4	6%
	Smelterville	39	0	100%	0	0%
	Wardner	2	0	33%	4	67%
	Site Wide	216	39	81%	60	19%
1997	Kellogg	169	15	87%	27	13%
	Page	3	4	100%	0	0%
	Pinehurst	18	56	95%	4	5%
	Smelterville	26	7	100%	0	0%
	Wardner	12	0	100%	0	0%
	Site Wide	228	82	91%	31	9%
1998	Kellogg	180	13	94%	12	6%
	Page	13	13	96%	1	4%
	Pinehurst	16	57	99%	1	1%
	Smelterville	34	8	100%	0	0%
	Wardner	12	0	100%	0	0%
	Site Wide	255	91	96%	14	4%
1999	Kellogg	161	170	94%	11	6%
	Page	2	7	100%	0	0%
	Pinehurst	21	86	99%	1	1%
	Smelterville	27	45	100%	0	0%
	Wardner	7	8	89%	1	11%
	Site Wide	218	316	96%	13	4%

[a]Does not include Pinehurst

[b]Only homes where children's blood samples were obtained

mg/kg: milligrams per kilogram

-: Not applicable

Table 6 House Dust Lead Exposure by Year 1974-1999[b]

Year	City	Number of Children	Concentration Range (mg/kg)		Mean House Dust Lead Concentration (mg/kg)			
			Minimum	Maximum	Arithmetic Mean	Standard Deviation	Geometric Mean	Standard Deviation
1974	Kellogg	68	1945	24500	8316	5722.5	6765	1.91
	Page	0						
	Pinehurst	49	940	4790	2317	1097.9	2087	1.59
	Smelterville	86	1940	26700	11997	5277.5	10789	1.65
	Wardner	11	2060	6800	5318	1547.3	5033	1.47
1975	Kellogg	243	325	9850	5094	2038.6	4552	1.73
	Pinehurst	65	465	6000	2042	1186.3	1707	1.87
	Smelterville	60	200	9350	4736	2852.2	3492	2.54
	Wardner	5	2550	3350	2710	357.8	2693	1.13
1983	Smelterville	42	322	18400	4734	4207.0	2922	3.07
	Area 2[a]	194	53	20700	3621	3520.1	2585	2.35
	Pinehurst	121	151	2915	590	459.0	471	1.92
1988	Kellogg	58	94	52700	3336	7790.4	1516	2.85
	Page	3	69	1160	746	591.4	432	4.91
	Smelterville	23	209	4640	1746	1376.7	1237	2.51
	Wardner	4	427	1480	736	503.5	637	1.80
1989[c]	Kellogg	47	228	52700	4568	9721.2	1652	3.31
	Page	5	69	1160	794	496.4	547	3.38
	Smelterville	14	209	4640	1628	1352.9	1193	2.42
	Wardner	2	610	610	610	0.0	610	1.00
1990	Kellogg	89	117	6230	1610	1164.9	1245	2.22
	Page	5	898	2070	1221	487.3	1159	1.41
	Pinehurst	57	119	7990	1140	1491.2	747	2.37
	Smelterville	15	777	4210	2117	1128.8	1849	1.72
	Wardner	5	691	2220	1231	749.8	1064	1.81
1991	Kellogg	75	274	3960	1460	761.0	1283	1.69
	Page	5	545	1680	1285	432.6	1202	1.57
	Pinehurst	59	65	13500	912	1732.0	603	2.16
	Smelterville	27	790	2700	1468	496.0	1393	1.39
	Wardner	4	307	964	784	319.5	712	1.75
1992	Kellogg	125	104	5530	1183	838.8	928	2.08
	Page	5	473	1500	792	420.5	719	1.61
	Pinehurst	78	165	3470	769	645.0	601	1.96
	Smelterville	26	140	3790	1175	1033.3	881	2.15
	Wardner	9	322	5240	1458	1508.9	997	2.51
1993	Kellogg	115	111	3210	966	563.7	806	1.91
	Page	6	139	794	550	227.1	486	1.89
	Pinehurst	55	111	3460	707	763.7	490	2.29
	Smelterville	26	201	3350	1307	818.6	1086	1.94
	Wardner	8	382	1290	766	353.4	695	1.61
1994	Kellogg	106	88	3770	835	551.7	660	2.13
	Page	7	90	1340	619	485.2	450	2.55
	Pinehurst	48	88	1490	491	283.7	420	1.82
	Smelterville	35	228	3060	1146	785.9	872	2.21
	Wardner	13	211	2270	1025	764.3	764	2.31

Table 6 House Dust Lead Exposure by Year 1974-1999[b] (continued)

			Concentration	Mean House Dust Lead Concentration (mg/kg)

Year	City	Number of Children	Range (mg/kg)		Arithmetic Mean	Standard Deviation	Geometric Mean	Standard Deviation
			Minimum	Maximum				
1995	Kellogg	98	62	4400	906	809	679	2.15
	Page	3	239	1430	791	600	622	2.46
	Pinehurst	38	22	1720	458	381	299	3.02
	Smelterville	20	297	3470	1020	1087	703	2.24
	Wardner	4	245	601	408	190	374	1.63
1996	Kellogg	108	85	2300	684	399	577	1.86
	Page	3	140	630	303	283	231	2.38
	Pinehurst	38	100	2100	519	459	403	2.00
	Smelterville	12	99	11300	2299	4213	667	4.69
	Wardner	3	130	890	637	439	469	3.04
1997	Kellogg	59	43	6800	1047	1445	631	2.63
	Page	2	230	690	460	325	398	2.17
	Pinehurst	19	140	15000	1155	3363	397	2.83
	Smelterville	15	110	1070	453	323	354	2.09
	Wardner	6	220	1100	668	473	509	2.33
1998	Kellogg	84	140	4000	856	764	654	2.04
	Page	4	550	1500	848	441	779	1.57
	Pinehurst	36	71	2000	399	367	302	2.08
	Smelterville	26	340	1100	621	201	595	1.34
	Wardner	10	270	6000	1589	2335	738	3.27
1999	Kellogg	93	199	15300	1134	2638	620	2.27
	Page	3	151	258	222	62	215	1.36
	Pinehurst	64	45.4	4010	435	492	337	1.99
	Smelterville	15	259	2150	596	527	459	1.97
	Wardner	2	254	2160	1207	1348	742	4.53

[a]Kellogg, Wardner, and Page Combined

[b]Vacuum bags collected only from homes where children's blood samples were obtained

[c]1989 exposures are projected from 1988 samples of the same homes

mg/kg: milligram per kilogram

Table 7

Percent of Children Exceeding the 10 mg/dl Blood Lead Remedial Action Objective (RAO) by City 1989-1999 (number of children)

City	1989	1997	1998	1999	RAO
Kellogg	52% (111)	15% (29)	10% (21)	6% (11)	<5%
Page	57% (8)	0% (0)	0% (0)	0% (0)	<5%
Pinehurst	29% (31)*	3% (3)	3% (3)	9% (9)	<5%
Smelterville	78% (28)	9% (3)	14% (6)	4% (2)	<5%
Wardner	54% (7)	8% (1)	8% (1)	11% (1)	<5%

* 1990 data used because 1989 data were not collected for Pinehurst

Table 8

Percent of Children Exceeding the 15 mg/dl Blood Lead Remedial Action Objective (RAO) by City 1989-1999 (number of children)

City	1989	1997	1998	1999	RAO
Kellogg	22% (47)	3% (5)	1.4% (3)	0% (0)	<1%
Page	36% (5)	0% (0)	0% (0)	0% (0)	<1%
Pinehurst	5% (5)*	1% (1)	1% (1)	2% (2)	<1%
Smelterville	42% (15)	0% (0)	2.3% (1)	2% (1)	<1%
Wardner	31% (4)	0% (0)	0% (0)	0% (0)	<1%

* 1990 data used because 1989 data were not collected for Pinehurst

Table 9 Children Living at Residence Less than Six Months or One Year Kellogg 1988-1999

Year	Percentage of Children at Address		Number of Children Living Less Than One Year at the Reported Address		
	< 6 months	<1 year	Total Newcomers	Number of Newcomers in Homes with Contaminated Yards	Percent of Newcomers in homes with Contaminated Yards
1988	20%	30%	51	36	71%
1989	28%	51%	108	73	68%
1990	27%	45%	86	44	51%
1991	28%	37%	66	37	56%
1992	26%	48%	101	44	44%
1993	23%	41%	94	30	32%
1994	37%	51%	119	36	30%
1995	28%	46%	117	59	50%
1996	22%	43%	97	30	31%
1997	24%	41%	81	15	19%
1998	23%	38%	141	6	4%
1999[a]	33%	49%	97		

[a]Yard remediation data not yet available for 1999

Table 10
1999 Compliance Status for Soil Lead Remedial Action Objectives (RAOs)

