APPENDIX A

Glossary

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GLOSSARY

*__Abatement__: Any set of measures designed to permanently eliminate lead-based paint hazards in accordance with standards established by Federal agencies.

***Accessible or Chewable Surface**: An interior or exterior surface painted with lead-based paint that is accessible for a young child to mouth or chew.

Arithmetic Mean: The sum of a set of measurements divided by the number of measurements.

Background Lead Exposure: Exposure to environmental lead that is not the result of human activity such as lead-based paint or industrial sources.

Baseline: Conditions prior to implementing interventions in response to §403 rules. Baseline risk characterization is performed in this risk analysis using blood-lead concentration data from Phase 2 of NHANES III and by assumptions on the relationship between blood-lead concentration and IQ score decrement.

Biokinetics: Processes affecting the movement of molecules from one internal body compartment to another, including elimination from the body.

Blood-Lead Concentration: Blood-lead concentration measures the mass of lead collected per volume of whole blood collected and is usually expressed in terms of micrograms of lead collected per deciliter of blood collected (µg Pb/dL blood).

Blue Nozzle Sampler: Refers to the vacuum sampler used to collect dust samples in the HUD National Survey and the Baltimore R&M Pilot study. The sampling flow rate is cited as 16 liters per minute. The sampler consists of a rotary vane pump connected to the same filter and sampling cassette used in the DVM sampler.

Body-Lead Burden: The level of lead carried in a body.

BRM Sampler: Refers to the vacuum sampler developed and utilized to collect dust in EPA's Baltimore Repair and Maintenance Study. It is a modified version of the HVS3 sampler, employing a portable handheld vacuum and other modifications to make it easy to use and to access small areas.

Confidence Interval: An interval that contains the true value of a parameter with a certain degree of confidence.

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* As defined in Section 1001 of Title X and Section 401 of TSCA Title IV amendment.

Conversion Factors: Use of regression models in this risk analysis to convert observed lead measurements from one format to another, typically to correct for differences in dust collection method. For example, a conversion factor was used to express the Blue Nozzle vacuum dust-lead loadings reported in the HUD National Survey as wipe-equivalent dust-lead loadings in order to determine which housing units in the HUD National Survey exceeded example standards for wipe dust-lead loadings.

Cumulative Distribution Function (CDF): For any number *x*, the CDF F(*x*) of a random variable X is the probability that the observed value of X will be at most *x*.

*__Deteriorated Paint__: Any interior or exterior paint that is peeling, chipping, chalking or cracking or any paint located on an interior or exterior surface or fixture that is damaged or deteriorated.

Dripline Soil Sample: Any soil sample collected from the drip line area about the residence. This is usually approximately 1-3 feet from the side (e.g. foundation) of the house, under the eaves.

Dry Room: (see Wet Room).

Dust Abatement: Removing settled dust from a housing unit using HEPA vacuums and wet mopping.

Dust Cleaning: Intervention where settled dust that is likely to be lead-contaminated is removed from residential surfaces using HEPA vacuums and wet mopping.

Dust-Lead Loading: Dust-lead loading measures the mass of lead collected per surface area sampled and is usually expressed in terms of micrograms of lead collected per square foot sampled (µg Pb/ft^2).

Dust-Lead Concentration: Dust-lead concentration measures the mass of lead collected per mass of dust collected and is usually stated in terms of micrograms of lead collected per gram of dust collected (µg Pb/g dust).

DVM Sampler: A device used to collect dust samples using a vacuum (personal air sampler) operating at a rate of two to three liters of air per minute. It was designed to collect only dust that would most likely stick to a child’s hand, not total lead on a surface. Thus, it tends to have low collection efficiency for particles larger than 250 microns.

* As define in Section 1001 of Title X and Section 401 of TSCA Title IV amendment.

Efficacy: Refers to the effectiveness of a method of abatement and is defined as the generalized evaluation of several key factors including the usability of a method, its hazard abatement effectiveness, and the amount of hazardous dust lead generated by a method, measured by air and post-cleanup wipe samples.

Empirical Model: A statistical regression model developed for this risk analysis from data collected in the Rochester lead-in-Dust study. The resulting model which predicts geometric mean blood-lead concentration for children aged 12-30 months as a function of environmental lead levels (dust-lead loading, soil-lead concentration, extent of deteriorated lead-based paint hazard) is used to predict a national distribution of children's blood-lead levels for this age group.

Encapsulation: A method of "abatement" that involves the coating and sealing of surfaces with durable coatings formulated to be elastic, long-lasting (e.g., at least 20 years), and resistant to cracking, peeling, algae, and fungus.

Enclosure: The resurfacing or covering of surfaces by sealing or caulking them with mechanically affixed, durable materials so as to prevent or control chalking, flaking, lead-containing substances from being part of house dust or accessible to children.

Entryway Soil: Any soil sample collected immediately adjacent to the entryway of the residence.

EPI Study: A targeted epidemiology study which measures both children's blood-lead concentrations and environmental lead levels as well as other factors (e.g., behavioral, demographic) influencing a child's blood-lead level.

Epidemiology: In broad terms epidemiology is concerned with the distribution of disease, and it is now customary to include within its orbit the study of chronic disease as well as communicable diseases which give rise to epidemics of the classical sort.

Expected Value: The average value of a statistic if it were calculated from an infinite number of equal-sized samples from a given population.

Exposure Route: The manner by which a chemical or pollutant enters an organism after contact (e.g., by ingestion, inhalation).

Exposure Pathway: The physical course a chemical or pollutant takes from its source to the organism exposed.

Exposure: Contact between a chemical, physical, or biological agent (e.g., lead) with the outer boundary of an organism (e.g., a child's skin). Exposure is quantified as the concentration of the agent in the medium in contact integrated over the time duration of that contact.

*__Friction Surface__: An interior or exterior surface that is subject to abrasion or friction, including certain window, floor, and stair surfaces.

__Geometric Mean__: The n^{th} root of the product of n values. Also, the exponentiation of the "arithmetic mean" of a set of n natural log-transformed values.

__Geometric Standard Deviation (GSD)__: The exponentiation of the "standard deviation" of a set of n natural log-transformed values.

__HEPA__: A High Efficiency Particulate Accumulator vacuum used in dust cleaning, fitted with a filter capable of filtering out particles of 0.3 microns or greater from a body of air at 99.97 percent efficiency or greater.

__Histogram__: A bar graph associating frequencies or relative frequencies with data intervals. The values of the variable are by convention represented on the horizontal scale, and the vertical scale represents the frequency or relative frequency of data values in each standard grouping of possible values for the variable. It illustrates the general shape of the observed data distribution.

__Human Exposure Studies__: Studies which investigate the association between elevated blood-lead concentration and elevated levels of lead in a child's residential environment. Examples of human exposure studies are the Rochester Lead-in-Dust study and the Brigham and Women's Hospital Longitudinal study.

__HVS3 Vacuum Sampler__: Vacuum method originally developed to measure pesticides in house dust and is now recognized as an ASTM standard for collecting floor dust samples to be analyzed for lead content.

__IEUBK Model__: EPA's Integrated Exposure Uptake Biokinetic Model for Lead, designed to model exposure from lead in air, water, soil, dust, diet, and paint and other sources using pharmacokinetic modeling methods to predict blood-lead concentrations in children 6 months to 7 years of age.

*__Impact Surface__: An interior or exterior surface that is subject to damage by repeated impacts, for example, certain parts of door frames.

__Individual Risks__: Hazards posed for children exposed to specified levels of lead in certain media within the residential environment.

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* As define in Section 1001 of Title X and Section 401 of TSCA Title IV amendment.

Intelligence Quotient (IQ): A score used to express the apparent relative intelligence of a person determined by dividing his/her mental age as reported on a standardized test by his/her chronological age and multiplying by 100. This risk analysis used IQ score decrement as a means of measuring the neurological effects of lead.

Intercept: See **Slope**.

***Interim Controls**: A set of measures designed to temporarily reduce human exposure or likely human exposure to lead-based paint hazards, including specialized cleaning, repairs, maintenance, painting, temporary containment, ongoing monitoring of lead-based paint hazards or potential hazards, and the establishment and operation of management and resident education programs.

Intervention: A procedure implemented to reduce or eliminate a lead-based paint hazard within a specific medium within a residence, when some type of mechanism is triggered for that medium (e.g., dust-lead standard is exceeded). Interventions considered in this risk analysis include dust cleaning, soil removal, paint maintenance, and paint abatement.

Intervention Studies: Studies which investigate the impact on children's blood-lead concentration of reducing childhood lead exposure via a range of intervention strategies. Intervention studies can contribute to conclusions about whether specific lead exposures are the cause behind elevated blood-lead concentration. Examples of intervention studies are the Baltimore R&M study and the Urban Soil-Lead Abatement Demonstration Project.

***Lead-Based Paint Hazard**: Any condition that causes exposure to lead from lead-contaminated dust, lead-contaminated soil, lead-contaminated paint that is deteriorated or present in accessible surfaces, friction surfaces, or impact surfaces that would result in adverse human health effects as established by EPA.

***Lead-Based Paint (LBP)**: Dried paint film that has a lead content exceeding 1.0 mg/cm² or 0.5 percent (5,000 parts per million (ppm)) by weight.

***Lead-Contaminated Soil**: Bare soil on residential real property that contains lead at or in excess of the levels determined to be hazardous to human health by EPA.

***Lead-Contaminated Dust**: Surface dust in residential dwellings that contains an area or mass concentration of lead in excess of levels determined by EPA to pose a threat of adverse health effects in pregnant women or young children.

Log-Linear Regression Model: A regression model in which the natural logarithm of the independent (predictor) variables is taken before fitting the model.

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* As define in Section 1001 of Title X and Section 401 of TSCA Title IV amendment.

<u>Lognormal Distribution</u>: A nonnegative random variable X is said to have a lognormal distribution if the natural logarithm of X has a normal (Gaussian) distribution.

<u>Maximum, Minimum and Range</u>: The largest and smallest observations in a data distribution are called *maximum* and *minimum* respectively. The difference between the maximum value and the minimum value is defined as the *range*.

<u>Measurement Error</u>: Error in an observed measurement attributable to sampling, laboratory, spatial and/or temporal variability.

<u>Measurement Error Model</u>: A regression model which attempts to account for measurement error in the observed predictor variables.

<u>Meta-Analysis</u>: The statistical integration of the results of independent studies.

<u>Microgram (µg)</u>: A microgram is 1/1,000,000 of a gram or 1/1,000 of a milligram.

<u>Monte Carlo Analysis</u>: An estimation method where approximations are obtained by repeated random sampling or simulation.

<u>Negative Predictive Value (NPV)</u>: Probability of a resident child having a blood-lead concentration below some specified threshold value, given that observed lead levels in a specified medium within the dwelling is below the standard for that medium.

<u>90% Confidence Bound on a Statistic</u>: The upper and lower limits of a 90% confidence interval.

<u>Paint Maintenance</u>: Intervention where all surfaces with deteriorated lead-based paint are repaired by feathering the edges of deteriorating paint and repainting with new, lead-free paint.

<u>Paint Abatement</u>: Intervention where all surfaces with deteriorated lead-based paint are encapsulated, enclosed, or removed using currently acceptable practices and materials.

<u>Parameter</u>: A characteristic of a population, such as the population mean or variance.

<u>Percentile</u>: A particular value in a set or distribution of numbers for which a specified percentage of the numbers are less than the given value. For instance, the 5th percentile of a set of blood-lead concentrations is the blood-lead concentration value such that 5% of the numbers are less than the value and 95% are greater than it. The 50th percentile is also known as the median.

<u>Performance Characteristics Analysis</u>: An analysis used to characterize the performance of options for the §403 standards based on the data from IEUBK model or Empirical model.

Perimeter Soil Sample: Any soil sample collected from the perimeter or remote areas of the residence's yard. (Note: in the Rochester Lead-in-Dust study, this terminology referred to samples collected adjacent to the foundation).

Pharmacokinetics: The study of the time course of absorption, distribution, metabolism, and excretion of a foreign substance (e.g., a drug or pollutant) in an organism's body.

Pica: An abnormal tendency to mouth or attempt to consume non-food objects, such as paint chips.

Piecewise Linear Function: The domain of a function divided into finite pieces such that in each piece the function is linear.

Play-yard Soil Sample: Any soil sample collected in areas where the child usually played. In the HUD National Survey, this was frequently a local playground. In other studies, this refers to an exterior site at the residence.

Population: A population of items is defined to be any set of items for which one wants to study and make inferences. Associated with each item in a population are one or more numbers or attributes of interest, which are called variables.

Population Risks: Hazards posed by childhood lead exposure to our nation as a whole.

Positive Predictive Value (PPV): Probability of a resident child having a blood-lead concentration above some specified threshold value given that observed lead levels in a specified medium within the dwelling is above the standard for that medium.

Primary Prevention Intervention: A *primary prevention intervention* prevents human exposure before it occurs (e.g. paint abatement occurs in the home before a new family with children moves in).

Probability Samples: Samples selected from a statistical population such that each sample has a known probability of being selected.

Probability: Given an experiment with an associated sample space, the objective of probability is to assign to each event a number, which will provide a measure of the likelihood that *A* will occur when the experiment is performed.

Random Samples: Samples selected from a statistical population such that each sample has an equal probability of being selected.

*[*]**Reduction**: Measures designed to reduce or eliminate human exposure to lead-based paint hazards through methods including interim controls and abatement.

Regression Model: A statistical representation of the relationship between a dependent variable such as blood-lead concentration to one or more independent variables such as environmental lead exposures. For example, a regression model could indicate that blood-lead concentration is an additive function of environmental lead levels.

Removal and Replacement: A method of abatement that entails removing substrates such as windows, doors, trim, or soil that have lead-contaminated surfaces and installing new (and presumably lead-free) or deleaded components.

Residual Error: The difference between the modeled predicted value of a random variable under specified conditions and the observed value of that variable under the same conditions.

Risk: The probability of deleterious health or environmental effects.

Risk Assessment: Within the context of this risk analysis report, risk assessment is that portion of the risk analysis consisting of hazard identification (Chapter 2), exposure assessment (Chapter 3), dose-response assessment (Chapter 4), and risk characterization (Chapter 5). Within the context of identifying lead-based paint hazards in a residence, risk assessment is an on-site investigation to determine and report the existence, nature, severity, and location of lead-based paint hazards within a specific residential dwelling.

Rochester Multimedia Model: A regression model obtained in the process of developing the "empirical model" (using data from the Rochester Lead-in-Dust study) which expresses blood-lead concentration for children aged 12-31 months as a function of environmental-lead levels (dust-lead loading, soil-lead concentration, extent of deteriorated lead-based paint hazard). This model differs from the empirical model in that it does not take into account measurement error in the predictor variables and assumes dust-lead loadings are based on wipe collection techniques. This model was used to characterize individual risks in this risk analysis.

Sample: A small part of something designed to show the nature or quality of the whole. Exposure-related measurements are usually samples of environmental or ambient media, exposures of a small subset of a population for a short time, or biological samples, all for the purpose of inferring the nature and quality of parameters important to evaluating exposure.

[*] As define in Section 1001 of Title X and Section 401 of TSCA Title IV amendment.

<u>Sampling Weights</u>: In a complex survey design, a sampling weight is assigned to a sampling unit to denote the total number of units in the population that is represented by that sampling unit. Sampling weights are necessary to make results of the survey representative of the population. For example, the sampling weight assigned to one of the 284 households in the HUD National Survey represents the number of homes that house represents nationally.

<u>Secondary Prevention Intervention</u>: A *secondary prevention intervention* reduces or eliminates human exposure on behalf of humans already exposed to the targeted hazard (e.g. paint abatement occurs in the home of a child who has an elevated blood-lead concentration).

<u>Sensitivity Analysis</u>: An investigation to determine the extent to which variations in key assumptions and approaches affect the results and conclusions of the analysis.

<u>Sensitivity and Specificity</u>: *Sensitivity* is the probability of a dwelling being above the media standards (e.g., soil lead, dust lead, etc.) given that there is a resident child with blood concentration above some specified threshold value. *Specificity* is the probability of a dwelling being below the media standards given that there is a resident child with blood concentration below some specified threshold value.

<u>Sirchee-Spittler Sampler</u>: Vacuum method used to collect dust samples in the Boston and Baltimore phases of EPA's Urban Soil-Lead Abatement Demonstration Project (USLADP). It is a hand-held, battery-powered vacuum unit designed to collect forensic evidence.

<u>Slope</u>: If the regression model is a simple regression model such that $y=\alpha+\beta x+\mathbf{e}$, then β is called the **slope**, and α is called the **intercept**. The slope is interpreted as the amount by which y changes when x is increased by one unit.

<u>Soil Removal</u>: Intervention where soil from areas with elevated lead concentrations are removed and replaced with clean soil, or the areas are permanently covered.

<u>Soil-Lead Concentration</u>: A measure of the mass of lead collected per mass of soil collected and is usually stated in terms of micrograms of lead collected per gram of soil collected (µg Pb/g soil). These units are also sometimes referred to as parts per million (ppm).

<u>Standard Error</u>: The standard deviation of errors around a fitted regression model.

<u>Standard Deviation</u>: A measure of the dispersion of a set of values that is the square root of the "arithmetic mean" of the squares of the deviation of each value from the "arithmetic mean" of the values.

<u>Subpopulation</u>: A subset of the population of interest that is used for analysis. Usually the subpopulation is taken to be representative of the entire population.

<u>Tails</u>: The portion of a distribution containing extreme values are called the tails of the distribution.

<u>Tap Weight</u>: The weight of the dust that was tapped out of the blue nozzle vacuum cassette and analyzed for lead. Note that a dust sample's tap weight is lower than its actual weight, as some dust may remain in the cassette.

[*]**<u>Target Housing</u>**: Any housing constructed prior to 1978, except for housing of the elderly or persons with disabilities (unless any child who is less than 6 years of age resides or is expected to reside in such housing for the elderly or persons with disabilities), or any 0-bedroom dwelling.

<u>Threshold</u>: The value above which something is true or will take place and below which it is not or will not.

<u>True Negative Rate</u>: Alternative terminology for *specificity*.

<u>True Positive Rate</u>: Alternative terminology for *sensitivity.*

<u>Uptake</u>: The process by which a substance is absorbed into the body.

<u>Vacuum Sample</u>: Collecting dust over a specified area by vacuuming the area. The contents of the vacuum bag or filter cassette are then analyzed for the amount of dust and the amount of lead. Results from vacuum sampling can be expressed as "dust-lead loadings" or "dust-lead concentrations".

<u>Variability</u>: A measure used to describe how data vary about the center of the distribution. It also tells the spread of the data.

<u>Wet Room</u>: An interior room in a house which is either a kitchen, bathroom, laundry, or utility room is classified as a 'wet room', otherwise the room may be classified as a 'dry' room. Terminology used in the HUD National Survey.

<u>Window Sill</u>: The portion of the horizontal window ledge that protrudes into the interior of the room, adjacent to the window sash when the window is closed.

<u>Window Trough</u>: The portion of the horizontal window sill that receives the window sash when the window is closed, often located between the storm window and the interior window sash. This is also sometimes referred to as a **window well**.

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[*] As define in Section 1001 of Title X and Section 401 of TSCA Title IV amendment.

Wipe Sample: Dust that is collected over a specified area by wiping the area with a moist cloth. The cloth and the dust on the cloth are then analyzed for the amount of lead. Results from wipe sampling are in the form of “dust-lead loadings.” Section 403 standards for lead in dust will likely be specified in terms of wipe dust-lead loadings.

XRF: “X-ray fluorescence” is a principle used by instruments to determine the lead concentration in substances, usually in milligrams of lead per square centimeter of surface area (mg/cm^2).

APPENDIX B

Health Effects Associated with Exposure to Lead and Internal Lead Doses in Humans

Table B-1. Health Effects Associated with Exposure to Lead and Internal Lead Doses in Humans.

Duration of Exposure	System	Effect	Blood Lead Levels at which Effect is Observed (µg/dL)	Reference
< 1 yr (occup)		Increase in death due to hypertension, nephritis, neoplasms	63-80	Cooper et al., 1985, 1988
NS (occup)		Increase in death due to cerebrovascular disease, nephritis, and/or nephrosis	NS	Fanning 1988; Malcolm and Barnett 1982; Michaels et al. 1991
< 3 yr (occup)		No increase in deaths	34-58 (means)	Gerhardsson et al. 1986b
NS		Acute encephalopathy resulting in death in children	125-750	NAS 1972
2 wk - > 1 yr (occup)	Cardiovascular	Increased blood pressure	≥ 30 - 120	deKort et al. 1987; Pollock and Ibels 1986; Marino et al. 1989; Weiss et al. 1986, 1988
> 1 yr (occup)	Cardiovascular	No effect on blood pressure	40 (mean)	Parkinson et al. 1987
> 1 yr (occup)	Cardiovascular	Ischemic electrocardiogram changes	51 (mean)	Kirkby and Gyntelberg 1985
NS (general population)	Cardiovascular	Increased blood pressure	44.9 (mean)	Khera et al. 1980
NS (general population)	Cardiovascular	Increased systolic pressure by 1-2 mmHg and increased diastolic pressure by 1.4 mmHg with every doubling in blood-lead level; effect most prominent in middle-aged white men	7-38	Coate and Fowles 1989; Harlan 1988; Harlan et al. 1988; Landis and Flegal 1988; Pirkle et al. 1985; Schwartz 1988
NS (general population)	Cardiovascular	No significant correlation between blood pressure and blood-lead levels	6-13 (median) or NS	Elwood et al. 1988; Grandjean et al. 1989; Neri et al. 1988; Staessen et al. 1990, 1991
NS (general population)	Cardiovascular	Degenerative changes in myocardium, electrocardiogram abnormalities in children	6-20	Silver and Rodriguez-Torres 1968

Table B-1. Health Effects Associated with Exposure to Lead and Internal Lead Doses in Humans. (Continued)

Duration of Exposure	System	Effect	Blood Lead Levels at which Effect is Observed (µg/dL)	Reference
NS (acute) (occup)	Gastrointestinal	Colic (abdominal pain, constipation, cramps, nausea, vomiting, anorexia, weight loss)	40-200	Awad et al. 1986; Baker et al. 1979; Haenninen et al. 1979; Holness and Nethercott 1988; Kumar et al 1987; Marino et al. 1989; Matte et al. 1989; Muijser et al. 1987; Pagliuca et al. 1990; Pollock and Ibels 1986; Schneitzer et al. 1990
NS (acute) (general population)	Gastrointestinal	Colic in children	60-100	U.S. EPA 1986; NAS 1972
NS (occup)	Hematological	Increased ALAS and/or decreased ALAD	87 or NS (correlated with blood-lead level)	Alessio et al. 1976; Meredith et al. 1978; Wada et al. 1973
NS (general population)	Hematological	Decreased ALAD	3-56 (adult) No threshold (children	Chisholm et al. 1985; Lauwerys et al. 1978; Roels et al. 1976; Roels and Lauwerys 1987; Secchi et al. 1974
NS (occup)	Hematological	Increased urinary or blood ALA	< 40-50, 87 (mean) or NS	Lauwerys et al. 1974; Meredith et al. 1978; Pollock and Ibels 1986; Selander and Cramer 1970
NS (general population)	Hematological	Increased urinary ALA	> 35 (adult) 25-75 children	NAS 1972; Roels and Lauwerys 1987
NS (general population)	Hematological	Increased FEP	≥ 25-35	Grandjean and Lintrup 1978; Roels et al. 1975
NS (general population)	Hematological	Increased EP	30-40 (males 20-30 (females)	Roels and Lauwerys 1987; Roels et al. 1975, 1976, 1979; Stuick 1974
NS (general population	Hematological	Increased ZPP	≥ 15 (children)	Hammond et al. 1985; Piomelli et al. 1982; Rabinowitz et al. 1986; Roels and Lauwerys 1987; Roels et al. 1976
NS (general population)	Hematological	Increased urinary coproporphyrin	≥ 35 (children) ≥ 40 (adults)	U.S. EPA 1986
NS (occup)	Hematological	Decreased hemoglobin with or without basophilic stippling of erythrocytes	≥ 40	Awad et al. 1986; Baker et al. 1979; Grandjean 1979; Lilis et al. 1978; Pagliuca et al. 1990; Tola et al. 1973; Wada et al. 1973

Table B-1. Health Effects Associated with Exposure to Lead and Internal Lead Doses in Humans. (Continued)

Duration of Exposure	System	Effect	Blood Lead Levels at which Effect is Observed (µg/dL)	Reference
NS (general population)	Hematological	Decreased hemoglobin	≥ 40 (children)	Adebonojo 1974; Betts et al. 1973; Pueschel et al. 1972; Rosen et al. 1974
NS (general population)	Hematological	Anemia (hematocrit of < 35%)	> 20 (children)	Schwartz et al. 1990
NS (occup)	Hematological	Decreased Py-5[1]-N	NS	Buc and Kaplan 1978; Paglia et al. 1975, 1977
NS (general population)	Hematological	Decreased Py-5[1]-N	7-80 (children)	Angle and McIntire 1978; Angle et al. 1982
NS (acute) (general population)	Hepatic	Decreased mixed function oxidase activity	NS (children)	Alvares et al. 1975; Saenger et al. 1984
NS (chronic) (occup)	Renal	Chronic Nephropathy	40 - > 100	Biagini et al. 1977; Cramer et al. 1974; Lilis et al. 1968; Maranelli and Apostoli 1987; Ong et al. 1987; Pollock and Ibels 1986; Verschoor et al. 1987; Wedeen et al. 1979
1-30 yr (occup)	Renal	No effect on renal function	40-61	Buchet et al. 1980; Huang et al. 1988
NS (chronic) (general population)	Renal	Renal (impairment with gout or hypertension)	18-26 µg/dL	Batuman et al. 1981, 1983
NS (acute) (general population)	Renal	Aminoaciduria; Fancoi syndrome	> 80 (children)	Chisholm 1962; Pueschel et al. 1972
0.1-20 yr (chronic) (occup)	Other	Decreased thyroxin (T_4)	≥ 56	Tuppurainen et al. 1988
NS (chronic) (general population)	Other	No effect on thyroid function in children	2-77 (levels measured)	Siegel et al. 1989
NS (general population	Other	Negative correlation between blood lead and serum 1,25-dihydroxyvitamin D in children	12-120	Mahaffey et al. 1982; Rosen et al. 1980
NS (chronic) (general population)	Other	No effect on vitamin D metabolism in children	5-24 (levels measured)	Koo et al. 1991

Table B-1. Health Effects Associated with Exposure to Lead and Internal Lead Doses in Humans. (Continued)

Duration of Exposure	System	Effect	Blood Lead Levels at which Effect is Observed (µg/dL)	Reference
NS (chronic) (general population)	Other	Growth retardation in children	≥ 30-60; Tooth lead > 18.7 µg/g	Angle and Kuntzelman 1989; Lauwers et al. 1986; Lyngbye et al. 1987
NS (chronic) (general population)	Other	No association between blood-lead levels and growth in children	10-47 (levels measured)	Greene and Ernhart 1991; Sachs and Moel 1989
< 18 yr (occup)	Immunological	Depression of cellular immune function, but no effect on humoral immune function	21-90	Alomran and Shleamoon 1988; Ewers et al. 1982
NS (acute)	Neurological	Encephalopathy (adults)	50 - > 300	Kehoe 1961; Kumar et al. 1987; Smith et al. 1938
NS (acute and chronic) (occup)	Neurological	Neurological signs and symptoms in adults including malaise, forgetfulness, irritability, lethargy, headache, fatigue, impotence, decreased libido, dizziness, weakness, paresthesia	40-80	Awad et al. 1986; Baker et al. 1979; Campara et al. 1984; Haenninen et al. 1979; Holness and Nethercott 1988; Marino et al. 1989; Matte et al. 1989; Pagliuca et al. 1990; Parkinson et al. 1986; Pasternak et al. 1989; Pollock and Ibels 1986; Schneitzer et al. 1990; Zimmerman-Tansella et al. 1983
NS (occup)	Neurological	Neurobehavioral function in adults; disturbances in oculomotor function, reaction time, visual motor performance, hand dexterity, IQ test and cognitive performance, nervousness, mood, coping ability, memory	40-80	Arnvig et al. 1980; Baker et al. 1983; Baloh et al. 1979; Campara et al. 1984; Glickman et al. 1984; Haenninen et al. 1978; Hogstedt et al. 1983; Mantere et al. 1982; Spivey et al. 1980; Stollery et al. 1989; Valciukas et al. 1978; Williamson and Teo 1986
NS (occup)	Neurological	No effect on neurobehavioral function in adults	40-60 (levels measured)	Milburn et al. 1976; Ryan et al. 1987
NS (occup)	Neurological	Peripheral nerve function in adults; decreased nerve conduction velocity	30- ≥ 70	Araki et al.1980; Muijser et al. 1987; Rosen et al. 1983; Seppalainen et al. 1983; Triebig et al. 1984
NS (occup)	Neurological	No effect on peripheral nerve function	60-80 (levels measured)	Spivey et al. 1980

Table B-1. Health Effects Associated with Exposure to Lead and Internal Lead Doses in Humans. (Continued)

Duration of Exposure	System	Effect	Blood Lead Levels at which Effect is Observed (µg/dL)	Reference
NS (general population)	Neurological	Neurological signs and symptoms in children and encephalopathy	60-450 (effects other than encephalopathy); > 80-800 (encephalopathy)	Bradley and Baumgartner 1958; Bradley et al. 1956; Chisolm 1962, 1965; Chisolm and Harrison 1956; Gant 1938; Rummo et al. 1979; Smith et al. 1983
NS (general population)	Neurological	Neurobehavioral function in children: lower IQS and other neuropsychologic deficits	40-200	dela Burde and Choate 1972, 1975; Ernhart et al. 1981; Kotok 1972; Kotok et al. 1977; Rummo et al. 1979
NS (general population)	Neurological	Neurobehavioral function in children: slightly decreased performance on IQ tests and other measures of neuropsychological function	Tooth lead: 6 - > 30 µg/g Blood lead: 6-60	Bellinger and Needleman 1983; Bergomi et al. 1989; Fulton et al. 1987; Hansen et al. 1989; Hawk et al. 1986; Needleman et al. 1979, 1985, 1990; Schroeder et al. 1985; Schroeder and Hawk 1987; Silva et al. 1988; Wang et al. 1989
NS (general population)	Neurological	No correlation between blood-lead levels and permanent effects on neurobehavioral development in children	10-15	Cooney et al. 1989; Harvey et al. 1984, 1988; Lansdown et al. 1986; McBride et al. 1982; Ernhart and Greene, 1990; Dietrich et al. 1987a; Bellinger et al. 1989a; McMichael et al. 1986; Pocock et al. 1989; Smith et al. 1983; Winneke et al. 1984
NS (general population)	Neurological	Decrease in hearing acuity in children	4-60	Schwartz and Otto 1987
NS (general population)	Neurological	Alterations in peripheral nerve function in children	20-30	Erenberg et al. 1974; Landrigan et al. 1976; Schwartz et al. 1988; Seto and Freeman 1964
prenatal (general population)	Developmental	Decreased growth rate	7.7	Shukla et al. 1989
prenatal (general population)	Developmental	Reduced birth weight and/or reduced gestational age, and/or increased incidence of stillbirth and neonatal death	12-17	Bornschein et al. 1989; McMichael et al. 1986; Moore et al. 1982; Ward et al. 1987; Wibberley et al. 1977

Table B-1. Health Effects Associated with Exposure to Lead and Internal Lead Doses in Humans. (Continued)