City	% of Homes with Soil Lead Concentrations > 1000 mg/kg		Community Geometric Mean Soil Conc. (mg/kg)	
	1999 Data	RAO	1999 Data	RAO
Kellogg	20%	0%	221	350
Page	17%	0%	334	350
Pinehurst	5%	0%	337	350
Smelterville	2%	0%	132	350
Wardner	44%	0%	596	350

Table 11
1999 Compliance Status for Housedust Lead Remedial Action Objectives (RAOs)

City	% of Homes with Dust Lead Concentrations > 1000 mg/kg		Community Geometric Mean Dust Conc. (mg/kg)	
	1999 Data	RAO	1999 Data	RAO
Kellogg	17%	0%	590	500
Page	0%	0%	198	500
Pinehurst	5%	0%	340	500
Smelterville	30%	0%	596	500
Wardner	50%	0%	742	500

Table 12 Mean Blood Lead Levels and Incidence of Toxicity by Age Group and Year

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1 Year Olds												
N	21	33	19	37	46	50	41	50	35	36	40	49
Minimum	4	6	4	4	4	1	2	2	2	1	2	2
Maximum	41	38	23	23	30	22	20	23	18	17	17	15
Arithmatic Mean	12.1	13.0	10.5	7.2	8.5	6.4	8.0	8.0	7.0	6.4	7.1	5.7
Standard Deviation	10.2	6.5	4.6	5.1	5.9	4.2	4.2	4.5	4.7	3.5	3.6	3.0
Geometric Mean	9.3	11.8	9.6	6.1	7.0	5.0	7.0	6.8	5.7	5.6	6.2	5.0
Geometric St. Dev.	2.1	1.5	1.6	1.7	1.8	2.1	1.7	1.8	1.9	1.7	1.6	1.7
# ≥10 mg/dl	12	22	10	9	16	9	11	15	8	6	9	7
% ≥ 10 mg/dl	57.1	66.7	52.6	24.3	34.8	18.0	26.8	30.0	22.9	16.7	22.5	14.3
# ≥ 15 mg/dl	5	9	2	4	8	2	3	5	5	2	3	1
% ≥ 15 mg/dl	23.8	27.3	10.5	10.8	17.4	4.0	7.3	10.0	14.3	5.6	7.5	2.0
# ≥ 25 mg/dl	2	2	0	0	1	0	0	0	0	0	0	0
% ≥ 25 mg/dl	9.5	6.1	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 Year Olds	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
N	23	29	35	24	51	48	57	32	46	40	39	33
Minimum	5	4	4	4	4	2	2	2	3	2	1	1
Maximum	28	40	30	24	23	26	21	17	31	18	19	17
Arithmatic Mean	11.7	13.6	11.1	7.3	8.2	7.9	7.7	6.9	8.1	6.2	6.2	6.5
Standard Deviation	6.2	7.2	6.4	5.3	4.4	4.7	4.2	3.9	5.2	3.4	3.7	3.9
Geometric Mean	10.3	12.0	9.5	6.1	7.3	6.8	6.6	6.0	6.9	5.4	5.2	5.5
Geometric St. Dev.	1.7	1.7	1.8	1.8	1.6	1.7	1.8	1.7	1.8	1.7	1.9	1.9
# ≥10 mg/dl	14	21	19	6	16	11	16	7	12	6	8	5.00
% ≥ 10 mg/dl	60.9	72.4	54.3	25.0	31.4	22.9	28.1	21.9	26.1	15.0	20.5	15.2
# ≥ 15 mg/dl	7	9	8	3	5	4	4	3	4	1	1	1
% ≥ 15 mg/dl	30.4	31.0	22.9	12.5	9.8	8.3	7.0	9.4	8.7	2.5	2.6	3.0
# ≥ 25 mg/dl	1	2	2	0	0	1	0	0	1	0	0	0
% ≥ 25 mg/dl	4.3	6.9	5.7	0.0	0.0	2.1	0.0	0.0	2.2	0.0	0.0	0.0
3 Year Olds	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
N	29	32	32	37	40	60	41	54	28	42	34	35
Minimum	4	4	4	4	4	1	1	2	1	1	1	1
Maximum	55	23	23	31	25	22	21	30	17	13	20	10
Arithmatic Mean	12.5	13.8	9.9	8.1	8.1	6.2	6.6	7.7	6.3	6.2	5.9	4.5
Standard Deviation	10.8	5.3	5.2	6.6	4.4	3.8	3.9	5.4	3.6	2.9	3.9	2.3
Geometric Mean	10.0	12.5	8.6	6.6	7.2	5.1	5.6	6.4	5.3	5.5	4.9	4.0
Geometric St. Dev.	1.9	1.6	1.7	1.8	1.6	1.9	1.8	1.9	1.9	1.7	1.9	1.7
# ≥10 mg/dl	18	27	14	10	13	9	7	14	6	7	4	1.00
% ≥ 10 mg/dl	62.1	84.4	43.8	27.0	32.5	15.0	17.1	25.9	21.4	16.7	11.8	2.9
# ≥ 15 mg/dl	5	14	6	5	3	1	2	7	1	0	1	0
% ≥ 15 mg/dl	17.2	43.8	18.8	13.5	7.5	1.7	4.9	13.0	3.6	0.0	2.9	0.0
# ≥ 25 mg/dl	3	0	0	2	1	0	0	1	0	0	0	0
% ≥ 25 mg/dl	10.3	0.0	0.0	5.4	2.5	0.0	0.0	1.9	0.0	0.0	0.0	0.0
4 Year Olds	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
N	19	32	36	33	50	43	48	43	58	30	43	34
Minimum	4	4	4	4	4	1	1	2	1	1	1	1
Maximum	18	29	21	17	20	14	15	25	54	22	14	12
Arithmatic Mean	8.6	11.3	10.2	6.6	8.1	6.7	6.0	7.4	7.3	5.5	5.3	4.9
Standard Deviation	4.4	5.7	4.7	3.4	3.9	4.0	3.1	4.6	7.2	4.3	2.9	3.0
Geometric Mean	7.6	10.0	9.2	5.9	7.2	5.1	5.2	6.3	5.6	4.3	4.5	4.0
Geometric St. Dev.	1.7	1.7	1.6	1.6	1.6	2.3	1.7	1.8	2.0	2.1	1.9	1.9
# ≥10 mg/dl	7	17	16	7	16	13	7	11	12	3	4	3.00
% ≥ 10 mg/dl	36.8	53.1	44.4	21.2	32.0	30.2	14.6	25.6	20.7	10.0	9.3	8.8
# ≥ 15 mg/dl	3	8	7	1	4	0	1	4	2	1	0	0
% ≥ 15 mg/dl	15.8	25.0	19.4	3.0	8.0	0.0	2.1	9.3	3.4	3.3	0.0	0.0
# ≥ 25 mg/dl	0	1	0	0	0	0	0	1	1	0	0	0
% ≥ 25 mg/dl	0.0	3.1	0.0	0.0	0.0	0.0	0.0	2.3	1.7	0.0	0.0	0.0

Table 12 Mean Blood Lead Levels and Incidence of Toxicity by Age Group and Year

	5 Year Olds											
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	30	20	43	32	43	46	46	46	37	40	37	50
Minimum	4	5	4	4	4	1	2	1	1	2	1	1
Maximum	25	21	22	16	21	21	17	16	17	15	11	14
Arithmatic Mean	11.7	11.5	9.4	7.1	7.3	5.6	6.3	5.7	5.7	5.9	4.7	4.6
Standard Deviation	4.7	4.5	4.3	3.7	4.1	4.0	3.1	3.1	3.0	3.1	2.8	2.5
Geometric Mean	10.7	10.6	8.4	6.3	6.4	4.5	5.6	4.9	5.0	5.1	4.0	4.0
Geometric St. Dev.	1.5	1.5	1.6	1.6	1.6	2.0	1.7	1.8	1.8	1.7	1.8	1.7
# ≥10 mg/dl	17	12	17	9	10	5	8	5	3	5	4	2.00
% ≥ 10 mg/dl	56.7	60.0	39.5	28.1	23.3	10.9	17.4	10.9	8.1	12.5	10.8	4.0
# ≥ 15 mg/dl	7	5	5	1	4	2	1	1	1	1	0	0
% ≥ 15 mg/dl	23.3	25.0	11.6	3.1	9.3	4.3	2.2	2.2	2.7	2.5	0.0	0.0
# ≥ 25 mg/dl	1	0	0	0	0	0	0	0	0	0	0	0
% ≥ 25 mg/dl	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	6 Year Olds											
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	24	29	48	42	38	54	51	37	52	33	40	40
Minimum	4	4	4	4	4	1	1	1	1	1	1	1
Maximum	18	41	16	18	21	14	41	13	13	12	11	10
Arithmatic Mean	10.0	13.9	8.0	6.2	7.3	4.5	5.5	5.7	5.3	5.7	4.4	4.0
Standard Deviation	4.9	7.8	3.5	3.5	4.2	3.4	5.8	2.8	3.2	2.9	2.3	2.4
Geometric Mean	8.8	12.1	7.2	5.6	6.4	3.4	4.3	5.0	4.4	4.9	3.8	3.3
Geometric St. Dev.	1.7	1.7	1.6	1.6	1.7	2.2	1.9	1.7	1.9	1.9	1.8	1.9
# ≥10 mg/dl	13	20	16	7	12	6	6	5	6	4	1	1.00
% ≥ 10 mg/dl	54.2	69.0	33.3	16.7	31.6	11.1	11.8	13.5	11.5	12.1	2.5	2.5
# ≥ 15 mg/dl	5	13	3	2	3	0	1	0	0	0	0	0
% ≥ 15 mg/dl	20.8	44.8	6.3	4.8	7.9	0.0	2.0	0.0	0.0	0.0	0.0	0.0
# ≥ 25 mg/dl	0	2	0	0	0	0	1	0	0	0	0	0
% ≥ 25 mg/dl	0.0	6.9	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0