Duration of Exposure	System	Effect	Blood Lead Levels at which Effect is Observed (µg/dL)	Reference
NS (general population)	Developmental	No association between blood-lead levels and birth weight, gestational age, or other neonatal size measures	3-55	Greene and Ernhart 1991; Factor-Litvak et al. 1991
NS (general population)	Developmental	Impaired mental development in children	10-15	Baghurst et al. 1987; Bellinger et al. 1984, 1985a, 1985b, 1986a, 1986b, 1987a, 1987b; Bornschein et al. 1989; Dietrich et al. 1986, 1987a, 1987b; Ernhart et al. 1985, 1986, 1987; McMichael et al. 1988; Rothenberg et al. 1989; Wigg et al. 1988; Winneke et al. 1985a, 1985b; Wolf et al. 1985; Vimpani et al. 1985, 1989
NS (general population)	Developmental	Inverse correlation between blood-lead levels and ALA and ALAD activity	10-33 (mean)	Haas et al. 1972; Kuhnert et al. 1977; Lauwerys et al. 1978
NS (general population	Reproductive	Increased incidence of miscarriages and stillbirths in exposed women	≥ 10 or NS	Baghurst et al. 1987; Hu et al. 1991; McMichael et al. 1986; Nordstrom et al. 1979; Wibberley et al. 1977
NS (general population)	Reproductive	No association between blood-lead levels and the incidence of spontaneous abortion in exposed women	2	Murphy et al. 1990
NS (occup)	Reproductive	Adverse effects on testes	40-50	Assennato et al. 1987; Braunstein et al. 1978; Chowdhury et al. 1986; Cullen et al. 1984; Lancranjan et al. 1975; Rodamilans et al. 1988; Wildt et al. 1983

ALA = δ-aminolevulinic acid; ALAD = δ-aminolevulinic acid dehydratase; ALAS = δ-aminolevulinic acid synthase; EP = erythrocyte protoporphyrins; FEP = free erythrocyte protoporphyrins; IQ = intelligence quotient; mmHg = millimeters of mercury; NS = not specified; (occup) = occupational; Py-5^1-N = pyrimidine-5-nucleotidase; wk = week(s); yr = year(s); ZPP = zinc erythrocyte protoporphyrin

APPENDIX C1

Characterizing Baseline Environmental-Lead Levels in the Nation's Housing Stock

APPENDIX C1

CHARACTERIZING BASELINE ENVIRONMENTAL-LEAD LEVELS IN THE NATION'S HOUSING STOCK

As discussed in Section 3.3.1.1, the §403 risk analysis used environmental-lead data from the National Survey of Lead-Based Paint in Housing ("HUD National Survey") to characterize baseline environmental-lead levels in the nation's 1997 housing stock. Here, the term "baseline" refers to conditions prior to implementing interventions in response to §403 rules. Data for 284 privately-owned, occupied housing units included in the HUD National Survey were considered in the characterization. In total, these units represented the entire U.S. privately-owned, occupied housing stock built prior to 1980 (USEPA, 1995a). Due to the complex sampling design employed, the HUD National Survey assigned sampling weights to each unit, which equaled the number of privately-owned, occupied housing units in the national housing stock built prior to 1980 that were represented by the unit (USEPA, 1995g).

In order to use the information from the HUD National Survey to represent baseline environmental-lead levels in the 1997 national housing stock, the following steps were taken:

1. Update the sampling weights assigned in the HUD National Survey to reflect the 1997 housing stock (including publicly-owned units).

2. Determine the total number of children residing in the housing units represented by each sampling weight.

3. Summarize the environmental-lead levels within each surveyed unit.

Methods for conducting each of these steps, and the results from implementing these methods, are summarized in the following sections.

1.0 UPDATING THE NATIONAL SURVEY SAMPLING WEIGHTS

Characterizing the 1997 national housing stock and its distribution of environmental-lead levels involved updating the sampling weights assigned in the HUD National Survey to reflect the 1997 national housing stock. The tasks performed to update these weights were the following:

1. Identify demographic variables that served to group the housing units by their potential for differing environmental-lead levels.

2. Use information within the National Survey weights and the 1993 American Housing Survey to determine total numbers of 1997 housing units within each of these housing groups.

3. Allocate these 1997 totals among the National Survey units within the housing groups.

The methods developed for each of these tasks are presented in the following subsections.

1.1 IDENTIFY SIGNIFICANT FACTORS ASSOCIATED WITH ENVIRONMENTAL-LEAD LEVELS

In updating the sampling weights of the 284 National Survey units, the units were classified into housing groups according to a set of demographic factors found to have a statistically significant influence on environmental-lead levels in the units. Then, the number of 1997 housing units in each group was determined. By grouping the housing units according to these factors, units within the same group had relatively similar distributions of environmental-lead levels, while units in different groups had considerably different distributions.

In determining an appropriate housing grouping, a set of candidate factors was identified, where these factors satisfied three criteria: 1) they would be either important in an economic analysis for §403 rulemaking, or they were likely to be significantly associated with environmental-lead levels; 2) their values for National Survey units existed within the National Survey database; and 3) their values were measured within the 1993 American Housing Survey, a national survey conducted by the Bureau of the Census and the Department of Housing and Urban Development (HUD) to characterize the nation's housing stock (Bureau of the Census and HUD, 1995). Then, a stepwise regression variable selection analysis selected a subset of these factors which explained the largest proportions of house-to-house variability in the following four environmental-lead measurements:

- A mass-weighted arithmetic average floor dust-lead concentration[*] for the unit (i.e., each measurement was weighted by the mass of the sample);
- An area-weighted arithmetic average floor dust-lead loading for the unit (i.e., each measurement was weighted by the square-footage of the sample area);
- A weighted arithmetic average soil-lead concentration for the unit, where results for samples taken from remote locations were weighted twice as much as results for dripline and entryway samples.
- Maximum XRF paint-lead level in the unit (for units containing lead-based paint[**]).

The set of factors included in this analysis are documented in Table C1-1.

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[*] Prior to calculating the mass-weighted average, dust-lead concentrations were adjusted to reduce bias associated with underestimated sample weights ("low tap weights") reported in the HUD National Survey for dust samples. The adjustment procedure is documented in USEPA, 1996c.

[**] Lead-based paint was considered present in a unit if its predicted maximum XRF value (as determined by statistical modeling techniques within the HUD National Survey) in either the interior or exterior was greater than or equal to 1.0 mg/cm².

Table C1-1. Demographic Factors Included in the Stepwise Regression Analysis.

Factor	How the Factor Categorized Housing Units for the Stepwise Regression Analysis
Year the Unit Was Built	Pre-1940; 1940-1959; 1960-1979
Race of Youngest Child	White/Non-Hispanic; Other
Urbanicity Status	City; Suburb/non-metro
Region of Country	Northeast; Midwest; South; West (U.S. Census regions)
Ownership Status	Owner-occupied; renter-occupied
Number of Units in the Bldg.	One unit; more than one unit
Annual Income of Residents	< $30,000; $30,000 or more

The analysis was performed twice on each endpoint: on data for National Survey units containing lead-based paint (LBP) and for units with no LBP. Table C1-2 provides the observed significance levels of each factor considered in the stepwise regression analyses when these levels were below 0.10. Lower significance levels imply a stronger effect on the measurement. The columns in Table C1-2 correspond to separate regression analyses. Across all analyses, the year in which a unit was built (as categorized by pre-1940, 1940-1959, and 1960-1979) had the strongest and most consistent effect on the environmental-lead level (with floor dust-lead concentration an exception). Statistical significance levels for the effect of year built were consistently less than 0.01. While similar significance levels were occasionally observed for other factors in the table, the extent of significance across the environmental-lead measurements was not as consistent for any other factor. Therefore, the year in which the unit was built was the only factor considered in grouping National Survey units for purposes of updating their weights to 1997.

The stepwise regression analysis assumed that the predicted maximum XRF value is an accurate indicator of whether or not a unit contains LBP. Also, those units with no predicted maximum XRF value were assumed not to contain LBP.

1.2 ESTIMATING NUMBERS OF HOUSING UNITS IN 1997 WITHIN YEAR-BUILT CATEGORIES

In this second task, the number of occupied housing units in 1997, both privately- and publicly-owned, was estimated for each of four categories denoting when the unit was built: pre-1940, 1940-1959, 1960-1979, and post-1979. These categories are hereafter referred to as "year-built categories." The results of this task are presented in Table 3-5 within Chapter 3 of this document.

Table C1-2. Demographic Factors Included in Stepwise Regression Analyses, and Significance Levels Associated With These Factors When Less Than 0.10.[1]

Demographic Factors[2]	Units with predicted maximum XRF value less than 1.0 mg/cm² or missing (n = 40)			Units with predicted maximum XRF value at or above 1.0 mg/cm² (n = 221)			
	Floor Dust-Lead Loading	Floor Dust-Lead Conc.[3]	Soil-Lead Conc.	Floor Dust-Lead Loading	Floor Dust-Lead Conc.[3]	Soil-Lead Conc.	Max. Observed XRF Value[4]
Year the Unit Was Built	< 0.01[5]		< 0.01	< 0.01		< 0.01	< 0.01
Race of Youngest Child			0.04				
Urbanicity Status	0.03						
Region of Country							
Ownership Status							
# Units in the Bldg.				0.01	0.01		
Annual Income of Residents							

[1] Column headings for this table identify the environmental-lead measurement being considered in the analysis and the group of National Survey units whose data are included in the analysis. Each column corresponds to a separate regression analysis. The demographic factors included in the regression analyses are included as rows of the table. As the significance level for a demographic factor gets closer to zero, the effect of the factor on the given environmental measurement is considered more highly statistically significant.
[2] See Table C1-1 for definitions of these factors.
[3] This analysis was performed on unadjusted dust-lead concentrations (i.e., no adjustment was made for bias due to underestimated sample weights).
[4] Regression performed on units where the observed maximum XRF value was at least 1.0 mg/cm².
[5] In the regression analysis of floor dust-lead loading in units without LBP, the effect of the year in which the unit was built was statistically significant with a p-value of less than 0.01 (i.e., significance can be concluded at the 0.01 level).

The primary data source for determining the number of units within each year-built category was the 1993 American Housing Survey (AHS) (Bureau of the Census and HUD, 1995). Data from the 1993 AHS provided estimates of the number of housing units in each year-built category in 1993. However, it was of interest to obtain estimates for 1997, not 1993. Therefore, the 1993 estimates were augmented to reflect additions to and removals from the national housing stock from 1994 to 1997. Once the 1997 estimate of the total within each year-built category was obtained, the total was distributed among the National Survey units in the group using information within the National Survey weights. Details on each of these procedures are now provided.

1.2.1 Characterizing the 1993 National Housing Stock

As in the National Survey, each unit in the 1993 AHS was assigned a weight that was interpreted as the number of units in the national housing stock represented by the given unit. Therefore, placing the AHS units among the four year-built categories and summing the weights of the units within each category yielded the estimated number of units in 1993 for each category.

Only occupied housing units in the 1993 AHS (either publicly-owned or privately-owned) were considered in updating to 1997. The definition of an "occupied" unit was one which was occupied by at least one resident who was classified as not having his/her usual residence elsewhere. Data for 40,931 occupied housing units were available from the 1993 AHS.

1.2.2 Updating the 1993 Housing Stock to 1997

Once the number of housing units in 1993 was determined for each of the four year-built categories, these totals were updated to reflect the 1997 housing stock. Updating the 1993 totals to 1997 was done in the following way:

1. For the post-1979 category, the total number of housing units constructed from 1994 to 1997 and occupied in 1997 was estimated and added to the 1993 total.

2. For all four year-built categories, the total number of housing units occupied in 1993 and lost from the housing stock from 1994 to 1997 was estimated and subtracted from the 1993 total.

In the first step, numbers of new, privately-owned housing units completed in 1994 and 1995 were obtained from Bureau of the Census and HUD (1996). This publication reported estimates of 1,346,900 such units completed in 1994 and 1,311,300 units in 1995. For this analysis, the 1995 estimate was also used in estimating totals for both 1996 and 1997. Therefore, the 1993 estimate for the post-1979 housing category was incremented by 1,346,900 + 3*1,311,300 = 5,280,800 units. Note that this approach assumes that new housing units are completed and occupied within the same year. In addition, no provision was considered for adding new publicly-owned units.

The second step, subtracting the number of housing units occupied in 1993 and lost from the housing stock from 1994 to 1997 within each of the four year-built categories, was more complex. Information on losses was not available by considering only the 1993 AHS. To obtain such information, the 1989 and 1991 AHS databases were obtained. As the AHS retains the same units from survey to survey, it was possible to determine those units that were occupied in one survey and lost from the housing stock by the next. Units were considered lost from the housing stock in a given survey if they were labeled as a "Type C non-interview" in the survey, meaning the unit no longer exists and is dropped from consideration for future surveys. Such losses include demolition, disaster loss, abandoned permit, or the unit was merged with another unit. While moving a house or mobile home from the site also labels the unit as a Type C noninterview, such an instance was <u>not</u> labeled as a loss from the housing stock for this effort, as it is assumed that the unit remains habitable in its new location.

As the AHS is conducted every two years, the probability that a unit is lost from the housing stock over a two-year period was initially estimated from the AHS data. In this procedure, a dataset of information on occupied housing units present in the 1989 AHS was created, with each unit identified by its approximate age in 1989 (in years), by its 1989 sample weight, and by whether or not it was classified as lost from the housing stock in the 1991 AHS.

Similarly, a dataset of information on occupied housing units present in the 1991 AHS was created, with each unit identified by its approximate age in 1991, by its 1991 sample weight, and by whether or not it was classified as lost from the housing stock in the 1993 AHS. Both datasets were combined into a single dataset (without regard to survey year), and a logistic regression analysis was fitted to the combined data to predict the probability of a loss over a two-year period as a function of age (in years). Each data point in the regression analysis was weighted by its sample weight. The resulting prediction model was

$$\text{P[loss over a two-year period]} = \frac{1}{1 + e^{5.82 - 0.0094*\text{age}}} \qquad \textbf{(1)}$$

where "age" is the age of the unit in years. The probability for a one-year period was roughly one-half of the probability for the two-year period. Table C1-3 provides the predicted probabilities of losses over a one-year period for every five years of age.

Table C1-3. Estimated Probability of an Occupied Housing Unit Becoming Lost from the Housing Stock Over a One-Year Period, Given the Age of Unit.

Age of Unit (yrs)	Probability of Loss	Age of Unit (yrs)	Probability of Loss
5	0.0013	45	0.0023
10	0.0014	50	0.0025
15	0.0015	55	0.0026
20	0.0016	60	0.0028
25	0.0017	65	0.0031
30	0.0018	70	0.0033
35	0.0020	75	0.0036
40	0.0021	80	0.0038

Note: These probabilities were estimated from equation (1) and adjusted to cover a one-year period.

Table C1-4 illustrates how losses from the housing stock from 1993 to 1997 were characterized within each of the four year-built categories considered in the risk analysis. First, an age (in years) associated with each of the four year-built categories was determined for 1993 and 1995. For the 1940-1959, 1960-1979, and post-1979 categories, this age corresponded to the age of a unit built in the middle year of the category. The single age assigned to all units in the pre-1940 category was equal to the age of a unit built in 1939. Then, the probability of loss from 1993-1995 and from 1995-1997 was determined from equation (1) based on the age of the unit; these probabilities are labeled in Table C1-4 as $p_{1993\text{-}95}$ and $p_{1995\text{-}97}$, respectively. The total number of units in the category in 1993 was then reduced by multiplying the total by the product $(1\text{-}p_{1993\text{-}95})*(1\text{-}p_{1995\text{-}97})$ (i.e, the last column of Table C1-4).

Table C1-4. Determining Losses from the Housing Stock from 1993-1997.

Year-Built Category	Age of units in 1993 (yrs.)[1]	Prob. of loss from 1993-1995 ($p_{1993-95}$)[2]	Age of units in 1995 (yrs.)[1]	Prob. of loss from 1995-1997 ($p_{1995-97}$)[2]	Proportion of 1993 Total That Remains in 1997 [3]
Pre-1940	54	0.0052	56	0.0054	0.989
1940-1959	44	0.0045	46	0.0046	0.991
1960-1979	24	0.0034	26	0.0034	0.993
Post-1979	7	0.0026	9	0.0027	0.995

[1] A single age is assigned to all units in a given category according to the approach indicated in the text.
[2] Determined from equation (1).
[3] Equal to $(1-p_{1993-95})*(1-p_{1995-97})$

Besides additions and removals, changes in the number of occupied homes in the national housing stock from 1993 to 1997 are also affected by the number of units that are occupied in 1993 and vacant in 1997, as well as by the number of units that are vacant in 1993 and occupied in 1997. However, in this approach, it was assumed that the number of occupied units in 1993 that become vacant in 1997 was approximately equal to the number of vacant units in 1993 that become occupied in 1997, thereby canceling each other out.

1.3 DETERMINING THE NUMBER OF 1997 UNITS REPRESENTED BY EACH NATIONAL SURVEY UNIT

The procedures outlined in the previous subsection provide a method for estimating total numbers of housing units in 1997 within each of the four year-built categories. The results are displayed in Table 3-5 in Chapter 3 of this report. The housing units were grouped within year-built categories to facilitate the linking of numbers of units with estimated environmental-lead levels. The linking process consisted of classifying the National Survey units among the four categories, then distributing the 1997 total among the National Survey units within each category. This distribution yielded an updated weight for each National Survey unit, reflecting changes in the numbers of units in the year-built category from the time the National Survey was conducted to 1997. A unit's updated weight represented the number of units in the 1997 housing stock associated with the National Survey unit (and therefore with its environmental-lead levels).

The 1997 totals include both privately-owned and publicly-owned housing units, while the 284 National Survey units were privately-owned. Therefore, the revised 1997 weights for the National Survey units represent publicly-owned as well as privately-owned units.

1.3.1 Updating the Weights to Reflect the Pre-1980 Housing Stock

To update the sampling weights for the 284 National Survey units to reflect the pre-1980 housing stock, the units were grouped according to the three pre-1980 year-built categories. (Recall that all National Survey units were built prior to 1980). For these three categories, the updated 1997 weight for each unit in the category was calculated as follows:

$$\text{1997 weight} = (\text{National Survey weight}) * (\text{Updating factor for the category}) \qquad \textbf{(2)}$$

where the updating factor was determined as follows:

$$\text{Updating factor} = \frac{\text{\# units in the category in 1997}}{\text{Total National Survey weights in the category}} \qquad \textbf{(3)}$$

(The sampling weights assigned in the National Survey were determined according to when the unit was built, whether the unit existed in a single- or multiple-unit building, the Census region in which the unit was located, and whether or not a child less than aged seven years resided in the unit).

Table C1-5 contains the updating factors applied to the National Survey units according to year-built category. As an example, Table C1-5 indicates that the updated 1997 weight for each of the 77 National Survey units in the pre-1940 category equaled the weight assigned in the National Survey multiplied by 0.936.

Table C1-5. Number of National Survey Units in the Pre-1980 Year-Built Categories, and the Multiplicative Factor Used to Update National Survey Weights to 1997.

Year-Built Category	# National Survey Units	Sum of National Survey Weights	Updating Factor
Pre-1940	77	21,020,019	0.936
1940-1959	87	20,472,997	0.963
1960-1979	120	35,686,004	0.980

1.3.2 Updating the Weights to Reflect the Post-1979 Housing Stock

Despite the fact that no HUD National Survey units were built after 1979, it was of interest to use the HUD National Survey data to characterize the entire occupied national housing stock, including those units built after 1979. Therefore, methods were developed to determine how to use environmental-lead information from the HUD National Survey to represent the post-1979 occupied housing stock.

As the post-1979 housing stock was built after the Consumer Product Safety Commission's 1978 ban on the sale of LBP and its use in residences, the post-1979 housing stock was assumed to be free of LBP. This same assumption was made in the HUD National Survey and is the reason for not including post-1979 housing in the survey. Therefore, only National Survey units not containing LBP were considered in representing post-1979 housing.

To determine whether the entire set of National Survey units without LBP should be considered in representing post-1979 housing or only a subset of these units, data on dust-lead and soil-lead concentrations for units having maximum and minimum XRF measurements below 0.7 mg/cm² were investigated. As the top two plots in Figure C1-1 illustrate, a noticeable relationship exists between lead concentrations and the age of the unit, with higher concentrations associated with older units. In contrast, the bottom two plots in Figure C1-1 show less of a relationship between concentration and age of unit when only units built from 1960-1979 were considered. This finding suggests that older units may be free of LBP, but dust and soil are more likely to remain contaminated with lead than for newer units, either due to previous renovation work on the units or from outside contamination.

As a result of the conclusions made from Figure C1-1, only the 28 National Survey units built between 1960 and 1979 and containing no LBP (predicted maximum XRF measurement less than 1.0 mg/cm²) were selected to represent the post-1979 housing stock. As a result, it was assumed that the environmental-lead levels for these 28 units represented levels that exist in the post-1979 housing stock. These units also were included among those representing the 1960-1979 housing stock. Therefore, the total 1997 sampling weight for these 28 units consisted of two parts: that representing the 1960-1979 housing stock, and that representing the post-1979 housing stock, 1997 weight = (1960-1979 housing stock weight) + (post-1979 housing stock weight), where the 1960-1979 housing stock weight was calculated as described above. The portion representing the post-1979 housing stock was determined by dividing the total number of post-1979 units in 1997 by 28,

$$\text{post-1979 housing stock weight} = (\text{total \# of post-1979 units}) \,/\, 28. \qquad \textbf{(4)}$$

2.0 POPULATING HOUSING UNITS WITH CHILDREN

To characterize risk reduction that may result from performing interventions in response to §403 rules, it was necessary to estimate numbers of children of specific age groups who reside within the national housing stock. This section documents the methods for populating the 1997 national housing stock with children.

Section 1.0 of this appendix presented methods to revising the sampling weights for HUD National Survey units to reflect the 1997 national housing stock of occupied units. Therefore, each weight represents a subset of the national housing stock. It was desired to link numbers of children with each weight. Two age groups of children were of interest:

- Children aged 12 to 35 months (1 to 2 years)
- Children aged 12 to 71 months (1 to 5 years)

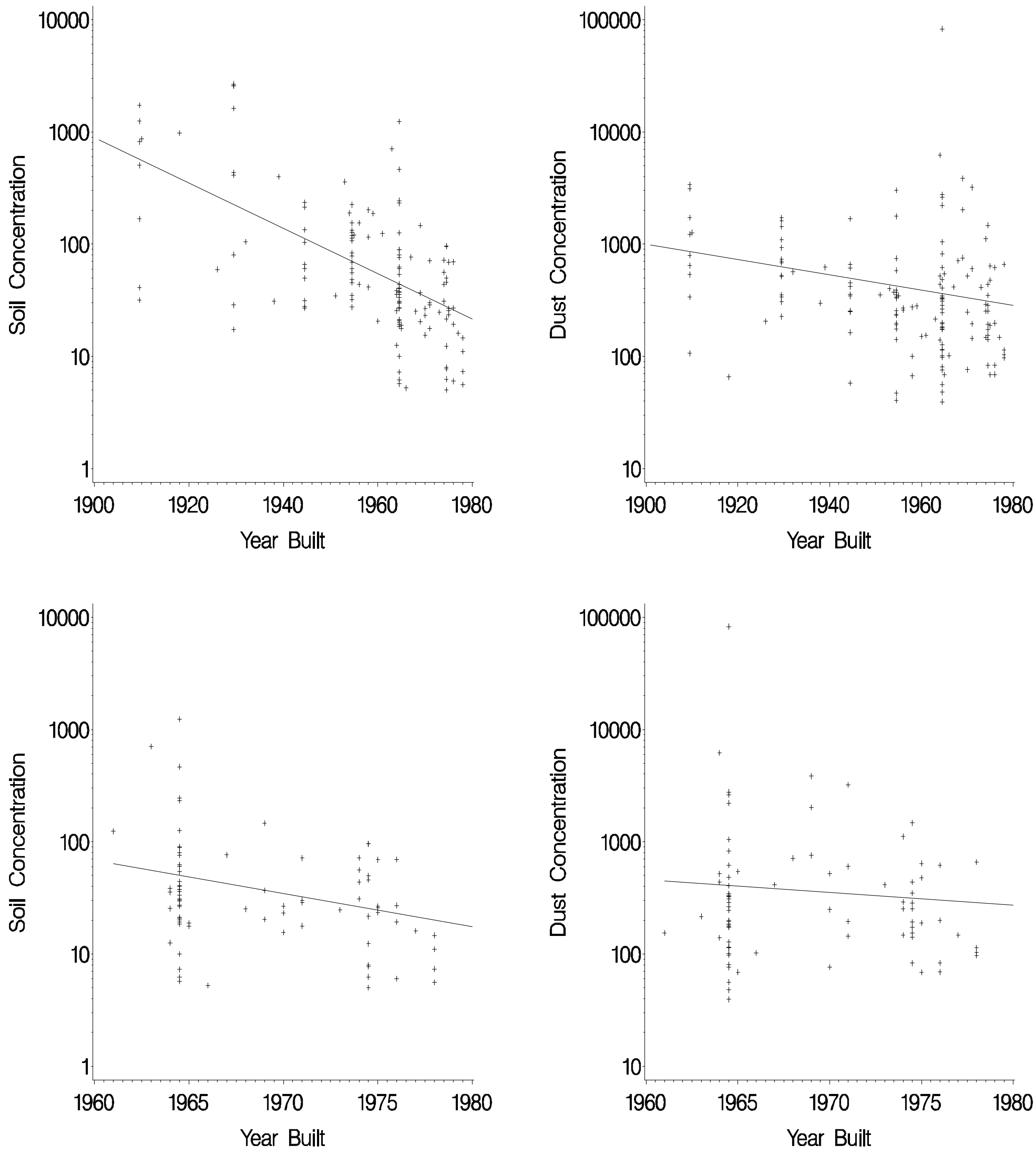

Figure C1-1. Plots of Dust- and Soil-Lead Concentration (µg/g) Versus Age of Unit, for HUD National Survey Units With Maximum XRF Value Less Than 0.7 mg/cm²

The 1-2 year age group was the primary group of interest in this risk analysis, while the 1-5 year age group was considered in the sensitivity analysis within Chapter 5 (Section 5.4.1).

For a given age group of children, the estimated number of children associated with the units represented within a 1997 sampling weight was the product of three statistics:

$$\text{\# children} = (\text{1997 weight}) * (\text{Average \# residents per unit}) * (\text{\# children per person}) \qquad \textbf{(5)}$$

As the 1997 weight was determined for each National Survey unit using the methods in Section 1.0 of this appendix, it was necessary to obtain estimates for the latter two statistics in equation (5).

The factor "average # residents per unit" in equation (5) was calculated for the housing group based on information obtained in the 1993 AHS. The 1993 AHS database provided information on up to 15 residents within each housing unit in the AHS. Once these units were placed within the four year-built categories, the average number of people residing in a unit (regardless of age) was calculated for each group. This average ranged from 2.5 to 2.7 across the four year-built categories. A common average of 2.7 residents per unit was used for all units in the national housing stock. While this average was based on 1993 data, it is assumed to also hold for the 1997 housing stock.

The third factor in equation (5), "# children per person," represented the average number of children (of the given age group) per person residing in units within the housing group. This factor was calculated from information presented in Day (1993). This document provided two types of information necessary to calculate average number of children per person:

1. Predicted numbers of births per 1,000 people in the general population within selected years from 1993 to 2050

2. Predicted numbers of people in the general population of specific ages for these selected years.

For 1997, Day (1993) predicted a total of 14.8 births predicted per 1,000 people in the U.S.[*] Therefore, it was assumed that in any subset of occupied housing in 1997, the units within this subset will contain 14.8 children less than one year of age for every 1000 residents.

Day (1993) also provided a predicted number of children of various age groups in the nation in 1997. A total of 3,907,000 children aged 0-11 months, 7,835,000 children aged 12 to

[*] This is a "middle series assumption" birth rate, indicating the level at which assumptions are placed on fertility, life expectancy, and yearly net immigration.

35 months, and 20,066,000 children aged 12 to 71 months were predicted. By dividing each of these latter two statistics by 3,907,000, approximately 2.01 children aged 12 to 35 months and 5.14 children aged 12 to 71 months are predicted in 1997 for every child aged 0-11 months. Thus, using the birth rate in the previous paragraph, a total of 2.01 x 14.8 = 29.7 children aged 12 to 35 months, and 5.14 x 14.8 = 76.1 children aged 12 to 71 months, are predicted in 1997 per 1000 people in the U.S.

Table C1-6 contains estimates of average number of children per unit in the 1997 national housing stock, according to age group. These numbers are the product of the final two factors in equation (5). Therefore, these numbers are multiplied by the 1997 sampling weights for each National Survey unit to obtain an estimated number of children residing in units represented within the weight. By summing the estimates across National Survey units, the total number of children aged 12-35 months and 12-71 months residing within the 1997 national housing stock is obtained by year-built category and for the nation. These results are presented in Table 3-35 in Chapter 3 of this report.

Table C1-6. Estimated Average Number of Children Per Unit in the 1997 National Housing Stock, by Age of Child.

Age Group	Estimated Average Number of Children Per Unit
12-35 months	2.7*0.0297 = 0.080
12-71 months	2.7*0.0761 = 0.205

3.0 SUMMARIZING ENVIRONMENTAL-LEAD LEVELS WITHIN THE HUD NATIONAL SURVEY UNITS

The methods of Sections 1.0 and 2.0 of this appendix were used to link each of the 284 units in the HUD National Survey with an estimated number of units in the 1997 national housing stock and an estimated number of children residing within these units. In this final step, it is necessary to summarize the environmental-lead levels within each National Survey unit.

The following statistics were calculated for each National Survey unit, summarizing the unit's dust-lead loadings and dust-lead concentrations from floors and window sills, and soil-lead concentrations:

- A mass-weighted arithmetic average floor dust-lead concentration* for the unit (i.e., each measurement is weighted by the mass of the sample);

- An area-weighted arithmetic average floor dust-lead loading for the unit (i.e., each measurement is weighted by the square-footage of the sample area);

- A mass-weighted arithmetic average window sill dust-lead concentration* for the unit (i.e., each measurement is weighted by the mass of the sample);

- An area-weighted arithmetic average window sill dust-lead loading for the unit (i.e., each measurement is weighted by the square-footage of the sample area);

- A weighted arithmetic average soil-lead concentration for the unit, where results for samples taken from remote locations were weighted twice as much as results for dripline and entryway samples. If a unit has no soil-lead results for a particular location, the arithmetic average was unweighted (i.e., results for the remaining locations were not weighted).

- An unweighted arithmetic average soil-lead concentration, considering only the dripline and entryway samples for the unit.

- The maximum paint-lead concentration in the interior and the exterior of the unit, as measured by XRF techniques in selected rooms and on selected components within these rooms.

- The amount of damaged lead-based paint measured in the interior and the exterior of the unit.

These summary values were used in the statistical models to represent environmental-lead levels in the national housing stock, in determining health benefits associated with intervention.

In the HUD National Survey database, some units have unrecorded (or "missing") values for dust-lead loadings or concentrations, or soil-lead concentrations, preventing values for one or more of the first six summary statistics above from being calculated. As the values of certain statistics were used as input to the IEUBK and empirical models to predict any risk reductions that may result from performing interventions in response to §403 rules, it was necessary that every housing unit have values for these statistics, even if no data existed for a particular unit. Therefore, an imputation scheme was devised to obtain summary values for units having no data in the National Survey database for the given parameter. In this approach, if a unit did not have data to allow the value of a summary statistic from being calculated, the value assigned to the unit equaled the weighted arithmetic average of those values for units within the same year-built

* Prior to calculating the mass-weighted average, dust-lead concentrations on floors and window sills were adjusted to reduce bias associated with underestimated sample weights ("low tap weights") reported in the National Survey for dust samples.

category and having the same indicator for the presence of LBP, with each value weighted by the 1997 weight for the respective unit. For example, a total of eight National Survey units were built prior to 1940 and contained no LBP. If one of these units had no floor dust-lead loadings, then the summary value of floor-dust-lead loading for this unit would equal the weighted average of the summary values across the other seven units. The inputed values are documented in Table 3-14 of Chapter 3.

Table C1-7 contains a listing of National Survey units within the three year-built categories in which they are classified. Also note that the 28 National Survey units built from 1960-1979 and containing no LBP were listed within a fourth category within Table C1-7, representing the national housing stock built after 1979. The dust-lead concentrations summarized in Table C1-7 were initially adjusted for underestimated sample weights (USEPA, 1996c). Also, dust-lead loadings summarized in Table C1-7 were initially adjusted to reflect loadings that would be obtained if wipe collection techniques were used, rather than the Blue Nozzle vacuum method employed in the HUD National Survey. The method to converting from Blue Nozzle vacuum to wipe loadings is presented in Chapter 4.