	7 Year Olds											
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	23	36	45	47	45	44	37	55	49	44	40	51
Minimum	4	3	4	4	4	1	2	1	2	1	2	1
Maximum	15	21	22	14	26	11	19	9	11	17	8	13
Arithmatic Mean	8.3	8.7	9.2	5.2	7.5	5.0	5.8	4.1	4.7	4.5	4.2	4.3
Standard Deviation	3.1	4.9	4.7	2.1	5.1	3.3	4.3	1.9	2.1	3.1	2.0	2.6
Geometric Mean	7.8	7.5	8.1	4.9	6.4	3.9	4.7	3.6	4.3	3.8	3.8	3.5
Geometric St. Dev.	1.5	1.7	1.7	1.4	1.7	2.2	1.9	1.7	1.5	1.8	1.6	1.9
# ≥10 mg/dl	9	13	20	1	12	7	8	0	1	4	0	2.00
% ≥ 10 mg/dl	39.1	36.1	44.4	2.1	26.7	15.9	21.6	0.0	2.0	9.1	0.0	3.9
# ≥ 15 mg/dl	1	5	6	0	3	0	2	0	0	1	0	0
% ≥ 15 mg/dl	4.3	13.9	13.3	0.0	6.7	0.0	5.4	0.0	0.0	2.3	0.0	0.0
# ≥ 25 mg/dl	0	0	0	0	1	0	0	0	0	0	0	0
% ≥ 25 mg/dl	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	8 Year Olds											
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	22	33	55	55	53	48	49	45	47	36	51	35
Minimum	4	4	4	4	4	1	1	1	1	1	1	1
Maximum	11	30	17	16	14	16	13	11	10	10	8	17
Arithmatic Mean	6.6	9.2	7.6	5.6	5.9	4.7	5.0	4.5	4.1	4.1	3.6	4.4
Standard Deviation	2.4	5.8	3.8	2.9	2.6	3.3	3.0	2.8	2.0	2.2	2.0	3.0
Geometric Mean	6.2	8.0	6.9	5.1	5.4	3.7	4.2	3.7	3.6	3.5	3.1	3.6
Geometric St. Dev.	1.4	1.7	1.6	1.5	1.5	2.1	1.8	1.9	1.6	1.8	1.8	2.0
# ≥10 mg/dl	4	11	16	5	7	4	4	4	1	1	0	1.00
% ≥ 10 mg/dl	18.2	33.3	29.1	9.1	13.2	8.3	8.2	8.9	2.1	2.8	0.0	2.9
# ≥ 15 mg/dl	0	6	4	1	0	1	0	0	0	0	0	1
% ≥ 15 mg/dl	0.0	18.2	7.3	1.8	0.0	2.1	0.0	0.0	0.0	0.0	0.0	2.9
# ≥ 25 mg/dl	0	1	0	0	0	0	0	0	0	0	0	0
% ≥ 25 mg/dl	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 12 Mean Blood Lead Levels and Incidence of Toxicity by Age Group and Year

	9 Year Olds											
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	38	31	49	58	48	52	46	42	45	36	51	43
Minimum	4	4	4	4	4	1	2	1	1	1	1	1
Maximum	24	20	12	11	16	13	16	10	8	9	10	10
Arithmatic Mean	7.6	8.4	6.4	4.9	6.3	4.1	4.7	4.2	3.6	3.9	3.2	3.3
Standard Deviation	4.2	4.2	2.3	1.7	3.0	2.3	3.2	2.2	1.8	1.9	1.9	2.0
Geometric Mean	6.8	7.5	6.1	4.7	5.7	3.4	4.0	3.6	3.2	3.4	2.8	2.8
Geometric St. Dev.	1.6	1.6	1.4	1.3	1.5	1.9	1.8	1.8	1.7	1.7	1.7	1.9
# ≥10 mg/dl	11	11	6	2	8	2	4	1	0	0	1	1.00
% ≥ 10 mg/dl	28.9	35.5	12.2	3.4	16.7	3.8	8.7	2.4	0.0	0.0	2.0	2.3
# ≥ 15 mg/dl	2	2	0	0	1	0	1	0	0	0	0	0
% ≥ 15 mg/dl	5.3	6.5	0.0	0.0	2.1	0.0	2.2	0.0	0.0	0.0	0.0	0.0
# ≥ 25 mg/dl	0	0	0	0	0	0	0	0	0	0	0	0
% ≥ 25 mg/dl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 12 Mean Blood Lead Levels and Incidence of Toxicity by Age Group and Year (Continued)

1 Year Olds	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	21	33	19	37	46	50	41	50	35	36	40	49
Minimum	4	6	4	4	4	1	2	2	2	1	2	2
Maximum	41	38	23	23	30	22	20	23	18	17	17	15
Arithmatic Mean	12.1	13.0	10.5	7.2	8.5	6.4	8.0	8.0	7.0	6.4	7.1	5.7
Standard Deviation	10.2	6.5	4.6	5.1	5.9	4.2	4.2	4.5	4.7	3.5	3.6	3.0
Geometric Mean	9.3	11.8	9.6	6.1	7.0	5.0	7.0	6.8	5.7	5.6	6.2	5.0
Geometric St. Dev.	2.1	1.5	1.6	1.7	1.8	2.1	1.7	1.8	1.9	1.7	1.6	1.7
# ≥10 mg/dl	12	22	10	9	16	9	11	15	8	6	9	7
% ≥ 10 mg/dl	57.1	66.7	52.6	24.3	34.8	18.0	26.8	30.0	22.9	16.7	22.5	14.3
# ≥ 15 mg/dl	5	9	2	4	8	2	3	5	5	2	3	1
% ≥ 15 mg/dl	23.8	27.3	10.5	10.8	17.4	4.0	7.3	10.0	14.3	5.6	7.5	2.0
# ≥ 25 mg/dl	2	2	0	0	1	0	0	0	0	0	0	0
% ≥ 25 mg/dl	9.5	6.1	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

2 Year Olds	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	23	29	35	24	51	48	57	32	46	40	39	33
Minimum	5	4	4	4	4	2	2	2	3	2	1	1
Maximum	28	40	30	24	23	26	21	17	31	18	19	17
Arithmatic Mean	11.7	13.6	11.1	7.3	8.2	7.9	7.7	6.9	8.1	6.2	6.2	6.5
Standard Deviation	6.2	7.2	6.4	5.3	4.4	4.7	4.2	3.9	5.2	3.4	3.7	3.9
Geometric Mean	10.3	12.0	9.5	6.1	7.3	6.8	6.6	6.0	6.9	5.4	5.2	5.5
Geometric St. Dev.	1.7	1.7	1.8	1.8	1.6	1.7	1.8	1.7	1.8	1.7	1.9	1.9
# ≥10 mg/dl	14	21	19	6	16	11	16	7	12	6	8	5.00
% ≥ 10 mg/dl	60.9	72.4	54.3	25.0	31.4	22.9	28.1	21.9	26.1	15.0	20.5	15.2
# ≥ 15 mg/dl	7	9	8	3	5	4	4	3	4	1	1	1
% ≥ 15 mg/dl	30.4	31.0	22.9	12.5	9.8	8.3	7.0	9.4	8.7	2.5	2.6	3.0
# ≥ 25 mg/dl	1	2	2	0	0	1	0	0	1	0	0	0
% ≥ 25 mg/dl	4.3	6.9	5.7	0.0	0.0	2.1	0.0	0.0	2.2	0.0	0.0	0.0