Table C1-7 also contains the updated 1997 sampling weights for each unit (as calculated in Section 1.0 of this appendix) and the estimated numbers of children aged 12-35 months and 12-71 months that reside within the units (as calculated in Section 2.0 of this appendix). For the 28 units listed in both the 1960-1979 and post-1979 categories, the sampling weights and numbers of children are only that portion representing units within the category.

Table C1-7. Estimated Environmental Lead Levels in the 1997 Housing Stock, As Determined from National Survey Units

Year Built	National Survey ID	LBP Present?	Wipe Floor Dust-Lead Loading (ug/ft2)	Vac. Floor Dust-Lead Loading (ug/ft2)	BN Floor Dust-Lead Conc. (ug/g)	Wipe W. Sill Dust-Lead Loading (ug/ft2)	Vac. W. Sill Dust-Lead Loading (ug/ft2)	Yardwide Avg. Soil-Lead Conc. (ug/g)	Obs. Max. Interior XRF (mg/cm2)	Obs. Max. Exterior XRF (mg/cm2)	Damaged Interior LBP (ft2)	Damaged Exterior LBP (ft2)	1997 Weight	# Children 12-35 mo.	# Children 12-71 mo.
<1940	0320408	No	8.43	1.72	320.	1.83	0.62	36.5	0.60	--	0.0	0.0	183,864	14,744	37,779
	0320507	No	17.2	4.19	338.	35.6	7.78	113.	--	--	0.0	0.0	183,864	14,744	37,779
	1210806	No	23.1	6.28	970.	17.6	4.55	279.	--	--	0.0	--	121,752	9,763	25,016
	1921709	No	23.5	5.86	448.	35.7	8.28	305.	--	--	0.0	--	199,528	16,000	40,997
	1932300	No	106.	40.0	412.	1220.	166.	279.	--	--	0.0	0.0	199,528	16,000	40,997
	1942606	No	31.4	9.10	246.	2250.	277.	259.	0.60	0.00	0.0	0.0	199,528	16,000	40,997
	1953009	No	0.99	0.13	103.	1.36	0.52	279.	0.60	--	0.0	0.0	199,528	16,000	40,997
	2022507	No	93.3	34.0	589.	176.	31.9	326.	0.60	--	0.0	0.0	1,140,935	91,492	234,428
	0211102	Yes	17.3	4.64	778.	0.14	0.08	84.2	2.8	8.7	0.0	0.0	183,864	14,744	37,779
	0221101	Yes	2.09	0.32	148.	0.80	0.33	394.	0.60	5.1	0.0	0.0	95,766	7,679	19,677
	0221507	Yes	26.7	6.95	975.	449.	65.1	2020.	10.	6.0	0.0	4.8	183,864	14,744	37,779
	0310102	Yes	13.2	3.08	297.	2.58	0.89	138.	0.60	0.60	0.0	0.0	183,864	14,744	37,779
	0310607	Yes	2.83	0.46	63.8	440.	68.3	1240.	3.4	--	0.0	--	183,864	14,744	37,779
	0310706	Yes	2.83	0.48	197.	59.6	12.8	534.	7.1	14.	0.0	0.0	95,766	7,679	19,677
	0311100	Yes	96.6	41.7	1600.	3.03	1.02	711.	5.3	5.8	0.0	57.6	183,864	14,744	37,779
	0320705	Yes	6.40	1.28	406.	0.86	0.35	274.	0.70	27.	0.0	0.0	183,864	14,744	37,779
	0350801	Yes	22.6	6.55	2110.	29.6	6.47	25.9	--	--	0.0	0.0	95,766	7,679	19,677
	0411207	Yes	236.	118.	1810.	14.6	3.88	805.	0.40	0.40	0.0	0.0	244,799	19,630	50,299
	0520106	Yes	4.61	0.81	86.6	4.92	1.54	59.6	0.60	0.40	0.0	0.0	244,799	19,630	50,299
	0520403	Yes	130.	51.8	299.	246.	41.8	102.	0.70	1.8	0.0	0.0	114,632	9,192	23,553
	0520700	Yes	75.7	27.2	938.	6190.	592.	258.	0.60	2.8	0.0	0.0	199,528	16,000	40,997
	0520908	Yes	12.2	2.93	631.	108.	21.2	17.4	0.70	0.60	0.0	0.0	114,632	9,192	23,553
	0711002	Yes	24.6	7.08	537.	8.32	2.41	642.	0.20	13.	0.0	0.0	111,365	8,930	22,882
	0720300	Yes	13.3	3.07	340.	2540.	307.	1460.	12.	0.60	0.0	0.0	111,365	8,930	22,882
	0720706	Yes	16.1	3.80	526.	298.	46.3	841.	8.0	5.0	0.0	24.6	111,365	8,930	22,882
	0721001	Yes	31.0	8.56	326.	2300. *	207. *	80.4	3.3	0.60	0.0	0.0	60,761	4,872	12,485
	0730606	Yes	49.3	14.8	527.	43700.	3150.	372.	10.	8.8	9.4	28.0	111,365	8,930	22,882
	0820506	Yes	6.83	1.32	130.	13.3	3.59	835.	0.70	3.6	0.0	226.8	111,365	8,930	22,882
	0911800	Yes	2.83	0.43	92.2	97.2	19.3	49.8	0.60	0.80	0.0	0.0	111,365	8,930	22,882
	0920900	Yes	4.73	0.84	187.	1.28	0.49	162.	0.60	54.	0.0	0.0	111,365	8,930	22,882
	0941005	Yes	4.84	0.86	244.	896.	127.	1620.	0.80	3.8	0.0	0.0	773,094	61,994	158,848
	0950402	Yes	17.7	4.26	641.	2310.	262.	2000.	0.30	0.30	0.0	0.0	773,094	61,994	158,848
	0951004	Yes	7.52	1.57	522.	101.	18.5	1170.	0.60	6.5	0.0	457.3	773,094	61,994	158,848
	1010909	Yes	23.2	6.63	1240.	24.4	5.84	851.	10.	51.	0.0	0.0	244,799	19,630	50,299
	1011303	Yes	44.2	13.3	1100.	2300. *	207. *	717.	0.80	--	0.0	--	244,799	19,630	50,299
	1011501	Yes	19.0	4.51	616.	48.3	9.95	4620.	0.40	38.	0.0	0.0	114,632	9,192	23,553
	1011600	Yes	46.2 *	17.9 *	451.	2300. *	207. *	392.	0.30	29.	0.0	182.0	244,799	19,630	50,299
	1041607	Yes	2.85	0.45	0.09	1.12	0.44	39.5	0.30	0.30	0.0	0.0	244,799	19,630	50,299
	1221902	Yes	100.	41.4	6320.	14600.	1200.	444.	6.4	11.	0.0	8.4	1,140,935	91,492	234,428
	1250406	Yes	32.8	9.01	2260.	96.4	19.1	628.	6.2	4.9	0.0	0.0	121,752	9,763	25,016
	1251107	Yes	74.1	27.2	1760.	85.7	17.4	1030.	5.0	0.00	0.0	0.0	121,752	9,763	25,016
	1251404	Yes	11.0	2.40	638.	36.3	8.08	569.	20.	4.0	0.0	0.0	1,140,935	91,492	234,428
	1352608	Yes	173.	78.1	2070.	2300. *	207. *	679.	7.0	10.	0.0	141.4	111,365	8,930	22,882
	1353705	Yes	4.85	0.86	451.	7.54	2.17	109.	13.	1.8	11.5	0.0	111,365	8,930	22,882
	1411909	Yes	197.	102.	4340.	7.05	2.06	586.	0.60	7.9	0.0	0.0	95,766	7,679	19,677
	1531201	Yes	134.	53.4	831.	542.	83.0	251.	0.90	14.	0.0	585.7	773,094	61,994	158,848
	1531300	Yes	16.8	4.29	303.	35.0	8.11	105.	3.3	4.4	0.0	112.0	111,365	8,930	22,882
	1631209	Yes	12.9	3.09	215.	210.	37.1	841.	1.4	1.6	0.0	0.0	199,528	16,000	40,997
	1631308	Yes	6.28	1.15	122.	229.	40.0	539.	1.2	1.6	0.0	0.0	199,528	16,000	40,997
	1740901	Yes	81.1	27.7	860.	2300. *	207. *	137.	9.4	15.	89.8	0.0	121,752	9,763	25,016
	1751304	Yes	14.8	3.54	198.	0.02	0.01	358.	2.9	9.5	17.6	0.0	121,752	9,763	25,016
	1820802	Yes	3.96	0.69	105.	0.81	0.32	1430.	0.60	--	0.0	0.0	60,761	4,872	12,485
	1830801	Yes	9.48	1.90	271.	3.07	1.03	841.	6.6	--	18.7	--	60,761	4,872	12,485
	1830900	Yes	375.	194.	3630.	8.85	2.36	841.	4.7	--	0.0	--	199,528	16,000	40,997
	1840503	Yes	114.	47.3	1970.	22.1	5.17	841.	1.2	--	0.0	--	60,761	4,872	12,485
	1851104	Yes	32.8	10.3	316.	414.	66.0	383.	0.60	4.6	0.0	0.0	121,752	9,763	25,016
	1931906	Yes	17.0	4.19	193.	1030.	132.	841.	4.4	2.7	0.8	0.0	199,528	16,000	40,997
	1951904	Yes	44.9	13.1	625.	303.	50.2	841.	6.0	--	0.0	0.0	60,761	4,872	12,485
	1952506	Yes	12.6	2.76	328.	0.38	0.17	841.	1.9	2.4	0.0	0.0	60,761	4,872	12,485
	2121507	Yes	27.2	7.68	281.	2300. *	207. *	860.	1.7	7.1	6.2	25.1	199,528	16,000	40,997
	2240406	Yes	225.	97.7	781.	28400.	2190.	335.	0.60	3.5	0.0	604.8	244,799	19,630	50,299

Table C1-7. Estimated Environmental Lead Levels in the 1997 Housing Stock, As Determined from National Survey Units. (Continued)

Year Built	National Survey ID	LBP Present?	Wipe Floor Dust-Lead Loading (ug/ft2)	Vac. Floor Dust-Lead Loading (ug/ft2)	BN Floor Dust-Lead Conc. (ug/g)	Wipe W. Sill Dust-Lead Loading (ug/ft2)	Vac. W. Sill Dust-Lead Loading (ug/ft2)	Yardwide Avg. Soil-Lead Conc. (ug/g)	Obs. Max. Interior XRF (mg/cm2)	Obs. Max. Exterior XRF (mg/cm2)	Damaged Interior LBP (ft2)	Damaged Exterior LBP (ft2)	1997 Weight	# Children 12-35 mo.	# Children 12-71 mo.
<1940	2311108	Yes	76.3	26.4	1280.	1850.	216.	841.	8.6	0.70	21.9	0.0	1,140,935	91,492	234,428
(cont.)	2343002	Yes	6.35	1.19	277.	85.6	16.0	256.	2.3	5.7	0.5	1.7	121,752	9,763	25,016
	2410801	Yes	8.95	1.85	612.	67.1	14.1	290.	5.9	7.6	238.6	77.3	121,752	9,763	25,016
	2441608	Yes	5.11	0.98	342.	469.	67.5	609.	9.4	3.9	0.0	0.0	121,752	9,763	25,016
	2521300	Yes	15.3	3.51	150.	1.13	0.42	35.0	0.50	0.60	0.0	0.0	244,799	19,630	50,299
	2541209	Yes	32.8	10.5	161.	254.	42.7	28.6	1.5	0.50	7.0	0.0	114,632	9,192	23,553
	2542009	Yes	11.1	2.31	277.	442.	68.6	125.	8.2	0.90	139.9	0.0	114,632	9,192	23,553
	2550309	Yes	1.32	0.17	57.5	21.8	5.29	76.4	0.60	6.6	0.0	0.0	244,799	19,630	50,299
	2551802	Yes	12.2	3.19	142.	16.7	4.02	159.	1.3	0.50	0.0	0.0	244,799	19,630	50,299
	2651800	Yes	25.1	6.46	399.	5.37	1.66	47.4	0.60	0.30	0.0	0.0	244,799	19,630	50,299
	2710101	Yes	8.47	1.69	261.	1.11	0.44	613.	2.6	5.0	0.0	0.0	244,799	19,630	50,299
	2721009	Yes	17.0	3.93	316.	1020.	142.	110.	2.9	0.50	0.0	0.0	244,799	19,630	50,299
	2931608	Yes	80.6	31.3	813.	401.	64.3	1160.	3.9	7.7	28.8	0.0	183,864	14,744	37,779
	3011103	Yes	79.7	27.8	1310.	808.	114.	1500.	12.	6.9	0.9	0.0	111,365	8,930	22,882
	3011905	Yes	8.84	1.98	764.	1130.	129.	2750.	10.	3.3	6.6	0.0	773,094	61,994	158,848
	3020401	Yes	8.94	1.79	327.	198.	31.9	1390.	0.60	5.3	0.0	16.5	773,094	61,994	158,848
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													19,676,320	1,577,844	4,042,893
1940-1959	0340406	No	2.80	0.53	60.6	1.45	0.53	25.2	0.60	0.60	0.0	0.0	258,519	20,731	53,118
	0341107	No	3.96	0.83	44.7	5.66	1.63	47.6	0.60	--	0.0	0.0	273,941	21,967	56,287
	1312701	No	0.51	0.07	62.0	2.40	0.80	36.3	0.60	0.00	0.0	0.0	227,108	18,212	46,664
	1722206	No	42.9	15.5	373.	8.63	2.48	39.3	--	--	0.0	--	108,151	8,673	22,222
	2230100	No	5.17	1.24	32.2	1.21	0.46	42.8	--	0.60	--	0.0	213,598	17,128	43,888
	2611101	No	0.73	0.10	52.9	5.22	1.62	75.1	0.30	0.30	0.0	0.0	181,223	14,532	37,236
	2731503	No	8.12	1.99	137.	113.	21.9	5.40	0.20	0.20	0.0	0.0	181,223	14,532	37,236
	3040706	No	2.43	0.43	186.	17.4 *	3.73*	43.5	--	0.60	--	0.0	227,108	18,212	46,664
	0120105	Yes	11.0	2.99	116.	53.8	11.6	34.6	1.6	3.7	0.0	0.0	273,941	21,967	56,287
	0131102	Yes	72.0	36.8	813.	42.5	9.59	60.4	1.5	1.8	0.0	0.0	273,941	21,967	56,287
	0131201	Yes	8.88	2.37	144.	80.9	16.4	109.	0.60	1.9	0.0	10.3	108,151	8,673	22,222
	0251900	Yes	5.40	1.23	269.	13.6	3.47	198.	0.60	0.60	0.0	0.0	273,941	21,967	56,287
	0310201	Yes	4.50	1.12	120.	8.46	2.44	214.	0.60	0.60	0.0	0.0	273,941	21,967	56,287
	0320101	Yes	7.47	1.81	333.	3.57	1.08	209.	1.0	3.1	0.0	0.0	273,941	21,967	56,287
	0321307	Yes	4.01	0.97	161.	0.01	0.01	146.	--	8.4	0.0	0.0	273,941	21,967	56,287
	0351205	Yes	28.9	9.93	706.	1400.	173.	81.4	3.2	3.3	0.0	33.7	258,519	20,731	53,118
	0410100	Yes	13.2	3.62	18.6	16100.	1330.	43.2	2.9	1.4	0.0	0.0	108,151	8,673	22,222
	0411306	Yes	171.	94.4	1240.	6540.	618.	122.	0.50	7.8	0.0	0.0	213,598	17,128	43,888
	0411603	Yes	7.99	2.10	215.	41.0	9.31	115.	7.0	0.60	0.0	0.0	213,598	17,128	43,888
	0520809	Yes	53.5	24.5	543.	3390.	353.	347.	0.40	--	0.0	0.0	108,151	8,673	22,222
	0531301	Yes	33.1	11.8	241.	21.7	5.43	160.	0.40	0.60	0.0	0.0	181,223	14,532	37,236
	0612002	Yes	6.29	1.62	705.	12.4	3.13	135.	0.50	10.	0.0	0.0	213,598	17,128	43,888
	0651901	Yes	1.25	0.19	78.0	105.	19.7	70.9	0.90	0.60	0.0	0.0	108,151	8,673	22,222
	0710103	Yes	5.64	1.24	232.	309. *	34.5 *	217.	0.60	0.60	0.0	0.0	227,108	18,212	46,664
	0750406	Yes	51.6	23.2	667.	11.3	3.02	52.4	0.70	1.4	0.0	0.0	227,108	18,212	46,664
	0821009	Yes	2.25	0.40	97.5	31.5	7.44	90.5	1.1	--	0.0	0.0	227,108	18,212	46,664
	0911503	Yes	37.6	13.7	259.	37.3	7.85	21.7	0.40	0.30	0.0	0.0	227,108	18,212	46,664
	0920801	Yes	1.90	0.34	80.1	0.07	0.04	9.26	0.50	0.30	0.0	0.0	227,108	18,212	46,664
	0921304	Yes	2.21	0.39	131.	309. *	34.5 *	75.8	0.50	0.00	0.0	0.0	227,108	18,212	46,664
	1010503	Yes	136.	71.0	1560.	113.	21.0	7030.	11.	30.	6.3	5.1	213,598	17,128	43,888
	1030204	Yes	3.00	0.57	101.	309. *	34.5 *	65.7	0.50	0.50	0.0	0.0	213,598	17,128	43,888
	1051200	Yes	1.37	0.21	112.	5.65	1.57	142.	0.30	0.40	0.0	0.0	213,598	17,128	43,888
	1120401	Yes	39.6	15.0	248.	8.52	2.28	99.0	0.90	2.6	0.0	6.5	181,223	14,532	37,236
	1121300	Yes	2.15	0.39	60.0	1.46	0.55	144.	0.70	17.	0.0	0.0	213,598	17,128	43,888
	1130806	Yes	10.0	2.75	258.	1.82	0.63	81.0	7.3	8.3	0.0	0.0	213,598	17,128	43,888
	1140508	Yes	15.5	5.58	775.	26.2	5.77	90.0	1.1	4.8	0.0	0.0	181,223	14,532	37,236
	1332402	Yes	8.32	2.26	275.	6.75	1.98	182.	0.60	0.60	0.0	0.0	291,118	23,345	59,816
	1333806	Yes	22.4	7.57	318.	7.76	2.14	61.1	0.60	2.2	0.0	0.0	227,108	18,212	46,664
	1352806	Yes	3.68	0.73	94.2	2.83	0.88	71.3	1.9	0.50	0.0	0.0	227,108	18,212	46,664
	1410406	Yes	4.67	0.98	166.	6.96	1.53	130.	0.60	1.9	0.0	0.0	273,941	21,967	56,287
	1440205	Yes	16.7	5.44	236.	54.7	11.9	24.9	1.4	2.2	0.0	0.0	273,941	21,967	56,287
	1450907	Yes	29.8	11.0	73.5	0.23	0.12	26.0	0.60	0.50	0.0	0.0	258,519	20,731	53,118

Table C1-7. Estimated Environmental Lead Levels in the 1997 Housing Stock, As Determined from National Survey Units. (Continued)

Year Built	National Survey ID	LBP Present?	Wipe Floor Dust-Lead Loading (ug/ft2)	Vac. Floor Dust-Lead Loading (ug/ft2)	BN Floor Dust-Lead Conc. (ug/g)	Wipe W. Sill Dust-Lead Loading (ug/ft2)	Vac. W. Sill Dust-Lead Loading (ug/ft2)	Yardwide Avg. Soil-Lead Conc. (ug/g)	Obs. Max. Interior XRF (mg/cm2)	Obs. Max. Exterior XRF (mg/cm2)	Damaged Interior LBP (ft2)	Damaged Exterior LBP (ft2)	1997 Weight	# Children 12-35 mo.	# Children 12-71 mo.
1940-1959	1521400	Yes	25.0	8.44	173.	130.	24.5	145.	2.4	2.8	6.3	0.0	227,108	18,212	46,664
(cont.)	1521509	Yes	22.5	7.13	394.	24.2	5.95	132.	1.5	13.	0.0	278.5	227,108	18,212	46,664
	1530500	Yes	3.51	0.69	160.	256.	39.7	264.	1.8	3.7	0.0	56.0	227,108	18,212	46,664
	1550102	Yes	10.0	2.78	287.	2.47	0.81	209.	3.5	2.1	12.5	3.0	227,108	18,212	46,664
	1550607	Yes	17.6	5.29	419.	309. *	34.5 *	145.	1.2	2.0	73.5	0.0	227,108	18,212	46,664
	1551704	Yes	27.8	9.63	314.	58.9	11.7	136.	2.9	2.6	0.0	0.0	227,108	18,212	46,664
	1730407	Yes	12.2	3.62	162.	299.	50.1	63.9	1.8	2.3	4.8	0.0	108,151	8,673	22,222
	1730704	Yes	5.18	1.18	210.	7.43	2.19	77.3	2.1	1.5	0.0	0.0	108,151	8,673	22,222
	1730803	Yes	6.40	1.50	88.4	62.3	13.3	77.3	1.8	1.5	0.0	0.0	108,151	8,673	22,222
	1731603	Yes	0.63	0.09	17.4	309. *	34.5 *	171.	1.5	1.4	0.0	0.0	108,151	8,673	22,222
	1750108	Yes	5.32	1.32	316.	6.47	1.74	53.8	1.2	1.8	0.0	0.0	433,850	34,790	89,143
	1831106	Yes	26.4	9.79	836.	173.	31.5	1410.	2.0	--	0.0	--	111,336	8,928	22,876
	1831304	Yes	14.8	4.31	444.	475.	74.0	1410.	0.60	--	0.0	--	108,151	8,673	22,222
	1840305	Yes	13.8	3.99	244.	177.	31.4	313.	20.	--	0.0	--	108,151	8,673	22,222
	1841105	Yes	17.1	5.37	284.	188.	33.8	313.	1.0	--	0.0	--	111,336	8,928	22,876
	2022705	Yes	13.5	3.73	94.4	15.3	3.98	60.1	0.70	1.5	0.0	0.0	433,850	34,790	89,143
	2030302	Yes	4.07	0.89	102.	5.45	1.68	33.7	0.60	0.60	0.0	0.0	433,850	34,790	89,143
	2110906	Yes	158.	90.2	1680.	475.	71.3	372.	0.60	6.3	0.0	7.3	108,151	8,673	22,222
	2141505	Yes	0.62	0.08	32.0	0.13	0.07	58.9	1.7	1.5	1.4	2.5	291,118	23,345	59,816
	2142107	Yes	5.79	1.35	93.6	309. *	34.5 *	123.	1.2	--	0.0	--	227,108	18,212	46,664
	2211902	Yes	17.9	5.58	61.7	9.66	2.73	22.0	0.70	0.90	0.0	0.0	213,598	17,128	43,888
	2332005	Yes	27.4	9.06	761.	59.9	12.0	313.	8.0	5.0	0.0	77.1	433,850	34,790	89,143
	2343606	Yes	4.20	0.90	136.	1.73	0.64	225.	0.80	2.5	0.0	0.0	433,850	34,790	89,143
	2421709	Yes	7.81	2.14	169.	107.	20.4	52.4	0.60	1.4	0.0	0.0	433,850	34,790	89,143
	2441509	Yes	36.6	13.7	1690.	50.7	11.1	4320.	0.60	3.9	0.0	118.3	411,982	33,037	84,650
	2451805	Yes	3.14	0.63	193.	335.	54.1	34.1	0.60	0.60	0.0	0.0	433,850	34,790	89,143
	2520906	Yes	40.3	14.6	321.	45.3	9.90	55.8	0.80	0.70	0.0	0.0	213,598	17,128	43,888
	2540102	Yes	78.8	34.0	254.	234.	40.6	102.	2.7	1.5	201.9	20.0	213,598	17,128	43,888
	2540201	Yes	4.97	1.09	266.	27.0	6.34	33.0	0.60	1.2	0.0	0.0	213,598	17,128	43,888
	2541407	Yes	56.2	26.5	378.	19.1	4.65	485.	0.60	0.50	0.0	0.0	181,223	14,532	37,236
	2541902	Yes	1.25	0.19	61.0	98.4	19.5	116.	0.70	0.50	0.0	0.0	213,598	17,128	43,888
	2610103	Yes	7.48	1.85	283.	16.9	4.38	43.5	0.20	0.20	0.0	0.0	213,598	17,128	43,888
	2651206	Yes	4.48	1.00	16.8	39.7	8.88	26.3	0.60	0.30	0.0	0.0	213,598	17,128	43,888
	2652303	Yes	4.38	0.98	273.	309. *	34.5 *	49.0	0.50	0.30	0.0	0.0	213,598	17,128	43,888
	2711505	Yes	18.6	5.73	210.	642.	95.8	218.	1.7	7.6	0.0	0.0	181,223	14,532	37,236
	2730703	Yes	2.13	0.39	84.7	9.28	2.64	119.	0.40	0.20	0.0	0.0	213,598	17,128	43,888
	2731800	Yes	19.9	6.70	114.	258.	44.2	12.1	0.40	1.0	0.0	0.0	213,598	17,128	43,888
	2812204	Yes	10.2	3.08	483.	15.1	3.96	162.	2.8	0.60	0.0	0.0	213,598	17,128	43,888
	2840403	Yes	15.2	5.31	1070.	9.29	2.60	52.1	6.1	8.7	0.0	0.0	213,598	17,128	43,888
	2841203	Yes	37.3	15.0	1270.	1290.	159.	61.9	9.6	13.	0.0	0.0	213,598	17,128	43,888
	2841500	Yes	4.84	1.16	118.	0.66	0.28	41.4	1.0	1.8	0.0	0.0	213,598	17,128	43,888
	2910107	Yes	10.1	2.68	230.	3.53	1.15	51.8	1.4	0.50	0.0	0.0	273,941	21,967	56,287
	2931202	Yes	16.9	5.21	316.	40.0	9.10	220.	0.80	0.50	0.0	0.0	108,151	8,673	22,222
	2940708	Yes	4.68	0.98	218.	6.77	2.00	44.3	1.7	1.5	0.0	0.0	273,941	21,967	56,287
	3011509	Yes	4.35	0.89	330.	11.8	3.24	346.	0.60	1.4	0.0	0.0	227,108	18,212	46,664
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													19,717,970	1,581,184	4,051,451
1960-1979	0130708	No	3.35	0.83	87.9	32.7	7.31	29.7	0.60	0.60	0.0	0.0	658,726	52,823	135,348
	0131003	No	6.35	2.01	111.	7.53	2.21	5.35	0.60	0.00	0.0	0.0	291,351	23,363	59,864
	0150201	No	12.2	5.99	68.8	11.7	3.22	6.16	0.60	0.50	0.0	0.0	291,351	23,363	59,864
	0330308	No	1.97	0.47	54.8	1.68	0.62	61.6	0.60	0.60	0.0	0.0	291,351	23,363	59,864
	0350306	No	2.65	0.57	112.	4.35	1.31	14.2	--	--	0.0	0.0	658,726	52,823	135,348
	0420901	No	9.30	3.54	20.2	1590.	206.	21.0	0.40	0.60	0.0	0.0	291,351	23,363	59,864
	0430108	No	3.89	1.08	68.8	12.7	3.44	21.3	0.30	0.60	0.0	0.0	116,364	9,331	23,909
	0440305	No	12.1	5.43	245.	3.11	1.03	97.4	0.50	0.60	0.0	0.0	116,364	9,331	23,909
	0440602	No	5.52	1.72	144.	8.69	2.85	79.3	--	--	0.0	0.0	316,764	25,401	65,085
	0541201	No	1.72	0.33	21.5	6.48	1.51	17.9	0.60	0.60	0.0	0.0	116,364	9,331	23,909
	0940700	No	1.79	0.34	47.0	81.5 *	12.2 *	7.23	0.30	0.30	0.0	0.0	291,351	23,363	59,864
	0940809	No	6.32	1.93	429.	1.00	0.40	17.7	0.30	0.30	0.0	0.0	291,351	23,363	59,864
	1020205	No	2.30	0.51	171.	15.0	3.97	49.2	0.30	0.50	0.0	0.0	316,764	25,401	65,085

Table C1-7. Estimated Environmental Lead Levels in the 1997 Housing Stock, As Determined from National Survey Units. (Continued)