3 Year Olds	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	29	32	32	37	40	60	41	54	28	42	34	35
Minimum	4	4	4	4	4	1	1	2	1	1	1	1
Maximum	55	23	23	31	25	22	21	30	17	13	20	10
Arithmatic Mean	12.5	13.8	9.9	8.1	8.1	6.2	6.6	7.7	6.3	6.2	5.9	4.5
Standard Deviation	10.8	5.3	5.2	6.6	4.4	3.8	3.9	5.4	3.6	2.9	3.9	2.3
Geometric Mean	10.0	12.5	8.6	6.6	7.2	5.1	5.6	6.4	5.3	5.5	4.9	4.0
Geometric St. Dev.	1.9	1.6	1.7	1.8	1.6	1.9	1.8	1.9	1.9	1.7	1.9	1.7
# ≥10 mg/dl	18	27	14	10	13	9	7	14	6	7	4	1.00
% ≥ 10 mg/dl	62.1	84.4	43.8	27.0	32.5	15.0	17.1	25.9	21.4	16.7	11.8	2.9
# ≥ 15 mg/dl	5	14	6	5	3	1	2	7	1	0	1	0
% ≥ 15 mg/dl	17.2	43.8	18.8	13.5	7.5	1.7	4.9	13.0	3.6	0.0	2.9	0.0
# ≥ 25 mg/dl	3	0	0	2	1	0	0	1	0	0	0	0
% ≥ 25 mg/dl	10.3	0.0	0.0	5.4	2.5	0.0	0.0	1.9	0.0	0.0	0.0	0.0

4 Year Olds	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	19	32	36	33	50	43	48	43	58	30	43	34
Minimum	4	4	4	4	4	1	1	2	1	1	1	1
Maximum	18	29	21	17	20	14	15	25	54	22	14	12
Arithmatic Mean	8.6	11.3	10.2	6.6	8.1	6.7	6.0	7.4	7.3	5.5	5.3	4.9
Standard Deviation	4.4	5.7	4.7	3.4	3.9	4.0	3.1	4.6	7.2	4.3	2.9	3.0
Geometric Mean	7.6	10.0	9.2	5.9	7.2	5.1	5.2	6.3	5.6	4.3	4.5	4.0
Geometric St. Dev.	1.7	1.7	1.6	1.6	1.6	2.3	1.7	1.8	2.0	2.1	1.9	1.9
# ≥10 mg/dl	7	17	16	7	16	13	7	11	12	3	4	3.00
% ≥ 10 mg/dl	36.8	53.1	44.4	21.2	32.0	30.2	14.6	25.6	20.7	10.0	9.3	8.8
# ≥ 15 mg/dl	3	8	7	1	4	0	1	4	2	1	0	0
% ≥ 15 mg/dl	15.8	25.0	19.4	3.0	8.0	0.0	2.1	9.3	3.4	3.3	0.0	0.0
# ≥ 25 mg/dl	0	1	0	0	0	0	0	1	1	0	0	0
% ≥ 25 mg/dl	0.0	3.1	0.0	0.0	0.0	0.0	0.0	2.3	1.7	0.0	0.0	0.0

Table 12 Mean Blood Lead Levels and Incidence of Toxicity by Age Group and Year (Continued)

	5 Year Olds											
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	30	20	43	32	43	46	46	46	37	40	37	50
Minimum	4	5	4	4	4	1	2	1	1	2	1	1
Maximum	25	21	22	16	21	21	17	16	17	15	11	14
Arithmatic Mean	11.7	11.5	9.4	7.1	7.3	5.6	6.3	5.7	5.7	5.9	4.7	4.6
Standard Deviation	4.7	4.5	4.3	3.7	4.1	4.0	3.1	3.1	3.0	3.1	2.8	2.5
Geometric Mean	10.7	10.6	8.4	6.3	6.4	4.5	5.6	4.9	5.0	5.1	4.0	4.0
Geometric St. Dev.	1.5	1.5	1.6	1.6	1.6	2.0	1.7	1.8	1.8	1.7	1.8	1.7
# ≥10 mg/dl	17	12	17	9	10	5	8	5	3	5	4	2.00
% ≥ 10 mg/dl	56.7	60.0	39.5	28.1	23.3	10.9	17.4	10.9	8.1	12.5	10.8	4.0
# ≥ 15 mg/dl	7	5	5	1	4	2	1	1	1	1	0	0
% ≥ 15 mg/dl	23.3	25.0	11.6	3.1	17.4	4.3	2.2	2.2	2.7	2.5	0.0	0.0
# ≥ 25 mg/dl	1	0	0	0	0	0	0	0	0	0	0	0
% ≥ 25 mg/dl	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	6 Year Olds											
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	24	29	48	42	38	54	51	37	52	33	40	40
Minimum	4	4	4	4	4	1	1	1	1	1	1	1
Maximum	18	41	16	18	21	14	41	13	13	12	11	10
Arithmatic Mean	10.0	13.9	8.0	6.2	7.3	4.5	5.5	5.7	5.3	5.7	4.4	4.0
Standard Deviation	4.9	7.8	3.5	3.5	4.2	3.4	5.8	2.8	3.2	2.9	2.3	2.4
Geometric Mean	8.8	12.1	7.2	5.6	6.4	3.4	4.3	5.0	4.4	4.9	3.8	3.3
Geometric St. Dev.	1.7	1.7	1.6	1.6	1.7	2.2	1.9	1.7	1.9	1.9	1.8	1.9
# ≥10 mg/dl	13	20	16	7	12	6	6	5	6	4	1	1.00
% ≥ 10 mg/dl	54.2	69.0	33.3	16.7	31.6	11.1	11.8	13.5	11.5	12.1	2.5	2.5
# ≥ 15 mg/dl	5	13	3	2	3	0	1	0	0	0	0	0
% ≥ 15 mg/dl	20.8	44.8	6.3	4.8	7.9	0.0	2.0	0.0	0.0	0.0	0.0	0.0
# ≥ 25 mg/dl	0	2	0	0	0	0	1	0	0	0	0	0
% ≥ 25 mg/dl	0.0	6.9	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0

	7 Year Olds											
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	23	36	45	47	45	44	37	55	49	44	40	51
Minimum	4	3	4	4	4	1	2	1	2	1	2	1
Maximum	15	21	22	14	26	11	19	9	11	17	8	13
Arithmatic Mean	8.3	8.7	9.2	5.2	7.5	5.0	5.8	4.1	4.7	4.5	4.2	4.3
Standard Deviation	3.1	4.9	4.7	2.1	5.1	3.3	4.3	1.9	2.1	3.1	2.0	2.6
Geometric Mean	7.8	7.5	8.1	4.9	6.4	3.9	4.7	3.6	4.3	3.8	3.8	3.5
Geometric St. Dev.	1.5	1.7	1.7	1.4	1.7	2.2	1.9	1.7	1.5	1.8	1.6	1.9
# ≥10 mg/dl	9	13	20	1	12	7	8	0	1	4	4	2.00
% ≥ 10 mg/dl	39.1	36.1	44.4	2.1	26.7	15.9	21.6	0.0	2.0	9.1	10.0	3.9
# ≥ 15 mg/dl	1	5	6	0	3	0	2	0	0	1	1	0
% ≥ 15 mg/dl	4.3	13.9	13.3	0.0	6.7	0.0	5.4	0.0	0.0	2.3	2.5	0.0
# ≥ 25 mg/dl	0	0	0	0	1	0	0	0	0	0	0	0
% ≥ 25 mg/dl	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	8 Year Olds											
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	22	33	55	55	53	48	49	45	47	36	51	35
Minimum	4	4	4	4	4	1	1	1	1	1	1	1
Maximum	11	30	17	16	14	16	13	11	10	10	8	17
Arithmatic Mean	6.6	9.2	7.6	5.6	5.9	4.7	5.0	4.5	4.1	4.1	3.6	4.4
Standard Deviation	2.4	5.8	3.8	2.9	2.6	3.3	3.0	2.8	2.0	2.2	2.0	3.0
Geometric Mean	6.2	8.0	6.9	5.1	5.4	3.7	4.2	3.7	3.6	3.5	3.1	3.6
Geometric St. Dev.	1.4	1.7	1.6	1.5	1.5	2.1	1.8	1.9	1.6	1.8	1.8	2.0
# ≥10 mg/dl	4	11	16	5	7	7	4	4	1	1	0	1.00
% ≥ 10 mg/dl	18.2	33.3	29.1	9.1	13.2	14.6	8.2	8.9	2.1	2.8	0.0	2.9
# ≥ 15 mg/dl	0	6	4	1	0	0	0	0	0	0	0	1
% ≥ 15 mg/dl	0.0	18.2	7.3	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9
# ≥ 25 mg/dl	0	1	0	0	0	0	0	0	0	0	0	0
% ≥ 25 mg/dl	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 12 Mean Blood Lead Levels and Incidence of Toxicity by Age Group and Year (Continued)

	9 Year Olds											
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N	38	31	49	58	48	52	46	42	45	36	51	43
Minimum	4	4	4	4	4	1	2	1	1	1	1	1
Maximum	24	20	12	11	16	13	16	10	8	9	10	10
Arithmatic Mean	7.6	8.4	6.4	4.9	6.3	4.1	4.7	4.2	3.6	3.9	3.2	3.3
Standard Deviation	4.2	4.2	2.3	1.7	3.0	2.3	3.2	2.2	1.8	1.9	1.9	2.0
Geometric Mean	6.8	7.5	6.1	4.7	5.7	3.4	4.0	3.6	3.2	3.4	2.8	2.8
Geometric St. Dev.	1.6	1.6	1.4	1.3	1.5	1.9	1.8	1.8	1.7	1.7	1.7	1.9
# ≥10 mg/dl	11	11	6	2	8	2	4	1	0	0	1	1.00
% ≥ 10 mg/dl	28.9	35.5	12.2	3.4	16.7	3.8	8.7	2.4	0.0	0.0	2.0	2.3
# ≥ 15 mg/dl	2	2	0	0	1	0	1	0	0	0	0	0
% ≥ 15 mg/dl	5.3	6.5	0.0	0.0	2.1	0.0	2.2	0.0	0.0	0.0	0.0	0.0
# ≥ 25 mg/dl	0	0	0	0	0	0	0	0	0	0	0	0
% ≥ 25 mg/dl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 13
Predicted and Observed Mean Blood Lead Levels for Two Year Old Children
Default Parameters - Three Dust:Soil Partition Scenarios

Observed and Predicted Blood Lead Levels (mg/dl)				
Year	**Observed**	**Default**	**40-30-30**	**75-18-7**
Kellogg				
1988	12.4	19.1	21.2	18.0
1989	13.7	25.6	25.0	24.5
1990	11.4	14.1	15.9	14.8
1991	9.2	12.8	13.8	14.3
1992	8.7	12.5	13.0	12.6
1993	7.8	11.6	11.8	11.9
1994	8.6	9.3	10.1	9.8
1995	6.8	12.0	11.7	11.5
1996	8.1	10.4	10.3	10.0
1997	7.1	8.4	8.4	9.3
1998	6.8	9.8	8.9	9.9
1999	7.8	8.3	7.4	8.7
Smelterville				
1988	5.0	12.9	12.9	11.0
1989	13.7	19.6	19.6	14.5
1990	13.3	22.4	22.4	22.4
1991	4.0	13.8	13.8	13.8
1992	9.6	12.9	12.9	12.2
1993	8.9	13.8	13.8	13.8
1994	8.4	14.9	14.9	12.8
1995	12.5	7.4	7.4	8.9
1996	10.4	6.1	6.1	8.2
1997	7.2	4.7	4.3	4.9
1998	7.0	7.5	6.5	8.5
1999	3.0	6.5	5.7	6.6
Sitewide				
1988	11.9	17.8	19.4	15.7
1989	13.4	23.1	23.1	21.9
1990	10.9	13.3	14.5	14.1
1991	7.5	11.0	11.9	12.5
1992	8.2	11.3	11.9	11.7
1993	7.8	11.0	11.3	11.4
1994	7.8	8.9	9.4	9.1
1995	6.7	10.8	10.4	10.6
1996	7.6	9.1	8.1	8.9
1997	6.3	7.4	7.3	7.7
1998	6.1	8.4	7.7	8.6
1999	6.6	7.3	6.9	7.4

Table 14
Predicted and Observed Geometric Standard Deviations, 1988-1999
Default Parameters - Three Dust:Soil Partition Scenarios

Observed and Predicted Geometric Standard Deviations				
Year	**Observed**	**Default**	**40-30-30**	**75-18-7**
Kellogg				
1988	1.68	1.43	1.32	1.40
1989	1.74	1.48	1.38	1.45
1990	1.61	1.56	1.35	1.40
1991	1.65	1.55	1.40	1.38
1992	1.72	1.74	1.51	1.52
1993	1.88	1.70	1.50	1.50
1994	1.89	1.73	1.50	1.50
1995	1.92	1.88	1.63	1.57
1996	1.94	1.79	1.57	1.82
1997	1.84	1.58	1.45	1.47
1998	1.93	1.59	1.48	1.48
1999	1.87	1.61	1.53	1.55
Smelterville				
1988	1.87	1.44	1.25	1.51
1989	1.61	1.60	1.36	1.66
1990	1.56	1.54	1.37	1.59
1991	1.56	1.51	1.34	1.54
1992	1.61	1.80	1.50	1.83
1993	1.79	1.76	1.51	1.94
1994	1.67	1.89	1.55	1.87
1995	1.72	1.83	1.67	1.90
1996	1.65	1.69	1.63	1.99
1997	1.52	1.25	1.23	1.25
1998	1.54	1.37	1.34	1.37
1999	1.87	1.36	1.32	1.35
Sitewide				
1988	1.74	1.52	1.89	1.62
1989	1.71	1.56	1.52	1.49
1990	1.62	1.65	1.62	1.56
1991	1.59	1.59	1.57	1.50
1992	1.65	1.70	1.59	1.55
1993	2.08	1.72	1.63	1.56
1994	1.84	1.70	1.60	1.54
1995	1.88	1.88	1.86	1.65
1996	1.88	1.75	1.79	1.56
1997	1.84	1.56	1.47	1.49
1998	1.86	1.56	1.46	1.51
1999	1.86	1.53	1.46	1.51

Table 15
Predicted and Observed Lead Toxicity
Percent of Children With Blood Lead Greater Than 10 mg/dl
Default Parameters - Three Dust:Soil Partition Scenarios

Observed and Predicted Lead Toxicity				
Year	**Observed**	**Default**	**40-30-30**	**75-18-7**
Kellogg				
1988	41	90	100	93
1989	54 (52)[1]	87	99	93
1990	41 (40)	64	77	68
1991	20	40	49	51
1992	32	34	37	46
1993	17 (18)	23	21	23
1994	20	20	18	19
1995	17	37	32	27
1996	17	22	20	20
1997	14 (15)	15	13	15
1998	9 (10)	12	9	13
1999	5 (6)	7	5	10
Smelterville				
1988	71 (72)	81	100	74
1989	76 (78)	65	97	85
1990	31	69	88	77
1991	23	50	69	58
1992	31	36	53	42
1993	20	39	61	41
1994	21	25	25	38
1995	24 (28)	16	16	16
1996	15 (12)	7	5	7
1997	9	0	0	0
1998	14	5	0	7
1999	4	0	0	4
Site Wide				
1988	46	81	89	82
1989	59 (56)	78	93	82
1990	37	48	56	55
1991	16 (15)	32	31	41
1992	27	28	29	35
1993	15	22	21	24
1994	17	16	15	17
1995	15	26	22	19
1996	13 (12)	17	13	13
1997	11	11	9	10
1998	8	9	6	10
1999	6	5	4	7

Ubk_Res1.xls, Table 4.5

Notes:

1 - Values in parentheses indicate total population values, and the full number of observations were not included in the model runs due to missing environmental media concentrations.

Table 16
Predicted and Observed Arithmetic Mean Blood Lead Levels for Two Year Old Children, Geometric Standard Deviations, and Toxicity
42:27:19:12 Dust:Soil Partition at 18% Bioavailability

	Arithmetic Mean Blood Lead Levels 2 Year Old Children (mg/dl)		Geometric Standard Deviations		Percent of Children with Blood Lead ≥ 10 mg/dl	
Year	**Observed**	**Predicted**	**Observed**	**Predicted**	**Observed**	**Predicted**
Kellogg						
1988	12	14	1.69	1.36	41	55
1989	14	17	1.73	1.41	55	54
1990	11	11	1.61	1.36	41	30
1991	9	9	1.65	1.36	20	13
1992	9	9	1.71	1.40	38	13
1993	8	9	1.88	1.38	17	8
1994	9	8	1.89	1.37	20	5
1995	7	7	1.92	1.42	18	8
1996	8	8	1.93	1.42	18	6
1997	7	6	1.84	1.39	14	2
1998	7	6	1.93	1.43	9	2
1999	8	5	1.87	1.48	5	2
Smelterville						
1988	5	12	1.87	1.24	71	55
1989	14	13	1.62	1.30	81	52
1990	13	15	1.56	1.33	31	58
1991	4	10	1.56	1.30	24	24
1992	10	10	1.62	1.39	31	19
1993	9	9	1.79	1.38	20	18
1994	8	9	1.67	1.41	21	10
1995	12	6	1.72	1.57	28	8
1996	10	3	1.60	1.51	12	4
1997	7	3	1.52	1.20	9	0
1998	7	5	1.54	1.34	14	0
1999	4	1	1.87	1.32	4	0
Site Wide						
1988	12	13	1.74	1.40	46	49
1989	13	16	1.71	1.44	58	49
1990	11	10	1.62	1.61	37	22
1991	7	8	1.58	1.51	16	10
1992	8	8	1.64	1.49	27	9
1993	8	8	2.08	1.47	15	7
1994	8	7	1.83	1.45	17	5
1995	7	7	1.86	1.49	16	6
1996	8	7	1.85	1.53	13	4
1997	6	5	1.84	1.43	11	1
1998	6	5	1.86	1.42	8	2
1999	7	5	1.86	1.42	6	1