Year Built	National Survey ID	LBP Present?	Wipe Floor Dust-Lead Loading (ug/ft2)	Vac. Floor Dust-Lead Loading (ug/ft2)	BN Floor Dust-Lead Conc. (ug/g)	Wipe W. Sill Dust-Lead Loading (ug/ft2)	Vac. W. Sill Dust-Lead Loading (ug/ft2)	Yardwide Avg. Soil-Lead Conc. (ug/g)	Obs. Max. Interior XRF (mg/cm2)	Obs. Max. Exterior XRF (mg/cm2)	Damaged Interior LBP (ft2)	Damaged Exterior LBP (ft2)	1997 Weight	# Children 12-35 mo.	# Children 12-71 mo.
1960-1979	1020502	No	3.30	0.78	160.	19.5	4.52	58.3	0.30	--	0.0	0.0	316,764	25,401	65,085
(cont.)	1021005	No	1.74	0.33	198.	4.60	1.46	25.5	0.50	0.30	0.0	0.0	316,764	25,401	65,085
	1040500	No	3.46	0.91	208.	9.64	2.73	24.5	0.40	--	0.0	0.0	116,364	9,331	23,909
	1323609	No	1.37	0.27	102.	81.5 *	12.2 *	20.4	0.60	--	0.0	--	312,998	25,099	64,312
	1441302	No	1.06	0.18	85.2	0.02	0.01	13.0	0.60	0.50	0.0	0.0	658,726	52,823	135,348
	2220507	No	5.81	1.85	123.	81.5 *	12.2 *	14.1	0.60	0.60	0.0	0.0	316,764	25,401	65,085
	2230209	No	2.00	0.39	68.6	4.60	1.38	5.58	0.60	0.60	0.0	0.0	316,764	25,401	65,085
	2511806	No	1.85	0.37	52.2	0.83	0.34	11.6	0.60	0.50	0.0	0.0	116,364	9,331	23,909
	2521201	No	12.9	5.58	183.	127.	24.2	73.4	0.60	0.10	0.0	0.0	316,764	25,401	65,085
	2551000	No	1.29	0.22	52.1	2.05	0.73	22.6	0.60	0.50	0.0	0.0	316,764	25,401	65,085
	2552107	No	1.47	0.25	40.5	0.52	0.23	27.2	0.60	0.50	0.0	0.0	316,764	25,401	65,085
	2822005	No	2.68	0.58	65.8	124.	23.7	82.5	0.60	0.00	0.0	0.0	316,764	25,401	65,085
	2831006	No	1.21	0.19	33.8	0.12	0.07	21.1	0.60	0.60	0.0	0.0	316,764	25,401	65,085
	2831709	No	3.01	0.73	64.3	6.10	1.85	40.8	0.60	0.60	0.0	0.0	116,364	9,331	23,909
	3050101	No	3.81	0.98	458.	81.5 *	12.2 *	6.68	0.60	0.60	0.0	0.0	312,998	25,099	64,312
	0130906	Yes	5.38	1.56	68.2	5.40	1.67	39.5	0.60	0.60	0.0	0.0	126,372	10,134	25,966
	0150102	Yes	7.59	2.72	188.	2.64	0.91	4.79	0.80	0.60	0.0	0.0	658,726	52,823	135,348
	0250902	Yes	3.61	0.97	206.	4.29	1.28	180.	0.60	0.60	0.0	0.0	352,318	28,252	72,391
	0252404	Yes	8.08	3.11	225.	329.	51.9	604.	1.0	0.60	0.0	0.0	291,351	23,363	59,864
	0311209	Yes	5.95	1.80	330.	885.	126.	186.	0.80	0.60	0.0	0.0	352,318	28,252	72,391
	0331009	Yes	3.08	0.78	27.5	8.63	2.48	15.3	0.60	0.60	0.0	0.0	352,318	28,252	72,391
	0340505	Yes	6.94	2.76	15.8	0.51	0.22	23.7	0.60	0.60	0.0	0.0	658,726	52,823	135,348
	0340802	Yes	11.5	6.33	652.	6.86	2.03	31.8	0.90	0.60	0.0	0.0	352,318	28,252	72,391
	0341404	Yes	2.92	0.74	34.1	28.0	6.73	20.0	1.0	0.60	0.0	0.0	658,726	52,823	135,348
	0410605	Yes	6.39	2.07	60.9	605.	91.1	127.	1.4	0.00	0.0	0.0	291,351	23,363	59,864
	0421206	Yes	41.7	31.7	643.	665.	98.7	22.8	0.50	1.7	0.0	0.0	291,351	23,363	59,864
	0430207	Yes	13.2	5.38	87.3	15.8	4.14	35.2	0.50	0.80	0.0	0.0	316,764	25,401	65,085
	0430306	Yes	13.5	6.81	7.04	6.96	2.07	27.2	0.40	0.70	0.0	0.0	316,764	25,401	65,085
	0430702	Yes	12.5	6.50	318.	217. *	28.3 *	26.4	0.40	0.40	0.0	0.0	116,364	9,331	23,909
	0440107	Yes	15.7	7.85	319.	130.	24.1	34.7	0.60	0.50	0.0	0.0	316,764	25,401	65,085
	0441105	Yes	4.40	1.19	75.4	10.7	2.98	5.22	0.50	0.60	0.0	0.0	116,364	9,331	23,909
	0441204	Yes	19.4	9.48	177.	326.	45.9	87.4	0.40	0.60	0.0	0.0	316,764	25,401	65,085
	0530105	Yes	7.27	2.35	246.	38.2	8.68	50.9	1.4	0.70	0.0	0.0	116,364	9,331	23,909
	0530600	Yes	4.18	1.15	193.	217. *	28.3 *	215.	1.0	0.60	0.0	0.0	291,351	23,363	59,864
	0531400	Yes	32.3	20.0	143.	103.	19.9	56.1	0.70	1.7	0.0	0.0	116,364	9,331	23,909
	0540203	Yes	8.59	3.31	59.9	217. *	28.3 *	14.8	0.80	0.70	0.0	0.0	316,764	25,401	65,085
	0541300	Yes	7.59	2.62	184.	160.	26.8	7.52	0.90	0.60	0.0	0.0	316,764	25,401	65,085
	0621607	Yes	2.37	0.49	63.2	0.45	0.20	39.4	0.70	0.30	0.0	0.0	126,372	10,134	25,966
	0631408	Yes	3.46	0.93	221.	26.2	6.36	85.4	0.40	--	0.0	0.0	126,372	10,134	25,966
	0840702	Yes	3.23	0.77	82.4	1.20	0.47	30.6	0.80	1.2	0.0	5.9	291,351	23,363	59,864
	0911404	Yes	1.71	0.30	98.6	1.76	0.61	29.8	0.30	0.30	0.0	0.0	173,719	13,931	35,694
	0930701	Yes	3.58	1.00	378.	1.53	0.57	19.7	0.60	0.30	0.0	0.0	312,998	25,099	64,312
	1011709	Yes	3.19	0.78	366.	0.45	0.20	996.	11.	0.40	28.8	0.0	116,364	9,331	23,909
	1020304	Yes	2.25	0.47	150.	217. *	28.3 *	26.6	0.80	0.70	0.0	0.0	316,764	25,401	65,085
	1020403	Yes	2.34	0.47	104.	0.81	0.34	25.0	0.70	0.30	0.0	0.0	316,764	25,401	65,085
	1020700	Yes	0.75	0.09	51.5	0.19	0.10	23.8	0.60	0.70	0.0	0.0	316,764	25,401	65,085
	1020809	Yes	2.65	0.57	263.	9.64	2.73	25.4	0.40	--	0.0	0.0	316,764	25,401	65,085
	1050509	Yes	1.02	0.15	44.1	217. *	28.3 *	116.	3.0	0.60	0.0	0.0	316,764	25,401	65,085
	1050608	Yes	1.09	0.20	124.	0.12	0.07	57.5	0.30	0.30	0.0	0.0	316,764	25,401	65,085
	1051408	Yes	1.50	0.27	127.	217. *	28.3 *	143.	0.30	1.7	0.0	0.0	116,364	9,331	23,909
	1150200	Yes	3.17	0.97	241.	60.6	12.9	35.3	1.0	9.1	0.0	0.0	291,351	23,363	59,864
	1150705	Yes	3.62	0.92	185.	450.	70.8	81.6	1.6	0.40	0.0	0.0	291,351	23,363	59,864
	1241801	Yes	2.48	0.51	112.	3440.	377.	196.	0.60	1.4	0.0	0.0	451,561	36,211	92,782
	1311505	Yes	1.37	0.25	81.8	1.73	0.62	20.8	0.60	0.00	0.0	0.0	173,719	13,931	35,694
	1312800	Yes	12.3	6.71	250.	0.50	0.20	13.8	0.90	--	0.0	--	312,998	25,099	64,312
	1322601	Yes	1.37	0.22	101.	0.74	0.31	33.3	0.60	--	0.0	--	312,998	25,099	64,312
	1353309	Yes	0.66	0.09	15.8	0.28	0.12	51.6	0.60	0.00	0.0	0.0	291,351	23,363	59,864
	1441005	Yes	1.93	0.36	46.9	0.83	0.34	18.8	1.5	0.50	0.0	0.0	658,726	52,823	135,348
	1510403	Yes	4.40	1.19	249.	217. *	28.3 *	4.63	0.50	0.60	0.0	0.0	173,719	13,931	35,694
	1510908	Yes	7.86	3.15	188.	1.87	0.66	14.8	0.30	0.20	0.0	0.0	312,998	25,099	64,312
	1520204	Yes	4.44	1.50	227.	7.31	2.16	35.9	0.30	10.	0.0	0.0	312,998	25,099	64,312

Table C1-7. Estimated Environmental Lead Levels in the 1997 Housing Stock, As Determined from National Survey Units. (Continued)

Year Built	National Survey ID	LBP Present?	Wipe Floor Dust-Lead Loading (ug/ft2)	Vac. Floor Dust-Lead Loading (ug/ft2)	BN Floor Dust-Lead Conc. (ug/g)	Wipe W. Sill Dust-Lead Loading (ug/ft2)	Vac. W. Sill Dust-Lead Loading (ug/ft2)	Yardwide Avg. Soil-Lead Conc. (ug/g)	Obs. Max. Interior XRF (mg/cm2)	Obs. Max. Exterior XRF (mg/cm2)	Damaged Interior LBP (ft2)	Damaged Exterior LBP (ft2)	1997 Weight	# Children 12-35 mo.	# Children 12-71 mo.
1960-1979	1530104	Yes	7.38	2.40	204.	51.3	11.3	78.7	3.3	0.10	0.0	0.0	312,998	25,099	64,312
(cont.)	1530302	Yes	6.81	2.11	328.	448.	66.2	68.4	0.90	1.5	0.0	0.0	312,998	25,099	64,312
	1530807	Yes	11.0	4.49	238.	48.3	9.95	40.5	0.60	2.5	0.0	0.0	312,998	25,099	64,312
	1531607	Yes	12.5	5.19	289.	5790.	618.	105.	22.	11.	12.5	27.5	173,719	13,931	35,694
	1531706	Yes	6.26	2.07	159.	545.	75.7	23.4	0.00	1.3	0.0	0.0	312,998	25,099	64,312
	1540202	Yes	2.26	0.49	139.	217. *	28.3 *	15.9	0.00	0.70	0.0	0.0	173,719	13,931	35,694
	1540400	Yes	8.48	3.47	159.	16.6	4.32	49.9	0.60	0.20	0.0	0.0	312,998	25,099	64,312
	1540806	Yes	13.1	5.97	175.	217. *	28.3 *	30.1	0.70	0.30	0.0	0.0	312,998	25,099	64,312
	1541200	Yes	3.28	0.82	180.	217. *	28.3 *	17.1	0.70	0.70	0.0	0.0	173,719	13,931	35,694
	1741701	Yes	40.0	31.9	141.	217. *	28.3 *	54.7	1.0	0.80	0.0	0.0	243,025	19,488	49,934
	1741800	Yes	10.5	4.15	143.	217. *	28.3 *	95.7	2.5	0.90	9.5	0.0	451,561	36,211	92,782
	1743103	Yes	1.21	0.19	29.1	0.07	0.04	28.6	1.0	3.3	0.0	0.0	451,561	36,211	92,782
	2040301	Yes	5.81	1.68	126.	22.8	5.53	14.8	0.60	3.6	0.0	0.0	451,561	36,211	92,782
	2122000	Yes	23.1	14.2	395.	132.	22.9	355.	1.4	0.60	0.0	0.0	291,351	23,363	59,864
	2130706	Yes	9.68	3.49	127.	9.59	2.72	13.7	1.5	1.3	57.3	0.0	173,719	13,931	35,694
	2131902	Yes	2.60	0.57	76.4	50.1	11.0	21.1	0.60	1.6	0.0	0.6	312,998	25,099	64,312
	2141604	Yes	9.93	3.72	87.0	3.70	1.21	39.2	1.1	0.60	0.0	0.0	173,719	13,931	35,694
	2151207	Yes	8.75	3.48	324.	42.3	8.63	17.5	1.2	0.50	0.0	0.0	312,998	25,099	64,312
	2211308	Yes	4.67	1.32	89.4	503.	75.4	20.4	0.70	1.3	0.0	8.0	316,764	25,401	65,085
	2230506	Yes	2.83	0.64	77.3	12.2	3.14	6.11	0.90	--	0.0	0.0	316,764	25,401	65,085
	2351500	Yes	5.26	1.56	135.	305.	45.8	115.	1.2	0.10	1.1	0.0	243,025	19,488	49,934
	2352201	Yes	3.14	0.88	180.	217. *	28.3 *	42.5	1.1	0.10	0.0	0.0	243,025	19,488	49,934
	2430403	Yes	4.76	1.47	457.	4.19	1.22	69.7	0.60	3.4	0.0	72.4	451,561	36,211	92,782
	2431807	Yes	4.69	1.70	215.	6.17	1.86	41.1	0.90	5.1	0.0	0.0	451,561	36,211	92,782
	2452605	Yes	4.79	1.40	315.	217. *	28.3 *	121.	1.0	0.60	0.0	0.0	451,561	36,211	92,782
	2520609	Yes	6.30	2.55	803.	0.22	0.11	15.7	0.60	0.50	0.0	0.0	116,364	9,331	23,909
	2521102	Yes	4.29	1.35	117.	149.	27.7	26.8	0.60	1.0	0.0	0.0	316,764	25,401	65,085
	2531804	Yes	1.31	0.21	60.0	0.42	0.19	66.4	1.2	0.50	0.0	0.0	316,764	25,401	65,085
	2541506	Yes	35.7	26.0	2200.	315.	50.2	45.2	4.6	0.50	12.8	0.0	116,364	9,331	23,909
	2620508	Yes	2.24	0.45	133.	217. *	28.3 *	46.1	0.40	0.60	0.0	0.0	126,372	10,134	25,966
	2621704	Yes	4.53	1.33	191.	1.40	0.53	68.5	0.40	8.8	0.0	0.0	126,372	10,134	25,966
	2622603	Yes	1.28	0.21	2.01	3.01	1.02	54.6	0.50	1.1	0.0	0.0	291,351	23,363	59,864
	2623007	Yes	1.19	0.19	130.	1.76	0.64	26.0	0.60	0.60	0.0	0.0	126,372	10,134	25,966
	2650208	Yes	2.56	0.60	93.0	14.9	3.90	52.7	0.50	3.0	0.0	6.0	116,364	9,331	23,909
	2711109	Yes	7.60	2.68	128.	32.0	7.54	32.0	0.70	0.80	0.0	0.0	316,764	25,401	65,085
	2751402	Yes	106.	124.	50400.	19.9	4.66	35.0	0.30	0.60	0.0	0.0	291,351	23,363	59,864
	2810307	Yes	3.33	0.78	137.	217. *	28.3 *	23.2	0.50	0.00	0.0	0.0	291,351	23,363	59,864
	2812105	Yes	3.39	0.79	137.	217. *	28.3 *	91.3	1.2	1.5	0.0	0.0	291,351	23,363	59,864
	2830602	Yes	5.12	1.72	170.	11.4	3.16	32.1	0.60	1.5	0.0	0.0	116,364	9,331	23,909
	2832004	Yes	6.16	1.95	283.	0.34	0.15	20.8	0.60	0.60	0.0	0.0	116,364	9,331	23,909
	2832103	Yes	1.74	0.31	87.5	217. *	28.3 *	75.6	0.20	0.20	0.0	0.0	316,764	25,401	65,085
	2840106	Yes	7.67*	4.25*	740. *	217. *	28.3 *	63.4	0.80	5.1	0.0	20.7	126,372	10,134	25,966
	2840205	Yes	7.67*	4.25*	740. *	217. *	28.3 *	63.4	0.70	2.0	0.0	25.7	316,764	25,401	65,085
	2841401	Yes	2.57	0.60	59.8	228.	35.9	35.6	0.60	1.6	0.0	0.0	116,364	9,331	23,909
	2940401	Yes	1.38	0.22	66.4	1.31	0.50	27.2	1.2	--	0.0	--	658,726	52,823	135,348
	3051000	Yes	1.95	0.37	152.	217. *	28.3 *	31.1	0.70	0.60	0.0	0.0	312,998	25,099	64,312
													----------	----------	----------
													34,984,547	2,805,411	7,188,275
>1979	0130708	No	3.35	0.83	87.9	32.7	7.31	29.7	0.60	0.60	0.0	0.0	889,038	71,292	182,671
	0131003	No	6.35	2.01	111.	7.53	2.21	5.35	0.60	0.00	0.0	0.0	889,038	71,292	182,671
	0150201	No	12.2	5.99	68.8	11.7	3.22	6.16	0.60	0.50	0.0	0.0	889,038	71,292	182,671
	0330308	No	1.97	0.47	54.8	1.68	0.62	61.6	0.60	0.60	0.0	0.0	889,038	71,292	182,671
	0350306	No	2.65	0.57	112.	4.35	1.31	14.2	--	--	0.0	0.0	889,038	71,292	182,671
	0420901	No	9.30	3.54	20.2	1590.	206.	21.0	0.40	0.60	0.0	0.0	889,038	71,292	182,671
	0430108	No	3.89	1.08	68.8	12.7	3.44	21.3	0.30	0.60	0.0	0.0	889,038	71,292	182,671
	0440305	No	12.1	5.43	245.	3.11	1.03	97.4	0.50	0.60	0.0	0.0	889,038	71,292	182,671
	0440602	No	5.52	1.72	144.	8.69	2.85	79.3	--	--	0.0	0.0	889,038	71,292	182,671
	0541201	No	1.72	0.33	21.5	6.48	1.51	17.9	0.60	0.60	0.0	0.0	889,038	71,292	182,671
	0940700	No	1.79	0.34	47.0	83.0 *	12.3 *	7.23	0.30	0.30	0.0	0.0	889,038	71,292	182,671
	0940809	No	6.32	1.93	429.	1.00	0.40	17.7	0.30	0.30	0.0	0.0	889,038	71,292	182,671

Table C1-7. Estimated Environmental Lead Levels in the 1997 Housing Stock, As Determined from National Survey Units. (Continued)