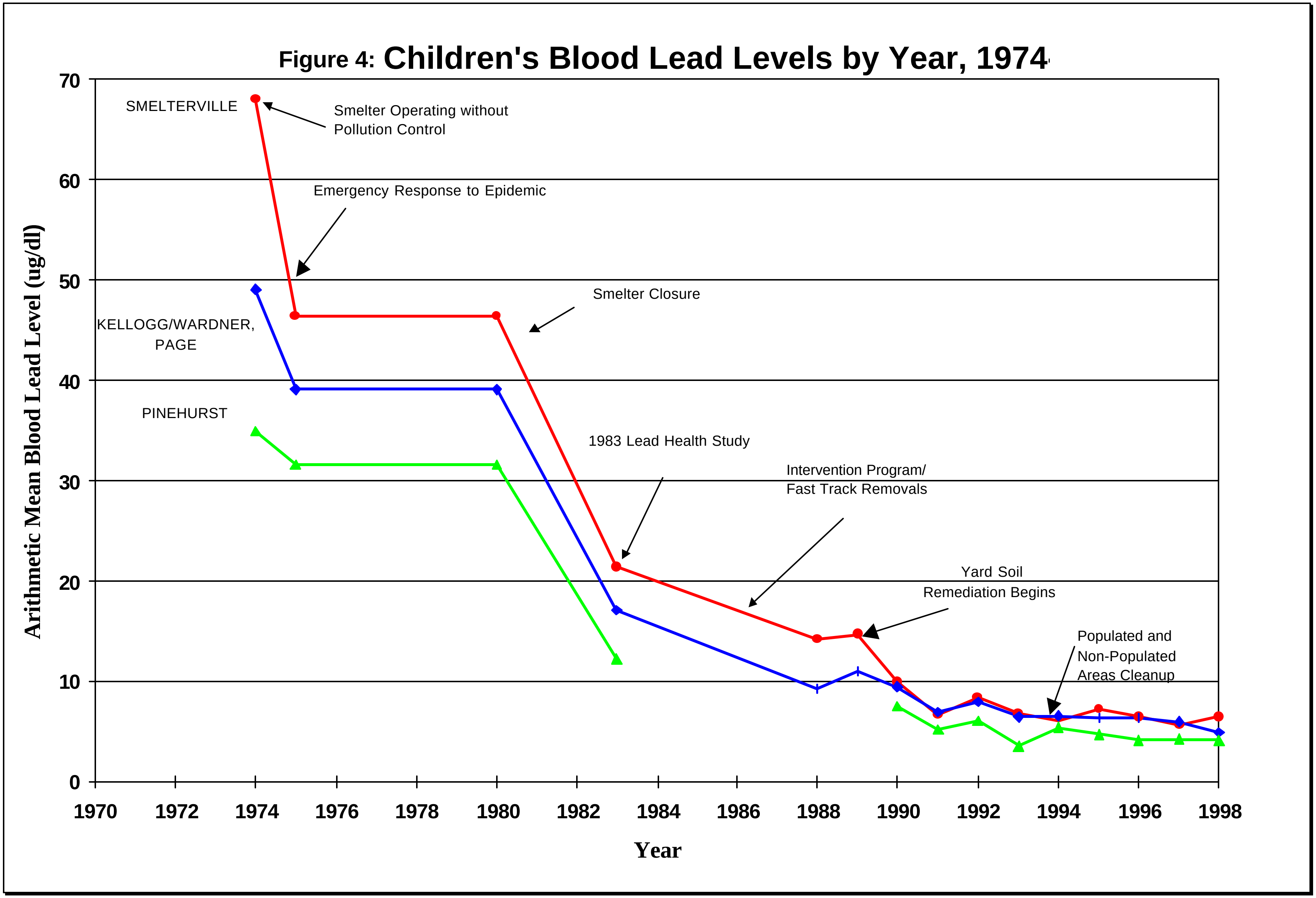


Figure 4: Children's Blood Lead Levels by Year, 1974
Arithmetic Mean Blood Lead Level (ug/dl)
70
60
50
40
30
20
10
0
SMELTERVILLE
Smelter Operating without
Pollution Control
Emergency Response to Epidemic
Smelter Closure
KELLOGG/WARDNER,
PAGE
PINEHURST
1983 Lead Health Study
Intervention Program/
Fast Track Removals
Yard Soil
Remediation Begins
Populated and
Non-Populated
Areas Cleanup
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
Year

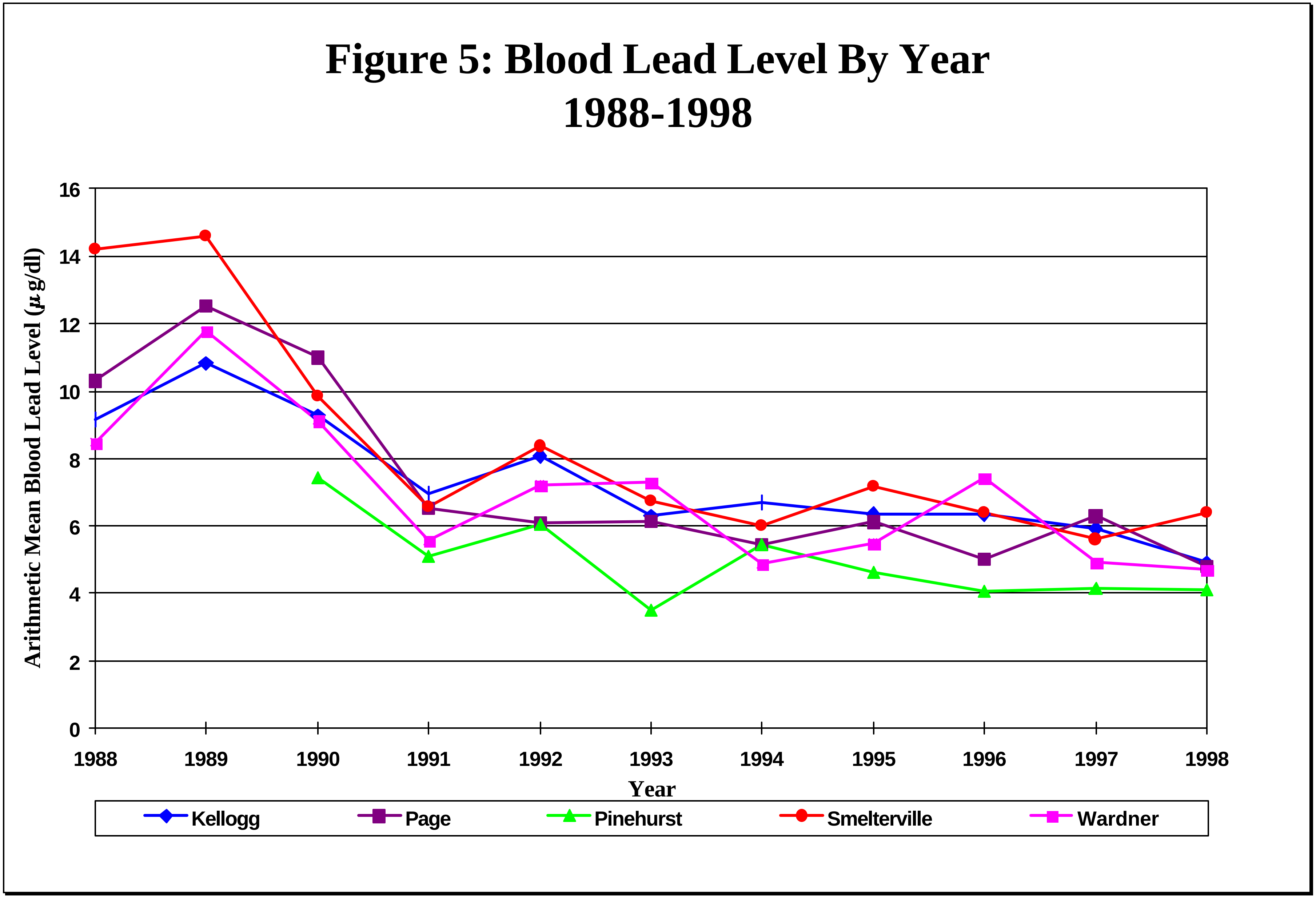


Figure 5: Blood Lead Level By Year
1988-1998
Arithmetic Mean Blood Lead Level (μg/dl)
0
2
4
6
8
10
12
14
16
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
Year
Kellogg
Page
Pinehurst
Smelterville
Wardner

Estimated Soil/Dust Bioavailability 1988-1998

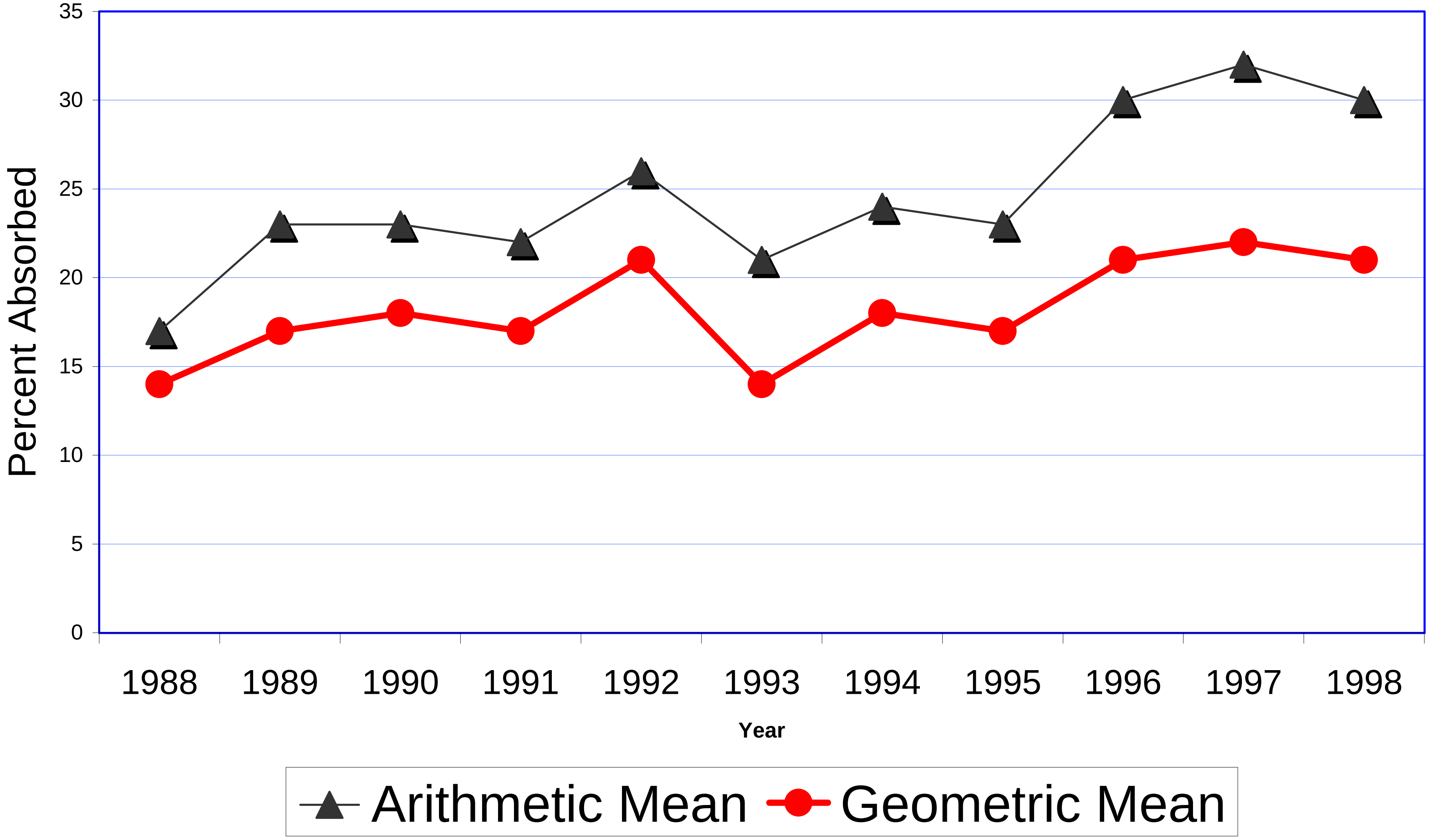


Table 4.29
Estimated Aggregate Soil and Dust Effective Bioavailability 1988-1998

Year	Bioavailability Arithmetic Mean	Bioavailability Geometric Mean
1988	17	14
1989	23	17
1990	23	18
1991	22	17
1992	26	21
1993	21	14
1994	24	18
1995	23	17
1996	30	21
1997	32	22
1998	30	21

Figure 6: Percent of Children with Blood Lead Greater Than 10 micrograms/deciliter

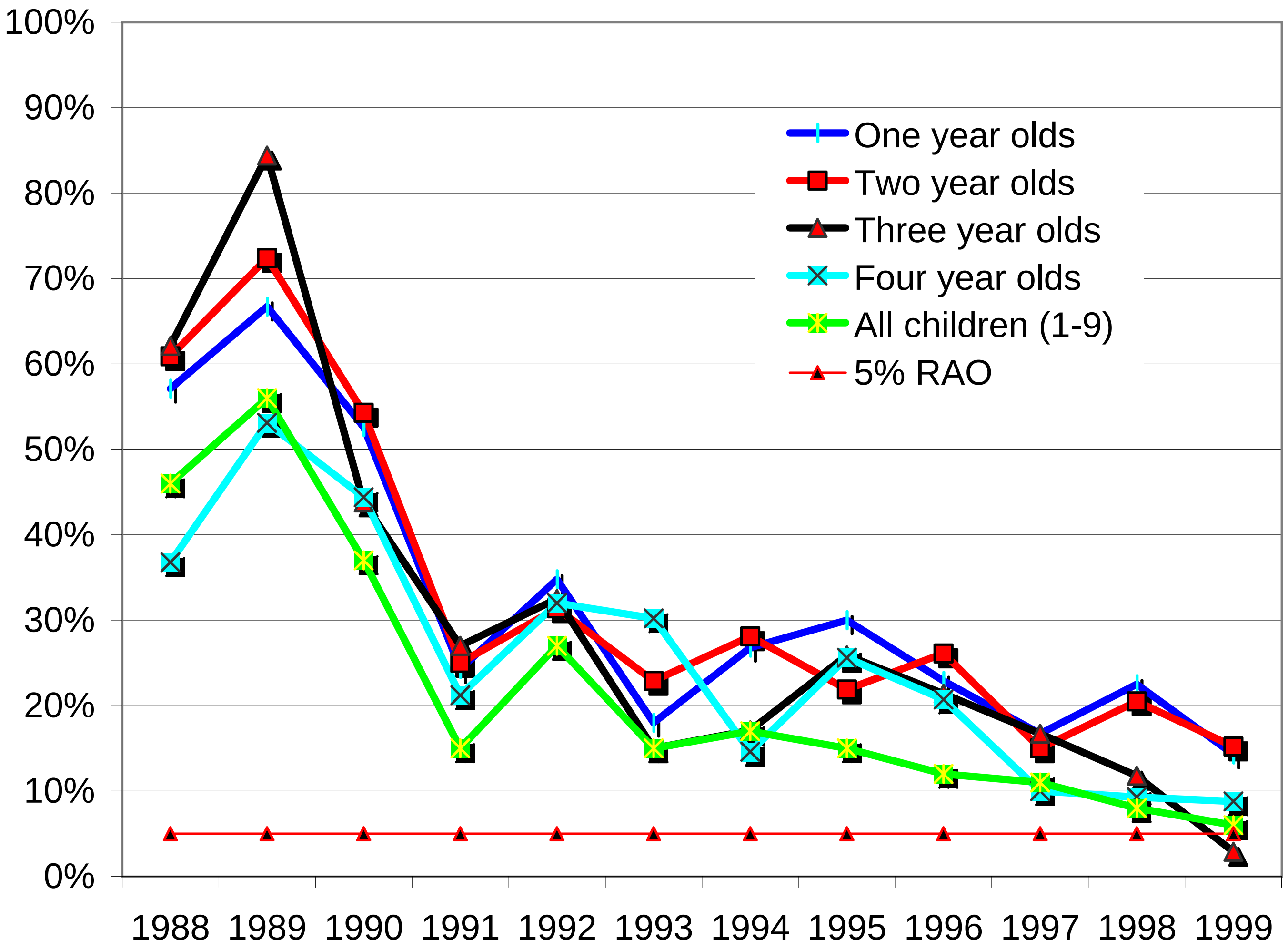


Figure 7: Percentage of Children above 10 micrograms per deciliter and Percentage of Children on Contaminated Yards