Year Built	National Survey ID	LBP Present?	Wipe Floor Dust-Lead Loading (ug/ft2)	Vac. Floor Dust-Lead Loading (ug/ft2)	BN Floor Dust-Lead Conc. (ug/g)	Wipe W. Sill Dust-Lead Loading (ug/ft2)	Vac. W. Sill Dust-Lead Loading (ug/ft2)	Yardwide Avg. Soil-Lead Conc. (ug/g)	Obs. Max. Interior XRF (mg/cm2)	Obs. Max. Exterior XRF (mg/cm2)	Damaged Interior LBP (ft2)	Damaged Exterior LBP (ft2)	1997 Weight	# Children 12-35 mo.	# Children 12-71 mo.
>1979	1020205	No	2.30	0.51	171.	15.0	3.97	49.2	0.30	0.50	0.0	0.0	889,038	71,292	182,671
(cont.)	1020502	No	3.30	0.78	160.	19.5	4.52	58.3	0.30	--	0.0	0.0	889,038	71,292	182,671
	1021005	No	1.74	0.33	198.	4.60	1.46	25.5	0.50	0.30	0.0	0.0	889,038	71,292	182,671
	1040500	No	3.46	0.91	208.	9.64	2.73	24.5	0.40	--	0.0	0.0	889,038	71,292	182,671
	1323609	No	1.37	0.27	102.	83.0 *	12.3 *	20.4	0.60	--	0.0	--	889,038	71,292	182,671
	1441302	No	1.06	0.18	85.2	0.02	0.01	13.0	0.60	0.50	0.0	0.0	889,038	71,292	182,671
	2220507	No	5.81	1.85	123.	83.0 *	12.3 *	14.1	0.60	0.60	0.0	0.0	889,038	71,292	182,671
	2230209	No	2.00	0.39	68.6	4.60	1.38	5.58	0.60	0.60	0.0	0.0	889,038	71,292	182,671
	2511806	No	1.85	0.37	52.2	0.83	0.34	11.6	0.60	0.50	0.0	0.0	889,038	71,292	182,671
	2521201	No	12.9	5.58	183.	127.	24.2	73.4	0.60	0.10	0.0	0.0	889,038	71,292	182,671
	2551000	No	1.29	0.22	52.1	2.05	0.73	22.6	0.60	0.50	0.0	0.0	889,038	71,292	182,671
	2552107	No	1.47	0.25	40.5	0.52	0.23	27.2	0.60	0.50	0.0	0.0	889,038	71,292	182,671
	2822005	No	2.68	0.58	65.8	124.	23.7	82.5	0.60	0.00	0.0	0.0	889,038	71,292	182,671
	2831006	No	1.21	0.19	33.8	0.12	0.07	21.1	0.60	0.60	0.0	0.0	889,038	71,292	182,671
	2831709	No	3.01	0.73	64.3	6.10	1.85	40.8	0.60	0.60	0.0	0.0	889,038	71,292	182,671
	3050101	No	3.81	0.98	458.	83.0 *	12.3 *	6.68	0.60	0.60	0.0	0.0	889,038	71,292	182,671
													24,893,064	1,996,175	5,114,778
												TOTAL ACROSS ALL UNITS:	99,271,901	7,960,614	20,397,397

* As no data for this parameter existed in the National Survey database for the given housing unit, this value is the average of the values across all units in the same year-built category and having the same value for the LBP indicator that had reported data (see Table 3-14 in Chapter 3). The average is weighted using the 1997 weights.

Note: Dust-lead loadings are area-weighted arithmetic averages for the unit. “Wipe” loadings are converted from Blue Nozzle (“Vac.”) vacuum loadings (see Chapter 4). Dust-lead concentrations are mass-weighted arithmetic averages of individual sample concentrations for the unit that have been adjusted for low tap weights (USEPA, 1996c). Soil-lead concentration represents a weighted arithmetic yardwide average for the unit, with remote sample results weighted twice that of entryway and dripline samples.

APPENDIX C2

Method for Computing Confidence Intervals Associated with Estimates in the Exposure Assessment and Risk Characterization

APPENDIX C2

METHOD FOR COMPUTING CONFIDENCE INTERVALS ASSOCIATED WITH ESTIMATES IN THE EXPOSURE ASSESSMENT AND RISK CHARACTERIZATION

In Chapters 3 and 5, approximate 95% confidence intervals were calculated for selected exposure and risk estimates to provide a measure of precision for these estimates. These risk estimates included children's geometric mean blood-lead concentrations in the nation's housing stock (Tables 3-36, 3-38, 3-39, and 3-40), the percentage of children's blood-lead concentrations greater than or equal to specified thresholds (10 or 20 µg/dL) (Tables 3-37, 3-38, 3-39, 3-40, 5-1, and 5-9), the percentage of children experiencing IQ decrements greater than or equal to 1, 2, or 3, as a result of lead exposure (Tables 5-1 and 5-9), and average IQ decrement due to childhood lead exposure. Confidence intervals were also computed for lead levels in dust which, when assuming fixed lead levels in other media, control the percentage of children with blood-lead concentrations greater than or equal to 10 µg/dL to specified levels (Tables 5-6 and 5-7). This appendix presents the methodology used to compute these intervals.

For endpoints estimated from the NHANES III data, the method for computing a confidence interval needs to account for the complex survey design associated with NHANES III. To do this, Software for Survey Data Analysis (SUDAAN) was used to compute standard errors for NHANES III distribution parameters. These standard errors were then used to compute standard errors for the estimated exposure and risk endpoints. These methods are presented in the following subsections, according to the type of baseline risk estimate.

1.0 GEOMETRIC MEAN BLOOD-LEAD CONCENTRATION

Data from Phase 2 of NHANES III were used to construct estimates of geometric mean blood-lead concentration for specified subgroups of the nation's children (e.g., 1-2 year old children, 1-2 year old children living in pre-1946 housing). For some confidence level α (from 0 to 1), a (1-α)*100% confidence interval for the geometric mean was calculated as

$$(e^{\ln(GM)-t_{(n-1,\alpha)}s},\ e^{\ln(GM)+t_{(n-1,\alpha)}s}) \qquad \textbf{(1)}$$

where GM is the estimated geometric mean blood-lead concentration of the subgroup of interest, s is the standard error of the arithmetic mean of the log-transformed blood-lead concentrations in this subgroup (computed using SUDAAN), n is the sample size for the subgroup, and $t_{(n-1,\alpha)}$ is the (1-α)*100th percentile of the Student t-distribution with n-1 degrees of freedom. In the risk analysis, α=0.05 (i.e., 95% confidence intervals were calculated). Note that this approach to calculating a confidence interval assumes that blood-lead concentrations are lognormally distributed. While the estimate of s accounted for the complex survey design, the degrees of freedom for the t-statistic were not adjusted. However, not adjusting the degrees of freedom is anticipated to have little effect because of the large sample size (987).

2.0 PERCENTAGE OF CHILDREN'S BLOOD-LEAD CONCENTRATIONS GREATER THAN OR EQUAL TO A SPECIFIED THRESHOLD

Data from Phase 2 of NHANES III were used to compute estimates of the percentage of children's blood-lead concentrations greater than or equal to a specified threshold for specified subgroups of the nation's children. In the risk analysis, two methods for characterizing the distribution of blood-lead concentrations were used:

Method 1: The distribution was characterized empirically from the observed NHANES III data. Under this method, which produced the estimates presented in Section 3.4.1 of Chapter 3, the estimated percentage equaled the observed percentage of children in the survey who were at or above the threshold, with each child weighted by his/her assigned sampling weight.

Method 2: The percentages were computed using the geometric mean and geometric standard deviation estimated in Method 1 assuming that the distribution of blood-lead concentrations is lognormal. This method was used to compute the estimates presented in Section 5.1.1 of Chapter 5.

Standard errors of the percentages estimated under Method 1 were calculated using SUDAAN to account for the complex survey design in NHANES III. If p_x is the estimated percentage of children with blood-lead concentration at or above X µg/dL (for some threshold X) and $SE(p_x)$ is the estimated standard error of this percentage, then (asymmetric) approximate (1-α)*100% confidence intervals associated with p_x were calculated as

$$\left(e^{\ln(p_x) - t_{(n-1,\alpha)}(SE(p_x)/p_x)},\ e^{\ln(p_x) + t_{(n-1,\alpha)}(SE(p_x)/p_x)}\right) \qquad \textbf{(2)}$$

where $t_{(n-1,\alpha)}$ is the (1-α)*100th percentile of the Student t-distribution with n degrees of freedom (Kleinbaum et.al., 1982).

Under Method 2, the value of p_x is estimated as

$$p_x = 100 - 100 * \left(\frac{\ln(X) - LGM}{\sqrt{LGV}}\right) \qquad \textbf{(3)}$$

where LGM and LGV are the weighted arithmetic mean and variance, respectively, of the log-transformed blood-lead concentrations. Assuming independence between LGM and LGV, and using the first order Taylor series approximation of equation (3), an estimate of variability associated with p_x is

$$var(p_x) = \frac{100^2}{LGV} \; {}^{2}\left(\frac{\ln(X) - LGM}{\sqrt{LGV}} \right) \left[var(LGM) + \left(\frac{\ln(X) - LGM}{2 * LGV} \right)^2 var(LGV) \right] \qquad \textbf{(4)}$$

The variance of LGM, var(LGM), was estimated in SUDAAN to account for the complex survey design employed in NHANES III. The variability associated with LGV, var(LGV) was estimated based on the chi-squared distribution and the "design effect" for LGV (DE_{LGV}):

$$var(LGV) = \frac{2 * LGV^2}{n - 1} * DE_{LGV} \qquad \textbf{(5)}$$

where n is the sample size for the subgroup of interest. The design effect for a given statistic quantifies the information lost due to the survey design employed and is calculated as the variance of the statistic assuming the complex survey design was employed in data collection, divided by the variance assuming simple random sampling was employed. Because a design effect for LGV was not easily available, the design effect for LGM was used. Although not the optimal solution, this was deemed more appropriate than not accounting for the complex survey design at all.

Because many of the percentage estimates were small, asymmetric confidence intervals were also calculated for model-based estimates using the logarithmic transformation, and the t-distribution with n-1 degrees of freedom (see Equation 2).

3.0 PERCENTAGE OF CHILDREN WITH IQ DECREMENTS GREATER THAN OR EQUAL TO 1, 2, OR 3

Data from Phase 2 of NHANES III were combined with an estimate of the relationship between blood-lead concentration and IQ decrements based on Schwartz, 1994 (Section 4.4 and Appendix D2) to construct estimates of percentage of children with IQ decrements greater than or equal to 1, 2, or 3 that results from lead exposure. Using notation from Section 2.0 above, estimates of this population characteristic were constructed assuming that blood-lead concentrations are lognormally distributed and that the relationship between blood-lead concentration and IQ score decrements is linear:

$$Percent[IQ\ \ Decrement \geq X] \ = \ p_{X/m} \ = \ 100 \ - \ 100 * \left(\frac{\ln(X/m) - \ln(GM)}{\ln(GSD)} \right) \qquad \textbf{(6)}$$

where X is the specified IQ decrement, m is the slope of the assumed linear relationship between blood-lead concentration and IQ score decrements, GM is the geometric mean blood-lead concentration for the subgroup, and GSD is the geometric standard deviation of blood-lead concentrations.

The standard error of the percentage in equation (6), necessary for calculating a confidence interval for this percentage, was calculated using a first order Taylor series approximation, using estimates of the variability associated with the values of GM, GSD, and the slope factor m. Thus, the confidence interval considers sampling variability from NHANES III data, as well as variability associated with the blood-lead concentration-IQ decrement relationship.

The function for computing the percentage of children with IQ decrements greater than 1, 2, or 3 was expanded in an alternative parameterization to simplify the procedure:

$$Percent[IQ\ \ Decrements \geq X] = 100 - 100 * \left(\frac{\ln(X) - \ln(m) - LGM}{\sqrt{(LGV)}} \right) \quad \textbf{(7)}$$

where LGM and LGV are the arithmetic mean and variance of the log-transformed blood-lead concentrations. Assuming independence between LGM, LGV, and m and using the first order Taylor series approximation to equation (7), the variability associated with estimated percentage of children with IQ decrements greater than X is

$$var(Percent[IQ\ \ Decrements \geq X]) = \frac{100^2}{LGV}\ {}^2\left(\frac{\ln(X/m) - LGM}{\sqrt{LGV}} \right) [\frac{1}{m^2} var(m) + var(LGM) + \left(\frac{\ln(X/m) - LGM}{2LGV} \right)^2 var(LGV)] \quad \textbf{(8)}$$

The variance of LGM was estimated in SUDAAN to account for the complex survey design employed in NHANES III. The variability associated with LGV was estimated as described in Section 2.0 of this appendix. The variability associated with m was assumed to be 0.041, based on the meta-analysis described in Schwartz, 1994 (Appendix D2).

Because many of the percentage estimates were small, asymmetric confidence intervals were calculated using the logarithmic transformation (Kleinbaum, et al., 1982) as described in Section 2.0.

4.0 AVERAGE IQ DECREMENT

Data from Phase 2 of NHANES III were combined with an estimate of the relationship between blood-lead concentration and IQ decrements based on Schwartz, 1994 (Section 4.4 and Appendix D2) to construct estimates of average IQ decrement. Estimates of this population characteristic were constructed assuming that blood-lead concentrations are lognormally distributed and that the relationship between blood-lead concentration and IQ score decrements is linear:

$$Average\ IQ\ Decrement\ = \ m * e^{(LGM + LGV/2)} \quad \textbf{(9)}$$

where m is the slope of the assumed linear relationship between blood-lead concentration and IQ score decrements and LGM and LGV are the weighted arithmetic mean and variance of the log-transformed blood-lead concentrations, respectively.

The standard error of average IQ decrement, necessary to calculate a confidence interval, was calculated using a first order Taylor series approximation and estimates of the variability associated with the values of GM, GSD, and the slope factor m. Thus, confidence intervals presented include sampling variability from NHANES III data, as well as variability associated with the blood-lead concentration-IQ decrement relationship.

Assuming independence between LGM, LGV, and m and using the first order Taylor series approximation to equation (9), the variability associated with estimated average IQ decrement is

$$var(Average\ \ IQ\ \ Decrement) = e^{2*LGM+LGV}\left(var(m) + m^2 * var(LGM) + \frac{m^2}{4} * var(LGV)\right) \qquad \textbf{(10)}$$

The variance of LGM was estimated in SUDAAN to account for the complex survey design employed in NHANES III. The variability associated with LGV was estimated as described in Section 2.0 of this appendix. The variability associated with m was assumed to be 0.041, based on the meta-analysis described in Schwartz 1994 (Appendix D2).

Confidence intervals were constructed using the t-distribution with degrees of freedom approximated by one less than the sample size.

5.0 INDIVIDUAL RISKS

Upper confidence bounds on the dust-lead loading which, assuming fixed lead levels in other media, controls the percentage of children with blood-lead concentrations greater than or equal to 10 µg/dL due to exposure at these levels, were calculated and presented in Section 5.3 (Tables 5-6 and 5-7) of the risk analysis. The method used to calculate these upper confidence bounds accounts for the variability associated with estimating the parameters of the Rochester multimedia model, which was used to estimate the dust-lead loading.

The method is presented for the example of predicting the floor dust-lead loading which, assuming fixed lead levels in soil and window sill dust, controls the percentage of children with blood-lead concentrations greater than or equal to 10 µg/dL to no higher than α%. This floor dust-lead loading was estimated as

$$PbF = e^{[\ln(10) - \ln(1.6) * \ ^{-1}(1-\alpha/100) - \beta_0 - \ln(PbS)*\beta_{soil} - \ln(PbWS)*\beta_{windowsill}]/\beta_{floor}} \qquad \textbf{(11)}$$

where $^{-1}$ is the inverse normal transformation, PbF is the floor dust-lead loading, PbS is the soil-lead concentration, PbWS is the window sill dust-lead loading and the β's are estimates of the coefficients for the Rochester multimedia model (Section 4.2.3). The variance of PbF was calculated using a first order Taylor Series approximation, considering the covariance between the parameter estimates from the Rochester multimedia model:

$$var(PbF) = PbF^2 [\frac{1}{z^2} var(y) - 2 * \frac{y}{z^3} * cov(y,z) + \frac{y^2}{z^4} * var(z)] \qquad \textbf{(12)}$$

where

$$y = \beta_0 + \ln(PbS) * \beta_{soil} + \ln(PbWS) * \beta_{windowsill} \qquad \textbf{(13)}$$

z = β_{floor}, PbS is the soil-lead concentration, and PbWS is the window sill dust-lead loading. Approximate 95% upper confidence bounds for PbF were then computed as

$$PbF + 1.65 * \sqrt{var(PbF)} \qquad \textbf{(14)}$$

In the same manner, this approach was used to calculate upper confidence bounds for the window sill dust-lead loading which controls the percentage of children's blood-lead concentrations greater than or equal to 10 µg/dL, assuming fixed soil-lead concentrations and floor dust-lead loadings.