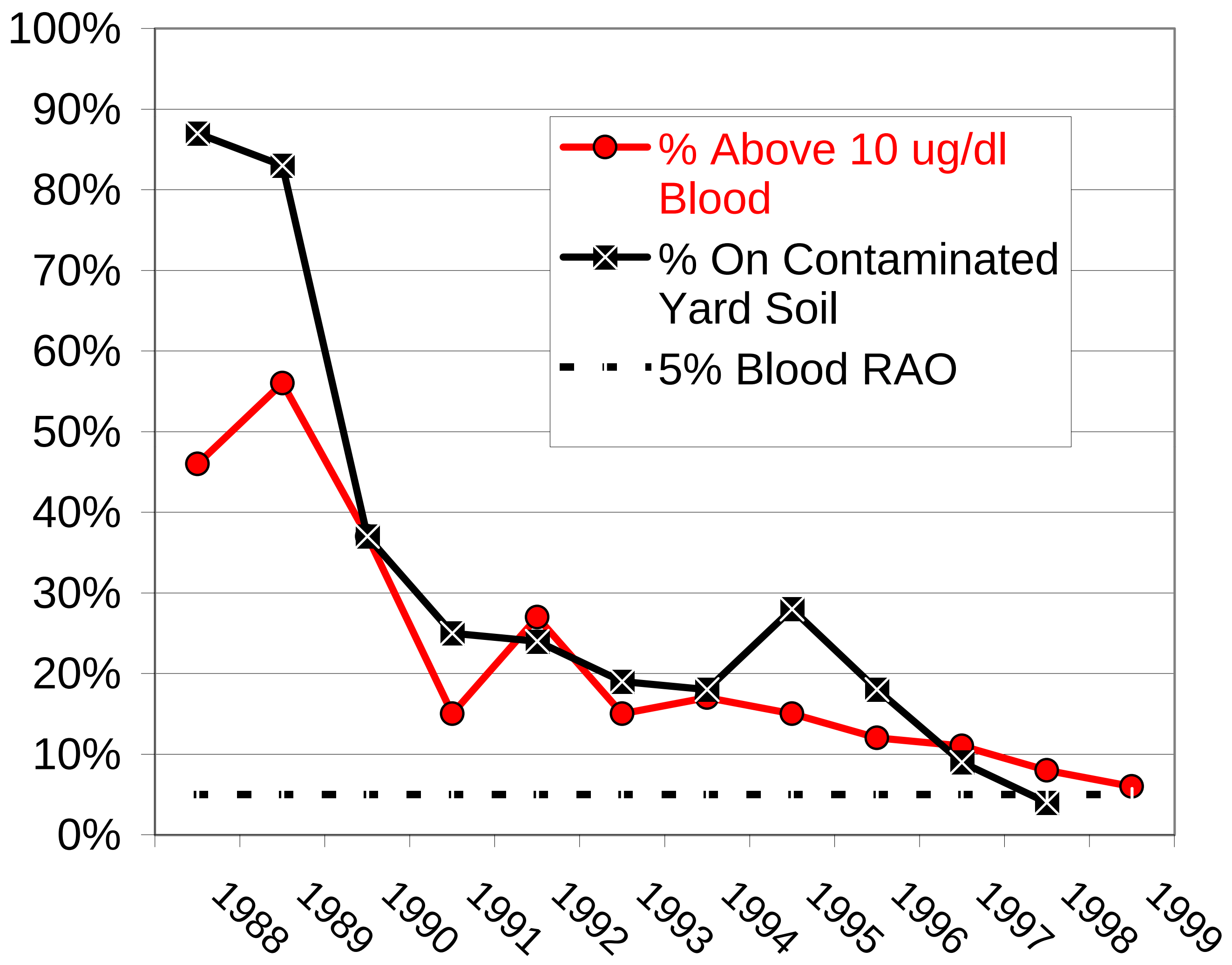
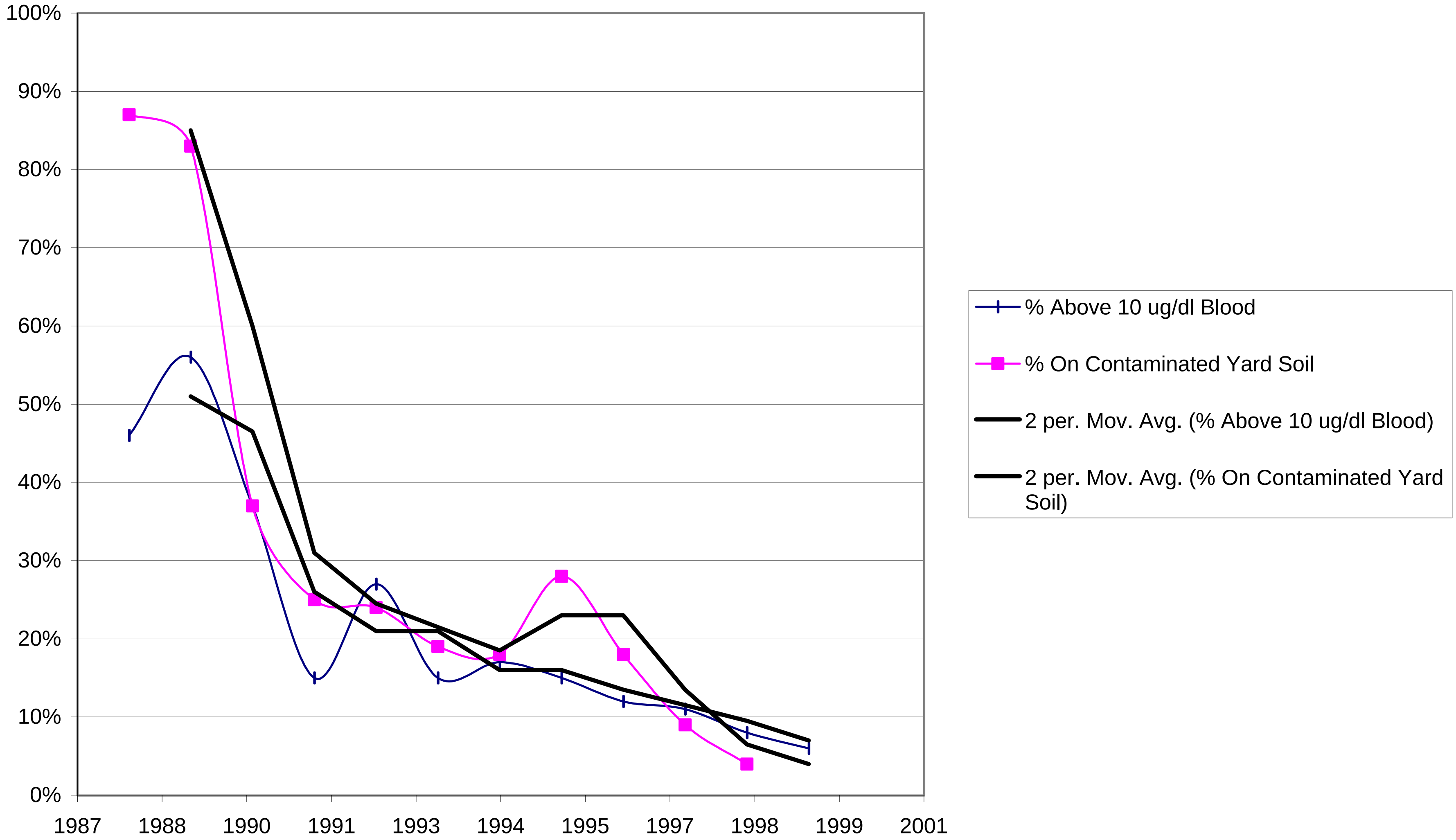


Figure 7: Percentage of Children on Contaminated Yards versus Percent of Two Year Olds above 10 micrograms per deciliter



Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
One year olds	57%	67%	53%	24%	35%	18%	27%	30%	23%	17%	23%	14%
Two year olds	61%	72%	54%	25%	31%	23%	28%	22%	26%	15%	21%	15%
Three year olds	62%	84%	44%	27%	33%	15%	17%	26%	21%	17%	12%	3%
Four year olds	37%	53%	44%	21%	32%	30%	15%	26%	21%	10%	9%	9%
All children (1-9)	46%	56%	37%	15%	27%	15%	17%	15%	12%	11%	8%	6%
5% RAO	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%

Table 4; Incidence of Toxicity (percentage above 10 microgram/dl) by Age

57	67	53	24	35	18	27	30	23	16.7	22.5	14.3
61	72	54	25	31	23	28	22	26	15	20.5	15.2
62	84	44	27	33	15	17	26	21	16.7	11.8	2.9
37	53	44	21	32	30	15	26	21	10	9.3	8.8
46	56	37	15	27	15	17	15	12	11	8	6

[redacted]

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
% Above 10 ug/dl Blood	46%	56%	37%	15%	27%	15%	17%	15%	12%	11%	8%	6%
% On Contaminated Yard	87%	83%	37%	25%	24%	19%	18%	28%	18%	9%	4%	
5% Blood RAO	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%